6.4 Planned Targets of Industrial Park Development

6.4.1 Selection of Target Industry

(1) Fundamental Point of View

First, it should be noted that there are many approaches to classifying manufacturing industries, depending on the analytical aims or methods.

In this research, it is supposed that industrial locations are influenced by not only area condition such as land, water supply, and labor force, but also social and political factors such as organization and governmental policy of development. Therefore we considered several categories of industries related to the following problems: (1) over population in San Jose metropolitan area, (2) uncontrolled land use in suburban areas, (3) existence of depopulated rural areas and (4) emerging problems such as environmental pollution.

In the Gran Puntarenas area, traffic conditions will be greatly improved in the near future by the construction of roads and a new port. Certain industries for industrial parks should be studied from long-term, macro-scopic and regional perspectives.

(2) Orientation for Strategic Classification

Here we proposed two categories of manufacturing industries: (1) industries whose location is strongly influenced by urban agglomeration, (2) industries whose location is somewhat influenced by natural, technological or historical situation.

(1) Industrial location related to urban agglomeration

i) in the metropolitan area
ii) in local areas

(2) Industrial location related to other factors

i) special products or historical speciality of local area
ii) dependency on local resources (e.g., agricultural or fishing)
iii) relationship with other industries
iv) connections to large-scale complex heavy industry
v) other specific conditions

Industries having characteristics listed under (1) are particularly akin to conditions which are peculiar to urban areas, such as:

(i) size and connection of urban population;

(ii) existing industrial agglomeration;

(iii) complex of urban function.

This category of industries dependent on location includes metalic and mechanic industries and their related industries, some textile, printing and food-processing industries. Many of the above industries are listed because this category includes various small businesses generated during rapid urban growth. Moreover, this industrial diversification is attributed to the fact that area is a market for consumer products and, at the same time, it provides easy connection to production processes, ready accessibility to technical, managerial and information sources, because of the proximity of various related industries.

Economical political functions, educational, scientific, cultural facilities, urban atmosphere etc. attract managers, technicians and laborers, all of which offers an important backgrand for the development of enterprises and human resources.

This survey does not study the relationship between urban and industrial agglomeration, but it can be clarified by investigations - conducted by corresponde - upon main industries in the metropolitan area, and case studies of various products.

A long-term program of industrial parks should be based upon research surveys which analyze among already-established urban oriented industries their nature size and classification. These are industries which would face difficulties is of locating in the over-connected urban environment. When the accessibility of Gran Pun-arenas to San Jose is improved, the attraction of many urban oriented industries would contribute to the stabilization of the population of this area.

In order to determine which industries should leave the metropolitan area, the following points should be checked: (i) great potential to grow consistently with population, but (ii) relatively small ratio of value added per area of industrial site and the comparatively low ratio of added value/industrial site.

Those industries related to (2) are as follows:

a) Wood processing and furniture: they utilize traditional designs or unique production technics.

b) Industries which utilize sea resources and mining resources. In Puntarenas we can find refrigeration processing of shrimp, tuna canning, salt, mining and diatomite production.

c) Various smaller-scale industries that process materials, parts, or semi-processed production for existing industries, repair equipment, or subcontract one part of the production process.

d) Industries related to large-scale chemical and steel plants. The production processes are combined directly pipe lines.

e) Other industries, whose conditions of location are restricted physically, such as the ship building industry in Puntarenas.

In the above, d) is determined in general from the standpoint of national development; a), b), c) and d) are determined upon feasibility studies of production items, taking into consideratio the special conditions of Puntarenas.

6.4.2 Characteristics of the Industrial Districts and Parks

The industry which has future growth potential vis-a-vis this area is agro-industry. Therefore, priority should be placed on the planning of industrial parks for the agro-industry.

If we set the population target of this area in the year 2000 at 150,000, however, industrial employment (including construction) should increase to about 10,000 persons. Therefore in order to crystalize on this situation, many other manufacturing industries which would tend to further concentration of the urban area should be established in this area.

The following Table 6.7 shows the location of industrial areas over the long-term. Areas designated No. 1 and No. 2 are those industrial parks which used to have their development more precise. Area No. 3 has zoning which restricts land utilization, but it will be developed after the new port of Caldera opens.

Number 4, indicated in the table, is land reserved for future development, which will be continued after the completion of the above mentioned two or three parks.

Number 5 may not be developed as an industrial park but should be restricted in its land use and industrial combination, a combination induced according to the needs of the urban population.

Table 6.7 Industrial Areas for Planning

No.	Location	Purpose and Characteristics	Expected Effects	Area (net.ha.)	No. of Employees	Initial Industries Expected	Time of Completion
1	Barranca (Socorrito)	1) An industrial park as the nucleous of a rural area. 2) Mult-purpose and complex industrial park which combines manufacturing industry and agro-industry.	1) Promote Employement 2) Induce Agro-industry 3) Industrial agglomeration	30-50 *50-80 man/ha	2000-3000	Food processing, and industries related to metal and mechanics and car repair	Early 1980_s
2	Puntarenas (Cocal)	1) Distribution and processing center for sea food. 2) Promotion of existing small scale industries and improvement of environment and urban facilities in the marine industria park, located reclaimed land.	1) Urban re-development 2) Promote local industries such as marine processing etc.	10-15 *100-150 man/ha. (excluding areas for urban facilities)	1000-2000	Sea-food processing shipbuilding and repairing, urban services	Early 1980_s
3	Caldera (Salinas)	1) Region-wide transport terminal for distributing, warehousing and processing port goods. 2) Long-term industrial zoning to supplement the function of Caldera port.	1) Systemize region-wide transportation. 2) Diversify the new port.	30 *5-20 man/ha.	500	Transport industry (truck and railway), -depots (construction materials, miscellaneous goods). -switchyard	Late 1980_s
4	Near Cabezas	1) Area reserved for long-term future development.	1) Utilize vacant land	50 *20-30 man/ha.	1000-1500	Water saving industries	1990_s
5	In urban areas or along road side	1) Mixed urban areas and isolated areas of smaller scale industries	Population settlement	Scattered location	2000-3000	Subsidiary industries Urban service industry	-
	Total			100-150	7000-10000 (& including existing industries)		

Note: No.1, 2, 4, - Industrial park
No.3,5, - Only for zoning

* Number of employees/area

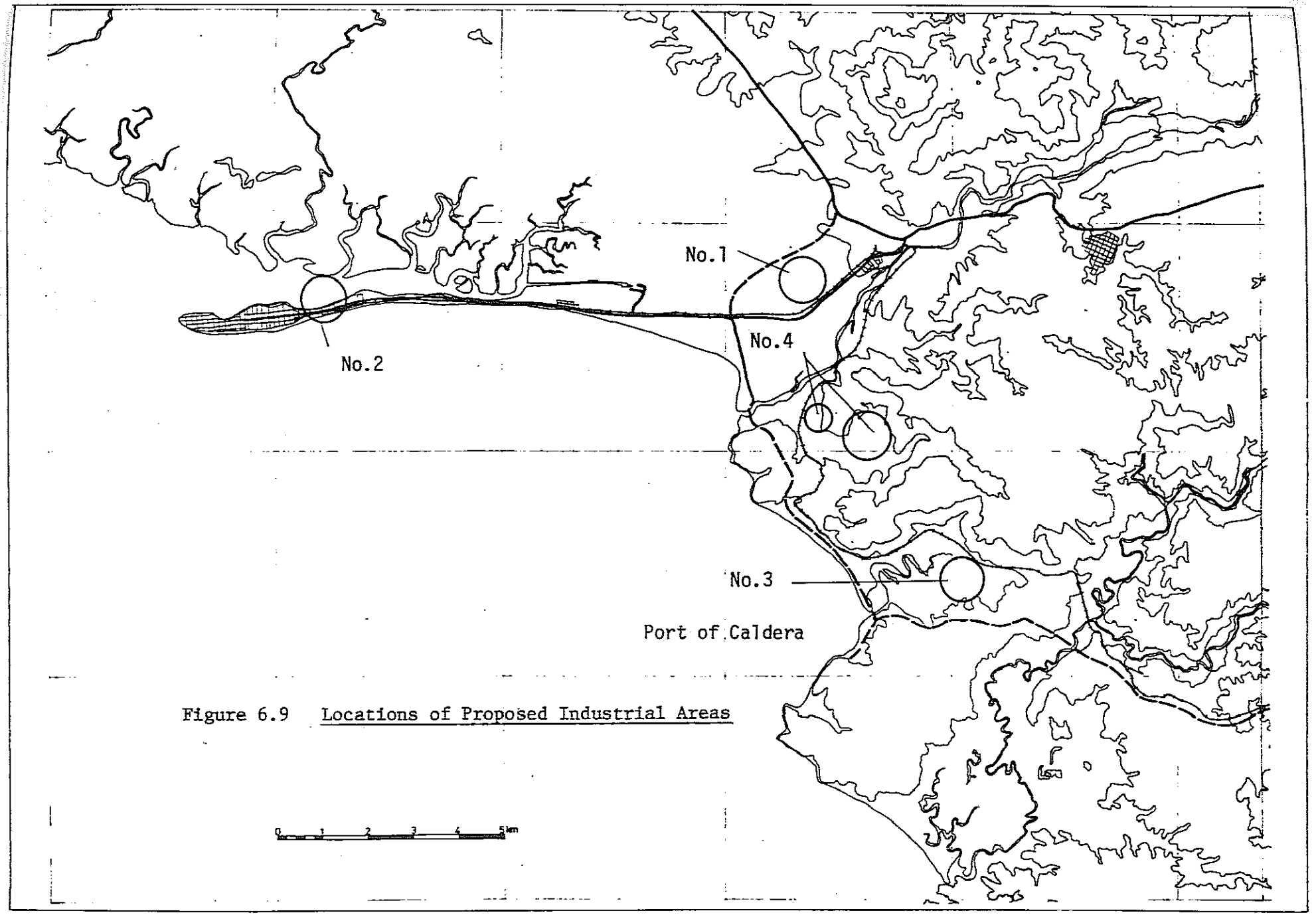


Figure 6.9 Locations of Proposed Industrial Areas

Figure 6.10 Concept Plan Ia (Land Use Plan)
Industrial Park in Barranca

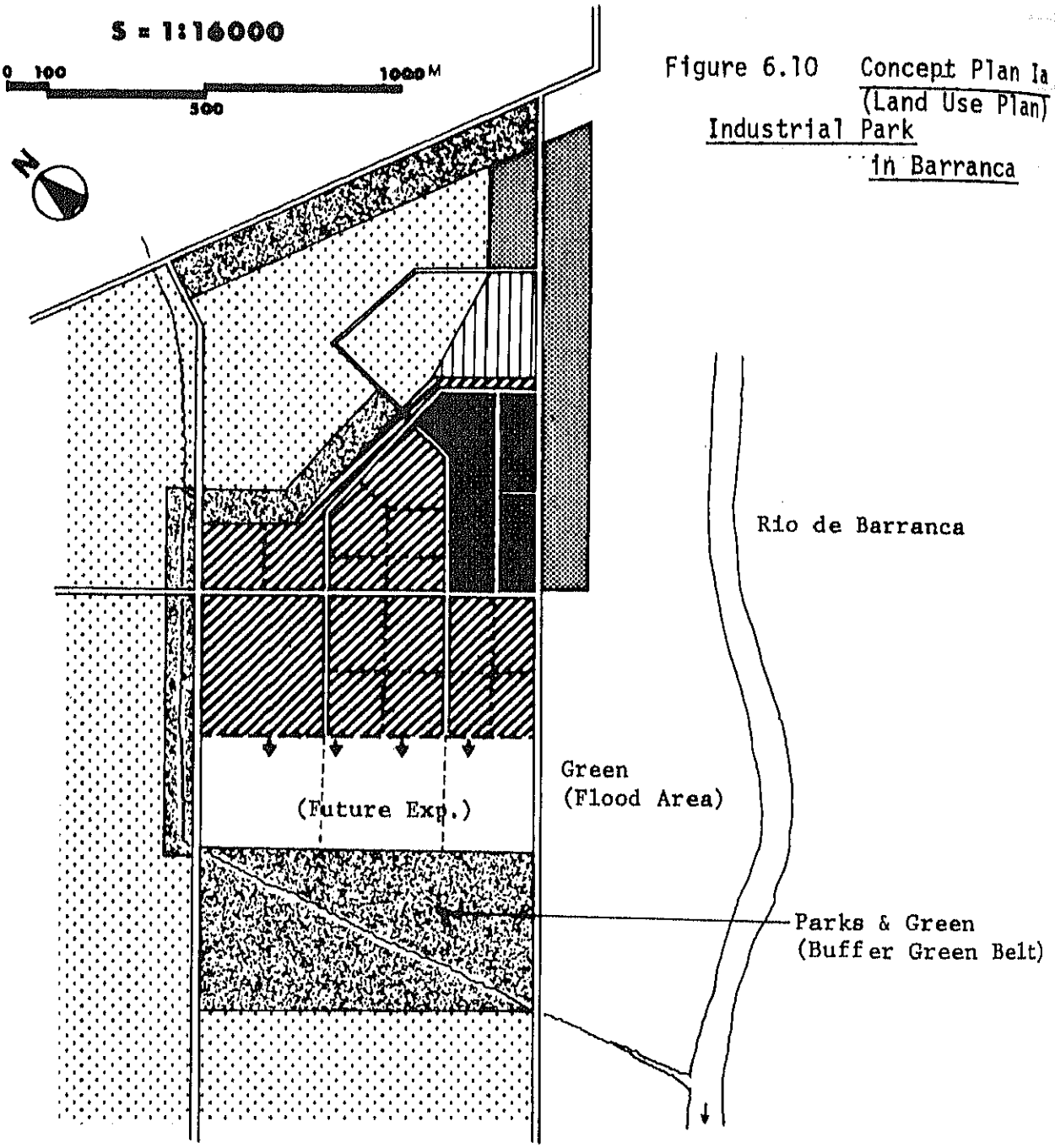


Figure 6.11 Concept Plan Ib (Structure Plan)

