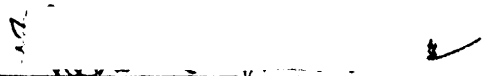


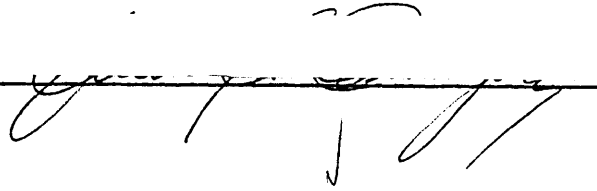
PLANNED INDUSTRIAL DISTRICTS  
AS A TOOL FOR  
INDUSTRIAL DEVELOPMENT  
IN PUERTO RICO

by

Luis M. Rodríguez Lebrón  
B.S., University of Puerto Rico (1950)

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Head, Department of City and Regional Planning

Author 

A B S T R A C T

Accelerated industrial development, as a part of a balanced development program is one of the most pressing needs of the Puerto Rican Economy. The basic purpose of such development is to raise the levels of living in the economic and social aspects of life. The effectuation of this goal has been undertaken by the government. At present, it is embarked in a large industrial promotion and development program for attracting new industries.

The author recognizes the need for a program of advanced industrial planning and estimates that the planned industrial district idea can be a major tool to guide and accelerate in an efficient way the course of industrial development.

The desirability of planned industrial districts are at present well understood in the United States and Europe. This paper, within the limitations of a thesis study, attempts to investigate the desirability of this type of development for Puerto Rico. The desirable characteristics and requirements that should guide the establishment of an industrial estate are discussed and its physical design advantages over a recent and partly developed industrial area are pointed out.

Emphasis on this paper has been placed on the physical design characteristics and requirements of the industrial district rather than on its effectuation or administration. This is attained through the study of those factors which influence the location and design of a planned industrial district in a selected site. Thus, the main subject matter of this paper is a plea for better design of industrial areas or a criticism of the policy of industrial areas development in Puerto Rico.

The author estimates that this type of development is completely feasible for Puerto Rico and believes it is a promising and interesting subject for further and more detailed studies because of its potentialities for creating a well-planned, successful, and modern industrial plant for the Island.

Thesis Adviser

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Louis B. Wetmore  
Visiting Professor  
of City Planning

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## Purpose of the Study

Rather than waiting to provide promotion, technical, and marketing assistance until enterprises are started, integrated groups of manufacturing activities should be planned in advance.

Recognizing the need of such a program of advance planning to guide and accelerate the course of industrial development, this paper, within the limitations of a thesis study, examines the desirable characteristics which should guide the establishment of a planned industrial district on the Commonwealth of Puerto Rico.

The main purpose is to study those physical factors influencing the location and design of a planned industrial district; being the conviction of the author that this type of organized and integrated development can be a major tool for the development of an efficient, well-planned, and coordinated industrial location program on the Island.

### Scope and Limitations

For its development, the paper is divided into three parts: the first two are almost introductory, stating the nature and background of the problem, the urgent necessity for an expanded program of industrialization as a part of a balanced development program, and the basic elements of the industrialization program. The last part deals with the role of the planned industrial district in the program.

This part is especially concerned with the selection of a site, according to the type of industry selected, for the design of an industrial district as a sample study of this type of development. The basis for this selection are the industrial areas proposed in the future land use scheme of the Master Plan for the San Juan Metropolitan Area.<sup>1</sup> The planning of the selected area is materialized through the preparation of a sketch master plan indicating the different land uses and other important physical characteristics.

The author recognizes two main gaps in the development of this paper. First, the lack of a detailed analysis for determining the regions for the location of economic activities in the whole Island; and second, the lack of a detailed study for determining the desirable type of economic activities to be located in the selected regions.

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<sup>1</sup> See figure# 1.

Although the writer is aware of the potentialities of other regions of the Island for industrial location, and of the fact that the decentralization of employment opportunities outside the San Juan Metropolitan Area is a requirement if heavy population concentrations, which may convert the Area in an urban monster, are to be avoided, there are two strong factors influencing the selection of the Area for the pilot study. These are: (1) the obvious recognition of the Metropolitan Area as a main regional industrial center and, (2) that to assure a fast workability and acceptability of this type of development in Puerto Rico, it should first be developed within the Area.<sup>2</sup>

It appears that this subject of the location of economic activity in Puerto Rico offers excellent possibilities for future study. For instance, studies pointing out specific regions and sites for industrial location on an island-wide basis and the relation of these to other fields of investigation which may stem out, such as population movements, housing needs, development of new towns, transportation problems, provision of the required utilities and facilities, and so forth.

Also, a forecast of the types of desirable industrial activities to be located in the whole Island is a promising field of research and would be very valuable, making the pilot study more realistic.

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<sup>2</sup> This is fully discussed on Part III, Section "The Site."

However, for the purpose of this paper, and due to the limited scope of the report and to the limited knowledge of the author in the field of industrial location, no detailed study or analysis is made of this nature.

The industries to be used in the pilot design fall under the light industrial classification and are selected from previous studies on the subject.<sup>3</sup> It should be made clear that heavy industry or a combination of light and heavy industrial activities were not investigated in connection with this problem because the activities within the heavy category require much more special and careful consideration in their selection than can be devoted in this paper. This is due to the fact that most of them constitute those core, complementary, and integrative industries whose location in the Island is a prerequisite for the establishment of other manufacturing enterprises. Also, most of the land proposed within the San Juan Metropolitan Area for heavy industrial activities is at present limited by natural barriers and will involve expensive and long-term improvements to make it available.

It is hoped that the considerations used while selecting the industries to be planned for would not affect adversely the results, fruitfulness, and realness of this paper, the reasons being that the author understands that because of the nature of the light industrial category, the physical requirements among plants do not vary too

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<sup>3</sup> Walter K. Joelson, "Suggestions for a Planned Industrial Program", 1952.  
R. L. Mier, "Added Thoughts on Master Planning for Industry".

widely. In other words, that the type of light industrial activities selected would not make much difference regarding the end product; that it can be considered a requisite in modern land use planning the need of bringing light industrial activities near home, for which purpose the organized industrial district is an effective method in guiding this type of land use allocation; and, that a part of the labor force should be spread among many small manufacturing activities rather than being concentrated in one or two large plants so as to give a safeguard against over-sensitivity to economic fluctuations.

PART I  
NATURE AND BACKGROUND  
OF THE PROBLEM

## Introduction

Puerto Rico is a Latin American country consisting of good citizens of the United States. It is united to the north by fraternal political ties, to the south by fraternal racial and historical ties, and to both by the cultures flourishing and mingling upon its soil.<sup>1</sup>

Like so many other places, the Island is underdeveloped. Its problems are grave and may be common to some other places in the globe, but with the difference that in Puerto Rico these are being tackled with confidence and in a determined and effective way which apparently is bringing successful results. There is a great spirit of building and pioneering and pride in accomplishments to date.

Puerto Rico is a crowded island. It has an average density of 668 persons per square mile and approximately 2,285,000 inhabitants. But from an economic point of view the population density is not so important as the relation of the Island's population to its meager resources which provide a weak base for the support of its large and rapidly growing population.

The primary resource is and has been its hard-worked soil. It is the foundation upon which the Island's economy was built and unfortunately it furnishes a narrow base. The people are, of course, the island's greatest resource and the most underdeveloped and unemployed. Puerto Rico's present crowded conditions are the result of an extremely fast population growth. As is typical of fast growing populations,

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<sup>1</sup> Governor Muñoz Marín, "A people Moves Ahead", U. S. Information Service, Dec. 1950.



children of preworking age make up a large proportion of the total population. This means that fewer productive workers must support economically more-non-productive persons than is the case in areas with a more stabilized population. The present age distribution emphasizes the difficulty that Puerto Rico must face in raising its levels of living if its population continues to grow at the rate at which it has been growing. It also means that for the next generation and more, a very large number of new workers will be continually entering the labor market.

The Puerto Rican economy will have to develop a much broader base than it has at present if it is to absorb this stream of new workers.

#### An Unbalanced Agricultural Economy

At the beginning of the 1940's decade the people in the Island, under a new leadership, undertook the task of transforming their economy from an unbalanced and disorganized agricultural one to a balanced economy that may provide the means for achieving higher standards of living.

According to Dr. Harvey Perloff, "The Puerto Rican agriculture faces a number of interrelated problems. First, the scarcity of land, with soils generally low in productivity and depleted by many years of constant use. Second, the pressures of a rapidly growing population, and third, the fact that the Island's climate and soils, together with the arrangements of the United States tariff, have forced it to grow crops which can be produced at lower costs by other countries whose land is more fertile and cheaper, whose labor rates are lower,

and which have land available for expanding production. An economic structure which is too dependent upon political arrangements is, however, in a precarious position. The keynote to the establishment of a firmer foundation is diversification and maximum efficiency. Under the particular circumstances in which Puerto Rican agriculture finds itself, it can achieve for the Island a degree of stability and security only by employing the most effective type of land use planning and by becoming a model of efficiency in farm management."<sup>2</sup>

The limitations of the natural resource base, together with the directing influence of the United States tariff, had turned the Puerto Rican economy into an essentially one-crop, one-industry economy: sugar cane. But total output and income grew at a fairly rapid rate during the first three decades of American rule. Unfortunately the economic expansion was outpaced by the growth in population, and the gains in total income were consumed by the increases in the number of consumers.

It was clearly recognized that the available land could not support many more people and that, while long-run influences might diminish the rate of growth of the population, there would be a substantial increase in the labor force for many years to come. The provision of alternative sources of employment, primarily industrial employment, was therefore recognized as the most pressing need of the Insular economy. Fortunately, agricultural development was not disregarded and it was accepted that agriculture is still the main-stay

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<sup>2</sup> Dr. Harvey Perloff, Puerto Rico's Economic Future, The University of Chicago Press, Chicago, Illinois, 1950.

of the Puerto Rican economy and it must have a central role in a balanced development program of economic development. If the goals for the Island's economy are to be achieved, agriculture must continue to provide employment for a large share of the labor force and a substantial portion of the increase in income.

In accordance with this determination, it was recognized that to offset the prospective reduction of employment in sugar cane activities and to increase the stability of agricultural production and employment there should be a great expansion in other crops and animal products. This higher production could only be achieved through the use of more efficient methods, and improved system of marketing, and the establishment of processing facilities. Also low costs of production, steady supply, standardization, and good presentation of products are all necessary for expansion of local sales and capture of a share of the mainland market.

The job of promoting diversification and a large expansion of the agricultural pattern of the Island is difficult and complex, especially because much of the expansion must take place outside the present familiar and known methods in Puerto Rico. It must be accomplished, however, because agriculture is still today, and probably will be for a long time, the foundation of the Commonwealth economy. It will also stimulate industrial development, providing a sound basis for further economic growth.

In carrying out this agricultural development program, coordination

and integration between the agricultural agencies and industrial development agencies should be sought and is a required element of the program. When the two programs are planned and operated together they give each other mutual support and strength. Expansion can then be both rapid and lasting.

#### Government Policies for Development

During a number of years the new leadership in government had been implementing a series of programs and activities which had modified greatly the political, social, and economic aspects of Puerto Rican life and are setting gradually the foundations for a balanced development program.

The first of these activities is what might broadly be termed social reform and is concerned essentially with just distribution. The land is being more equitably distributed and the first proportional benefit farms, the small owner-operated family farms, and the subsistence plots were established. Other measures were aimed at preventing abuses and bringing about a more uniform distribution of income. The eight-hour law was improved, and the principle of minimum wages was initiated. The tax burden was redistributed so that those farther away from poverty would pay higher taxes for the general welfare of the whole Island.

A second feature is the continuing improvement of the public services and facilities, both to lay the foundation for economic expansion and to encourage social progress. Electric power and water

supply facilities are being greatly expanded; transportation, communication and sewerage have been made the concern of separate governmental agencies. A substantial part of the public budget is being devoted to the expansion and improvement of education and other community facilities; and a large-scale slum clearance and public housing program has changed the living conditions of many families.

A third and central aspect of the over-all program is the direct promotion of economic development, the attempt to enlarge sources of income and employment through the creation of new industries and economic activities, the improvement and expansion of the resource base, and an increase in investment and productivity.

Summarizing, the planned development program of Puerto Rico has been geared toward coordinated and integrated programs of rationalized agricultural and industrial expansion as sources of employment opportunity and economic activity and the achievement of population equilibrium in its relation to other production factors, the basic goal being the provision of a permanently improved level of living.

The program consists of four fundamental goals, to be attained by 1960.<sup>3</sup>

1. Reduction of unemployment to five per cent of the total labor force, i. e., to a level where only fractional unemployment would exist. This calls for the creation of around 200, 000 new jobs during the present decade.

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<sup>3</sup> Dr. Rafael Pico, "Puerto Rico: Its Problems and Its Program"; The Town Planning Review, Vol. XXIV, July 1953.

2. A three -fold increase in real production. The accomplishment of this goal would edge production up to a level of about \$2,500 million by 1960.

3. One hundred per cent increase in average production per worker. Augmented productivity will have to account for most of this increase.

4. Increased annual family income to a minimum of \$2,000. Government basic services would be considered as income in this connection. This goal presupposes an acceleration of government services.

PART II

INDUSTRIALIZATION AS A PART OF A BALANCED  
DEVELOPMENT PROGRAM

### Planning Board's Participation

A planned development program is a lot more than attracting industries through promotional activities and the like. In the planning and performance of this kind of program a balance should be obtained among the different governmental and private activities not simply for raising the economy but to raise the standard of living of the people for longer life, higher income, better nutrition, more and better homes, and higher educational achievements.

At this point is where the Planning Board plays an important role. Not being a direct development agency, the Board is concerned with the coordination and integration of a balanced development program and making clear the industrialization program is just a part of an ever widening program of development throughout the Island.

The Board occupies a strong position within the administrative structure of the Commonwealth Government. It acts as a staff advisor to the Governor and Legislature on matters of economic and social development and fiscal policy. It coordinates and integrates the developmental activities of the government departments and public corporations within the framework of policy set by the Governor and Legislature. In other words, its responsibility is to give such recommendations and guidance to the different development agencies and private enterprises so as to create a balanced development "climate."

It looks as if one of the real great achievements of the Board is the planning and recommendation of the different services and



facilities which are so badly needed to obtain a development atmosphere. As put by Dr. Picó,<sup>1</sup> "The content of a balanced development program, which should be the goal of a good system of priorities, is not properly defined by the single word 'production.' It is considerably more difficult of definition. The question is not one of public services versus production, for both are parts of the same picture. The real question is how much of what services are essential for production and attracting investments and how much of what kinds of services represent unessentials. Planning's basic role is to determine this ideal balance and try to obtain it."

Basic Elements of the Industrialization Program

Knowing the urgent necessity for an expanded program of industrialization as a part of a balanced development program, the government established clearly its intention to carry through such a program by the creation of industrial development agencies.

The sources of private investment were too reluctant to provide the desired rate of industrialization. It was determined that until the desirability of Puerto Rico as an industrial center has been established more securely, the government would provide factory buildings, credit, and means of off-setting the generally high costs of establishing enterprises on the Island through a program of capital investment and subsidies. Influencing the direction of industrial development toward the outlined and desired goals of the

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<sup>1</sup> Dr. Rafael Picó, "The Role of Planning in Puerto Rico," The Annals of the American Academy of Political and Social Science, Jan. 1953.

Island will also be obtained from these promotional activities.

In 1942 the government created the Industrial Development Company for the purpose of opening up new manufacturing opportunities and to point the way for private enterprises. The industrial program under the Development Company and, since 1950, under the Economic Development Administration<sup>2</sup>, has played a big role in the increase of industrial employment in the Island, and has contributed substantial know-how to the problems of industrialization.

At the beginning of the program the operations were oriented largely toward the construction and operation of manufacturing subsidiaries. The operation of these industries provided constructive experience. Although the operations of the Company were never objects for political controversy, government orientation regarding wages to avoid political repercussion, did influence the administrative policies of the Company in these factories. This contributed in the long run to difficulties in putting the manufacturing subsidiaries in a profitable operation, thus limiting earnings for reinvestment.

Beginning in 1948 the efforts of the Development Company were directed to attract mainland investors, and to the construction of facilities for sale or lease, to aid in this effort. Two main

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<sup>2</sup> In 1950 the mechanics of the industrial development were reorganized. The Economic Development Administration was created as a regular department of the government. The Administration was vested with the powers of the Board of Directors of the Industrial Development Company, which thus became in essence a corporate subsidiary of the Administration.

reasons were responsible for the directing of the industrial development policy on attraction of continental firms. One reason is that each mainland firm is likely to be a fairly complete package containing its own market, its own production know-how, and some capital of its own. This means that once they are established they are in a position of making a rapid contribution to the Island's economy. The other reason is the lack of familiarity with manufacturing in the local business community and the decided preference of businessmen for commercial and real estate investment. Actual private construction of industrial plants is small and has shown little increase. Although it appears that the policy of attracting mainland firms is soundly based, it is clear that the industrial development program is suffering from a serious shortage of private investment.

The industrial program today is successful but not enough for helping to accomplish the set goals. Because of this, higher industrial objectives must be set. In order to achieve this, the Bureau of Economics and Statistics of the Planning Board, in its 1951 Economic Report to the Governor, outlined three major recommendations to increase the power of the industrial development program and its capacity to make the greater possible contribution to the economy. The recommendations go along the following lines: the expansion of the existing program, which already has a good record within limited scope. This involves primarily an intensified promotion and service program to attract mainland firms. The two other

recommendations are aimed to greatly broaden the scope of the whole program. First, it is proposed that internal economic and industrial engineering research be directed to planning and blueprinting industrial complexes that can be successfully established in Puerto Rico as entire entities; second, it is proposed that a promotion, service, and incentive program parallel to that now aimed at attracting mainland firms be directed toward the attraction of local investors and businessmen. This recommendation was made in the light of the comparatively large amount of Island's funds that have been flowing into trade and banking. These three recommendations do not envisage separate operations; on the contrary, they should be completely merged in operation.

The development of an intensive economic and industrial engineering research program for planning and blueprinting industrial complexes is the most sound and important recommendation; the other will just be complementary functions to this program. This is true in the light that lack of integration is the most basic weakness in the industrialization program. The bulk of the sponsored plants are neither a source of supply nor of demand for other local industries. They do not contribute to the chain-reaction growth which constitutes the internal dynamics of a modern industrial economy. New core industries should be established which should lead to research into the ~~satellite~~ plants that can be established, rounding out the complex.

As complement to the above-mentioned program, certain basic elements of industrialization should be attained. They were pointed

out by Dr. Harvey Perloff<sup>3</sup> as the following:

1. Keeping the prices of the basic commodities as low as possible-by lowering the cost of farm production through improvement in techniques; by reducing transport, handling, and marketing costs through measures which encourage greater efficiency; and by lowering consumption taxes--so as to release a maximum of consumer income for the purchase of locally manufactured goods.

2. Developing a skilled industrial labor force.

3. Providing adequate and cheap power and transportation facilities, as well as water for industrial purposes and good industrial sites.

4. Encouraging the largest possible volume of savings, consistent with the fulfillment of basic consumption needs, and the channeling of savings into productive investments.

5. Providing for a broad share of the risks involved in establishing new industries, through direct public investments and public aids to private risk-taking enterprises.

6. Making of an aggressive search for new extensive market outlets for locally produced goods and, once obtained, making an effort to retain them by maintaining quality of production and establishing effective marketing organizations.

7. Protecting new industries from unfair competition through the enforcement of antidumping provisions and through subsidies.

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<sup>3</sup> Op. cit. page 3

8. Encouraging continual research in new products and new processes.

9. Developing good labor-management relations and an institutional framework conducive to the expansion of industry.

PART III

THE ROLE OF THE PLANNED INDUSTRIAL DISTRICT

### Introduction

After the desirability of industrialization has been established as a leading part of a balanced development program, it looks as if the industrial program is moving into a second stage where the need arises of being more selective about the new industry which is going to be developed. At this time, the considerations which a community should have in mind while developing a program of attracting new industry, deserve a lot more attention.

In general the most important characteristics of the new industrial activities from the point of view of the Puerto Rican community are: stability, productivity, capitalization, integration, and diversity. By stability is meant willingness and tendency to remain in the community where established; by productivity, the ability to utilize a great amount of labor and pay fairly high wages; by capitalization, as a contributor to the two proceeding features and giving the plant a stake in the community; by integration, contributing to the chain-reaction growth of other plants; and by diversity, the ability to give the community a number of sources of income, which would not all be equally affected by adverse political or economic conditions or technical changes.

One of the main problems of the policy of industrialization is to bring the decision influencing investment into the line of the needs and requirements of the community. Also, there is a need for review of the basic policy of geographic location of industry so as to resolve arising problems of labor, conflicting



interests of individual communities, businessmen, and the long-range physical planning objectives of the Planning Board.

In developing a planned approach of this type, the organized industrial idea deserves special consideration as the advantages of this kind of development are of substantial importance to the community, the industrial entrepreneur, and the employee.

The planned industrial district idea is not a new one. It dates back to the 19th century in such countries as Great Britain, Germany, Holland, and the United States. In the United States, the railroad companies have been the motivating force behind the development of many industrial districts as they are potential freight producers. Their development has been of increasing importance as communities became aware of the fact that they are a major tool in promoting a sound economic base and in guiding a proper allocation of land uses. Also, the present trend toward the increase of land area per worker and the industrial dispersion and redevelopment programs are important factors which induce their development.

Defining a planned industrial district, it is a suitably located tract of land which has been developed and, at least, partially improved according to a comprehensive plan, and which is promoted for industrial use by a sponsoring, managerial association. According to their organization and features they may be classified two ways into the following different types:

A. Method of land disposition:

1. Those where improved sites are sold or leased.
2. Those where buildings are erected by the district developer or by the site purchaser and then are either leased or sold.

B. Kind and purpose of developer:

1. Those developed by railroad companies and the site restricted to those industries which are freight revenue producers.
2. Those which are developed by a local community group-- such as a chamber of commerce, a municipal government, or a port commission; for the purpose of assuring a sound economic base to their community.
3. Those which are developed in conjunction with a planned residential community as in the British New Towns.
4. Those which are developed by speculators or investors with none of the above motives, merely to make money.

The development of a comprehensive industrial district includes real estate, building, financing, installing of utilities and services, maintenance, and servicing functions. Some of these servicing functions may be provided in a commercial basis, such as: fire and public protection, street cleaning, public warehousing, landscaping, architectural control, street lighting, banking, and social and recreational facilities.

As said before, the advantages of industrial districts in an organized basis are very real to the community as a whole, to the

industry, and to the employee. They serve the community as a means for guiding industrial growth by dividing industrial activity into several suitable and desirable locations which can be better controlled and served, contributing to the provision of stability among industries and consequently a sound economic base for the community, This results in a reduction in cost of extending utilities and other community services. Furthermore, it will eliminate the complaints of residential property owners which always arise in the case of scattered, single locations. These planned areas are not only aesthetically pleasing, but are conducive to superior working conditions and result in uncongested freight and traffic movement. In the case of Puerto Rico they may prove very helpful in the establishment of integrated industrial complexes. The district also provides the community with a means of preserving suitable and attractive land for industrial use and a possible workable pattern for the redevelopment of blighted areas.

From the viewpoint of prospective manufacturers, they are spared the many worries attending a search for a site. It provides land or buildings immediately available with all the facilities and services required, thus representing for them a saving in time and expenses. Another advantage deals with financing--many industries would prefer to pay an annual rent (tax deductible as a cost of doing business), and use all their capital to finance productive operations, rather than to tie up substantial capital in ownership of land and buildings. Also, the developer of the planned industrial

district is presumably a pro, while an industry (moving only once in many years) is an amateur at land development. These considerations are of great importance for new industrial enterprises moving into Puerto Rico and for local investors going into business.

For the employee it provides a more pleasant environment for work and a lot more facilities and services in a communal basis, such as club facilities, dining facilities, meetings and forms of recreation, which could not otherwise be provided by separate industrial plants.

Although, some of the discussed characteristics are found in those industrial areas in Puerto Rico which are sponsored by the Industrial Development Company, the preceding paragraphs suggest the direct contributions that the planned industrial estate can make to the development of a better and modern planned industrial program for the Island, especially from the design and development point of view.

Because of its importance, the following sections of this paper will attempt to investigate, in more detail, this type of development through the preparation of a sketch master plan for a selected industrial site within the Metropolitan Area of San Juan.

#### Potential Manufacturing Groups

Before entering into the technical aspects of the different plant requirements, a few paragraphs should be devoted to illustrate briefly the factors influencing the selection of the possible industrial activities for the district.

The selection is based on previous studies performed by

R. L. Meir and Walter K. Joelson<sup>1</sup>, on the assumption that the core industries required for the location of the selected small light industrial plants in Puerto Rico are being established on a pre-determined schedule that form mutually servicing and supporting industrial complexes, and on the several factors justifying small plant locations in Puerto Rico, as pointed out by Dr. Harvey Perloff<sup>2</sup> and mentioned on the next section.

Joelson's study rates a selected number of industries according to labor intensity, capital intensity, wage rates, growth trends, size of plants, and transportation characteristics. The final suitability of each industry is rated.

The following is his list of suggested suitable industries, which as evaluated on a similar but much less detailed study by Meier and by the author's criterion, seem to be at present the most reliable group of light industrial activities to be located in the Island.

Apparel and Footwear

Footwear Cut Stock

Footwear

House Slippers

Leather Dress Gloves

Men's Dress Shirts and Nightwear

Men's and Boys' Underwear

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<sup>1</sup>Op. cit. page iv

<sup>2</sup>Op. cit. page 3

Trousers

Work Shirts

Women's Suits and Coats

Women's Skirts

Blouses

Dresses (Unit Price)

Women's and Children's Underwear

Corsets and Allied Garments

Children's Dresses

Children's Coats

Children's Outerwear

Fur Goods

Fabric Work Gloves

Robes and Dressing Gowns

Waterproof Outer Garments

Belts

Embroidery

Fur-felt Hats and Bodies

Textiles

Cotton Broad Woven Fabrics

Cotton Yarn

Narrow Fabrics

Woolen and Worsted Fabrics

Wool Yarn

Full-Fashioned Hosiery

Seamless Hosiery

Knit Outerwear

Knit Underwear

Miscellaneous Products

Confectionery Products

Handbags and Purses

Radios and Related Products

Electronic Tubes

Ball and Roller Bearings

Ophthalmic Goods

Watches and Clocks

Costume Jewelry

Needles, Pins, and Fasteners

The industrial requirements of the selected activities are studied from the point of view of the main manufacturing groups as it is estimated, and especially for the first two groups, that for the purpose of the sample design these various types of light industrial plants within the groups do not vary greatly in their physical requirements. The estimated most important activities included in the third group, because of their miscellaneous character, are reclassified into other groups to facilitate the study of their general characteristics and requirements. These are metal goods and electric apparatus assembling.

The following paragraphs attempt to investigate in some detail

the general characteristics<sup>3</sup> of the manufacturing groups which are of potential location for the planned industrial district to be designed.

Apparel and Textile Industries - As the apparel group, most textile industries are a simple and homogenous group with no particular or very strong characteristics from the planning point of view.

The bulk of the raw materials used in the particular ones selected for establishment in Puerto Rico is hardly ever large enough for transport to seriously affect location. Their most important locational feature is the employment of a high proportion of skilled and semi-skilled female labor. Because of their harmlessness and their dependence on female labor they should be located as near as possible to residential areas. Factories in these groups are no nuisance to neighbors and no noise or foul smell are produced in the operation, thus making them suitable for light industrial areas.

They are bound to occupy simple unspecialized factories, and the amount of space needed per worker remains very constant in the different branches of these industries, so that the amount of land needed for a certain number of workers can be calculated more accurately than in other industrial groups.

In determining the size of the site it should be taken into account that any changes making these industries more automatic

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<sup>3</sup> Main Source of Reference: Gordon Logie; Industry in Towns, London, 1952.



will have the effect of reducing the number of workers for a given size of factory or weight in production and that in the past few years there has been an increasing tendency to one-story operation, thus accounting for an increase in site size.

From inspection it is determined that the textile industries suited for Puerto Rico are not among those branches for which a large supply of soft water is indispensable for production and those in which their trade wastes are often difficult to dispose of.

The apparel branches suitable for the Island, and the textile branches, are mechanized industries, thus being their main principal service electricity for power and for good lighting which is essential to the production process. Gas and water supply are secondary services needed.