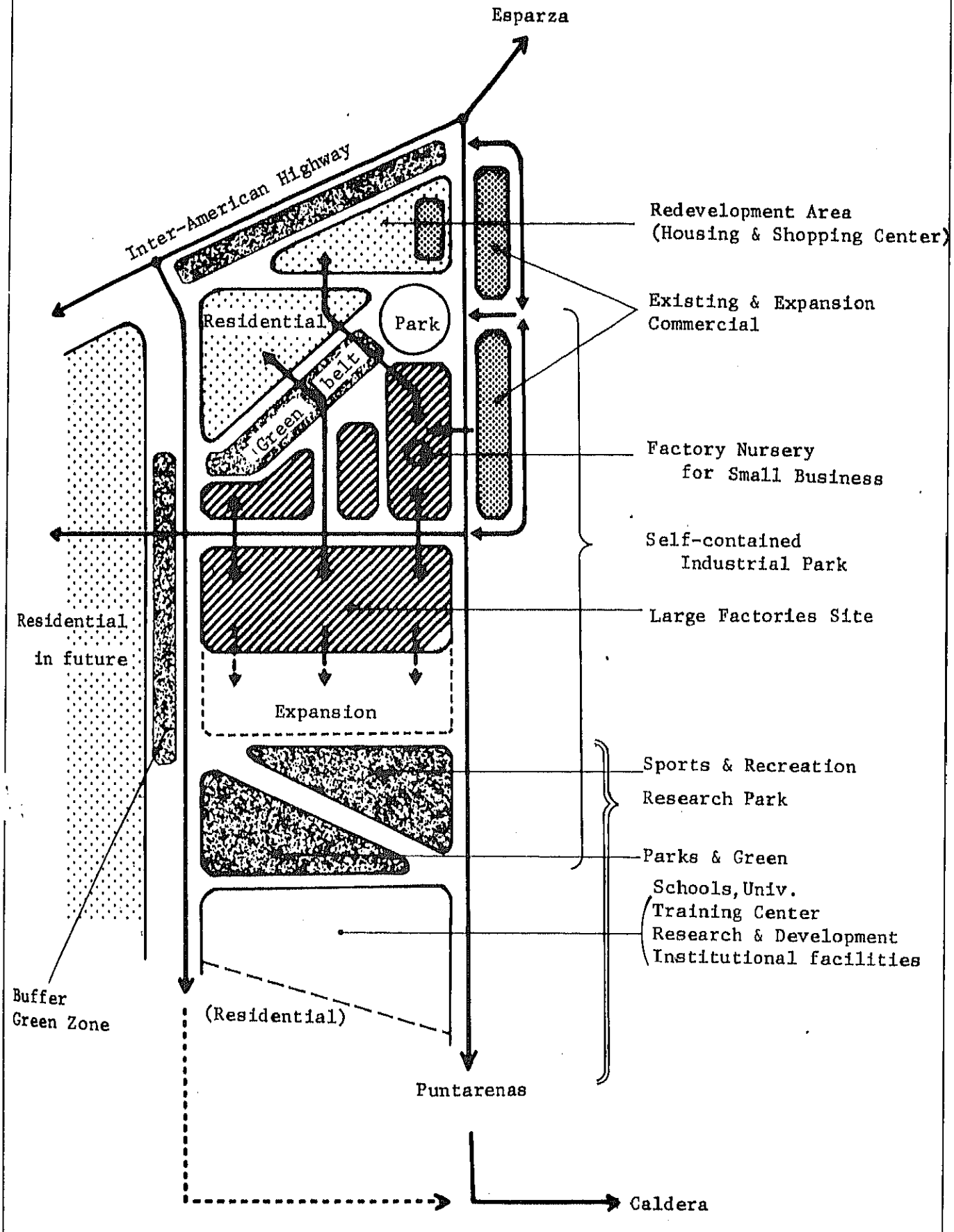
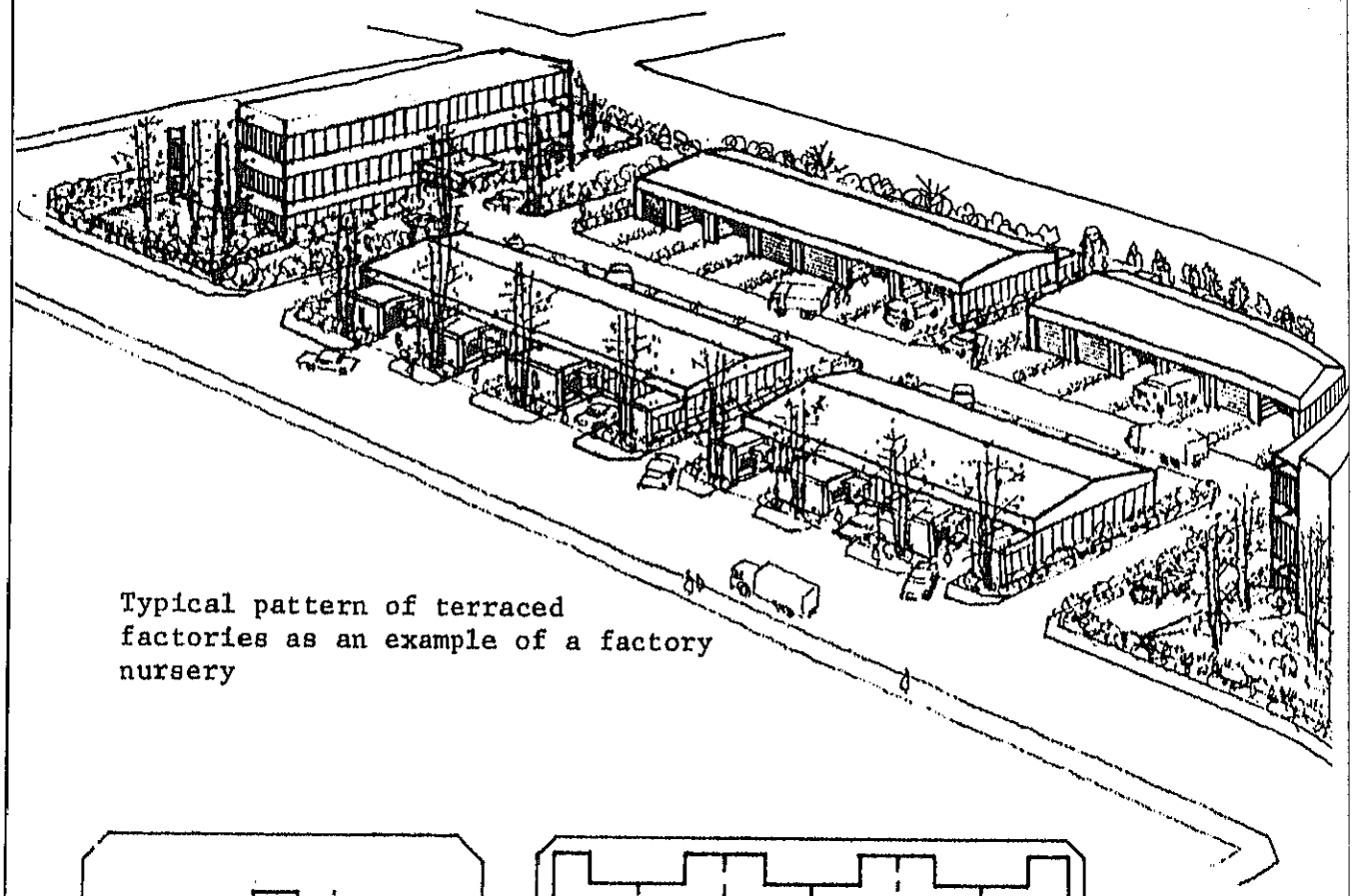
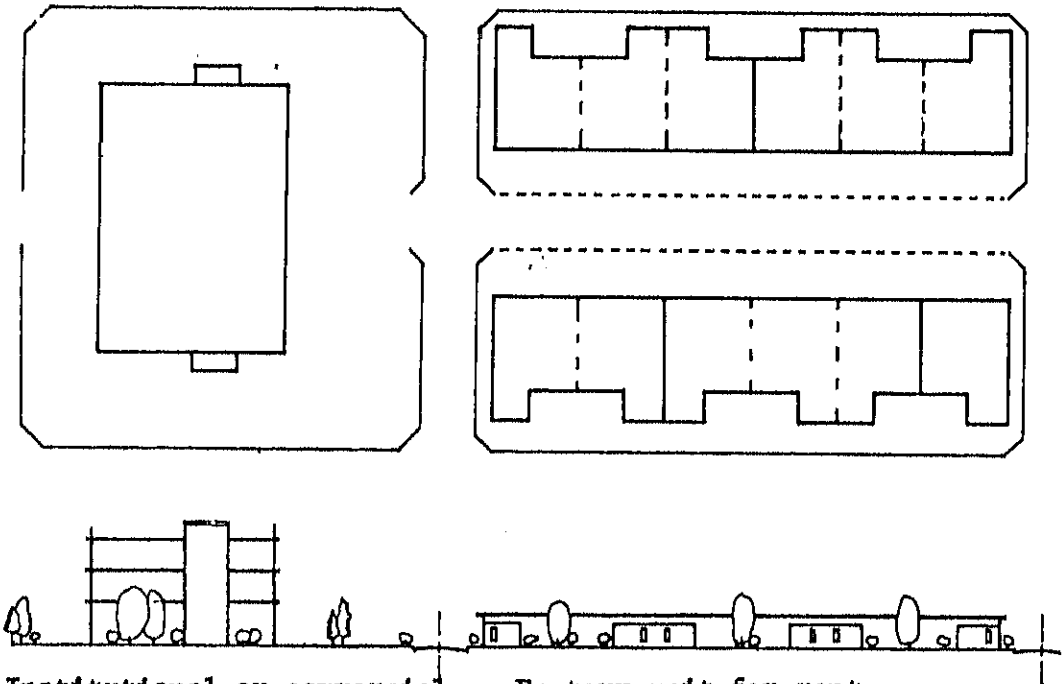


Figure 6.12 Concept Plan Ic (Sketch of Factory Nursery)



Typical pattern of terraced factories as an example of a factory nursery

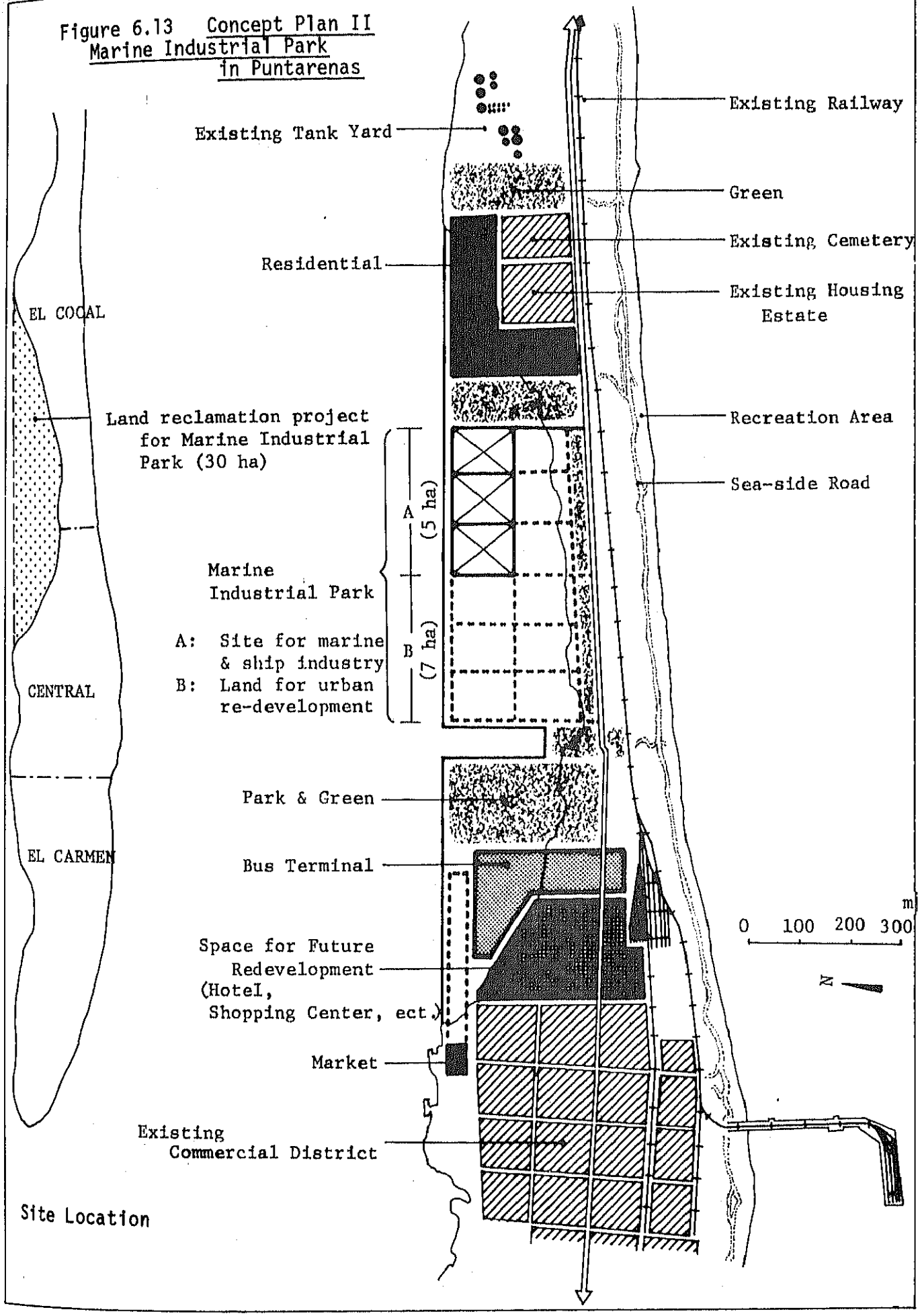


Institutional or commercial building for future re-development

Factory unit for rent

* The factory nursery is a rental work shop or laboratory for small businesses or producers' cooperatives.

Figure 6.13 Concept Plan II
Marine Industrial Park
in Puntarenas



6.5 Consideration of Related Facilities Concerning Industrial Development of the Hinterland

Permanent residential and other facilities for port staff and longshoremen is necessary.

6.5.1 Staff

One of the problems that ports of developing countries must overcome is the maintenance of suitably talented men who can manage and control a port.

They must control the flow of persons and materials and assure efficient functioning of operation. Despite the importance of this work, personnel are often attracted to desk work or project arrangement undertaken by the Central Government. This is attributed to the following facts: the port is situated far from Meseta Central (a fact common to all new harbors), working hours are long, loading facilities are inadequate and working conditions are unpleasant owing to the climate. Recreational or cultural facilities are generally not found in new ports.

The problem of maintaining suitable staff and workers in the port of Caldera is certain to arise in the near future. It is necessary to resolve this problem as part of the development of Gran Puntarenas, especially considering urban environment facilities within the port area. The efficient management of a new harbor will be important vis-a-vis the national economy. Therefore, the staff should be trained in their own harbors; the training of dock workers should be organized in the local areas. Institutional planning is reportedly being undertaken to maintain talented personnel and to introduce equipment for opening the new port of Caldera.

6.5.2 Longshoremen

According to the new Puntarenas Harbor Construction Plan ('73 OTCA), the loading capacity of the new harbor is estimated to be 500,000 t/year. This was estimated by setting the loading capacity of one gang (24 people) to be 20 t/hr for general cargo. Eight hour shifts, effects of rainy seasons, strong sunlight and high temperature were also taken into consideration in this estimation. (The present loading capacity of ports is estimated at 10 t/hr for one gang loading general cargo, owing to the retardation of mechanization.)

The number of needed laborers has been estimated on the basis of projected cargo, 500,000 t/year, for Caldera harbor. Labourers are estimated to total 330. This number includes warehouse workers, guardmen, clerical employees, pilots, etc. When including also dependents and people associated with related services in the hinterland, the total becomes approximately 1,200.