It was stated in the preceding paragraphs that the above discussed manufacturing groups are not dependent at all on transportation factors for their location. But being assumed in this case their probable location in the San Juan Metropolitan Area and estimating that a great part of the raw material will be coming from the mainland, they should be located within reasonable distance and if possible in direct routes from the major port of entry to the Island, the San Juan Port.

Footwear Industry - The branches of the footwear manufacturing group suitable for location in Puerto Rico carry more or less the same general physical characteristics than the apparel and textile industries. Except, that because the intensive use of machinery their

process tends to be somewhat noisier but by no means uncontrollable as to ban them from light industrial areas, and also it employs more skilled masculine labor than female labor, although some female labor is employed in polishing and packing.

The weight of the raw materials used is small and transportation is not such an important factor in their location, but as the apparel and textile groups, a desirable location will prove to be one within reasonable transport distance from the San Juan Port because of the same reasons stated above. There are no particular service needs apart from electric power.

An integrated operation can very well be developed through the use by the footwear industries as raw material source fabrics produced by the suitable textile industries for Puerto Rico.

As the apparel and textile groups, some of the products of the footwear industries can very well develop local markets, but it is estimated that most of the production will be for the mainland markets. This consideration should be taken into account while selecting the site.

Metal Goods - The industrial activities in this manufacturing group are concerned with the manufacture, modeling, or assembling of various metals into relatively small type finished products.

It includes a wide variety of manufacturers and the feature that most of the production work consists of the manipulation of small pieces of metal means that only simple and unspecialized types of factories are needed as on the other discussed manufacturing groups.

Their most important characteristic is the need for skilled labor and the high value added by manufacturing being these extraordinary features as regarding the Island's employment goals.

The finished goods are generally valuable in relation to their weight, thus transportation is not an important factor in location. Although for some of those probable of location in Puerto Rico, because of the lightness of the finished product, good access to the International Airport<sup>4</sup> may prove desirable for shipping to the mainland.

The harmlessness of the production process in these activities justify their suitability for light industrial areas. They rarely cause any kind of nuisance, the only exception being sheet metal work and forging, which are often noisy. Although in the case of those to be located in Puerto Rico it is expected that these preliminary manufacturing services will be supplied by local foundries and metal works industries.

Generally, the utilities required are water, gas, and electricity, the later being the most important one. Also, special consideration should be given to the exclusion of dust or moisture in some of the processes involved in these activities.

It is expected that some of the industries in this manufacturing group will serve as complementary industries to new machinery operations to be established in the Island and that others

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<sup>4</sup> A new International Airport is under construction at the northeastern part of the Metropolitan Area.

will serve as well, local and mainland markets.

Electric Apparatus Assembling - The industrial activities under this manufacturing group from the planning point of view have no marked areas apart from a plentiful supply of skilled labor, mostly masculine. Nearness to a large consumer market is an **asset** but is not essential as the products are not bulky to transportation in relation to their value.

The industry uses rather small quantities of raw materials, so it is seldom affected by material shortages or strikes in supply industries. In this manufacturing group, a rapidly increasing share of components, sub-assemblies, and completed pieces of equipment are being transported by air freight. Thus, good and direct access to the new airport will be a valuable asset for this manufacturing group.

The production processes are by no means noxious and can be carried on in any unspecialized, simple type factory, being extremely suitable for location in light industrial areas. Electric power is the main utility needed and gas is used to some extent.

Employment in Puerto Rico in this type of electronic industry as of 1952 was under 1,000 persons. But, the established firms constantly are transferring the most mobile portion and the most labor intensive of their operations to the Island. Thus, in a few years, most of the plants which are established may be expected to expand from an original size of 30-50 workers to somewhere in the

range of 100-500 apiece.<sup>5</sup>

One of the biggest boosts to electronics in the Island can be the assembling of TV sets as Puerto Rico is probably a \$10-20,000,000 market for TV in the years 1953-58. This is large enough to set up home-based manufacturing which might also supply some Latin American markets.<sup>6</sup>

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<sup>5</sup> R. L. Meier, "Electronics - A Preliminary Industry Analysis",  
<sup>6</sup> Op. cit page 3

### DESIRABLE PLANT SIZES

Existing reliable literature and basic research done on the aspects of requirements and general characteristics for light industrial activities is very small. This is especially true in those aspects dealing with the average minimum size, as to the number of workers certain plants should employ to operate on an efficient basis.<sup>7</sup> The situation becomes even worse because of variations as to manpower between different firms in the same industrial branch. These variations are due to different operating policies, markets served, capitalization, and so on.

In the case of light industries to be located in Puerto Rico, it seems that the question of average plant size for a given industry will depend mostly on the objectives the entrepreneur has for establishing in the Island and especially from the point of view of the type and size of market he is intending to serve. Although, there is the fact that certain economies are attained at particular sizes and levels of production in certain given industries, and he must consider these.

Besides, experience in Puerto Rico is so small to give at present a fair picture of the optimum size for the selected industrial activities and also very little is known about the economic size of plants for different types of industries.

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<sup>7</sup> Dorothy A. Muncy, Space for Industry, Urban Land Institute Technical Bulletin No. 19, page 8.

A detailed study or survey to determine at least the desirable average minimum or maximum sizes of the different potential light industrial activities for the district is not within the scope of this paper.

Because of the above mentioned limitations an attempt is made to determine the desirable optimum sizes for plants in the district using as a basis experience in the United States, the very limited experience of Puerto Rico, and the following factors justifying small plant location in Puerto Rico, as pointed out by Dr. Harvey Perloff.<sup>8</sup>

"To those not acquainted with manufacturing patterns, especially when they live in industrially underdeveloped areas, industrialization is generally visualized as a process of building up an aggregation of huge, mass-production plants, each having thousands of employees who work on assembly lines or care for their complicated machinery. This is the popular mental image of American industry, and it is usually assumed that industrialization elsewhere must inevitably take a similar form.

"As a matter of fact, there are few mass-production giant plants even in the United States, but there are tens of thousands of small plants, each employing only a small number of persons. Studies have shown that there are only a few industries in which large plants are necessary for achieving economic production, but for many industries

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<sup>8</sup> Op. Cit. page 3

the small plant has certain definite advantages.

"For Puerto Rico, with its large volume of unemployment and the shifting of the rural unemployed to urban slums, its relatively limited capacity for saving and investing, and its low average level of purchasing power, the small plant has special importance. This is true particularly for industries producing for the home market.

"In Puerto Rico, as elsewhere, small-scale industry offers the advantages of involving small capital outlay while employing a large number of workers, of not requiring too radical a change in social organization, of permitting less investment in public utilities and transportation that would otherwise be necessary, thus involving important capital savings, and of permitting a relatively high degree of flexibility through its ability to adjust the nature and quantity of its output to local demand. In setting the scope and direction of industrialization in the Island, it is important that due consideration be given to these factors."

Experience in the United States have shown a marked tendency toward small plants operation. Of the total number of manufacturing establishments accounted for in the year 1939 only four-tenths of one percent employed over a 100 wage earners. Ninety-six and eight-tenths percent of all manufacturing establishments employed 250 or less wage workers, 91.7 percent employed 100 or less wage earners, 85.2 percent employed 50 or less and 72.4 percent 20 or less wage earners.<sup>9</sup>

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<sup>9</sup> A. C. Shire, The Importance of Small Plants in Industry (International Technical Congress), Paris, September 16-21, Pamphlet.



Of course, there is the possibility that the above mentioned figures could have been offset by the last World War. Because of this, an study of 220 factory sites and facilities which were built during World War II was investigated.<sup>10</sup> The study which covered a full cross-section of American industrial activity showed a marked tendency for the 250 to 499 employees size of plant. Nevertheless, the results of this study can not be considered representative of what may be established in Puerto Rico and especially for the district, as seven major industry groups were excluded from the survey and within these one of those expected to be located in the district. Also, the sample included a mixture of light and heavy industrial plants some of which will never be expected to be located in Puerto Rico, but it is worth rating this marked tendency in this size of plant.

As to Puerto Rico, as said before, industrial experience is relatively none and the actual industrial physical plant is too small and variable to give definite and clear cut pictures. Some activities are located in existing buildings not adapted for industrial purposes while others are located in standard typical industrial buildings, thus not giving a basis for comparison. Anyway, the available data can be used critically observing the experience in the United States as they give a basis for making a good guess to set a range for the optimum sizes of plants to be established

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<sup>10</sup> Op. Cit. page 29

in the district.

A sample survey<sup>11</sup> performed by the author in the San Juan Metropolitan Area and in other leading cities of the Island disclosed the following figures: The average employment per plant in the establishments investigated in the San Juan Metropolitan Area was about 136 and in Mayaguez City about 185.

Another sample survey performed by the Puerto Rico Industrial Development Company<sup>12</sup> which covered 17 light industrial firms established within the San Juan Metropolitan Area presented an average employment per plant of 144 employees and a median employment per plant of 121 employees. (See Appendix B.)

From the above it could be clearly observed the tendency for small plants operation in Puerto Rico and even in the United States as shown by the mentioned figures and as pointed out by Dr. Perloff. Because of this and due to the limited amount of knowledge in this

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<sup>11</sup> See Appendix - for complete figures and procedure. The survey included 18 manufacturing establishments in the San Juan Metropolitan Area and which are classified into the three manufacturing groups expected for the district and 13 manufacturing establishments in the City of Mayaguez which are classified under the apparel - textile group. Those located within the San Juan Metropolitan Area, include only brand new-buildings constructed for industrial purposes by the Industrial Development Company. Those located in Mayaguez cover a mixture of new and old buildings, may be some of them not suited for industrial purposes.

<sup>12</sup> PRIDCO: Master Planning Section, Analysis of A Selected Group of Industrial Firms in San Juan Metropolitan Area, Dec. 31, 1954. (Unofficial Report).

aspect of industrial location in Puerto Rico and even in the United States where more comprehensive and detailed studies<sup>13</sup> than this have not been able to produce such a data, and using as a basis the above mentioned results and the potentialities and characteristics of the selected manufacturing groups as outlined elsewhere in this paper, it is estimated that plant sizes ranging from a 100 to 250 employees can be considered optimum sizes for plants to be established in the district. This range will introduce the needed flexibility in the industrial district type of development, thus giving a variation in the size of sites for different choices and at the same time limiting a minimum plant size so as to avoid excessively small plants which do not contribute in an efficient way to the industrialization program, but should be provided with all services, thus, not producing an efficient economic operation.

#### The Sketch Master Plan

This sketch plan is an attempt to show how the organized industrial district can in some ways improve the design of industrial areas on the Island and help in producing a more efficient industrial operation process which will revert in benefit to the community, the industrial worker, and the entrepreneur. A comparative analysis pointing advantages of the proposed sketch plan over and already developed industrial area in Puerto Rico will follow in the ~~last~~ section of this report so as to give an idea of what the author considers the benefits of this type of development. (See figure 4.)

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<sup>13</sup> Op. Cit. page 29

THE SITE - Metropolitan San Juan is located at the North-east of the Island, facing the Atlantic Ocean to the North. Part of its coastline forms a large bay, which is connected by a two mile channel to an interior lagoon. The Area varies from a plane in the center to a swampy area along the bay and the channel and to a very hilly one towards the South.

It covers almost 76 square miles and contains nearly a half million people;<sup>14</sup> it represents, therefore, 1/45 of the area of Puerto Rico and almost 1/5 of its total population. Of the total area, only 20% is built up.

In the first sections of this paper, it was stated the conviction of the author that to insure a fast workability and acceptability of the industrial district type of development in Puerto Rico, it should first be developed within the Metropolitan Area of San Juan. The features which justify this statement can be termed as a high degree of urbanization which is being experienced by the Area and which places this section of the Island above all others. Most, if not all of the desirable elements required for the establishment of an organized industrial district are present and in a satisfactory manner.

The greatest asset of the Area is the availability of labor<sup>15</sup>

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<sup>14</sup> Projection for the Master Plan for the year 1975 estimate at one million the total population.

<sup>15</sup> The total labor force as of 1953 is 190,000; estimated for 1975 is 400,000. Of these is estimated that 120,000 will be employed in manufacturing. Source: Master Plan for the San Juan Metropolitan Area, Puerto Rico Planning Board.

within **commuting** distance from practically everyplace; also vacant land for industrial purposes is being made available through the great improvements which are undergoing the transportation facilities,<sup>16</sup> including a new International Airport and improvements in the San Juan Port. The housing needs and problems are being tackled and large private and public housing developments are under construction; the marketing facilities are being greatly improved including a new planned metropolitan market and related processing and port facilities; the grade of the utilities provided are rated the best on the Island; and the type of community facilities and related public and private services provided are efficient and numerous. For all practical purposes the Area is the most complex and important section of Puerto Rico, it is the core of the Island.

The basis for the selection of the site for the sample design is the proposed future land use scheme,<sup>17</sup> as outlined in the Master Plan for the Area. It indicates different general locations for industrial purposes. Some of them are just a recognition of the existing land use pattern, others recognize the beginning of a definite industrial trend, and still others are on purely vacant and undeveloped land.

<sup>16</sup> See figure 1- Master Plan for Major Highways and Throughfares,

<sup>17</sup> See figure 1- " " " " " " "

The selected site is among those mentioned in the last recommendation and zoned for light industrial activities. It is located on the Southern Central part of the Metropolitan Area.<sup>18</sup> Existing and under construction housing developments and a public institution surround the site by almost all its sides and is limited on the South by the proposed Metropolitan By-Pass.<sup>19</sup> It covers approximately an area of about 62 acres of land.

The size of the selected site was accepted by the author as determined by the standards and the considerations used while developing the future land use scheme for the San Juan Metropolitan Area. It is taken for granted that the proposed acreage is reasonable and big enough to produce an efficient operation in the industrial district to be designed. The author is completely aware of the relation which exists between the efficiency of operation of an industrial district and the minimum or maximum size of the tract to be used for such purposes. This involves considerations as to benefits to the industrialization program and the community, considerations as to the facilities the district can provide and afford and so on. Unfortunately this type of paper does not permit this determination as it is understood that such investigation will require intensive and extensive research in this matter, of which very little known, even in much more industrialized countries than Puerto Rico.

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<sup>18</sup> See figure -1

<sup>19</sup> See figure -2-

The selection is based on the different location factors as they are affected by the requirements of the selected manufacturing groups and the suitability of the land for industrial purposes. Briefly, the site was selected among others; first, because its immediate availability being completely on vacant land; second, because its commanding central location and accessibility after the improvements of the highway system; and third and most important of all, because of its excellent suitability for light industrial purposes and location next to low cost housing developments with a large potential manufacturing labor force.

#### Topography

Level land with good natural drainage is preferred so as to avoid big earth movements, although it is not a controlling factor. In this case, the site has a general 2.5% gentle slope going up from its Northeastern part to the proposed By-Pass on the South and is almost flat running from South to North. Two creeks border the nearby area on the east and west, and a drainage channel on the North assisting the run off and providing good natural drainage. Thus, subsoil conditions are excellent for foundations.

On the South, the site is almost on all points at the same elevation of the existing road which consequently will almost be the right of way of the proposed By-Pass.

Therefore, topographically the site is not completely regular and although some investment is involved in its preparation, it is

justified by the favorable location factors available on it. Some general land improvements were and are being carried on the North and East of the area while the surrounding housing developments are constructed.

#### Transportation

Transportation facilities are one of the prime factors investigated by a future industrialist in deciding where to locate his plant. In this case, under this heading comes: trucking, both for incoming raw-materials and outgoing finished products from and to the San Juan Port and local delivery; and employee commuting. Railroads are excluded; first, because the only existing line does not serve the port and is very inefficient in its operation; second, because the nature of the light industrial groups selected do not require rail for freight transportation being in the Area the required transport distances relatively short.

This site is so centrally located and at the North of the proposed Metropolitan By-Pass that after the completion of the Highways Master Plan, direct access to all points of the Area is achieved. Therefore, making the district available to labor commuting from all points of the Area and providing direct accesses and routes for meeting the transportation requirements of the selected activities.

Mass transportation lines at present are available up to the housing development in the Northern limit of the site and to a certain extent through the road on the Southern limit. Although,



mass transportation facilities have become less important because of increasing use of the automobile, the proposed improvements to the highway system will enable bus lines<sup>20</sup> to go through the district connecting the immediate housing development with the site and making the district available to labor commuting from all parts of the Area. This is extremely important because some of the selected industries require skilled labor which may not be available on the immediate surrounding residential areas.

The proposed improvements will bring direct access to the San Juan Port facilities and will place the district within reasonable transport distance to the International Airport, which are essentials; especially the first, to most if not all of the selected activities. Also, the location of the area fronting the Metropolitan By-Pass places the district in a position having direct routes into the different regions of the Island, in case needed, and into the different local markets within and out of the Metropolitan Area.

#### Relation to Other Land Uses

The importance of this site selection factor is dependent upon the type of industrial use expected to be allocated in the district, as some industries seek location near market areas, labor force pools, raw materials, and so on.

Labor availability is the most important requirement of most of the selected light industrial groups. The location in the discussed site makes the district available to about 150,000 people which are expected for the year 1975 to be living within a

<sup>20</sup> See figure 2

1- $\frac{1}{2}$  mile walking distance in surrounding housing developments and with an estimated 18,000<sup>21</sup> potential manufacturing workers. Also, as stated before the district is available to labor from all parts of the Area.

The type of manufacturing process and the possible effect of the industry in the environment, especially when residential areas are nearby as in this case, is very important point to take into consideration. The selected industrial groups as analyzed for their general characteristics in the preceding sections do not show any nuisance element in their process or in their industrial set-up. Therefore, the industries are very well suited for a light industrial district and the area itself is excellent for light industrial location because its nearness to residential areas which are potential labor producers and may probably shorten the journey to work for at least a portion of the community.

Heavy freight trucking will not be a nuisance in the Area because it will be able to use in a near future some of the major routes proposed in the highways improvement plan thus avoiding passing through strictly residential streets in nearby developments. Because of the nature of the light industry selected the direction of the prevailing winds do not affect the selection of the site as none of the industrial types is expected to produce bad smells or great noise in its operation.

Thus, the location of the light industrial district in this

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<sup>21</sup>For the year 1975 the Master Plan for the San Juan Metropolitan Area estimates at 12% of the total population the potential number of workers in Manufacturing. (See figure 3.)

area does not create any problem for the adjacent neighbors, on the contrary it will be welcomed because of the employment opportunities offered by it.

### Utilities

As stated before, the grade of the utilities provided in the Metropolitan Area are rated the best in the Island.

For the activities selected for the district the most needed service is electricity because its importance as a source of power. Electric power on the Island is produced and distributed by the Puerto Rico Water Services Authority, a Government Corporation. A rapid development of steam and water power generating facilities, and their integration into a completely inter-connected system, is giving Puerto Rico and its industries an ample and highly dependable source of electric power. A new modern and highly efficient steam generating station gives San Juan an additional 60,000 KW capacity. This power station is located somewhat near the district and power transmission lines are within reasonable distance, therefore, electric power is readily available to the area.

Manufactured gas and oil as service of fuel are also available and can be readily obtained if needed for some of the industrial activities. Also, bottled manufactured gas is available.

The Puerto Rico Aqueduct and Sewer Authority, another Government Corporation, controls the water systems of the Island and supplies water of good quality at reasonable costs. A recently constructed and modern plant in the San Juan Metropolitan Area is capable of

producing water of good quality for industrial purposes, although the selected industrial groups do not require heavy quantities of water. Main lines are available within reasonable distance from the site.

Availability of nearby lines for sewage and waste disposal are important for the disposal of non-utilizable by-products. In the case of this light industrial district it becomes less important, although needed, because none of the selected industrial groups show to be a heavy waste producer when analyzed for their general characteristics. Anyway, a huge and modern sewage treatment plant has been proposed and soon will be under construction for serving the Metropolitan Area. Also, a trunk sewer is available within reasonable distance from the district site.

Plant Area Requirements - Floor space per worker varies with the type of industry. In most industries the figures are nullified and not comparable because of deficiencies in degree of mechanization and storage space, inefficient manufacturing processes, plant layouts, number of stories, amount of unused space or overcrowding caused by trade fluctuations, employee efficiency and so on.<sup>22</sup>

The determination of the floor space ratio to be used for design purposes is based on what is used in industries abroad, as

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<sup>22</sup> It should be noted that more comprehensive and detailed studies than this have not been able to developed conclusive space standards by type of industry. Dorothy Muncy, Space for Industry, Urban Land Institute Bulletin No. 23, page 12.

modified according to the limited experience obtained in Puerto Rico and also trying to appraise the extent to which mechanization and other advance in technology my increase the floor space per worker.

The fact is, that the floor area required per worker is a function of technology, which varies from industry to industry and is subject to constant change. Probably an ever-advancing technology will change industrial space needs in the direction of more area.<sup>23</sup>

It is estimated that the ratio of floor area per worker will increase as a consequence of increasing mechanization in the industrial processes, of increase in training and skill of workers, which obviously increase the number and size of machines supervised by a single worker. Also, changes in production processes and new technology, probably increasing the use of heavy and bulky machinery requiere bigger floor areas which can be supplied with more economy and efficiency in one-story factories.<sup>24</sup>

Another important consideration is that all the potential light manufacturing groups for the district, because of the nature of their processes and product manufactured require simple, unspecialized types of plants.

By inspection it is found from studies of actual factories in

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<sup>23</sup> Muncy, Op. Cit. page 29

<sup>24</sup> Philadelphia City Planning Commission, Industrial Land Use Plan.

England<sup>25</sup> that most light industries and especially some pertaining to the selected manufacturing groups vary from a ratio of 150 to 250 square feet per worker. Similar figures are obtained from the study mentioned in the preceeding section where most light industries and some of those which form part of the selected manufacturing groups vary from a ratio of 150 to 250 square feet per worker.

Surveys performed in Puerto Rico disclosed the following figures. A survey performed by the author in the San Juan Metropolitan Area and which included six manufacturing plants in the electric apparatus assembling group, eight in the apparel and footwear-textiles group, and four in the metal goods group presented an average floor area ratio of 120, 121, and 380 square feet per worker respectively in the above mentioned groups. The thirteen apparel and footwear-textile plants surveyed in the City of Mayaguez yeilded a floor area ratio of 71 square feet per worker. Also, the sample survey recently performed by the Industrial Development Company covering 17 light industrial firms established within the San Juan Metropolitan Area presented an average floor area ratio varying from 100 to 150 square feet per worker.

It should be noted from the figures presented in Appendix A , which are product of the sample surveys performed by the author, that plant density or floor area ratio is very variable. As said before, this is due to the fact that experience is very limited and

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<sup>25</sup> Op. Cit. page 23

that so far no attention has been placed on this aspect by the different industrial concerns, as the incoming new industries locate or establish in existing buildings not adapted for industrial purposes while others are located in standard typical industrial buildings.

Nevertheless, the absence of a reliable definite trend in plant area requirements in Puerto Rico and the difficulties which have found others<sup>26</sup> in determining conclusive space standards by type of industry, the author attempts to set a range in such aspect for design purposes. This range will cover all the selected manufacturing groups. It is estimated that this procedure will not affect adversely the fruitfulness and end result of the sketch plan because independently of the type of manufacturing group, the plant requirements call for simple and unspecialized small type of plants and at the same time a high degree of flexibility in design is introduced.

Other factors such as the permanent warm climate of Puerto Rico, the fact that the industries selected are highly mechanized, and the probability that industries to be located in the Island require more space than usual because of the procedure of the raw material from the States and the distant mainland markets to be served, suggest that the ratios found in actual industries in Puerto Rico should be raised at least to meet the figures presented by actual plants in the States and England so as to meet the different

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<sup>26</sup> Op. Cit. page 29

factors and conditions prevalent on the Island. Also, this is done keeping in mind the extent to which technology might affect the actual space data.

Because of this a ratio of a 150 to 250 square feet per worker is proposed to be used for design purposes.

Coverage - Coverage or structural density is a function of the required plant size, plus allowance for future expansion, landscaping, loading platforms and necessary drives, storage area, parking, recreation, and other required services. In the planned industrial district type of development the last three items may be pooled and used by all firms in the district.

In order to determine structural coverage for the district a complete land cost analysis should be carried out; covering cost of land, feasibility of assembly and acquisition, the amount increased in costs of services and utilities per unit decrease in density, and so on. This type of study is not within the scope of this report. Thus, the feasibility of the estimated density relies on the assumption that land costs are reasonable as determined by the standard set for industrial zoning purposes in the San Juan Metropolitan Area.

The zoning regulations for the San Juan Metropolitan Area indicate a 75 percent maximum permissible coverage for light industrial activities which is estimated by the author to be too high for the case of organized industrial districts where room is devoted for the mentioned services and facilities and substantial room is



reserved to give flexibility for expansion.

Recently the Puerto Rico Planning Board and the Industrial Development Company have become aware of the need of lowering this ratio so as to promote the development of better-planned and modern industrial areas. For this purpose an ammendment to the zoning regulations is being proposed to introduce an special light industrial zone where the permissible coverage is limited to a maximum of 40 percent and the maximum permissible height to two stories, assuming they could go higher provided the total floor area does not exceed 60 percent of the total lot area. This presupposes parking facilities within the plant lots.<sup>27</sup>

Also, the tendency toward a one-story operation and all other factors working toward an increase in land area per worker suggested that the actual ratio be lowered but within the existing land limitations. It is a fact that with rising living standards, requirements for parking areas, landscaping, and facilities for health, welfare, and recreation of workers on the industrial areas will increase. Consequently ground area of plant required per ground area of factory structure will increase.<sup>28</sup>

The determination of this modern standard is the result of a sample study of site adequacy of individual site plans.<sup>29</sup>

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<sup>27</sup> From an interview with Telesforo Carrero, Director, Bureau of Urbanism, Puerto Rico Planning Board.

<sup>28</sup> Chicago Plann Commission, Chicago Industrial Study, 1952.

This study was performed by the Puerto Rico Planning Board and the Industrial Development Company in some recently established plants which are estimated to be functioning perfectly in the lot sizes located. The sample was selected at random from different established industrial areas in the San Juan Metropolitan Area and were investigated thoroughly as to the efficiency of their operation including all the facilities provided and expansion factors. A parking ratio of one parking space per each 100 square meters (approximately 1000 square feet) of floor space was considered adequate.

An attempt was made by the author to perform a similar investigation including several more plants so as to determine the trend which is being followed by the recently established industries in Puerto Rico, but unfortunately it resulted impossible. This is due to the fact that the data is not comparable in most cases because most of the established industrial plants have been located in lots containing much more area than what is really needed, because of topographical features, land assembly and acquisition procedures and so on; thus making very difficult the determination of the really utilizable land in the plant lots.

If land limitation in Puerto Rico is taken into consideration, the proposed coverage compares more or less favorably with the

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29 The author visited most of the plant sites included in the study reaching the conclusion that they are adequate and the industrial operation is efficient. Thus, the selected sample is a good base for selecting the proposed zoning standard.

demonstrated trend in the States during the last years toward more open-site designs. The results of the Detroit Land Use Study<sup>30</sup> show that the average structure density in the Detroit Area is one in five. A site of not less than five times the actual size of the plant is considered a minimum by Leonard Yaseen in his book Plant Location and a 49 percent coverage is characteristic of those industries located in the outer zone of Chicago.<sup>31</sup> Also, the results from the study related with industrial space performed by Dorothy Muncy<sup>32</sup> indicate that more than half of the examined plants have a coverage ranging between 10 and 35 percent.

In the desing of the industrial district it is the intention that the plant sites contain only the required manufacturing area, storage area, loading and unloading facilities, managerial and visitors parking, landscaped areas, and land for future expansion in case expansion in volume of business and changes in technology or manufacturing process require it. Recreation, employee parking, bus terminal, first aid station, police and fire protection, and cafteria facilities will be provided in a communal basis so as to avoid duplication of services and waste of land. Using the recommended coverage for zoning purposes as a starting point and as

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<sup>30</sup> Detroit City Planning Commission, Land Use in Detroit, 1947.

<sup>31</sup> Op. Cit. page 48 In this same report is informed that a survey of newly constructed plants in the Chicago Area revealed that the average amount of land coverage was 47 percent.

<sup>32</sup> Op. Cit. page 29.

influenced by the limitation of land available for industrial purposes, the high costs of land in the Metropolitan Area, taking into consideration that the industrial requirements call for simple, unspecialized type of plants, and that employee parking and several other facilities will be provided in a communal form, a 45 percent coverage is selected for design purposes.