330 people (longshoremen etc.)— Unmarried (50%) - 165

Married (50%) - 165

Family (3 people/family) - 500

Total 1,200

Related services (20% of the total) - 200

The problem of obtaining suitable dock workers needed in the near future is not so difficult to solve compared to resolving those of management of staff. This is because people are expected to move from Puntarenas to the new port. But to cope with problems related to the irregularity of loading, and the mechanization or modernization of the port, it will be necessary to stabilize a supply of quality labor. Some kind of welfare facilities will be required at appropriate spots in both ports.

Besides the demanded labor supply, people also connected with construction industry, livestock and fishing industries are expected to flow in. Together with the problem of maintaining suitable laborers as mentioned above, technical training centers for machinery and transportation systems operators should be established.

6.5.3 Necessity of Related Facilities

A comprehensive training center should be planned as a joint facility - with related government offices - aimed at supplying technical workers needed in land transportation and inland industrial areas together with the above mentioned maritime workers (consisting chiefly of managing staff, and longshoremen). One suitable site for these facilities might be the hilly area around Mata de Limon near Caldera. An alternative might be the seaside industrial park in Puntarenas city or its adjacent reclaimed land (proposed plan).

6.6 Experiences of the Development of Industrial Parks in Japan

6.6.1 Performance

In Japan both governmental and private organizations have carried out the planning and construction of industrial parks. Industrial parks are also sometimes called industrial estates. These two organizations took the leadership in this new field and thus have contributed to the recent development of industrial parks, which became the basis of drastic economic growth in this country. In this sense, they are so-called frontiersmen, or actual development commanders. These organizations are classified mainly into four groups as follows:

(a) Government Agencies

(1) The Japan Regional Development Corporation

(2) The Small Business Promotion Corporation

(3) The Housing Development Corporation

(4) The Environmental Pollution Control Service Corporation

(b) Local Government Agencies

(1) Prefectural governments and municipalities

(2) Local government-affiliated institutions and corporations

(c) The Small Business Cooperative

The cooperative is subsidized by long-term and low-interest loans from both the Small Business Promotion Corporation and the prefectural governments. Each cooperative erects its own industrial park. An enterprise, a member of the cooperative, must observe the basic rule: the enterprise itself should remove its plant and its related facilities, which are located in built-up areas, into planned industrial parks.

(d) Private Land Developers

Private real estate companies and general construction companies set up joint venture companies and share the risk in the construction of industrial parks.

6.6.2 Breakdown of Operation Expenditure

(An average for approx. 1,000 sites)

Land	30% (Inland - 35%, coastal industrial zone - 28% for fishery compensation)
Land reclamation, Land levelling	35% (22% inland, 40% coastal)
Facilities	17% (mainly road construction and drainage works)
Interest on loans	11%
Rent for office and other	7%

Table 6.8 Performance of Industrial Parks Development in Japan (1975)

Administrative Organ	Number of Industrial Parks (A)	Area of Parks (ha) (B)	Area Sold (ha) (C)	<C/B>
1) Government Agencies	145 (12)	4,480 (7)	2,560 (6)	0.57
2) Local Government Agencies and Other Related Corporations	921 (76)	60,500 (89)	36,180 (90)	0.60
(1) Local Government Agencies	629 (52)	44,270 (65)	30,570 (76)	0.69
(2) Local Government Officiated Organizations	292 (24)	16,230 (24)	5,610 (14)	0.35
3) Private Developers	148 (12)	2,580 (4)	1,430 (4)	0.55
Total	1,214 (100)	67,560 (100)	40,170 (100)	0.59

Source: Ministry of International Trade and Industry, 1975

1) Government agencies include the Japan Regional Development Corporation and the Housing Corporation.

2) Local government agencies include the Land Development Corporation, joint venture organizations of the public and private sector.

The Small Business Promotion Corporation was involved in 218 projects during the period of 1961-1974 and is included in 2). The Environmental Control Service Corporation was involved in 57 projects during the period of 1966-1974 and is included in 1).

Breakdown of Assets

Loans	49%	(in case of local government - 80%)
Self-prepared capital	26%	
Advancement of payment for pant site	15%	(in case of reclamation of coastal zones - 31%)
Other	11%	

Operation Period

Site purchase	2 years
Development	3 years
Sale	3 years
Total average	8 years

(Except large-scaled land reclamation which requires 10 to 20 years)

6.6.3 Background of Reasons for Expanding the Construction Business

(a) It becomes essential to control the following environmental destruction which has been caused by recent excessive concentration of population and industry.

- Pollution problems, change in traffic and transportation.
- Shortages of housing, land, and water.

(b) It becomes difficult to retain a sound community because of outgoing of population and low standard of living conditions in depopulated areas.

6.6.4 Related Corporations for Industrial Parks and Operation Systems

The following three corporations' experiences should be very helpful to promote the development plan of the Gran Puntarenas region.

(a) The Japan Regional Development Corporation.

(b) The Small Business Promotion Corporation.

(c) The Environmental Pollution Control Service Corporation.

The activities of these three corporations are as follows:

Note: The Small Business Promotion Corporation does not handle actual construction business but undertakes guidance, assistance and investment. Each cooperative carries out construction.

Japan Regional Development Corporation

Attaining a high level of industrialization and urbanization, Japan has made rapid progress in developing regional development tools. Environmental pollution, traffic congestion, soaring prices of land and other problems have occurred as a result of recent excessive concentration of population and industry around the three largest metropolitan areas in the country.* On the other hand, rural areas have suffered from depopulation and deterioration of farm villages caused by the exodus of youth.

These problems of overpopulation and underpopulation, which are expected to become more serious according to current forecasts, need urgent and drastic political changes to achieve balanced growth, and to prevent the breakdown of the gigantic megalopolitan areas.

With this situation as a background, the Japan Regional Development Corporation was established as a governmental corporation in 1974.** The aim of the corporation is to attain a regionally balanced nation by relocating people and industries from metropolitan areas to local areas, by developing new towns - some of which are centered around universities and in rural areas to deal with the population increase - and by implementing regional development plans in cooperation with provincial governments and municipalities.

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* Densely inhabited core cities of the three regions are:

	Population (1000)	Km^2	Person/ha
Tokyo (capital city)	8,420	579	145
Osaka	2,720	206	132
Nagoya	2,070	326	64

Source : National Census 1975.

Note : Figures correspond to central areas (wards) in each city, not to the administrative area of the municipality.

** The Corporation for Relocation of Industry and Development of Coal Mining Areas, which was established in 1972, was reorganized into this corporation.

Purposes of the Corporation

The purposes of the corporation include (i) contributing to the attainment of a suitable distribution of population and industry and (ii) promotion the welfare of rural areas by dispersing people and manufacturing industries from metropolitan areas to rural areas and working toward regional development.

For realization of these purposes, the corporation is engaged in many aspects of planning and development projects of local areas. Activities include both the preparation and implementation of projects for specially designated industrial and residential areas, and promotion of the deconcentration of industries.

Activities

(1) Deconcentration of Industries

a) Financing

Loans are granted for relocating the manufacturing industries from excessively concentrated industrial areas to less industrialized areas. The Corporation makes relocation of loans up to 50 percent of the total cost of relocation and/or up to 80 percent of the assessed value of the land to be vacated. Terms of payment of loans are up to three years, or until the land to be vacanted can be sold. Another condition requires that the land to be vacated must be used for the betterment of the area. If no suitable purchaser of the land can be found within three years after the relocation loan is made, the Corporation will purchase the land.

b) Industrial park development is concerned both with the development, management and sale of industrial parks in less industrialized areas and the construction of related infrastructures and facilities for people working there.

(2) Regional Core City Development in Rural Areas

a) This development involves the development, management and sale of land for residential lots, industrial sites, commercial centers, campuses etc., which are necessary for regional core cities. Cities currently planned will be economic and cultural centers of each region and are located outside the three major metropolitan areas.

b) It also involves the construction, management and sale of urban facilities for private and/or semi-private use, including educational and cultural facilities, hospitals, government offices, shopping centers and facilities for recreation.

c) Construction, management and sale of public facilities, which are required for new towns, such as roads, parks, sewerage systems, green belts, plazas, and other facilities, are other functions of this development.

d) The implementation of projects, such as urban renewal, land readjustment, inland port construction and other projects, is stipulated by the "City Planning Law."

e) Finally, it involves implementation of large scale projects for comprehensive and planned development of specially designated areas.

(3) Redevelopment of Coal Mining Areas

To facilitate activities of manufacturing industries in impoverished coal mining areas, the Corporation is also engaged in preparation of land for factory sites, construction of factories, buildings for lease or sale, supply of water for industrial use, investment in the enterprises and loans for plants.

The redevelopment work of the Corporation is a continuation of the activities of the Agency for Promotion of Coal Mining Areas which was founded in 1962.

Guiding Principles for Development

a) The basic guiding principle of the Corporation in its development activities is to respect the opinions of local inhabitants. The Corporation appraises and selects sites for development from among the applications submitted by local governments. The opinions of local inhabitants are reflected in the master plan of each project.

b) The Corporation makes every effort to protect the environment and prevent pollution caused by development. Environmental assessment studies are conducted to assure that development is integrated with nature.

c) As projects of the Corporation have a close relationship with those of the central government, prefectural governments and municipalities, the Corporation cooperates and co-ordinates its activities with the respective organizations for implementation of projects under the comprehensive regional development plan.

Number of Projects in Progress

Regional core cities 4
(population is approx. 100,000 - 200,000)

Industrial parks 7
(100 - 200 ha average)

Coal Mining Area Redevelopment
(factory sites; 3 - 200 ha) 21

Funds budgeted for Activities in Fiscal 1976

Regional Core City Development	35.0	(billion yen)
Deconcentration of Industries	79.5	
Redevelopment of Coal Mining Areas	27.7	
Total	142.2	

Small Business Promotion Corporation

The Corporation was established in August, 1967, in accordance with the "Law of Small Business Promotion Corporation," as an organization to carry out the measures designated by the government for small and medium enterprises. (Hereinafter we call small- and medium-enterprises "smaller business.")

Four major activities carried out by the Corporation are as follows:

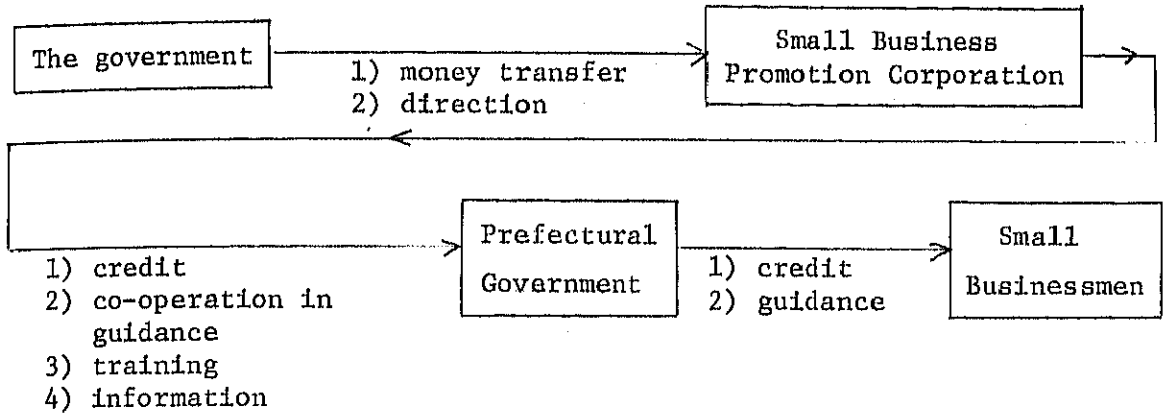
(i) Assistance to the guidance activities conducted by the prefectural governments.

(ii) Giving credit to smaller business through the prefectural governments.

(iii) Training instructors in smaller business guidance activities.

(iv) Information service to the prefectural governments concerning smaller business.

Flow Chart of Business Activities.



(1) Loans and Guidance Activities

Loans of the Corporation have a stronger character in policy financing than those of other government-affiliated institutions. Therefore, they are characterized by the following aspects.

a) Loans of the Corporation are exceptionally long-term credit with a low rate in interest.

b) They are given, accompanied by consultation and guidance service.

c) Projects and facilities eligible for loans are all appointed by laws and ordinances.

So far as the consultation and guidance activities are concerned, they are free service performed by the Corporation in cooperation with the prefectural governments and are given according to the process of the projects eligible for loans, in other words, from planning and construction to business management.

Credits are given in the form of equipment funds through the prefectures to smaller businesses which are making efforts for the modernization and rationalization designated by the government as structural strengthening activities.

Besides this type of credit through prefectures, there is another type of credit given by the Corporation to the prefectural governments themselves which acquire lands, construct factories and try to sell them to smaller businesses by installment.

The kinds of the structural strengthening activities of the Corporation are as follows:

(h) Promotion of Joint Small Factories

This activity aims at promoting the grouping of smaller businesses which engage in the same or the related trade, for the purpose of enjoying the benefits of economies of scale.

(i) Promotion of Preceding Acquisition of Real Estate

In order to carry on business in large-scale, such as in an industrial estate or wholesale estate, it is necessary to acquire large tracts of land. In this case, as for the small business, the most serious problem is the remarkable increase of land price.

This activity aims at solving this problem. By giving credits to prefectural governments and development corporations, they are able to acquire large grounds as future sites for small firms.

This system is thought to be very favorable, because the amount to be born by small firms is limited only to the real cost in spite of the remarkable increase of market price.

(j) Besides the above-mentioned activities, credit is given to the industries specified by the law.

(2) Training

In order to promote modernization and to strengthen the structure of smaller business, Small Business Promotion Corporation carries on two types of training. One is the training for instructors who compose the staffs of prefectural governments and are in charge of guidance for smaller business. The other is the special training, for smaller business, which might be difficult to be carried out on the prefectural level.

To execute the training activity smoothly, the Corporation established Small Business Training Center and a dormitory for trainees. A great many training courses are held and are subsidized by the government.

So far as the technical training is concerned, the Corporation provides many unique machines which have never been used elsewhere for training.

(3) Information Service

Small Business Promotion Corporation makes various kinds of research to promote the modernization and to strengthen the structure of smaller business. The Corporation also makes a study to carry out guidance activities. The results of the research are proffered to all

(a) Promotion of "Grouping" Factories, Stores (wholesale), Trucking Centers, Warehouses, etc.

This activity aims at the grouping either of factories, stores, garages and warehouses through the activity of business cooperatives or of other similar types of organizations in order to improve business circumstances and productivity.

(b) Promotion of Establishment of Joint Facilities

This activity aims at promoting the establishment of joint facilities through the activity of business cooperatives in order to better benefit.

(c) Promotion of Merger or Participation

This activity intends to promote the merger or establishment of jointly participating companies in order to attain the optimum size of business.

(d) Promotion of Joint Retail Stores

This activity aims at promoting the establishment of shopping centers or super markets by small retailers through the activity of business cooperatives in order to rationalize management.

(e) Modernization of Shopping Districts

This activity intends to promote the renovation of shopping districts by small retailers through the activity of business cooperatives for the purpose of realizing modernization.

(f) Promotion of Voluntary Chains by Retail Stores

This activity intends to promote the establishment of voluntary chains by retail stores, maintaining their independence, for the purpose of enjoying the merits of scale.