Plant Sites - As said before, plant area requirements are a function of technology and are subject to constant change, therefore, the ratio of land per worker is also very variable and subject to constant change, being on e a function of the other. However, certain general factors may be expected to exert their influence for a long time to come in most industries. Some of these work toward a relative increase in area per worker, others toward a decrease.

Increased mechanization plus complementary trends toward one-story buildings and increased areas for parking, loading and handling of materials will require more space. A partial counteraction to the need for more space may be a reduction in parking requirements because increased mechanization may have a long run effect in lowering manufacturing employment and employment density. Other factors, such as better plant layout resulting in a more efficient use of available land; better scheduling of purchases and sales declining the requirements for storage; and better economic planning helping to reduce excess capacity, are working also toward a relative decrease of area per worker. But, it can be recognized that those

factors working for an increase in land area per worker really outweigh those working for a decrease.

The assumption of growing land requirements is confirmed by figures available from the recent past indicating the average amount of land used per worker in certain industrial areas of the States. A comparison of the land actually used for industry at various periods in the past in the City of Philadelphia and its surrounding area indicated a growth of about 20 percent in 14 years. In Chicago, a survey of 40 industrial firms which have recently relocated in new plants showed the following average increases:

Land Area	343%
Building Coverage	226%
Floor Area	45%
Employment	34%

In sharp contrast with the moderate gains in floor area and employment is the expansion in site and building area. It is evident that the space required for future industrial plants may be estimated on the basis of an increasing trend of more land area per worker.

The design elements so far determined from density standards and area requirements used abroad and from the limited experience in Puerto Rico give the basis for determining an average manufacturing employment density to be used for design purposes.

On the basis of the ranges established for plant sizes, plant area requirements and the recommended coverage, and presupposing

plants one story high, a minimum and a maximum plant site size was computed. The minimum plant size of .77 acre which yielded a ratio of 143 workers per net acre and a ratio of 85 workers per gross acre was arrived at using the following assumptions:

Plant Size	100 employees
Plant Area Requirements	150 square feet per worker
Coverage	45 percent

The maximum plant size of 3.2 acres which yielded a ratio of 78 workers per net acre and a ratio of 47 workers per gross acre was assumed at using the following assumptions:

Plant Size	250 employees
Plant Area Requirements	250 square feet per worker
Coverage	45 percent

For computing the gross densities in<sup>33</sup> both cases, it was assumed that net will approximately be 60 percent of gross because it is assumed that land area to be devoted for the communal facilities and the streets will occupy about 40 percent of the total district area.<sup>34</sup>

<sup>33</sup> Gross densities were computed so as to allow comparison with figures given in the Philadelphia Industrial Land Use Plan. However, the author recognizes that both gross figures may not be comparable directly because of differences which may exist on the percentage which is net of gross in both cases. Also, the author is aware of the fact that gross figures should come out from the design layout rather than being calculated.

<sup>34</sup> The area of the entire district is referred to as gross area, while net area refers to the area of the parcels actually used for manufacturing. The estimated 40 percent of the total area that approximately will be covered by streets and facilities is discussed in the next Section where the streets and the facilities are investigated in some detail so as to predetermine the amount they will cover.

The minimum and maximum plant sites produced an average of 110 workers per net acre which compares favorably with the City of Chicago where an average net overall density of 100 employees per acre of land occupied by manufacturing establishments is found. Of course, both figures are not directly comparable because the second includes light as well as heavy industrial plants and because land availability, costs and other factors are not similar, but on the absence of data for Puerto Rico it is worthwhile observing experience abroad.

The recent survey of 17 light industrial plants performed by the Industrial Development Company was used critically by the author to arrive at conclusions as to employee density in the investigated plants.<sup>35</sup> To compute the average employment density for this survey the author excluded those plants which showed an excessively small ratio or in other words, those which obviously were out of the trend marked by most of them. This was done so as to avoid misleading figures influencing the average. This misleading figures are due, as said before, to the fact that industrial plants in many cases are established in sites containing much more area than what is really needed, because of topographical figures and land assembly and acquisition procedures. In total, five plant figures were excluded from the average. The computed average showed a net density of 110 workers per net cuerda or of 114 workers per net acre. As it can be seen the determined employee density of 110 workers per net acre to be used for design purposes compares favorably with the

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<sup>35</sup> See Appendix B.

mentioned survey.

The average gross density of 66 workers per acre arrived at for design purposes is very near the standard of 50 workers per gross acre adopted in the Philadelphia Industrial Land Use Plan for industrial areas with small light industrial plants.

The Philadelphia Study determines that the evidence allows no hard and fast conclusions but that it seems to support as reasonable the assumption that about one gross acre of land is required for every 50 workers, in this type of small light industrial plants.

The Plan further indicated that the adopted standard may be compared with several districts in and out of the City. This comparison also serves to evaluate critically the computed average gross density for the industrial district to be designed and is introduced to give evidence of the difficulty of arriving at conclusions in the field of industrialization and even more in the design aspects discussed in this Section and the preceding ones.

In the City, the Plan indicates that, "17 out of 37 light industrial districts showed gross densities of more than 30 workers per acre, ranging from 32.9 for Frankford to 133.5 for the Callowhill Street district; the median for this group of districts was 61.4, with eight out of 17 concentrated in the range between 54.0 and 69.7." Outside the City it is indicated that, only eight of 41 districts showed densities of over 30 workers per acre, ranging from 31.9 in Phonexville to 82.8 in Hatboro; four out of the eight districts showed densities of less than 40 persons per acre.



The main consideration involved for arriving at minimum and maximum plant site sizes is that in order that maximum and efficient use can be made of the predetermined layout and construction of the industrial district, flexibility should be the most important criterion under which the plan is developed. This required elasticity is obtained in the sketch plan by the provision of a variation in the size of industrial sites rather than using a basic module or average plant size per manufacturing group.

On the other hand the average net and gross employee densities were computed to allow comparison with the figures for amount of land used per worker in the discussed industrial areas in the States and in some light industrial plants in Puerto Rico so as to conclude if the selected design elements were reasonable. Also, the density determinations will permit to estimate approximately the total number of workers for the district and the total floor area before the layout is designed, thus helping to determine if the assumed area for the communal facilities to be provided, especially parking, is within reasonable limits, and helping to determine the number of workers to be expected in each manufacturing group which will enable a tentative distribution of the net land acreage within the established size ranges for the different manufacturing groups, so as to introduce flexibility in the design. Also, this tentative distribution will enable the author to determine if the percentage of total land area to be devoted for streets was estimated correctly.

It could be clearly observed from the above statements that design involves a process of readjustment where the land distribution pattern is subject to minor changes from the predetermined or initial assumptions arrived at while investigating the design considerations.

#### Predetermined Land Distribution

Streets - The district is affected by recommendations of the Highway Master Plan. The proposals include: two main street 60 feet right-of-way almost bisecting the site in both ways, and a major thoroughfare, the Metropolitan By-Pass, 50 meters right-of-way (approximately 164 feet) limiting the site on the South. The first two are considered to be the principal connections and traffic arteries between the district and the adjacent residential areas; the latter, a main connection with all points of activity within the Metropolitan Area and for providing direct access, if needed, to the inland. Thus, these proposals form the external circulation system of the district and account for a share of the district area.

In the determination of how much land area approximately should be devoted to streets, consideration must be given to where the parking and loading operations are to be carried out, to adequate width of street right-of-way, adequate width of street pavement, and the suitability of the pattern and size of the block.

As provisions will be made for off-street parking as well as off-street loading, it is estimated that a width of street right-of-way of 60 feet is sufficient for secondary or service streets. This

right-of-way allows 10 feet on each side for sidewalks and combine planting and utility strips, and a 40 feet pavement which is estimated will handle successfully freight trucking and employees and bus traffic.

The selected right-of-way compares favorably with the widths of secondary streets in a group of industrial districts investigated, where pavement and right-of-way widths vary from 30 to 60 feet and from 50 to 70 feet respectively as shown in the table below. Notice that the highest incidence is on the selected standards for design purposes. This same standards are being used in industrial areas in Puerto Rico and are producing fine results.

District	:	Width in feet of
	:	Road: Right-of-way
Fairfax Industrial District .....	:	60
Trinity Industrial District .....	:	40
Clearing Industrial District .....	:	40
Airlawn Industrial District .....	:	40
Central Manufacturing District, Chicago	:	40
Peachtree Industrial Boulevard Develop-	:	40
ment .....	:	40
Oklahoma Industries Inc. ....	:	40
New England Industrial Center.....	:	40
Bergen County Industrial Terminal .....	:	30
Newton Industrial Center .....	:	29

Source: United States Chamber of Commerce, Organized Industrial Districts, page 51.

The block pattern must be designed to conserve <sup>land</sup> to permit the best arrangement of facilities and improvements, to assure maximum

accessibility, and to allow for certain degree of flexibility in lot depths to meet the requirements of the selected manufacturing groups. From investigation of most industrial districts in the States and the few designed in Puerto Rico it was found that the gridiron layout is preferred.<sup>36</sup> It is estimated that the pattern because of its simplicity and because it permits the meeting of the mentioned requirements, should be used for industrial areas always that topographical conditions allow it, although some British industrial estates are successfully adapting a curvilinear street pattern. The gridiron pattern is especially important for the district to be designed where the danger involved in at-grade rail crossings do not exist.

The size of blocks depends to some extent on the planned depths of industrial sites. It is the opinion of most district developers that a depth of about 200 feet is essential to satisfy the manimum requirements of an individual industry and that a depth of 500 feet is quite unusual.<sup>37</sup> Several organized industrial districts in the States have a variety of block sizes rening from 720 by 300 feet to 2400 by 1200 feet.

In this special case and where the minimum and maximum plant sizes are relatively small and because of the need of shallow lots

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<sup>36</sup> United States Chamber of Commerce, Organized Industrial Districts

<sup>37</sup> Ibid.

for the small factories to be established, most blocks will be only about 400 feet deep. Although, some others may be deeper, a block 400 feet deep by 100 feet long is considered as typical.

With 60 feet streets on all sides of this typical block, a ratio of street area to block area of 23 percent is established. As the block represents the area of the parcels to be used for manufacturing and knowing the approximate percentage of the total area to be occupied by the required services and facilities as determined in the next Section, it is understood that streets will occupy about 23 percent of the total gross area.

Although, it is understood that the parcels to be occupied by the services and facilities require streets, it is estimated that this will not alter too much the determined street percentage being this one only approximate.

This percentage compares very favorably with the recommendations established in the Philadelphia Industrial Land Use Plan for a district with small light plants, where streets will occupy about 23 percent of the total area. Also, experience in Puerto Rico have shown that street percentage in industrial areas vary from about 20 to 25 percent of the total area.

The minimum turning radius for intersecting service streets in the district should be 27 feet<sup>38</sup> as it has been set that the minimum turning radius for a tractor and a trailer is that same

<sup>38</sup> Andrew Watcher, the Selection and Planning of Industrial Areas, MIT thesis.

figure. Where service streets intersect the main streets on the external system the minimum radius should be 50 feet<sup>39</sup> to allow trucks and buses to make right turns and remain in their proper lanes without encroaching the high speed lane.

Facilities Served by the District - For the sample design, recreational and social facilities, employee parking, bus terminal facilities, banking, fire and public protection, first aid medical facilities, and dining facilities are provided in a communal basis. Also, landscaping services, street lighting, street cleaning, and public warehousing, can be provided as a communal service in this type of development. Shopping is not considered so as to avoid duplication of services as on the south side of the site a shopping center for serving this section of the Metropolitan Area has been already proposed and local shopping exists on the adjacent neighborhoods. The advantage of pooling such facilities is obvious from the standpoint of the quality of the services offered.

Those mentioned in the first group account for a share of land in the district. Because of this, they will be investigated to where possible, to determine the percentage of the total gross area to be devoted for these purposes.

Recreation facilities - It is argued that at the end of a workday, workers want to get home immediately and there are some doubts if employees would be disposed to use the district recreational

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<sup>39</sup> National Committee for Traffic Safety, Building Traffic Safety into Residential Areas.

facilities unless the plant is too distant from any recreation area.

This possible attitude and the fact that most of the workers are expected to come from nearby housing developments suggest that the recreation facilities for the district should be provided for a double purpose, serving the employees, and at the same time the adjacent neighborhoods, although some of the adjacent neighborhoods have their own facilities. Of course, the administration of such a recreation program requires careful and efficient administration.

It is estimated that the recreation facilities which will be patronized mostly are those for intra-plant competition. It is expected that this type of competition will arouse both spectating and participating interest and the workers feeling to be identified with the district.

On the light of the mentioned attitudes and considerations it becomes difficult if not impossible to arrive at a fair figure of employees for which recreation facilities should be provided. Also, the number of workers which will be using the cafeteria facilities is very difficult to estimate so as to determine how much area should be devoted for these purposes. In this determination considerations such as the procedure of the workers and the habits of the working classes are very important. Unfortunately no time can be devoted to investigate this aspect thoroughly as it is considered that it is not so important for the sample design.

Because of the mentioned reasons a net land area of about 4 acres is selected more or less arbitrarily and is considered

adequate for the provision of the different types of sports which are found in a neighborhood playground plus the cafeteria building where the indoor recreation and club and meeting facilities are estimated can be provided also.

This 4 acres will be allocated in a single central spot where it will be accessible by foot to all the workers of the district as walking distances from any point in the district to other is always less than half a mile, which is considered an adequate walking distance for this kind of facilities, especially in the kind of weather found in Puerto Rico.

Employee Parking - It is estimated that a pooling of a facility of this kind in concentrated spots will help to avoid traffic congestion within the plant sites and the district and at the same time duplication of required drives and pavements is avoided with a consequent saving in construction expenses, maintenance, and land space. The all-year-round warm climate of the Island enables employees to walk without any nuisance a relative short distance from the parking pools to their respective factories.

Nevertheless, limited parking facilities should be provided for managerial employees and visitors within the plant sites. In those plants where showrooms of the goods manufactured is a common practice, sufficient parking space should be allowed for the expected visitors or customers.

There are three types of off-street parking ratios commonly used in organized industrial districts; percent of main shift



employment, space per number of employees, and space per square feet of floor area. It is recognized that the ratio stating space per number of employees is assumed to be the most convenient as most of the results of studies on existing industries are given in this way, and the ratio of space per square feet of the floor space per worker varies with the type of industry.

In this case where the gross average density for the district has been computed on the basis of an assumed percentage the net area will be of the gross area, is advisable to use two ratios to arrive at the amount of land needed for parking purposes. These are: space per number of employees and space per square feet of floor area.

Using the assumed 60 percent that net will be of gross and knowing that the total district covers an area of 62 acres, the area of the parcels to be used for manufacturing is 37.2 acres and the land area to be occupied by plants at a 45 percent coverage is 16.7 acres. Using as a reasonable parking standard the ratio of one parking space per each 1000 square feet of floor areas determined by the Planning Board and the Industrial Development Company,<sup>40</sup> about 730 parking spaces will be required.

<sup>40</sup> This ratio was established for zoning purposes by the above mentioned agencies after a careful study of site adequacy including parking requirements and other facilities in different established firms in the San Juan Metropolitan Area. This same study is mentioned in this paper in the Section dealing with coverage.

For the purpose of checking and readjusting the determined parking figure, the space per number of employees ratio will be used. A study performed on existing industries shows that parking standards are high in all distance zones from the business district.<sup>41</sup> Even in the five-mile zone, three-fourths of the plants provided one or more on-site parking spaces for every 3.4 employees on the combined major and second shifts. This is equivalent to one space for every two workers in the major shift. These results suggest that parking standards are not too dependent on urban locations as expected.

Of the plants included in the same study, 85.1 per cent provided at least one parking space for every two employees in the major shift. At present in some existing districts in the States the standard of one parking space per each three employees is considered no longer adequate.

For calculating the required employee parking area for the district it is assumed a standard of one space per five employees is a reasonable one. This might look a little high as compared to experience in the United States and where the car ownership ratio is one car per four persons as compared to car ownership in Puerto Rico of one car per approximately 25 persons. But, the present car ownership ratio in Puerto Rico is estimated will continue rising as income levels go up, thus accounting for an increase in workers driving to work.

Also, this standard compares very well with the above used

<sup>41</sup> Op. Cit. Page 29.

of one space per 1000 square feet of floor area, as according to the established range of square feet per worker the average is 200, thus the same being equivalent to about one parking space per five employees.

On the basis of the selected standard and using the assumed gross average density of 66 workers per acre, about 800 parking spaces should be provided. As seen both figures are relatively close and being both of them obtained through assumptions it is appraised that the highest one should be used for design purposes, in this way introducing also, a safety factor.

Therefore, about 240,000 square feet or approximately a net land area of 5.5 acres are needed to accommodate the estimate number of cars using a 300 square feet per car parking space standard.<sup>42</sup>

Other Facilities - As said before, bus terminal facilities, banking, fire and public protection, and first aid medical facilities will be provided in a communal basis.

The determination of the area to be dedicated for fire and public protection services is based on what is recommended for master planning purposes in Puerto Rico.<sup>43</sup>

<sup>42</sup> It is estimated that this 300 square feet includes the service drives and other facilities of the parking area.

<sup>43</sup> Puerto Rico Planning Board, Recommended Procedures and Standards for the Preparation of General Plans.

Standards developed for community facilities in Puerto Rico recommend for cities of 50,000 people or over, the allocation of a central fire and police station, and if necessary, the allocation of local fire and police stations to serve distant areas from the central station, especially distant industrial or commercial areas.

It is suggested that the fire and police protection services to be provided for the area will be provided by the government and will serve the adjacent neighborhoods, thus taking the place of the local stations recommended in the mentioned standards. Of course, the manufacturing firms will be charged for the services.

A minimum lot area of 600 square meters is considered adequate for local police stations and a fire station with two pumps will occupy a minimum lot area of 500 square meters according to the recommended standards. The above are adopted for the purpose of the sample design.

More or less arbitrarily and using the author criterion it is estimate that the bus terminal will cover about 1000 square meters so as to leave enough space for waiting buses during the rush hours. In the same way it is estimated that the banking and the first aid medical facilities will cover a total area of about 1000 square meters.

Therefore, for design purposes the facilities or services mentioned in this part will cover a net land area of about 3,100 square meters or about .76 acres.

Summary - Of the total district area of 62 acres, the external streets account for about 23 percent or about 14 acres; the communal services and facilities to be provided by the district are estimated to cover about 10.3 acres or about a 16.5 percent; and the net manufacturing area will cover 37.7 acres or about 60.5 percent of the total area.

As seen the investigation in the preceeding sections determined that there is a deviation of .5 percent from the assumptions arrived at while computing the average gross density.

Thus there is no need of readjustment of the already determined density figures because this is a very minor deviation of the initial assumptions and this figures are only approximate and subject to minor changes when adjusted to fit the proposed layout.

On the light of the above mentioned considerations the following table summarizes the land distribution pattern to be used for the sketch plan design:

LAND USE	: APPROXIMATE AREA (Acres)	: PERCENTAGE OF TOTAL
Occupied by Manufacturing and related operations	: 37.7	: 60.5
Occupied by Communal Facilities	: 10.3	: 16.5
Street System	: <u>14.0</u>	: <u>23.0</u>
	: 62.0 Acres	: 100.0%

Utilities - The district should be provided with an adequate water distribution system for consumption and fire protection.<sup>44</sup> A sewer system designed to serve efficiently the area should also be provided. Adequate spacing of manholes and suitable service connections are required. Electricity for power and street lighting and gas lines as a secondary source of power are main needs.

In this case, because of the type of lot arrangement proposed with service streets on the back of each plant site, utilities should be placed on the planting strip of the street right-of-way. Usually 10 feet on each side of the street is allowed for utility lines and sidewalks. The standard practice is placing the underground water and gas lines on one side of the street with the sanitary and storm sewers on the opposite side. Street lighting, electric power and telephone lines can be placed on either side of the street. From an esthetic and functional point of view it is desirable these lines be placed underground, but its feasibility depends if this can be done at reasonable cost and justified as costs are measured against benefits obtained.

Restrictions Imposed - In order to assure and to maintain the amenity and attractiveness of the district and to provide the advantage of protection against nuisance created by undesirable neighbors, limitations are imposed by the district developer through covenants or

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<sup>44</sup> The standards of the National Board of Fire Underwriters can be of great help for determining design details such as water pressure, pipe sizes, spacing of hydrants, and so on, for fire protection.

deed restrictions in addition to zoning regulations.

Of course, the imposing of some of these restrictions may vary depending on the character of the organization of the district, type of land disposition, and purpose of the developer. A discussion covering the effectuation of this plan is not within the scope of this paper. Because of this, and being aware of how the above-mentioned factors may affect the restrictions and covenants imposed, no attempt is made to suggest the desirable ones for this industrial district. The following paragraphs give only an idea of the restrictions imposed in other districts in the States.

These may cover setbacks and distance between buildings, maximum permissible coverage, location of loading platforms, driveways, architectural plant design, utility casements, landscaping, off-street parking, control of nuisances, use of land, and others.

In the case, loading is done in the building side fronting the service street a minimum setback of fifty feet measured from the property line to the loading platform should be required so as to avoid obstruction of the street by loading trucks. In most parts the maximum length of vehicles is limited to forty feet. Also, sufficient area should be provided for waiting trucks.

Landscaping of the strips between the street pavement and the property lines of the sites is a common practice. The developer provides the basic planting as an encouragement for landscaping.

In most cases it is imposed to the entrepreneur to keep and maintain it through covenants. Also, the increasing interest of developers and manufacturers in attractive appearance through the landscaping of the site open areas, maintenance, and new plant design features, is often effectuated through the use of covenants.



Manufacturing Land Area Distribution - It is estimated that the district will employ 4,100 workers at a density of 66 workers per gross acre in an available site area of 62 acres.

The total number of workers are distributed among the different manufacturing groups according to the potentialities offered by each group for employment opportunities. This is done in a more or less arbitrary way although a lot of attention is placed on existing tendencies of industries in the selected manufacturing groups as to the type, quantity, and quality of labor employed as outlined elsewhere in this paper and in other sources of information.<sup>45</sup>

It is estimated that the textile, apparel and footwear groups will offer the higher employment opportunities because of their known high employee ratio and relative easy mobility which enables them to establish in Puerto Rico seeking labor differentials and because these manufacturing groups, and specially the apparel group, already are successful industries on the Island.

The electronics group is estimated to be next in employee density. This is justified on the light of the potentialities of Puerto Rico, as said elsewhere, for electronics and specially TV assembling.

<sup>45</sup> Specially Logie, op. cit. page 23, and Perloff, op. cit page 3.

<sup>46</sup> It is estimated by R. L. Mier, op. cit. page iv, that Puerto Rico shows a trend to become a fifth center for location of the Electronic Industry.

The last in number of employees is expected to be the small prefabricated metal goods group which is a relatively unknown industry for Puerto Rico and is assumed will have a slow start, although its potentialities for further development are great.

Based on these considerations it is estimated that the textile, footwear and apparel groups will account for 2,050 workers, or 50% of the total, the electronics group will account for 1,230, or 30% of the total, and the metal goods group will account for 820, or 20% of the total. It should be clear that by no means the author expects the percentages as stated in round figures to be accurate. But, it is estimated that for design purposes they are sufficiently reliable and reasonable because independently of the type of manufacturing group, the plant requirements as stated elsewhere in this report call for simple and unspecialized type of plants.

Correspondingly the textile, footwear and apparel groups will cover about 18.9 acres of the total manufacturing land area of 37.7 acres, the electronics group will cover about 11.3 acres, and the metal goods group will cover about 7.5 acres.

As said before, in order to attain some flexibility in the sample design, the total plant area required by each manufacturing group is distributed into different plant site sizes, rather than using only one average size per manufacturing group. This is done using the established range which varies from .77 acre to 3.2 acre, although for design purposes the round figures of 1 acre will be used as a minimum and 3 acres as a maximum, and always keeping

in mind that independently of the type of manufacturing group, the plant requirements call for simple and unspecialized type of plants so that each group may have plant sizes varying from the minimum to the maximum sizes. Also, it should be considered that, as discussed under the Section dealing with plant sizes, the trend should be toward the small plant type, thus, most plants will be approaching the minimum size rather than the maximum.

Using the mentioned assumptions as limits, the following distribution is made:

MANUFACTURING GROUP	NUMBER OF WORKERS	(ACRES) NET LAND AREA REQUIREMENTS	% OF TOTAL MANUFACTURING AREA	PLANT SIZES (ACRES)	NO. OF PLANTS
Textile, Apparel and Footwear	2,050	18.9	50	1	6
				1.5	4
				2	2
				3	1
Electric App. Assembling	1,230	11.3	30	1	2
				2	3
				3	1
Metal Goods	820	7.5	20	1	1
				2	2
				3	1
Total Number of Plants					23

The above plant sizes are approximate areas and by no means fixed. Some variations may be found in the sketch plan in order to fit them to the proposed street pattern.

Land Distribution Figures Obtained from the Layout

As said before, the predetermined land distribution figures were only approximate and subject to minor changes when adjusted to fit the proposed layout. Thus, the predetermined land distribution was computed for orientation purposes but by no means could be considered fixed or final, as necessarily design involves a process of readjustment due to certain features such as topography, existing developments, shape and size of the tract of land, and others.

From the proposed layout the following land distribution is obtained:

LAND USE	AREA (Acres)	PERCENTAGE OF TOTAL
Occupied by Manufacturing and Related Operations	40.5	65.3
Occupied by Communal Facilities	10.0	16.2
Street System	<u>11.5</u>	<u>18.5</u>
	62.0 Acres	100.0%

From the above it could be observed that finally net is 65% of gross. Therefore, the district is developed at a density of 71 workers per gross acre and will provide employment to about 4400 workers.

Advantage of this type of development

In this section, the advantages of the Sketch Plan are discussed mainly pointing out the disadvantages of an existing industrial area in Puerto Rico, developed with the guidance of the old zoning regulations, as measured by what the author considers desirable features for modern industrial areas.

The existing industrial area<sup>47</sup> is located just East of the site selected for the sketch plan. It is excellent for comparison purposes because of the similarity with the selected site in relation to adjacent land uses and highway facilities. Also, the type of industrial activities located in this area are within the light industrial category and some in similar manufacturing groups as the ones selected for the district.

Although plenty of land is available on this area for the development of a complete and integrated industrial district, it is being developed in a piecemeal way and without reference or guidance to a master plan for the whole area. This is done following the existing zoning and subdivision regulations whose maximum permissible standards at present are not oriented for this type of outlying industrial park.

The area contains about two industrial concentrations which can be identified as such and several scattered locations. In other words, the area have been developed in a disorganized way and practically

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<sup>47</sup> See figure 1.

it could be said that each tract of land has been planned without reference to the others.

It is estimated that for comparison purposes the two main developments in this area should be treated as separate industrial districts and should be discussed apart because they are entirely different.

The center district<sup>48</sup> which is the one that is fully developed with 16 lots, covers an area of about 8.5 acres. Thirteen of these lots have almost the same area averaging .34 acre, the rest have areas of .55, .72, and .80 acre. These bigger lots have been obtained from an aggregation of two or more of the small lots.

The district consists of only one block which is about 270 feet in depth in one end and about 310 feet in the other. The block length is about 980 feet, although not limited immediately in both ends by streets.

Of the 16 lots, 10 are covered with plants. The coverage varies from 31% in plant J to 73% in Plant D and most plants are in between the 55% and 60% coverages.<sup>49</sup> It could be observed from the above that coverages are not exceedingly high as compared with the adopted figure of 45% for the sketch plan, but when lots are small as in this area, these high coverages together with the lack of set backs, lack of storage space within the buildings, and lack of proper landscaping and site arrangements make the area look too crowded.

<sup>48</sup> Marked in figure 5 with number one.

<sup>49</sup> See figure #5.

No attempt is made to present a land distribution table for this district as it is estimated it will not be significant because the area is too small and because the expressway area that should be taken into account for such purposes may mislead the figures. Also, as it is very difficult to obtain employee figures for these plants because of confidential reasons, being most if not all of the plants privately established and not government aided, it was not possible to compute the average employee density in the developed plants.

As said, the above discussed district was completely developed by private concerns under the existing zoning and subdivision regulations whose maximum permissible requirements are not oriented toward the planned industrial district type of development.