(g) Promotion of Joint Computation

This activity aims at promoting the establishment of a joint computation center, in the form of cooperatives or jointly participating companies of smaller businesses, in order to actualize the rationalization of management.

the guidance organizations. Besides, the Corporation carries out the activities of technical development and information service for smaller business.

The Environmental Pollution Control Service Corporation

The Environmental Pollution Control Service Corporation was established in 1965 in conformity with the Environmental Pollution Control Service Corporation Law and performs the undermentioned business.

Business Activities of Control Service Corporation

(1) Construction and transfer business for manufacturing cooperations:

- (a) Construction and transfer of joint pollution control facilities.
- (b) Construction and transfer of buildings for joint use of firms.
- (c) Construction and transfer of sites for removal of factories.
- (d) Construction and transfer of joint welfare facilities.

(2) Loan Business:

- (a) Loans for the installation of joint pollution control facilities.
- (b) Loans for the installation of individual pollution control facilities.
- (c) Loans for the installation of industrial waste treatment plants established by the industrial waste treatment agents.

CONSTRUCTION AND TRANSFER BUSINESS

Areas eligible for construction and transfer business are the undermentioned, concentrating therein on factories and firms.

- (i) The areas where air or water pollution is serious or may become serious in consequence of the operations performed in factories and firms.
- (ii) The areas being specified by the regulation under Clause 1, Article 3 in the Noise Regulation Law, (the 98th Law in 1968).
- (iii) The areas being specified by the regulation under Article 3 in the Offensive Odor Control Law, (the 91st Law in 1971).

(iv) As for the noise control facilities and the offensive odor control facilities, the areas designated by the Director General of the Environment Agency are eligible in addition to (ii) and (iii).

This designation is made in review of the present or expected level of nuisance due to noise or offensive odor.

(1) Buildings for Joint Use (Factory Apartment Building: Flatted Or Terraced Factory)

Even if in the case wherein the individual factory or firm is unable to get satisfactory results with the mere establishment of the pollution treatment facilities, if several factories and firms in the same industry cooperate to construct a cooperative building which utilized shared facilities to prevent pollution instead of the usual factory building, it would be possible to achieve satisfactory results in the prevention of pollution. Besides planning further modernized facilities by appropriating a part of the building for a cooperative workshop, cooperative warehouses and joint welfare facilities, it would serve not only the prevention of pollution but also both modernization and rationalization in the entire production and management and the consolidation of area of city streets, too. The control service corporation is prepared to construct buildings for joint use and transfer them by long-term installments at a low rate of interest, when such a joint use of building is necessary in a concentrated area of factories and firms.

(2) Green Buffer Zone: Parks & Green Belt

For drastic solution of the problem regarding the industrial pollution in an urban area, first comes the question of whether the utilizable land is reasonably allocated or not. For this purpose, it is required to investigate the establishment a buffer area shutting off the industrial parts from the residential parts in the areas being liable to cause heavy pollution. In the buffer zones, it will be de sirable to establish welfare facilities including parks, green areas, athletic fields, etc. The control service corporation is prepared (1) to construct the green area and athletic field, etc. as a buffer zone in areas liable to cause heavy industrial pollution in consideration of the conditions of location for the factories and firms, geographical and weather conditions, etc., (2) to establish the facilities to serve jointly the welfare of both employees in factories and firms and the neighborhood and (3) to transfer the above-mentioned by long-term installments at a low rate of interest. Since 1968, in regard to the green buffer zone to be established in conformity with the city plan, the Japanese Government has been offering subsidy money.

Table 6.9 Government Subsidy Money for the Fiscal Year

(unit: 1 million yen)

Year	Government subsidy money	Year	Government subsidy money	Year	Government subsidy money
1968	250	1971	570	1974	2,755
1969	215	1972	800	1975	2,655
1970	280	1973	2,200		

(3) Joint Pollution Control Facility (Treatment Facility for Joint Service of Producers' Co-op)

Soot and smoke, wastewater, toxic & hazardous gas, noise, etc., that are generated as a result of the work in factories are the objects specified by the Air Pollution Control Law, Water Pollution Control Law, Noise Regulation Law, Prefectural Regulations, etc. An enterprise is required to establish the facilities to prevent and exclude all these industrial pollutants. In this case, it is advisable to set up facilities for joint use of several enterprises, rather than each individual enterprise setting up its own facility, because it would be profitable in respect to the cost of treatment and the location in constructing the facilities.

The Control Service Corporation constructs, on behalf of users, for joint use of factories such facilities (including attached facilities and sites) as soot and smoke treatment, wastewater treatment, dust treatment, specified substances treatment disposal facilities, low-sulfurous fuel storage for emergency, noise control facilities, offensive odor control facilities, and industrial wastes treatment plants and then transfers the abovementioned facilities to the users (or specified controllers) by long-term installments at a low rate of interest.

Wastewater treatment facilities are those facilities that dispose of contaminated substances floating and dissolved in sewage or waste liquid. Disposal is attained through devices that use the method of precipitation, filtration, centrifugalization, concentration, flocculation, adsorption, extraction, ion exchange, neutralization, biological treatment, mixing, underground permeation, drying, etc. (Public sewage, basin sewage, and city sewage are excluded from eligible business.)

Dust treatment facilities are those facilities that prevent substances that come about when a substance is broken, sorted or disposed of or accumulated by other mechanical treatment. Besides the precipitation device or dust arrestor, the device prevents particulates from scattering by the method of watering, coating, closing, etc.

Soot and smoke treatment facilities are those facilities that dispose of (1) sulfur oxides generated as a result of combustion of fuel and the like, (2) soot and dust generated as a result either of combustion of fuel and the like or of the use of electricity as a heat-source, (3) cadmium, chlorine, hydrogen fluoride, lead, their compounds, etc., which are generated as a result of combustion, synthesis, resolution and other treatments (excluding mechanical treatments), and (4) toxic & hazardous substances being liable to adversely affect human health or living environment. For treatment of substances in gaseous form, the elutriation (including the absorption), neutralization and adsorption treatment device (including a high stack of more than 70 meters having the purpose of diffusion disposal) are included; for disposal of substances in particle shape, dust-collecting methods such as gravity sedimentation, inertia separation, centrifugalization, filtration, elutriation, electric precipitation, sound wave agglomeration etc. are included.

Specified substances treatment facilities infer the disposal of specified substances prescribed in the Air Pollution Control Law (e.g., ammonia, hydrogen fluoride, hydrogen cyanide, carbon monoxide, formaldehyde, methanol, hydrogen sulfide, hydrogen phosphate, hydrogen chloride, nitrogen dioxide, acrolein, sulfur dioxide, chlorine, carbon bisulfide, benzene, pyridine phenol, sulphuric acid (including sulfur trioxide), silicon fluoride, phosgene, selenium dioxide, chlorosulfonic acid, yellow phosphorus, phosphorus trichloride, bromine, nickel carbonyl, phosphorus pentachloride and mercaptan).

Low-sulfurous fuel storage facilities for emergency. The sulfurous quantity of stored fuel must maintain a 1.2 percent minimum and follow the pollution reduction plan noted by the Prefectural Governor in conformity with Clause 2, Article 23 in the Air Pollution Control Law. The attachments such as oil pipe, conveying pump, valve changeover device, thermostat, stirring device, etc. are also included.

Noise control facilities are utilized by constructing soundproof buildings to prevent noise and vibrations from happening through ventilation, shock, etc. or soundproof rooms (built of concrete, concrete blocks, or wood and attached with sound absorbing material on the inside, while the entrance and exit are fixed with a double type door respectively or doors with sound absorbing material are attached to the inside), and by utilizing such devices as hanging base, silencer, silencer device (facilities with silence box, soundproof cover, soundproof hood, etc. with sound absorbing material attached to the inside), sound sheltering fence (built of ferro concrete, concrete, bricks, concrete blocks, etc. with a height of more than 2.5 meters) and sound sheltering wall (including a part of the ceiling). (Selections forming the common factory structure are not included.)

Offensive odor control facilities are those facilities that prevent malodorous substances prescribed in the Offensive Odor Control Law (e.g., ammonia, methyl mercaptan, hydrogen sulfide, methyl sulfide, tri-methyl amine) from discharging (including leaking).

For treatment, the device uses the method of thermo-decomposition, elutriation, absorption, neutralization, adsorption, ion exchange, oxidation, reduction, electric precipitation, chemical treatment, dissolution, etc. and another device that uses the method of closing.

Industrial wastes treatment plants are those plants that dispose of industrial wastes prescribed in the Waste Disposal and Public Cleaning Law. For disposal, the device uses the method of fractionation, collection, preservation or transfer, thus preventing pollution, maintaining safety and stability or decreasing the quantity of pollution.

6.7 Definition of Industrial Districts and Industrial "Parks"

An organized or planned industrial district is a tract of land subdivided and developed, based on a comprehensive plan or the use of industrial communities. The plan includes detailed provisions for streets, parks, green and utilities. These facilities should be installed before the sale or lease transaction of sites. Otherwise, they should be installed later. These installations are necessary provisions to protect the occupants. To define the term, industrial parks, the following descriptions are quoted from "Industrial District Restudied."*

The comprehensive plan must insure adequate control of the area and buildings through zoning, private restrictions incorporated as legal requirements in deeds of sale or leases, and the provision of continuing management, all with a view to protecting the investments of both developers of the district and industries occupying the improved sites. The management handles negotiations with local governmental authorities on behalf of the tenants, and it may erect buildings prior to sale or lease for speculative purposes.* A Report on the Dartmouth College Conference on Industrial Parks, prepared by William Lee Baldwin, sponsored by Arthur D. Little, Inc. and The State of New Hampshire, June, 1958.

The matter of further defining planned industrial districts was the subject of considerable discussion at the Dartmouth College Conference on Industrial Parks in June of 1958,[1/] and resulted in the above composite definition which incorporates elements of earlier definitions published by the Urban Land Institute[2/] and the Department of Commerce.[3/]

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* Urban Land Institute, "Industrial District Restudied": Technical Bulletin No. 41, 1961; Washington D.C.

1/ For ULI's contribution to the Dartmouth College Conference on Industrial Parks, see "The Effects of Industrial Parks on the Community," Urban Land, November, 1958.

2/ Planned Industrial Districts, Technical Bulletin No. 19, Urban Land Institute, October, 1952.

3/ Organized Industrial Districts, U.S. Department of Commerce, June, 1954.

Industrial "Parks"

Although the term industrial "park" has become increasingly popular over the past several years and is now widely used, to date only one or two serious attempts have been made to define an industrial park qualitatively. William Lee Baldwin in preparing the final report on the proceedings of the Dartmouth College Conference on Industrial Parks noted the inability of the conferees to come to any unanimous agreement as to specifically what constitutes an industrial park and offered the following definition as a synthesis of the diverse opinions expressed at the seminar sessions:

An industrial park is a planned or organized industrial district with a comprehensive plan which is designed to insure compatibility between the industrial operations therein and the existing activities and character of the community in which the park is located. The plan must provide for streets designed to facilitate truck and other traffic, proper setbacks, lot size minimums, land/use ratio minimums, architectural provisions, landscaping requirements, and specific use requirements, all for the purpose of promoting the degrees of openness and park-like character which are appropriate to harmonious integration into the neighborhood.

The industrial park must be of sufficient size and must be suitably zoned to protect the areas surrounding it from being devoted to lower uses. The management is charged with the continuing responsibility of preserving compatibility between the park and the community as well as protecting the investments of the developer and the tenants.

If the above definition is accepted, an industrial park is simply a more highly restricted type of planned industrial district in which special attention and emphasis is given to aesthetics and community compatibility. In actual practice, however, all too often an industrial park is any industrial district or vacant tract of land that the owner or developer chooses to call by that name, and any relationship between the above definition and the character of development found in existing "parks" appears to be coincidental. Hence, in many instances the term is nothing more than a semantic gimmick used to gain community acceptance on the one hand and to promote a piece of real estate on the other.

CHAPTER VII

URBAN PLANNING

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7.1 General

7.1.1 Introduction

Urban planning may be defined as a continuing decision making process to determine future actions in order to realize urban physical environment desirable in the light of socio-economic and cultural goals and aspirations of people in the community. In the context of Gran Puntarenas, urban planning should be essentially viewed as a means of coordination for public and private decisions which would have major impacts on the future of the quality of living environment to avoid costly duplications and to achieve maximum efficiency in investments.

When the scale of a community was small and the pace of its change slow, such coordination could have been achieved without a formally structured urban planning function. When urban development in the community was changing slowly or following the past trends, a periodic review of a master plan document would have been sufficient as a tool of coordination. However, there is every indication that Gran Puntarenas would be a focus of dynamic socio-economic change expected in Costa Rica in next twenty years. Characteristics of such a change would be quite different from what was observed in the past in terms of its scale and pace. In order to accommodate expected momentum for change and growth, existing decision making process for urban planning should be reviewed and upgraded to cope with the new reality.

Urban planning as a decision making process has two major aspects; policy determination and policy effectuation. Urban planning is first and foremost a process through which a community determines a coherent set of long-range policies for the betterment of its physical environment. Implicit in this statement is a need for a public forum where all the interested parties of the community can take part in deliberation and debates. All major alternatives open to the community should be considered and evaluated in the forum.

Urban planning is at the same time a process of effectuating determined policies. All major decisions or projects which might have substantial impacts on the quality of physical environment of the community should be assessed against the determined set of long-range policies.

In the long run, success of regional development will be very much dependent upon the kind of urban living environment which the region could offer as more and more people will be living in urban areas in the near future. This is particularly true in Gran Puntarenas because its urban living environment should be pleasant and efficient enough to attract people from its hinterland who would otherwise move to the Meseta Central Region.

7.1.2 Terms of Reference

Terms of reference for this chapter on urban planning may be summarized under three headings which correspond with three sections following this introduction.

(a) Progress to Date and Assessment of Present Situation

In terms of progress to date in urban planning, there are two major planning documents for Gran Puntarenas; Plan Director prepared by the Instituto Nacional de Vivienda y Urbanismo (INVU) in 1969 and Estudio de Desarrollo Urbano Integral de le Zona Puntarenas-Barranca-Caldera prepared by the Ingenieros de Centroamerica Ltd. (INDECA Ltd.) in 1975. The former has been adopted as an official general plan for the area since 1970 in accordance with the provisions of the Urban Planning Law of 1968. The latter was commissioned by the Instituto Costarricense de Puertos del Pacifico (INCOP) as a review of the former to take into consideration possible impacts of the construction of the Port of Caldera and other projects not foreseen at the time when the INVU prepared the original study. These two studies are to be examined in the following part of this chapter and are to be related with existing urban development in the study area.

(b) Urban Growth Potential

On the basis of the evaluation of the two documents and existing urban environment in the study area, development potentials and problems are then to be identified. Mention is to be made of the policy to correct regional disparities and to decentralize industries in Costa Rica. A set of objectives for the urban development in the study area is to be formulated with a view to its regional implications.

(c) Development Policy Alternatives

In the light of the analysis of past progress and existing situation and on the basis of the assessment of development potentials, possible alternative courses of action for the future are then to be identified. Some alternative scenarios for the urban development in the study area are to be postulated to assess their possible implications. Some policy alternatives for land use and circulation in the study area are to be recommended for consideration. In order to effectuate chosen policy alternatives, the setting-up of proper administrative tools is essential. Some comments are to be made along this line of consideration.

7.2 Progress to Date and Assessment of Present Situation

7.2.1 Plan Director

As mentioned earlier, a planning document prepared by the urban planning group of the INVU with a title "Plan Director Puntarenas" has been in force as the official plan to guide the urban development of the study area since 1970 in accordance with the provisions of the Urban Planning Law of 1968. A brief explanation of urban planning administration in Costa Rica is given here to facilitate the understanding of those readers who are not familiar with it.

(a) Urban Planning Law of 1968

The Urban Planning Law of 1968 is the basis for urban planning administration in Costa Rica. Its provisions are divided into three parts; Part One dealing with the National Urban Development Plan and creation of the Urban Planning Office within the INVU, Part Two dealing with the formulation of general plan and other regulatory means for local urban planning and Part Three describing other supporting stipulations including expropriation of land for public purposes.

The National Urban Development Plan is the statement of urban development policy at the national level. Its objectives are to realize orderly growth of urban centers, to establish satisfactory balance between urban and rural development by properly distributing population and economic activities, to develop urban areas which would achieve the best utilization of natural and human resources and to promote investments for the improvement of living conditions. The Urban Planning Office created within the INVU is to take charge of preparation and updating of the National Urban Development Plan in cooperation with the OFIPLAN. The Urban Planning Office is empowered also to offer planning services and to make recommendations to municipalities. It can also review proposed general plan documents before adoption by municipality, examine urban development proposals before approval, and reject them if they violate provisions of the Urban Planning Law.

Section 15 of the Part Two of the Law gives jurisdiction over urban planning to the municipal or canton level of government, subject

to the veto power of the Urban Planning Office of the INVU. The main instrument of urban planning at the municipal level is "Plan Director" or urban general plan. Such a plan should cover the following aspects:

i) Statement of general policy for urban development,
ii) Demographic study including its projection and distribution,
iii) Land use plan,
iv) Circulation plan for streets and terminals,
v) Plan for community facilities such as schools, parks, playgrounds, hospitals, libraries, museums, markets etc.,
vi) Plan for public utilities such as water, gas, sewer, drainage, waste disposal etc.,
vii) Urban renewal plan for conservation, rehabilitation, and redevelopment.

The municipal council must hold a public hearing and obtain approval from the INVU before adopting a general plan officially. In order to implement provisions of the general plan, the municipality may enforce local ordinances or by-laws in the following areas:

i) Land use zoning,
ii) Subdivision regulations,
iii) Official map designating public rights-of-way and land for public purposes,
iv) Urban renewal actions for deteriorated or deteriorating areas, and
v) Building codes.

In general, the Urban Planning Law of 1968 has adequate provisions for regulating urban development in the study area.

(b) Instituto Nacional de Vivienda y Urbanismo (INVU)

The INVU or National Institute for Housing and Urban Planning is an autonomous national corporation founded in 1954 for the purpose of promoting housing and orderly urban development in Costa Rica. Basically, the INVU has three major functions; developer, loan lender, and planner. As a developer, it can construct, sell or lend housing for those Costa Rican families who cannot otherwise afford adequate housing by themselves. As a loan lender, it can issue public bonds and provide mortgage loans for housing. As a planner, it establishes the Urban Development Plan at the national level and offers planning services to municipalities as mentioned before. With combined ability to plan, raise money and implement, the INVU is a powerful agency for the improvement of housing and urban development in Costa Rica. Because both technical expertise and financial resources are very limited at the canton level of government, the INVU should be playing a central role for the planning of urban development of the study area.

(c) Plan Director

The foregoing explanation of the Urban Planning Law of 1968 and the INVU should be adequate to make clear the characteristic of the Plan Director. The document was prepared by a team of professionals under the direction of Leonardo Silva King in 1969 and officially adopted in April 1970.

The study was composed of three parts; first part giving a general introductory remarks, second part providing a detailed analysis of then existing situations in the study area and third part dealing with conclusions and recommendations. The area covered by the study includes the old town on the sandbar, Chacarita, El Roble and Barranca extending eastward up to the Inter-American Highway. A target year of 1980 was adopted for projection purposes.

Aspects covered by the analysis of existing situation are demographic and employment study, socio-cultural study, land use, basic social capital including community facilities and housing, public utilities, and industries and commerce. Major conclusions and recommendations of the Plan Director are now presented in a summary form.

i) Geophysical Aspects

Due to natural limitation, the city cannot expand within the old settlement. Therefore it should be developed toward east in the direction of Barranca. In addition, the filing-in of the Estero near Pueblo Nuevo is regarded as a necessity to provide industrial sites that require access to the waterfront.

ii) Population and Employment

Population of Puntarenas City has grown at the same rate as the national population of Costa Rica. Given a general trend toward urbanization, Puntarenas should develop industries to increase gainful employment in order to mitigate the flow of migration.

iii) Social Aspects

Public apathy is considered a problem; and the promotion of community development associations is advocated.

iv) Land Use and Urban Expansion

Incompatible land uses occurred due to the lack of urban development plan in some areas. Buffer green belts should be developed to protect public health.

v) Basic Social Capital

Deficiency in the number of classrooms and teachers if noted in primary and secondary schools. Creation of a vocational training school at the secondary level is recommended. The construction of replacement housing is recommended to eradicate deteriorated housing areas in the city.

vi) Utilities

Improvement of water supply system is recommended as a high priority. The poor condition of sanitary sewer is noted as a serious problem for further study. In terms of transportation, the construction ofan alternative coastal scenic route is recommended to alleviate the traffic bottleneck near Angostura.

vii) Industry and Commerce

Fishing and tourism are recommended as two major sources of employment. To promote fishing industry in the area, construction of a fishing port and a fish market is recommended as well as the initiation of public education campaign to increase local fish consumption.

Many proposals presented in the Plan Director may be considered still valid today, although some proposed projects such as coastal touristic road have not been materialized. In 1973, however, the Government of Costa Rica made a decision to locate a new international deep-water port at south Caldera upon recommendation forwarded by a Japanese consulting mission. In connection with this decision, the proposed South Coastal Highway was re-routed to be connected with the existing Inter-American Highway near Barranca via Caldera and El Roble rather than at Esparta where its connection was originally proposed. At the same time it was also decided that the South Coastal Highway is to be connected with a proposed alternative highway to San Jose at the inter-change near the city of Orotina. In view of these projected developments which were not envisaged when the Plan Director was prepared, a commission was given to the INDECA Ltda. to review and update the Plan.

7.2.2 INDECA Report

The INDECA Report is a culmination of the planning study undertaken by a team of experts under the direction of Eduado Jenkins Dobles of the INDECA Ltda. in 1975. The objective of the study is "to plan development of the general area between Puntarenas, Barranca and Caldera in such a way that the construction of the new port would not mean economic and social damage for Puntarenas, but on the contrary, and to ensure the urban expansion in the area which could be called Gran Puntarenas to be rational, healthy, safe, attractive and in harmony with the ecology of the area."

The report first reviews past activities at the port and examines proposals contained in the Plan Director. Gran Puntarenas in this report is defined as the area composed of the Districts of Puntarenas, Barranca, Esparta, San Juan Grande and Macacona. The total population in this area were 43,279 of which 31,030 were classified as urban according to the 1973 population census. The District of San Juan Grande is essentially rural but it is included in the definition because the new Port of Caldera itself is located in this District.

The study also defines a zone of influence of Gran Puntarenas which extends northward up to Chomes and Punta Morales and southward to the Rio Grande de Tarcoles, containing total population of 65,291 in 1973.

The report then enumerates probable activities which might have impacts on the future urban development in the fields of port and port-related activities, transportation, storage, tourism, industry and fishing. On the basis of these probable activities, population in Gran Puntarenas is projected to grow to 73,773 in the year 1990, requiring about 152 hectares of additional land for urban development.

Employment forecast in the basic sector of economy is used as a basis for this population projection. It is assumed that one job in the basic sector has a multiplier effect of creating two additional jobs in the service or non-basic sector. Subdividing the total number of jobs in both sectors by the assumed labour participation ratio produces a projection for a total population. In the report it is projected that a total of 4,544 new basic jobs would be created, resulting in a total number of new jobs of 13,632 (4,544 + 4,544 x 2). The addition of this number to the existing number of employment of 14,003 results in a total projected employment of 27,665 for the year 1990. Subdividing the total employment by a projected labour force participation ratio of 37.5 percent, a total population forecast of 73,773 can be obtained (27,665/0.375). The projected basic jobs of 4,544 consist of the following components: ports 1,545, transportation 52, plant of the National Production Council 89, tourism 732, new industries 502, Fertica expansion 233, expansion of existing industries 1,375, fishery 293 and construction 693.

The report then postulates standards for area requirements of a neighbourhood unit for 10,000 inhabitants. In residential neighbourhood a gross density of 140 persons per hectare is recommended as a standard. If residential area represents two thirds of the total urban area, an overall population density becomes about 100 persons per hectare. Applying these standards against the available land for urban development, the report states that there is a land area sufficient to accommodate the expected growth of population well beyond the year 2000. A total area of 2,188 hectares is evaluated as suitable for urban development in Gran Puntarenas. This projection of land requirement concludes the analytic portion of the report.

The proposal portion of the report begins with a statement of goals, objective, and strategies for development. This is followed by recommendations on land use zoning, transportation and terminals, community facilities and utilities.

The remaining portion of the report deals with the identification of priorities, financial measures and administrative organization for implementation.

In short, the INDECA report is a comprehensive compendium of information on the existing and expected development projects and provides a solid planning framework for the urban development in Gran Puntarenas. Its scope of concern is limited basically to the aspect of urban physical development in Gran Puntarenas, as specified in the terms of reference. In order to make assessment of the feasibility of its proposals, however, two other major fields of concern have to be investigated; they are first, a study of industrial development potentials and feasibility and second, a coordination with the national policy on regionalization. The two aspects are in fact interrelated as both are concerned with the future role of Gran Puntarenas in terms of development policy at the national level. This current study of Japanese mission with its emphasis on industrial potentials is expected to complement the INDECA report in this respect.

7.2.3 Present Situation

(a) General

The City of Puntarenas, the capital of the Province of the same name, is located on a narrow sandbar which penetrates into the Gulf of Nicoya. The sandbar is about 7 kilometers in length and 700 meters in width in the downtown. Its topography is flat and does not exceed 5 meters above the average sea level and two meters above high tide. The climate is tropical and rainfall is intensive from May to November, resulting in the annual rainfall of about 2,000 milimeters. The dominant wind blows from the south in the winter and from the north in the summer. The summer season begins in November and ends in April, attracting a great number of tourists along the beaches near the port.

Puntarenas was mentioned as a port as early as 1765 and officially recognized as a port in 1814. The first development plan of the city was laid out in 1840 to be known as the Carrillo plan. Puntarenas obtained a city status in 1858. Existing wharf structure, constructed in 1929 with a planned capacity to handle 160,000 tons a year, is now handling over 600,000 tons a year, resulting in a costly delay in shipping operation.

The government for the Canton of Puntarenas or the Central Canton of the Province governs the City of Puntarenas. There is no political entity which solely governs the urban portion of the Canton which extends to Jaco and Chomes, stretching farther to the other side of the Gulf of Nicoya. The south side of the Barranca River belongs to the Canton of Esparta. Therefore, the area defined as Gran Puntarenas in this report is divided into two political entities; Cantons of Puntarenas and Esparta. The city of Esparta is located on a plateau about 200 meters above sea level with a population of about 5,000. The topography in the Canton of Esparta is hilly and development is limited to flat table lands on the hill and narrow coastal plains.

(b) Urban and Rural Population

As mentioned earlier, Gran Puntarenas is defined as an area composed of the districts of Puntarenas, Barranca, Esparta, San Juan Grande, and Macacona. According to the 1973 Census, urban and rural population in Gran Puntarenas were distributed as shown in Table 7.1.

Table 7.1 Population of Gran Puntarenas

Districts	Urban	Rural	Total
Puntarenas	26,331	609	26,940
Barranca	-	5,883	5,883
Esparta	4,699	1,987	6,686
San Juan Grande	-	1,465	1,465
Macacona	-	2,395	2,305
Total	31,030	12,249	43,279

Source: 1973 Census of Population

(c) Land Use

General description of and some comments on the existing land use pattern of Gran Puntarenas are to be briefly mentioned here.

1. Puntarenas Sandbar

The central urban core of Gran Puntarenas is located on a narrow protrusion of a sandbar which extends for a distance of about seven (7) kilometers to the Nicoya Gulf. The south side of the sandbar is a long pleasant beach extending over its full length, catering mainly for domestic tourists. The north side of the sandbar facing the Estero is dotted with fishery-related small industrial establishments. The National Pier of the Port of Puntarenas is projecting across the beach on the south part of the sandbar. The Terminal of the Electric Railway of the Pacific is located near the pier area.

Dominating urban functions on the sandbar may be classified into four groups: 1) port and port related activities; 2) tourism; 3) fishery and 4) commerce and services. This part of Puntarenas has been almost fully developed, containing a population of about 20,000 over an area of about 160 hectares.

2. Chacarita

Chacarita is the general area around the existing airport near the base of the sandbar. At present, it contains a mixture of

fair to poor housing as well as the airport and a cemetry. The airport is to be relocated to Zapotal because it is dangerously close to the surrounding residential quarters.

Immediately to the east of Chacarita, there is a large-scale fertilizer factory called "Fertica."

The area appears to represent a poor mix of incompatible land uses. It is clear that no residential development should have been allowed in this area in the first place. It is now not only difficult but costly to eliminate incompatibility of land uses in this area.

3. El Roble-Barranca

In this area of Gran Puntarenas, one can observe a linear equivalent of what is known an urban sprawl. Here, a cluster of new housing and industrial developments are rather sparingly located along major thoroughfare, intermixed with a spacious expanse of agricultural land.

With the introduction of the Port of Caldera and the construction of the Barranca-Caldera part of the South Coastal Highway, El Roble will become the center of gravity of Gran Puntarenas Large tracts of open land are still available in this area. It is highly important to prepare a detailed development plan to guide its future development in advance, in order to avoid repeating the mistake in Chacarita.

The low-lying land in the El Roble area has been known to have a drainage problem in the rainy season. Before any urban development is allowed to take place in the problem area, it is essential to conduct an engineering study on the feasibility of the construction of a drainage network. Those areas which cannot be economically provided with an adequate drainage system should not be developed for urban purposes.

4. Caldera

Apart from the construction of the Port of Caldera, urban development in this area is currently limited to tourist and resort buildings near Mata de Limon. The large estuary is mostly covered with mangrove trees. Piecemeal filling-in of the mangrove estuary should be avoided to preserve its ecological balance.

Flat land suitable for the urban development is in a short supply in the Caldera area. Only large flat tract of land is located near the Salinas station about three kilometers east of the Port site.

Hill-side land should not be developed in order to protect its vegetation and soil and to preserve its natural land scape.