As appreciated from the preceding discussion lot sizes are small, and relatively high coverages are permitted, therefore flexibility and elasticity accounting for variations in plant sizes, design and siting are absent.

From an esthetic point of view the area is pleasant to the eye because most of the plants are not constructed more than one or two stories high, although at present zoning regulations permit a maximum height of three stories, and modern designs are used. But, the crowding of structures, the lack of set-backs and the consequent lack of landscaped areas subtract a great deal to the attractiveness of the area.

A marginal service street is provided siding the existing expressway for the purpose of avoiding interruptions in the adjacent

expressway. But as loading and parking are done in this marginal street, it gets congested. Moreover, it is estimated that as the ratio of car per worker increases, as expected, this marginal street will prove not to be a reliable way of handling loading and parking, thus bringing inevitable congestion to the expressway. This problem could have been solved through the use of lower coverages so that parking and loading facilities be provided within the plant sites, although, it is estimated that communal parking facilities are more convenient for the type of district where the total area is developed by a single concern and where most sites are leased. As said before, the concentration of this facility in certain strategic spots helps to avoid traffic congestion and at the same time savings in land and improvements. In some way the firms could be charged for this service either directly or indirectly, including the charge for the service in the rent cost. Of course, this could have been done also if the overall industrial area would have been developed with guidance to a master plan or predetermined layout instead than in a piecemeal way.

Also are absent in this industrial area all those desirable services and facilities which are of substantial benefit to the employee, providing a pleasing working environment and which are provided in a communal basis in the sample design. Within the area none of the following facilities or services are offered:  
recreative and social facilities, dining facilities, bus terminal, banking, first aid medical facilities, fire and public protection.



The provision of these facilities in a central shared basis not only provide a more pleasant environment to work but its advantages are obvious from the standpoint of the quality of the services offered which could not otherwise be provided by separate industrial concerns. As said before, this type of central shared facilities are mostly possible in the type of development recommended in this paper where the total area is developed according to a predetermined layout and where proper management is exercised so as to assure that this communal facilities would be provided in<sup>an</sup> efficient way. Management could very well be in hands of the district developer, if most sites and plants are only leased, or in hands of a cooperative formed by the same plant owners in cases where most sites are sold.

The fire and police protection facilities should also be sustained by the district firms and charged indirectly. These facilities could very well serve, as said before, the adjacent neighborhoods.

It should not be interpreted from the above statements that it is the understanding of the author that the discussed communal facilities are only possible in districts developed by government agencies. On the other hand, it should be understood that central shared facilities are only possible in industrial areas where management is completely under a single body or agency so as to avoid a piecemeal development or provision of services.

The other district to be discussed is the one on the western end of the area zoned for industrial purposes.<sup>50</sup> This section is being

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<sup>50</sup> Marked on figure 5 with number two.

developed by the Industrial Development Company and so far they have produced five lots which range in area from 1.14 acres to 4.5 acres, although the lots in the southeast contain a high percentage of land which is not buildable. From Figure 5 it could be observed that coverages on the three constructed plants is low and that plenty of land is available within the sites for the different needed complementary facilities.<sup>51</sup>

Immediately it could be noticed the difference between this development and the one privately developed. Also, this marked difference in design could be observed between the other district beginning to be developed by the Industrial Development Company on the eastern part of the industrial area<sup>52</sup> and one proposed to be developed by a private concern,<sup>53</sup> where sites are small and lot depths are very short.

The total industrial area also have several scattered locations. Some of these contain in their plant sites much more area than needed while others are very well planned, like the Sylvania Company Plant.<sup>54</sup> In other words, the whole area presents a mixture of different types of industrial developments which show no evidence of one being related to the other in an efficient or proper way.

It seems that the main criticism to this partially developed industrial area is the lack of advanced planning or the lack of a

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<sup>51</sup> See figure 5.

<sup>52</sup> Marked on figure 5 with number three.

<sup>53</sup> Marked on figure 5 with number four.

<sup>54</sup> Marked on figure 5 with letter N.

predetermined master plan for the total development of the area; for which purposes the planned industrial district principle could have been a proper instrument.

The above statement means that the advantages of the planned industrial district concept are very real above and under good physical design if used as the proper instrument to layout in advance industrial areas in a comprehensive and integrative basis. What is really criticized is the policy used in the development of industrial areas.

Why not use the same policy of development used in the subdivision of raw land zoned for residential purposes where complete neighborhoods are laid out in advance so as to make all subdivisions fit and related to each other as to the needed services and facilities. Even more, why not make developers dedicate land for the needed services and facilities in the proposed industrial subdivisions.

Now that positive steps are being taken by the Puerto Rico Planning Board and the Industrial Development Company toward the setting of better design standards for industrial areas<sup>55</sup>, the experience obtained in the discussed industrial area should be used constructively to change the policy of development for industrial areas toward the production of layouts in advance.

Aside from the discussed considerations, what really marks the proposed sample design or make it different from the discussed industrial development is the provision of certain amenities which are absent in the other. The proposed district is conceived under the

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<sup>55</sup> New amendments proposed to the zoning regulations are oriented toward the industrial park type of development.

principle that the industrial area should be a lot more than a dirty place where breadwinners go to work and that at the same time the area should be so well designed and esthetically pleasing that will lead to an integration of light industries with residential neighborhoods, making the community to accept as a reality the compatibility of residential and light industrial uses.

Of course, the provision of amenities may produce higher development costs in this type of industrial areas but the economic and social gains or advantages are so much more valuable and tangible that costs differences are justified.

As said before, the advantages of the proposed type of development are very real to the community, the industrial firms and the worker. Among other discussed advantages, through the planned integration of light industries with residential neighborhoods, more suitable and desirable locations can be obtained for light industrial purposes, where plants can be better served thus contributing to the provision of stability among firms and consequently a more efficient operation which reverts in benefit to the community and the employee.

This type of development not only results in a good residential neighbor but by consequence it is conducive to superior working conditions with a more pleasant environment for work.

To conclude, it is the opinion of the author that, although, the development of the total industrial area used for comparison purposes has been successful and so far is working more or less efficiently, the planning in advance of the area would have made it more efficient

and attractive and conducive to the amenities which distinguish the proposed type of development. The disadvantages of the compared type of development as they become more and more apparent should be used as constructive experience for further situations and the industrial district idea should be investigated in more details because of its potentialities for creating a more successful, efficient and modern industrial plant for the Island.

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APPENDIX A

INDUSTRIES INVESTIGATED IN THE SAN JUAN METROPOLITAN AREA

MANUFACTURING GROUP	BUILDING AREA SQUARE FEET	NUMBER OF EMPLOYEES	SQUARE FEET PER WORKER
Electric Apparatus	33,800	150	220
	4,240	55	78
	11,393	100	114
	23,169	170	135
	12,187	125	97
	11,636	65	180
	Average =		110
Apparel-Textiles	12,000	100	120
	11,697	160	73
	20,500	248	83
	11,716	100	117
	44,951	400	110
	23,000	150	153
	33,953	250	158
	23,201	150	155
Average =		194	121
Metal Goods	8,511	100	85
	11,636	23	505
	23,515	50	470
	23,235	50	464
Average =		55	380
TOTAL AVERAGE EMPLOYMENT PER PLANT		=	136 WORKERS

INDUSTRIES INVESTIGATED IN THE CITY OF MAYAGUEZ

Apparel-Textile	14,000	250	56
	80,000	300	270
	9,000	100	90
	4,400	75	59
	9,000	120	82
	14,500	400	36
	10,000	300	34
	5,000	100	50
	10,000	110	91
	6,000	100	60
	5,800	100	58
	3,000	50	60
	14,000	400	35
	Average =		185



APPENDIX A (CONT'D)

FORM USED FOR SAMPLE SURVEY

NAME OF FIRM

ADDRESS

1- PRODUCT MANUFACTURED

2- BUILDING AND SITE

Lot Area

Building Area

Employee Capacity

Parking Facilities, If Any

3- EMPLOYMENT

Persons Employed

Full Time

Part Time

Seasonal

4- REMARKS

APPENDIX B

SURVEY PERFORMED BY THE INDUSTRIAL DEVELOPMENT COMPANY

FIRMS <sup>1</sup>	LAND AREA (CUERDAS)	EMPLOYMENT	DENSITY PER CUERDA
B	.70	60	85
C	11.50	90	8 *
J	4.00	125	31 *
K	1.30	175	134
O	4.00	60	15 *
Q	.50	37	74
W	.50	75	150
X	.80	85	106
Y	2.10	50	25 *
Z	1.40	121	86
AA	1.30	119	90
BB	3.90	380	95
CC	1.00	183	183
DD	1.00	180	180
II	3.30	450	139
JJ	2.00	205	102
NN	1.40	63	46 *

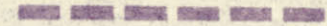




<sup>1</sup> Withheld to avoid disclosing figures for individual companies.  
 \* Plants excluded for calculating the average.

Computed Average Net Density = 110 workers per net cuerda  
 114 workers per net acre

Average Employment per Plant Including All Plants = 144 workers  
 Median Employment per Plant Including All Plants = 121 workers



MASTER PLAN OF MAJOR THOROUGHFARES  
SAN JUAN METROPOLITAN AREA

EXPRESSWAY   
 AVENUE   
 MAIN STREET   
 EXISTING ROUTE   
 PARKWAY 



THE SELECTED SITE

INDUSTRIAL AREA USED FOR  
COMPARISON PURPOSES

● GENERAL LOCATION OF INDUSTRIAL AREAS  
RECOMMENDED BY THE MASTER PLAN

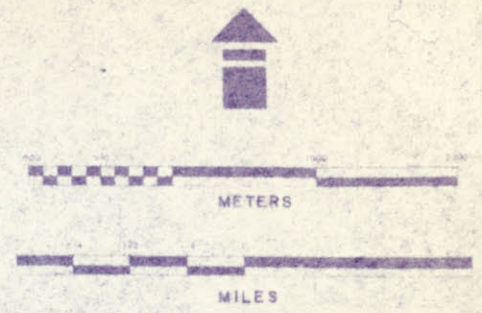
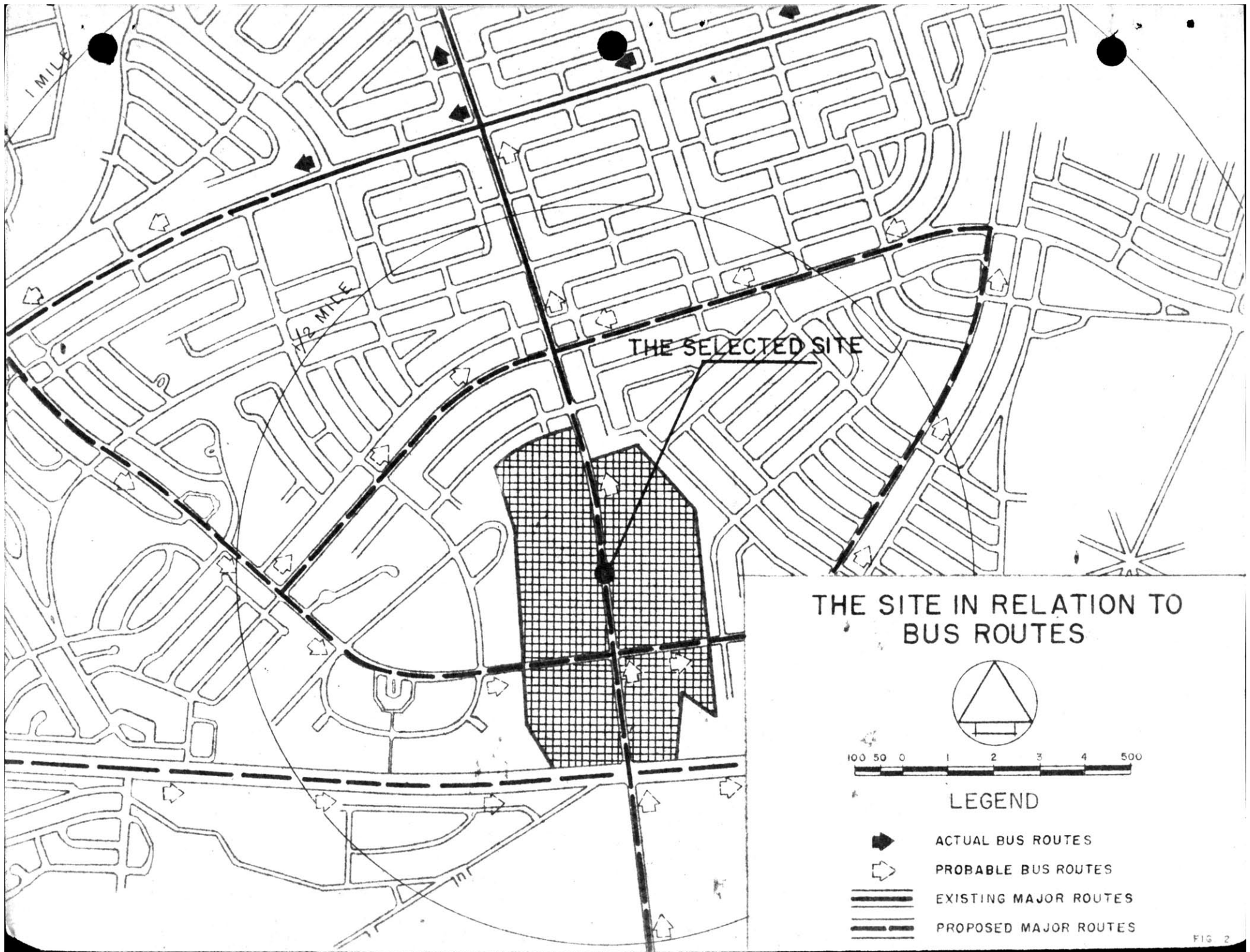
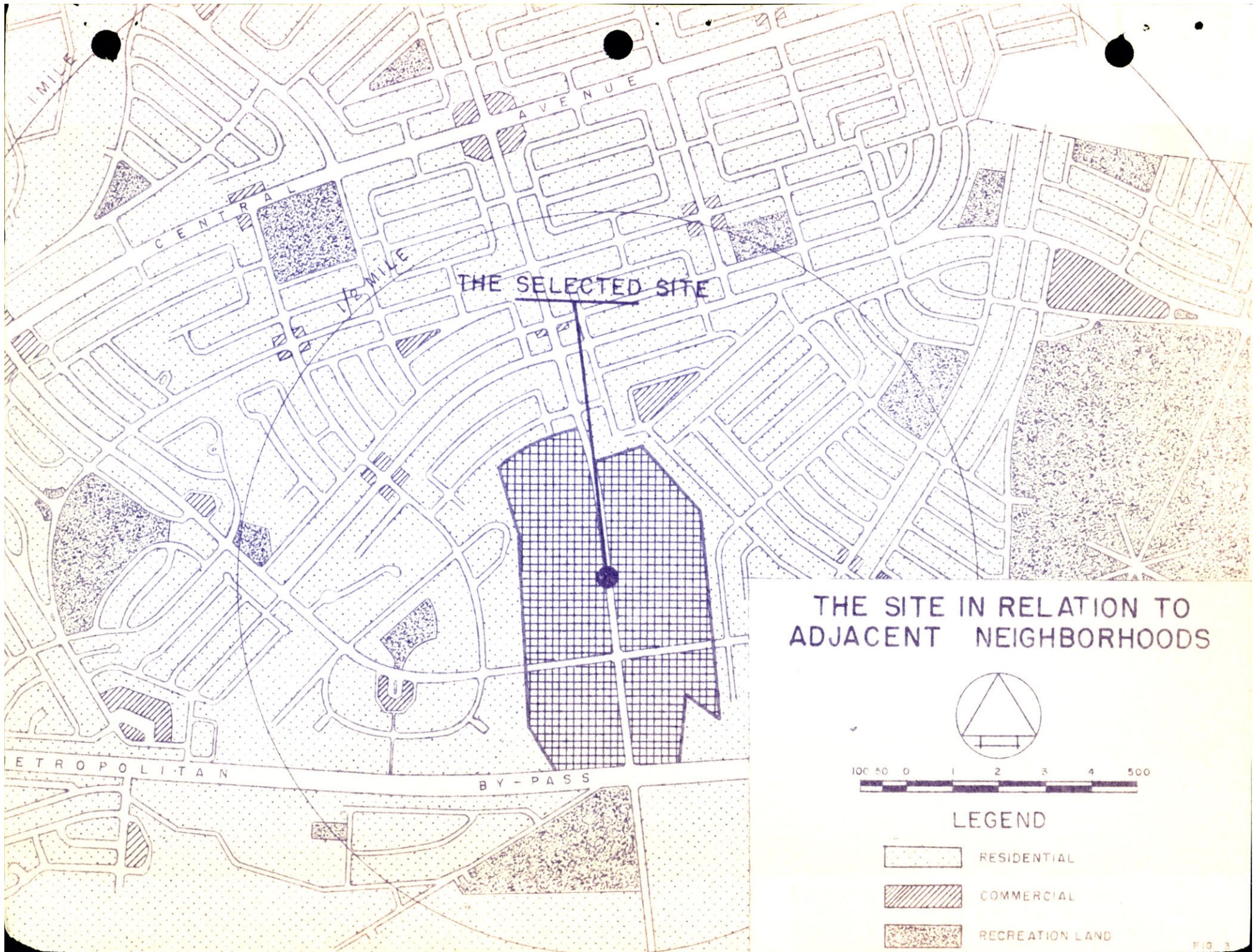