5. Esparza

Esparza is a small community on a plateau approximately 200 meters above sea level at distance of about 10 kilometers,

from the proposed El Roble interchange along the highway. Although it is small, the town is laid out on the traditional grid system with a pleasant plaza facing a church.

A cursory examination of topography shows that sufficient land is available near the existing settlement to accommodate additional population of about 40,000. Since this area was not examined in the INDECA Report, information is not available to make a further assessment at present.

(d) Circulation

The city of Puntarenas is a center of the regional transportation network. Main highway connecting the sandbar with the mainland is Route 17 which joins Inter-American Highway at Barranca. Another important inter-city connection is a ferry service to the Nicoya Peninsula with a terminal near the Punta. Two points may be pointed out with respect to the inter-city traffic. One is the bottleneck near Angostura where the Route 17 becomes a narrow two-lane pavement squeezed between the railway and the Estero. In fact all activities on the sandbar depends on the portion of the Route 17 as far as land transportation is concerned. The other is a high volume of through traffic caused by the ferry service in the center of the old settlement.

In terms of public transportation, Puntarenas is served well by the railway, airport and bus. Bus is particularly popular as it offers a fast reliable service at resonable charges. There is, however, no central bus terminal at present. Various street corners are used as bus depots for inter-city services. Passengers off the ferry boat have to take inter-city bus line to one of the street corner depots to have a ride on an inter-city bus. Paved feeder streets are limited to the old settlement on the sandbar and to the urban area of Esparta. There are still some undeveloped streets even in the old part of Puntarenas. They are, however, expected to be improved after the completion of the sewer system.

Apart from private cars which are largely limited to the affluent segment of the community, predominant means of circulation within the urban area is bus on fixed routes. There are also a limited number of taxis which cruise on streets. As more people will be living in the Chacarita-El Roble-Barranca areas, efficient transit connection between the city center and these residential areas becomes increasingly important.

Gran Puntarenas is expected to experience a dynamic improvement in highway network in the near future. With the completion of the port of Caldera, a portion of the South Coastal Highway between Caldera and Inter-American Highway via El Roble would be completed. This part of the Highway is designed as a limited access highway with grade-separated interchanges at El Roble and Barranca. At first this highway will serve mainly as an access road to the port of Caldera but in the future it will be connected with the Caldera-San Jose Highway and the South Coastal Highway which runs southward along the Pacific coast to Quepos and Palmar.

Readers are referred to Chapter IX "Transportation" for more comments and recommendations on the transportation network of the Gran Puntarenas area.

7.3 Urban Growth Potential

7.3.1 Regional Perspective

The city of Puntarenas is the dominant urban center of the Central Pacific Region which is one of the six planning regions of Costa Rica adopted by the OFIPLAN. Future role of Puntarenas in a regional perspective should be considered in terms of the Central Pacific Region. The Region is composed of the Cantons of Central, Montes de Oro, Esparta, Parrita, and Aguirre in the Province of Puntarenas, the Cantons of San Mateo and Orotina in the Province of Alajuela, and the Canton of Turrubares in the Province of San Jose. According to the 1973 population census, the Region has 127,167 inhabitants, representing about 6.8 percent of the total population of the country. Some salient characteristics of the Region's population are examined in this section with a view to arriving at a reasonable population target for the development of Gran Puntarenas in the regional framework. Breakdown of population by districts of the Region is shown in Table 7.2.

Table 7.2 Urban and Rural Population of the Central Pacific Region

Canton	Urban	Rural	Total
Province of Puntarenas:			
Central	26,331	39,231	65,562
Montes de Oro	1,673	5,306	6,979
Esparta	4,699	7,396	12,095
Parrita	1,365	10,536	11,901
Aguirre	2,155	12,318	14,473
Province of Alajuela			
San Mateo	489	2,480	2,969
Orotina	3,170	5,309	8,479
Province of San Jose			
Turrubares	212	4,497	4,709
Total	40,094	87,073	127,167

Source: 1973 Population Census

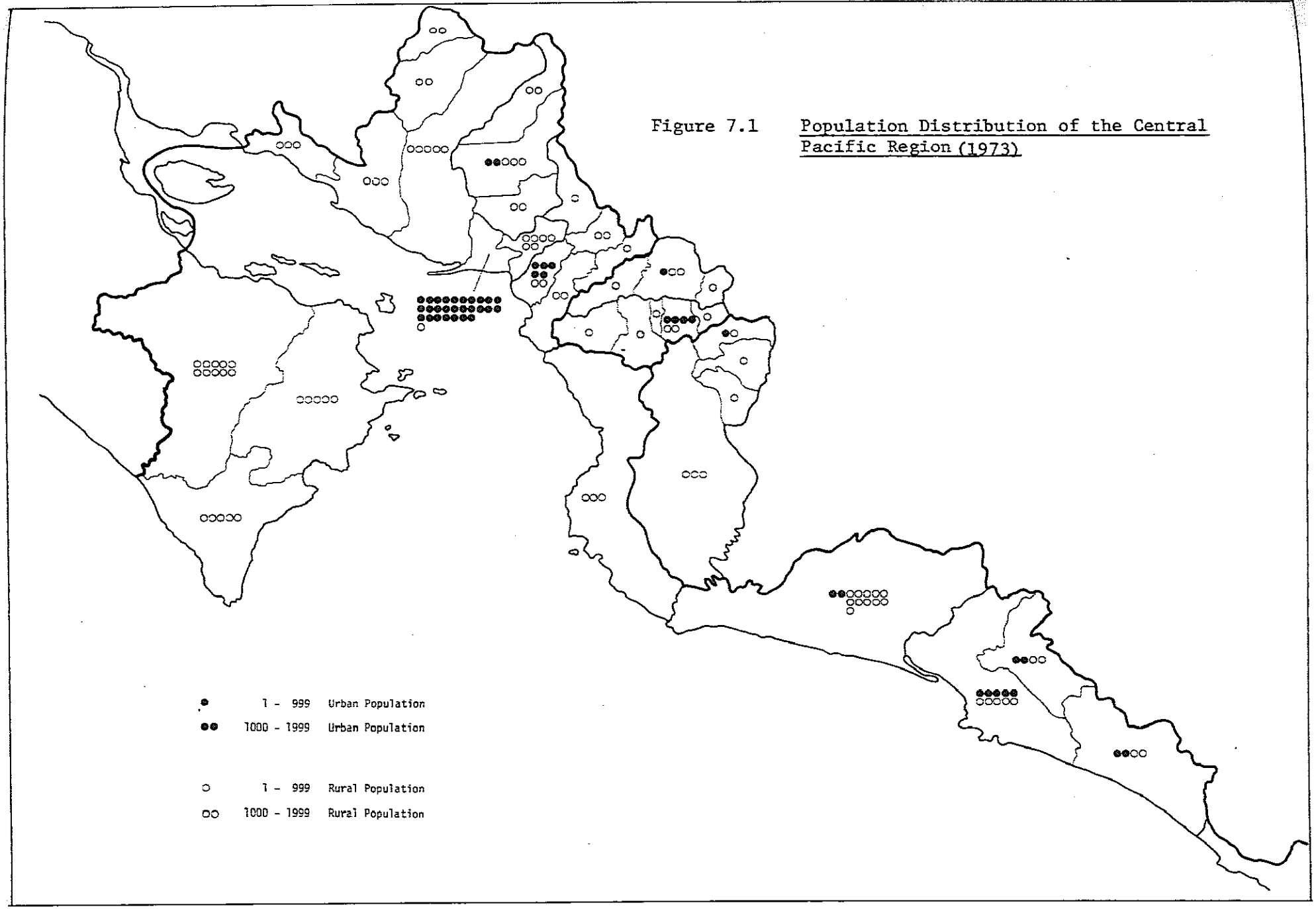

Figure 7.1 Population Distribution of the Central Pacific Region (1973)

As can be seen from the table, the population in the region is only 31.5 percent urbanized, with Puntarenas being the only urban conglomeration with urban population exceeding 5,000. Average overall population density in this region is 27.7 persons per square kilometer.

According to a study prepared jointly by the OFIPLAN and the IDESPO of the National University of Costa Rica, the Region experienced a net out-migration between 1963 and 1973 for all age groups. In the decade, population of the region nominally increased from 107,302 to 127,139.1/ This is, however, far below the number which would have been achieved without out-migration.

If the same trends continue, the population study indicates that the region's population would start declining after achieving a maximum number of 136,200 as shown in Table 7.3.

Table 7.3 Population Projection with Migration
Central Pacific Region

Year	Women	Men	Total
1963	52,245	55,057	107,302
1973	62,069	65,079	127,139
1978	63,872	67,029	130,901
1983	65,602	68,871	134,412
1988	66,532	69,668	136,200
1993	66,545	69,607	136,152
1998	65,863	68,841	134,704
2000	65,386	68,339	133,725

Source: Proyecciones Regionales de la Población de Costa Rica, OFIPLAN and IDESPO, September 1976.

1/ The figures used in this study are slightly different from the Census due to the difference of dates. The OFIPLAN study is based on data taken on July 1st while the Census is counted on May 14th.

The same study indicates, however, if migration does not take place at all, the region's population would increase as shown in Table 7.4.

Table 7.4 Population Projection with No Migration Central Pacific Region

Year	Women	Men	Total
1973	62,069	65,070	127,139
1978	73,167	74,428	147,595
1983	83,411	84,740	168,151
1988	93,536	94,893	188,429
1993	103,502	104,913	208,415
1998	113,358	115,004	228,362
2000	117,329	119,207	236,536

Source: *Proyecciones Regionales de la Población de Costa Rica*, OFIPLAN and IDESPO, September 1976.

In other words, the Region's population would reach 236,536 if the net migration is nil. This figure may then be taken as a modest target for the development of the Region.

Another population study prepared by the OFIPLAN with a title "OPCIONES PARA LA DISTRIBUCION ESPACIAL DE LA POBLACION DE COSTA RICA EN EL ANO 2000" provides a set of regional population projections based on land use and its productive capacity. According to this study, in the year 2000 the Region's population would be able to hold only 107,191 even if the use of land is optimized, or 71,293 if present trends of land use continue assuming that no new secondary industry takes place in the Region. This study also shows that the rural areas of the Region would be able to hold only 49,479 or about 50,000 in the year 2000, even if the use of land is optimized.

The Central Pacific Region excluding Gran Puntarenas had a population of about 84,000 in 1973. Again sustaining of this level of population within the Region outside Gran Puntarenas seems to be a reasonable but modest target for the development. The above discussion may now be summarized in Table 7.5.

Table 7.5 Target of Urban and Rural Population Distribution; Central Pacific Region

	1974	2000
Gran Puntarenas		
Urban	31,030	140,000
Rural	12,249	13,000
Outside Gran Puntarenas		
Urban	9,064	34,000
Rural	74,824	50,000
Total	127,167	237,000

7.3.2 Urban Development Objectives

(a) National Policy on Urban Development

In formulating development objectives for Gran Puntarenas, mention should be made of the policy of the Government of Costa Rica to avoid excessive concentration of population in the Meseta Central Region. The Central region at present contains more than 60 percent of the national population and more than 80 percent of the nation's urban population. The majority of industrial, commercial and financial activities of Costa Rica are found in this Region.

A report prepared by the OFIPLAN with a Title "Consideraciones para la Definición de una Política de Desarrollo Urbano" indicates that outside the Central Region only Limon on the Caribbean side and Puntarenas on the Pacific side have potentials for future industrial development. The same study suggests that population of Gran Puntarenas would be able to grow to 150,000 if a concerted effort is made for its industrial development. This figure roughly approximates the target population of 153,000 for Gran Puntarenas mentioned earlier in this Chapter.

(b) Industrial Development Objective

In order to sustain the population of 150,000 in Gran Puntarenas, it is tentatively estimated that some 10,000 new jobs must be created in the basic sector in Gran Puntarenas by the year 2000.

From the urban planning perspective, topography of the Gran Puntarenas area provides sufficient land which may be developed to accommodate such a level of development without excessive construction costs. Elsewhere in this report an evaluation of industrial potential of Gran Puntarenas for achieving such a development target is to be made by industrial development experts.

This section of the Report is not suggesting at this moment that the target of creating 10,000 new jobs in the industrial sector is feasible or achievable. This evaluation should be based on a detailed feasibility study for each type of industry. Notwithstanding this qualification, it is recommended that the population of 150,000 should be adopted as a target for urban planning purposes. Staging for the realization of urban development proposals should be adjusted findings of the industrial feasibility studies.

(c) Development of Urban Core

To complement the policy on industrial development, a policy on urban development to provide attractive living environment should be established. This is particularly important in Gran Puntarenas because apart from the old urban core on the sandbar, there is no focal point of urban activities which could be developed as the heart of a city of 150,000 people. The old core would not be able to play such a function because of its poor accessibility and shortage of land for its expansion.

Development of the secondary urban core should be give a high priority for the future urban growth of Gran Puntarenas. El Roble, being the gravity center of Gran Puntarenas, can be suggested as a possible best location for the development of the secondary urban core.

7.4 Development Policy Alternatives

7.4.1 Alternative Scenarios

For the purpose of stimulating discussions, the following three scenarios for the future of Gran Puntarenas are presented.

(a) Scenario One

If population of Gran Puntarenas grows with the same rate as population of Costa Rica as a total, as found in the Plan Director, the 1973 population of 43,279 will grow to about 75,000 by the year 2000. The figure indicates an increment of only 32,000 over a period of 27 years. In order to sustain this level of population, a total of some 12,000 gainful employment should be created. This target appears to be achievable with the expected activities at the port of Caldera and a limited development in fishery and tourism without a large input to

stimulate the manufacturing employment sector, if the existing industrial sector shows a stable growth. Because of the slow rate of population growth, it would not be feasible to develop a secondary urban core. Emphasis on new development would have to be limited to facilities for domestic tourism and recreation. In this scenario, the Central Pacific Region would lose some 100,000 persons due to out-migration, because it is estimated that the Region could hold only some 130,000 inhabitants if the present trends of migration continue through the year 2000.

(b) Scenario Two

Scenario Two envisages population of 75,000 by 1990 and 100,000 by 2000. This level of growth is the one foreseen in the INDECA report. An increment of population by the year 2000 in this scenario is some 57,000 over a period of 27 years. If the labor force participation rate of 37.5 percent is employed, additional 21,000 jobs must be created. If one third of the total jobs should be in the basic sector, some 7,000 jobs should be created in that sector of economy. Discussions in the INDECA report suggest that this level of growth would be the maximum feasible target on the basis of what can be reasonably foreseen at present, although this judgement is only tentative.

(c) Scenario Three

Scenario Three is the future envisaged in the statement of the national policy on regionalization and urbanization. As pointed out earlier, in order to stop the out-migration of people from the Central Pacific Region and thereby to relieve the population pressure on the Meseta Central, Gran Puntarenas should be growing to a metropolitan area of 150,000 inhabitants by the year 2000.

Table 7.6 Development Policy Alternative Scenarios
Population of Gran Puntarenas

	1973	2000
Scenario 1 [Plan Director]	43,279	75,000 (12,000)
Scenario 2 [INDECA Report]	43,279	100,000 (21,000)
Scenario 3 [OFIPLAN]	43,279	150,000 (40,000)

( ) indicates the number of new employments required.

In order to sustain this level of growth, some 40,000 new jobs must be created in the community. There is an intuitive feeling that this rate of growth could not be achieved without a strong and a concerted commitment of the national government for the decentralization of manufacturing industries. Development of agro-industry would not be sufficient to cope with this rate of growth because it has to be geared to the slow-growing agricultural production.

More investigations are needed to evaluate relative merits and demerits of the three scenarios for the future of Gran Puntarenas. Whichever avenue is taken, urban development strategy should be coordinated with regional and industrial development policies at the national level.

7.4.2 Urban Development Policy

Some suggestions on urban development policy are stated for each part of Gran Puntarenas in this section. Reference should be made to the map of land use study.

(a) Puntarenas Sandbar

Because of its beautiful beach and unique geographic setting, old Puntarenas on the sandbar has a big potential as a tourist and recreation center for the domestic market.

The Estero side of old Puntarenas could be developed for fishery port and fishery related industry. With proper precaution and improvement of wastewater control, this development may not be detrimental but rather complementary to the touristic development.

Pollution of water particularly in the Estero requires immediate attention. Further comments on this problem should be made elsewhere in the report.

A proposal to reclaim the indented part of the Estero side of Pueblo Nuevo by dredging came to the attention of the mission during its field study. The project could provide some 20-25 hectares of much needed land along the waterfront. It merits a further study as it can be envisaged as a site for an integrated fishing port/fish processing complex. It may also provide enough space for a ferry/bus terminal and also for a sewer treatment plant.

The mission was advised that an economic feasibility study undertaken by the INVU some years ago found the project not feasible mainly because of a high cost of steel sheet-piling. There are, however, some indications that suggest a possible change in this situation. For example, an introduction of off-shore fishing may increase the amount of catch and thereby require more land for the processing industry. Rising land value in the city center, employment of a construction method less expensive than the steel sheet-piling and possible

sharing of dredging cost with the fishery port authority are among the factors which may favourable affect the feasibility of the project. A review of the feasibility study is recommended, taking these factors into consideration.

The rehabilitation and improvement of the old city core is essential for the promotion of tourism. Experience elsewhere shows that the delapidated downtown is not only a physical problem but also a social one as it tends to attract those who are less adaptable than others to rapid social changes. In order to be successful, measures for the physical renewal of the old city core should be coordinated with efforts for social development. A program for job training should be initiated to provide greater opportunities for local residents to benefit more from the projected industrial promotion.

The stability of a sandbar is based on the balance of sand movement. As any development project which would have influence upon the movement of sand along the coastal line between the Boca de Barranca and the Punta might endanger the stability of the sandbar, a careful analysis of sand movement in the water should be conducted before any such project is implemented. A project to control the flow of water of the Barranca river, for example by a dam, might affect the stability of the sandbar because it would reduce the supply of sand at the mouth of the river.

(b) El Roble-Barranca

This area can be envisaged as the future secondary center of Gran Puntarenas. It already has a hospital and a vocational school. More public facilities are also in the offing in the Socorrito area. At present, however, there is no coherent system of urban development such as the grid layout of old cities nor any visual focal point of activities.

Across the highway from the INVU development, a private development called "Villa del Mar" is being promoted. This is an urbanization oriented to a domestic leasure house market. If successful, it would be a good indication of the development potential of El Roble.

El Roble appears to be a desirable location for the construction of a bus/railway transportation terminal for inter-city traffic. There should be an efficient public transit service connecting the El Roble Terminal with the Ports of Caldera and Puntarenas.

The existing Fertica plant should be contained by a buffer green belt. (Elsewhere in the report, pollution control measure for the plant should be mentioned by experts).

It is suggested that major bulk of future population in the order of 70,000 persons are to be housed in the El Roble/Barranca area

to avoid costly scatteration of settlements. Residential areas could be developed as a cluster of neighborhood units as suggested by the INDECA Report.

In the area near Barranca, to the north of existing CNP Plant, a development of an agro-industrial park is recommended for consideration. This area is located at the strategic hub in terms of the regional highway network. In addition to agro-industry, an assortment of light to medium industrial activities may be located in this industrial park. The provision of a planned industrial park may be publicly promoted as an incentive for industrial development.

(c) Caldera

As mentioned earlier, available flat land is scattered in small parcels at Salinas, Alto de las Mesas and Altieda. Each of the three zones may not be able to hold more than 10,000 inhabitants. It is suggested here that no intensive urban development should be allowed in the Caldera area except for some commercial development in Mata de Limon and transport-oriented installations (e.g. warehousing and trucking) in Salinas.

The Caldera-El Roble portion of the South Coastal Highway is currently designed as a limited-access divided motorway. No direct access to this highway is envisaged between the Port and El Roble.

A limited development of industrial site with direct berthing capacity may be realized in or near the second or later stage development of the Port of Caldera. However, it is recommended that a waterfront site for heavy industry should be sought outside the Gulf of Nicoya to protect its environment and touristic trade.

Between the Boca de Barranca and Roca Carvallo, two tourism-oriented projects are envisaged; namely, Playa Dona Ana and Riviera del Pacifico. Domestic demand for recreational facilities will increase as Costa Ricans becomes more affluent with the future economic development.

The mission took a favorable note of an idea to create an artificial salt-water lake at the mouth of Mata de Limon by controlling the tide by means of a dam. However, it is recommended to carry out an ecological and botanical study of the vulnerability of mangrove trees to changes of the tide water level.

(d) Esparza

Possibility to develop Esparza into a residential community is suggested for a further study. Experience elsewhere in the world shows that an expansion of an old community is preferable to the creation of an entirely new settlement for migrants in terms of social integration.

In addition, Esparza seems to offer a better climate and environment attractive to white collar workers, than coastal settlement. Provision of an efficient public transit system would be a pre-requisite for the expansion of Esparza as a satellite community of Gran Puntarenas.

7.4.3 Implementation Policy

One of the essential requirements for the implementation of a coordinated urban planning policy in Gran Puntarenas is the creation of a workable institutional framework. As far as the Urban Planning Law of the Republic is concerned, the responsibility for urban planning is clearly vested with the Canton level of government. Present municipal governments in the area are, however, not adequately equiped with necessary human and financial resources to undertake urban development envisaged in Gran Puntarenas.

The INDECA Report suggests the following five possible alternatives for the establishment of a responsible implementing agency for the development of Gran Puntarenas.

(a) Local Development Corporation

A special purpose local development corporation is often used for the implementation of a project of national importance in various countries. It is usually vested with broad executive powers to overcome many limitations inherent in traditional governmental bureaucracy.

(b) Regional Development Board

On the Caribbean Coast, the JAPDEVA is vested with powers to plan and implement development projects in the region. The INCOP may be reorganized in a similar way to act as a regional development agency.

(c) Municipal Federation

It is possible for the two Canton governments of Puntarenas and Esparza to form a federation for implementing the urban development. The federation may create a subsidiary corporation for the purpose of urban development.

(d) Development Council

Another alternative is to create a development council with representatives from various government agencies. The main function of such a council tends to be coordinative rather than executive.

(e) Executive Commission

An executive commission could be formed with a relatively small number of personnel to perform the responsibility. The performance of such a commission depends greatly upon personalities of its key persons.

To evaluate pros and cons of the five alternatives, one should distinguish regional planning agency from urban planning agency. To plan and implement a set of regional planning policies for a region as large as the Pacifico Central Region, a cordination among various public agencies is essential in a country like Costa Rica with a tradition of diversified autonomous public institutions. The concentration of executive powers into a single corporate body may not be effective in such a political environment as it tends to conflict with functional government bureaucracy.

At the regional scale, therefore, it is recommended to establish a regional development council for the entire Pacifico Central Region as the coordinating agency for various public authorities. It is logical to expect the OFIPLAN to play the leading role in such an organization.

On the other hand, the implementation of urban development proposals could be effectively carried out by a single-purpose corporation with broad executive powers. The reorganization of the INCOP to include the urban development of Gran Puntarenas in its executive responsibilities seems promising for the purpose. Such a development board should be authorized to plan, program and implement various projects within policy guidelines set by the above mentioned Regional Development Council.

CHAPTER VIII

ENVIRONMENTAL AFFAIRS

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8.1 Introduction -- Population Concentration in the Meseta Central

Costa Rica is a beautiful country with a mild climate and verdant almost all the year round. Good quality water is plentiful especially in the central plateau area. Although the country is situated in the tropical zone, 10 degrees northern latitude, the climate is quite moderate in the high volcanic plateau, more than 1,000 meters above sea level.

Compared with Japan, the population of Costa Rica is one fiftieth that of Japan; land area is about one seventh, that is, nearly equal to the combined areas of Shikoku and Kyushu.

The capital of the country, San Jose, is situated in the central plateau. More than one third of the total population is concentrated in the province of San Jose and neighboring provinces, i.e., about 73 percent of the total population lives in four land-locked provinces, San Jose, Alajuela, Cartago and Heredia. (Table 8.1) Of the remaining three provinces, Guanacaste and Puntarenas border the Pacific Ocean and Limon is on the Caribbean.

In Japan, average population density is 284 persons per km^2. But because 70 percent of the total area is mountainous forest where it is difficult to live, population density is actually 947 persons per km^2. In Costa Rica, average population density is 35 persons per km^2. Meseta Central has a population density of over 200 persons per km^2. Moreover, even in areas of altitude more than 3,000 meters, cattle and horses can be pastured. In other words, almost all areas of the country except virgin forest area can be used effectively for animal husbandry and farming throughout the year.

Table 8.1 Population of Costa Rica

(1973; thousands)

	Total	Urban	Rural
San Jose	695	428	267
Alajuela	326	81	245
Cartago	205	73	132
Heredia	134	51	83
Sub Total	1,360 (73%)	633 (83%)	727 (65%)
Guanacaste	179	43	136
Puntarenas	218	46	173
Limon	115	39	76
Total	1,872 (100%)	760 (100%)	1,112 (100%)

8.2 Water

8.2.1 Role of Rivers in the Central Plateau -- Drainage

In this country, the rainy season extends from May to November; in some areas, however, it rains almost the whole year, having an annual rainfall of more than 3,000 mm. Average annual rainfall in each river drainage basin are noted in Table 8.2.

Northeastern parts of Limon Province and southeastern parts of Cordillera de Talamanca have the heaviest rainfall of more than 4,000 mm a year. The driest area is located in Guanacaste and north of Puntarenas, bordering the Pan American Highway.

Many cities are situated in the central plateau, which receives a considerable rainfall. Sewarage systems especially are a necessity in this area in order to absorb rapidly the large volume of run off water. Almost all the cities generally have centrally located sewarage systems to collect the rain water, and domestic sewage and wastewater separately. However, sewarage systems drain freely into rivers, without final treatment.

Cities like San Jose, Alajuela, Heredia etc. lie scattered on the central plateau, mainly in the area of the drainage basin of the Rio Grande de Tarcoles and its tributaries, northwest of Tres Rios, as shown in Table 8.3. The city of Cartago is located on the drainage basin of the Rio Reventazon and its tributaries.

Table 8.2 Average Annual Rainfall and Area of River Drainage Basins

Name of basin	Principal cities	Area covered (km^2)	Av. Ann. rainfall (mm)	Season of heavy rainfall or dry season
Banano	Aguas Zarcas	215	2,802	all year
Moin	Limon	330	3,110	all year
Reventazon	Cartago	2,787	2,996	all year at lower altitude
Rio Tartuguero Rio Colorado		2,061	4,769	July - Dec.
San Carlos	Quesada	3,535	3,033	2,500 upper part, 5,000 lower part
Tempisque	Liberia	3,412	2,022	Sept. - Nov., dry in Jan. - May
Bebedero	Cana	2,078	2,167	2,500 upper, 1,500 at mouth
Abangares	Puntarenas	1,316	2,168	dry in Jan. - May
Barranca	San Ramon Esparza	380	2,451	dry in Jan. - May
Grande de Tarcoles	San Jose, Alajuela	2,019	2,216	dry in Jan. - March abundant rainfall in Sept.-Nov.
Grande de Terrada	Pto Cortes	5,182	2,839	uniform rainfall in May - Nov. heavier in lower area

Table 8.3 Cities and Towns on the Rio Grande de Tarcoles and Its Tributaries

Rio Grande	Palmares	Rio Bermudez	Sto Domingo
Rio Colorado	Naranjo	Rio Turales	S. Antonio
Rio Trojas	Sarchi Norte	Rio Virilla	S. Isidro
Rio Sarchi	Sarchi Sur	Rio Tibas	S. Vicente
Rio Rosales	Grecia		
Rio Prendas		Rio Torres	S. Juan
Rio Poas	S. Pedro	Rio Navarro	San Jose, Guadalupe
Rio Itiquis		Rio Maria Aguilar	San Jose, S. Pedro, Curridabat
Rio Ciruelas	Alajuela, Sta Barbara	Rio Tiribi	Tres Rios, Desamparacos
Rio Alajuela		Rio Jorco	Alajuelita
Rio Segundo	Heredia	Rio Canas	
	Barba	Rio Agres	Escazu
	S. Joaquin	Rio Uruca	Sta Ana

This means, almost all areas of the central plateau are covered by the drainage basins of two rivers. These rivers play a very important role of receiving all sewage water of roughly more than 200,000 m^3 per day. This corresponds to the wastewater emitted by a population of more than one million; moreover, an appreciable volume of industrial waste may be discharged into the river. All upper parts of the main river, the Rio Grande de Tarcoles for instance, form deep valleys and canyons with steep slopes and stream gradients. In the central plateau area, no one can utilize the river water for any purpose. No problems with water pollution, however, really exist with the river. The river gradient is so steep that, after flowing several kilometers, the water is naturally aerated and then purified. Because along the lower parts of the river there are few large cities, towns, or ranches that would use the water, consequently, there are no problems for pollution control presently.

8.2.2 Water Supply and Sewage Treatment

Costa Rica is greatly blessed with beautiful and rich nature. Many Costa Ricans live in the high altitude area, that is, they live on the upperstream area of rivers. Costa Ricans utilize what they call "Ojo de Agua" - water from artesian springs or underground wells - in many places in the central plateau area of the country. Even the people living in Puntarenas still get their drinking water through a pipe line more than 80 km from an "Ojo de Agua" in Alajuela, constructed by the Pacific Coast Railroad in 1936.

People living on plains or at the mouth of rivers in countries like Japan, however, must utilize even the water from the lower end of rivers for domestic use. In West Germany, for instance, the water from the Rhine River must repeatedly be used, twenty times and more, by many contiguous cities along the river. Recently in many Japanese cities - including those in industrial areas - situated at the mouth of rivers, it has become difficult even to obtain adequate underground water for either domestic or industrial use because of the subsidence of the ground level. Therefore, these cities have had to use the surface water from the nearest river. The quality of the river water must be kept as good as possible, because the contamination of the water tends to cause stringent problems both for municipal health and industry.

Water Supply

The San Jose metropolitan water system is supplied by a combination of spring water without treatment and surface water with conventional treatment. There are more than three water treatment plants in the area as shown below. All plants draw off untreated water from the surface water of upstream rivers.