FIGURE 1

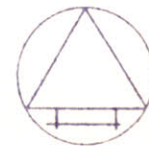








THE SITE IN RELATION TO ADJACENT NEIGHBORHOODS

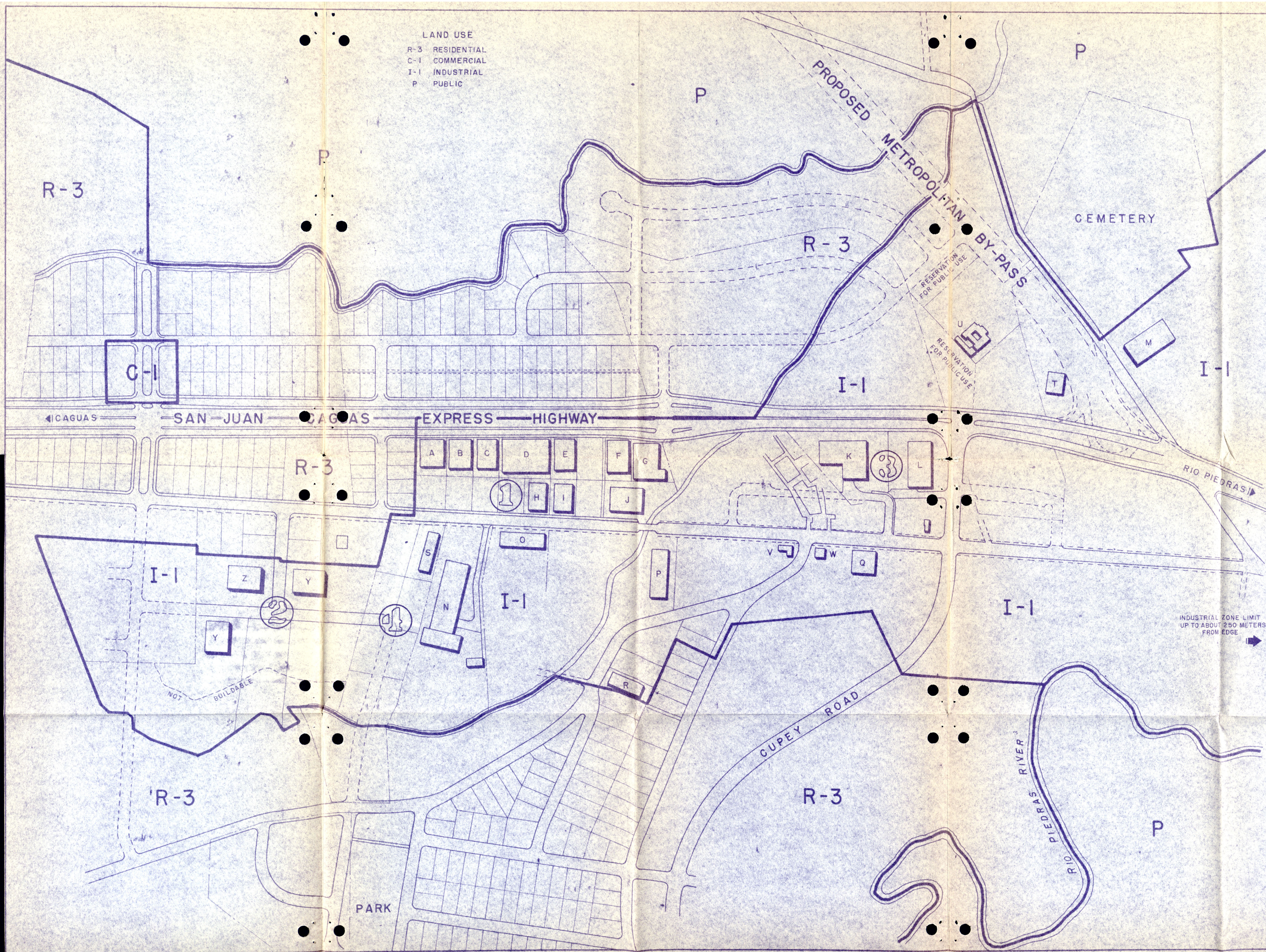


LEGEND

- RESIDENTIAL
- COMMERCIAL
- RECREATION LAND



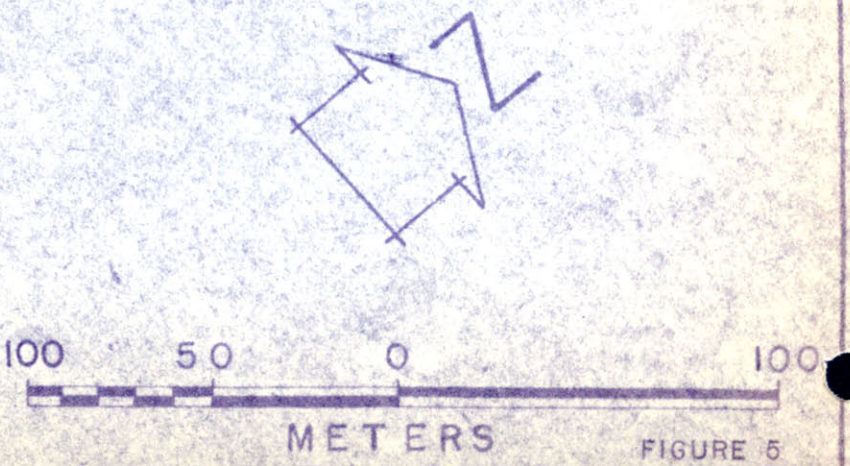
LAND USE  
 R-3 RESIDENTIAL  
 C-1 COMMERCIAL  
 I-1 INDUSTRIAL  
 P PUBLIC



● LIGHT INDUSTRIAL DISTRICT USED FOR COMPARISON

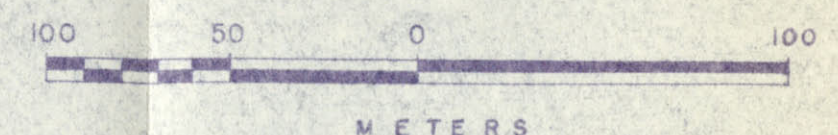
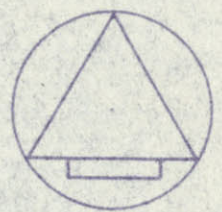
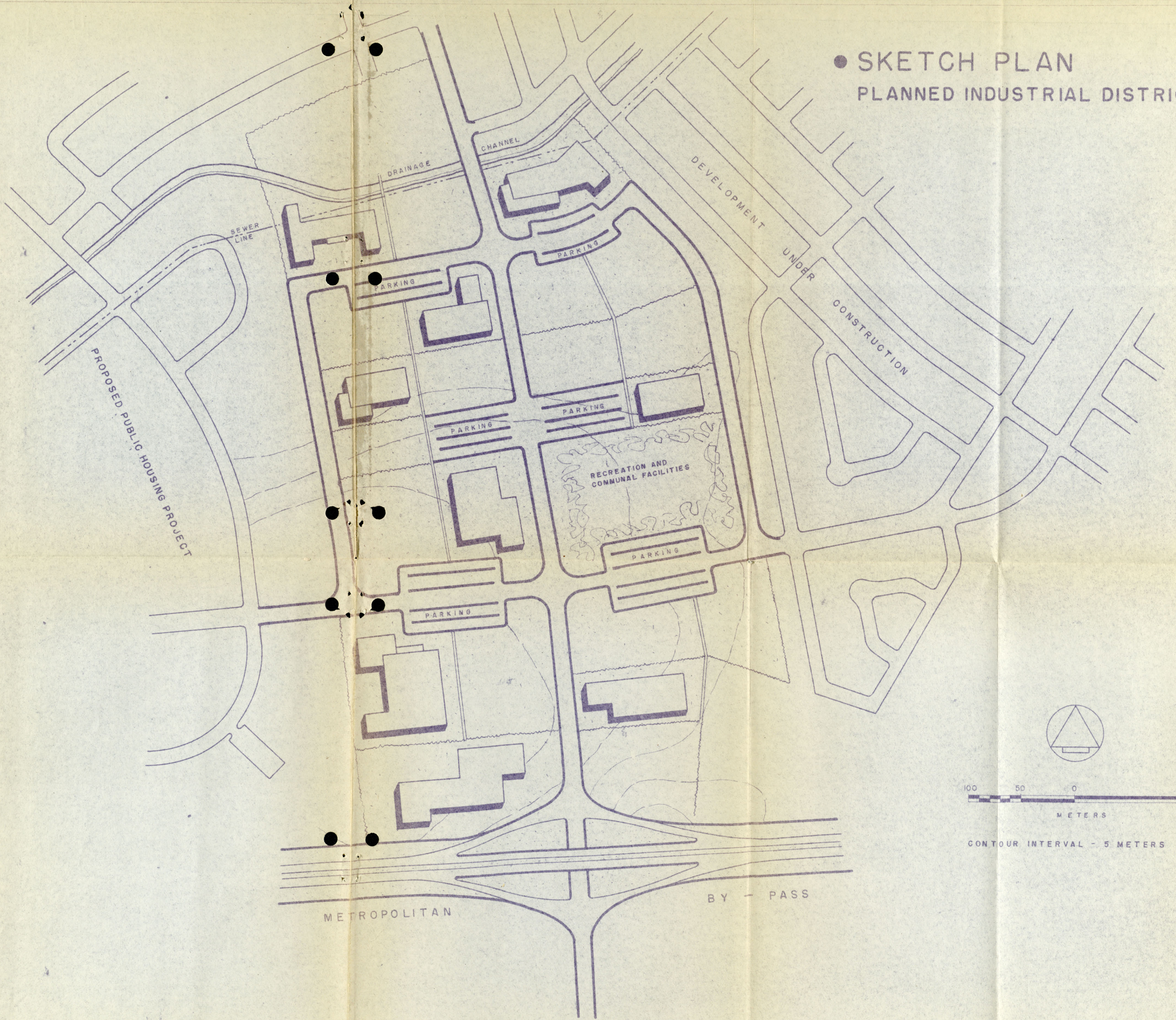
TYPES OF EXISTING INDUSTRIES AND OTHER USES

- A FURNITURE MANUFACTURING
- B PLASTICS
- C RATTAN FURNITURE MFG.
- D PLASTICS
- E MIAMI TYPE WINDOWS
- F ICE CREAM FACTORY
- G FURNITURE MANUFACTURING
- H PLASTICS
- I MIAMI TYPE WINDOWS
- J ELECTRONIC COMPONENTS
- K ELECTRONICS
- L HERMETIC SEAL PRODUCTS
- M MIAMI TYPE WINDOWS AND DOORS
- N ELECTRONICS
- O ELECTRONIC PRODUCTS
- P CONCRETE PRODUCTS
- Q BEVERAGES
- R FOOD PRODUCTS
- S WAR SURPLUS
- T GAS SERVICE STATION AND REST.
- U MUNICIPAL ASYLUM
- V GROCERY
- W GROCERY
- Y PAINTS
- Z STAPLES
- PROPOSED STREETS OR UNDER CONSTRUCTION





● SKETCH PLAN  
PLANNED INDUSTRIAL DISTRICT



CONTOUR INTERVAL - 5 METERS