Tres Rios Plant: 600 l/sec (dry season) to 900 l/sec

Conventional chemical flocculation with conventional settling basin and slow sand filters, with newly constructed "valveless" rapid sand filters.

Guadalupe Plant: 270 1/sec

Conventional chemical mixing followed by sedimentation pond, another improved sedimentation and rapid filtration plant.

Los Sitios Plant, Moravia: 200 - 300 1/sec

New system of presettling, mechanical flocculation, sedimentation and "valveless" sand filters.

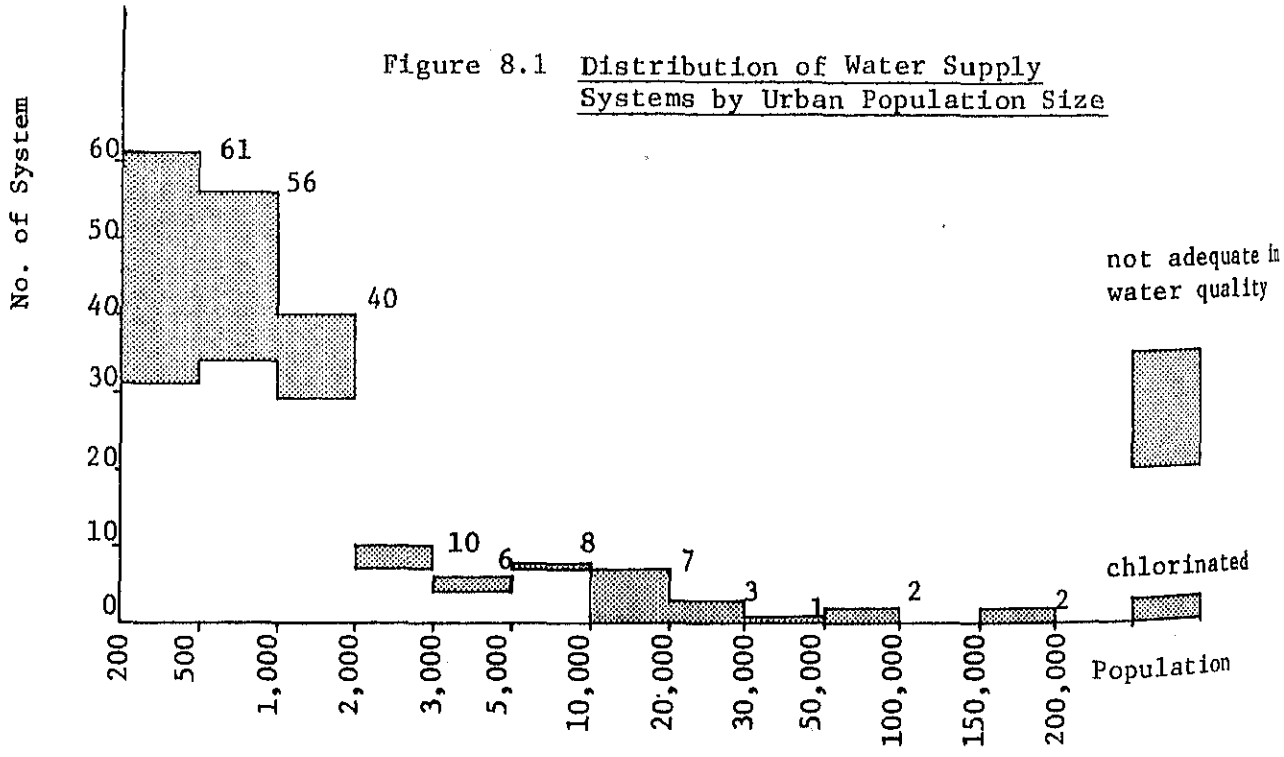
In all these plants, alum, lime and sodium fluorosilicate (imported from Belgium) is being fed as chemicals.

Throughout the country 98 percent of all houses in all urban areas are connected to distribution systems with the remaining 2 percent getting their water from local public faucets for drinking water (see Table 8.7). In rural areas with population concentrations between 200 and 2,000, 74 percent of the houses are connected to some public water system, but dispersed rural areas lack this facility. Only several rural areas are served by well- and hand-pumps (see Table 8.9).

Altogether there are 432 water supply systems in operation in the country, of which 196 systems supplying water to 55 percent of the population (802,000) are administered by Acueductos y Alcantarillado (AyA) and the remaining 236, 45 percent (637,000), are municipally administered.

In regard to the water quality of each system, statistics show that 15 localities having a population of more than 10,000 persons, supply acceptable drinking water; however, 69 systems of 181 smaller localities, having less than 10,000 persons, supply low quality drinking water (Figure 8.1).

Figure 8.1 Distribution of Water Supply Systems by Urban Population Size



Sewage Treatment

In Costa Rica, there are two types of sewage systems, a drainage system and domestic sewage networks. In the latter, every house should connect its household sewer to a septic tank. If it has no septic tank, it can connect the household sewage directly to the public sewer. Traditionally each house has an old style latrine, simply a deep hole (pozo negro) in the ground. It is used mainly in rural areas, but sometimes also in urban areas. Their hygenic condition remains dubious.

The National Housing Census of May 1973 summarized the situation of sewage disposal facilities in eight cantons of metropolitan area, as shown in Table 8.4.1, and in the central cantons of other provinces, as shown in Table 8.4.2.

General Engineering Features of a Septic Tank and a Oxidation Ditch

Septic Tank: If the average volume of water supply is 250 - 300 liter per capita per day, for a house of 8 family members, the volume of sewage water to be discharged is 2 - 2.4 m^3/day; then the detention time of the septic tank is about one day. After decomposing the waste component incompletely, Biochemical Oxygen Demand (BOD) of the waste may be treated in the tank to about 50 percent removal, it is said. (Biochemical Oxygen Demand is the degree of organic contamination which is degradable by the presence of microorganisms with dissolved oxygen in water, expressed in ppm's.) The effluent then would flow into a public sewage system through two 100 mm diameter parallel porous pipes, the elements of these drain pipes are loosely connected to let the effluent penetrate into soil partially.

In Japan, a kind of septic tank (simplified purifier in the form of a plastic tank) was devised for houses in an area which had no public sewage system. Its treatment was not so sufficient as to be drained through an open channel into a river in urban areas. Thus the system could not be approved by public authorities. Probably the retention time and the treatment device would be insufficient to decompose the organic contents in Costa Rica.

As already noted, almost all urban areas in the central plateau, lack final sewage treatment plants except in two cities. Cartago and Alajuela have Imhoff tanks serving more than 30 percent of their inhavitants, 7,820 and 10,800, respectively (AyA, September, 1976). Puntarenas and Limon discharge their sewage water without treatment into the sea. Four cities - Liberia, Canas, Nicoya and San Isidro del General - have oxidation ponds for final treatment in order to discharge their effluent into the middle of the river.

The housing area in El Roble, which has been designed and supervised by the Instituto Nacional de Vivienda y Urbanismo (INVU), has a sewage treatment plant with an oxidation ditch of German style.

Table 8.4.1 Sewage Disposal Facilities in Eight Cantons of Metropolitan Area

Canton	No. of Houses (% of total houses)	Population	Various Sewage Disposal Facilities			
			Sewage	Septic tank	Cement Latrine	Other Type
Costa Rica	330,857 (100)	1,853,356	15	29	27	29
San Jose (province)	126,900 (100)	689,407	25	38	22	15
Project/2nd stage*	90,334 (100)	122,000	34	44	15	7
Central Canton	42,425	212,722	62	27	8	3
Curridabat	2,663	15,498	-	60	26	14
Tibas	6,494	34,544	8	71	15	6
Alajuelita	4,078	32,013	-	43	40	17
Desemparados	13,271	74,044	16	44	25	15
Moravia	3,528	19,492	9	56	23	12
Montes de Oca	6,446	33,455	13	65	14	8
Goicoechea	11,429	60,879	4	70	17	9

* The 2nd stage sewage project will be completed in 1981.

Source: Censos Nacionales de 1973, Vivienda

Table 8.4.2 Sewage Disposal Facilities in the Central Cantons of Other Provinces

Provinces and Cantons	No. of Houses	Population	Various Sewage Disposal Facilities (% of total houses)				
			Public Sewage		Septic Tank	Latrines		No devices
			No. of Houses	(%)		metal plates	wooden	
Puntarenas	39,653	215,483	2,400	(6)	27	20	18	26
C. central	11,942	64,444	1,241	(10)	30	8	23	22
Esparta	2,234	12,033	-	-	33	41	19	7
Alajuela	55,974	323,880	5,232	(9)	23	44	15	9
C. central	17,403	95,437	5,232	(30)	23	36	7	3
Cartago	34,057	203,048	4,450	(13)	27	30	24	6
C. central	10,958	64,606	2,753	(25)	26	30	13	5
Heredia	22,957	132,879	3,804	(17)	33	39	7	4
C. central	6,409	36,329	3,804	(59)	19	16	5	1
Guanacaste	29,226	177,185	367	(1)	11	32	29	26
Liberia	3,512	21,170	-	-	23	43	23	8
Limon	22,090	111,474	1,997	(9)	28	8	38	14
C. central	8,190	39,570	1,997	(24)	39	3	26	6

Source: Censos Nacionales de 1973, Vivienda

Two kinds of raw waste, one from the housing area and the other from Monsenor Sanabria Hospital at El Roble, are mixed with one another to be fed into the oxidation ditch having a Kessner bruch type cage rotor as an aerator. (See Table 8.5).

Oxidation Ditch

As these data are seemingly insufficient, and no explanation is shown for the processing equipment of Liberia and Canas, we can draw no decisive conclusions. The treatment seems adequate when the load is light, but when high it may be insufficient.

Only suggestions can be made with regard to sewage treatment and equipment, that is:

(a) It seems important to consider the insertion of a mechanical sludge scraping device in the settling compartment of the circular oxidation basin, "Decantador." The equipment is not expensive, improves the operation and the maintenance of sludge control and consequently it effectively and uniformly re-circulates the sludge in the aeration zone.

(b) It also seems important to consider instead of an oxidation ditch the use of an aerated lagoon or stabilization pond requiring more than seven to ten days retention time. It requires wider land-use but it will be probably stabler and cheaper to operate. It can also use solar energy by photo-synthesis of green algae or water weeds especially in the hot tropical area. The treated water can also be reused for irrigation.

A covered basin made of plastic or rubber sheet or of asphalt can be used instead of a concrete basin, in order to prevent the possibility of hygienic pollution by the waste penetrating into subterranean water.

(c) If the treatment of sewage and industrial wastes would be combined and inserted in an industrial park, the emission of poisonous materials should be strictly controlled and not be mixed with other wastes. If the sludge is composed of emissions from sewage treatment and food industry waste treatment, for instance, it can be reused on farmland without any danger. But if it contains any poisonous or harmful materials like heavy metals, it becomes very difficult to find an area to dispose the sludge without fear of harmful effects.

8.2.3 Present Status and Future Goals of Water and Sewage Works Administered by Acueductos y Alcantarillado

The Instituto Costarricense de Acueductos y Alcantarillado (AyA) was established as an independent and autonomous organization.

Table 8.5 Operational Data of Oxidation Ditches in Three Cities

Design conditions and results	Liberia (two basins)		Cañas (two basins)		El Roble (single basin at present)		
Population served	1,908		1,070		5,500 3,700 from houses (1) 1,800 from hospital (2)		
Quantity of waste (m^3/day)	907		367		1,665		
BOD (kg/day)	80.3		34.9		300		
					Case 1	Case 2	Case 3
					(1) 132	140	385
					(2) 116	90	170
BOD inlet(s) (mg/l)	85	156	133	103	Av. 127	124	315
BOD effluent (mg/l)	-0	93	66	20	48	45	55
BOD % reduced	-100	40	50	81	62	64	83

Sources:
1. Direccion de Estudios y Proyectos Departamento de Estudio e Investigacion (ICAYA), Investigacion de Parametros en las Lagunas de Estabilizacion de Cañas y Liberia, 1976.
2. Universidad de Costa Rica, Estudio de los Canales de Oxidacion de El Roble, Puntarenas, 1976.
3. The effluents of Liberia and Cañas are discharged into rivers, and that of El Roble into the sea.

It initiated in 1961 the following activities: planning, project generation, selection, design, execution, supervision, operation and maintenance of water, sewarage and sewage systems of urban and rural areas in cooperation with the plans of Oficina de Planification (OFIPLAN), individual municipalities and the Ministry of Public Health and OFIPLAN.

Since 1963, the Inter-American Development Bank has participated in the above services by granting loans and technical assistance to the AyA. These loans were included for financing several projects:

(a) Studies on water supply and sewage systems for metropolitan areas of San Jose and the interior and construction of 80 rural water supply systems.

(b) Partial financing of a program consisting of the construction, improvement and expansion of water supply and sewage systems in the cities of Liberia, Limon, Puntarenas and San Isidro del General and the first stage of a sewage system in San Jose.

In January 1977, the Water Supply and Sewage Sector Memorandum in Costa Rica was published under the auspices of the W.H.O. and the International Bank for Reconstruction and Development Cooperative Program. It paints out national health plan goals for 1974-1980 with several recommendations. Its important points are noted hereunder (see Tables 8.6 and 8.7).

Table 8.6 Actual Service Levels with Estimated or Present Population

1) Population at end of 1975 (1,000)

Urban	727	37%
Rural	1,233	63%
Total	1,960	100%

2) Actual Service Levels

Water supply sewarage and sewage

	A	B	C	D	E	F
Urban	86%	9%	95%	49%	45%	94%
Rural	44%	9%	53%	-	81%	81%
Total	60%	9%	69%	18%	68%	86%

Estimated Population Annual Growth Rate

Urban	3.0%
Rural	2.0%
Total	2.4%

Concentrated rural areas	70%
Dispersed rural areas	30%

A: House connection
B: Other public systems (public stand pipes)
C: Total served
D: Sewage connections
E: Latrines, etc.
F: Total served

The following data seems slightly different than that in Table 8.6.

Table 8.7 Situation of Water Supply in Costa Rica (December 1975)

Type of Population	Total Population	Population Using House-Connection		Population Using Other Public Water System		Population Served (,000)	
Urban	747.0	730.0	98%	17.0	2%	747.0	100%
Rural	1,273.0	663.7	52	48.3	4	712.0	56
Concentrated	891.1	663.7	74	35.6	4	699.3	78
Dispersed	381.9	-	-	12.7	3	12.7	3
Total	2,020.0	1,393.7	69	65.3	3	1,459.0	72

1) Concentrated rural areas have 200 to 2,000 persons per km^2,
2) Dispersed rural areas have less than 200 persons per km^2.

Source: Ministerio de Salud, Diagnostico Tecnico-Administrativo de la Situacion del Saneamiento Ambiental en Costa Rica (1976), page 20.

Recommendations:

1) A relatively high degree of water-born and other diseases resulting from unhygienic sewage disposal, in spite of endeavors for rural latrinization being undertaken by the Ministry of Public Health. Thus various measures are advisable in fields such as pollution control, housing improvement and sanitary control of food.

2) Water quality is generally acceptable although in rural areas secondary contamination of unprotected wells is sometimes a problem.

3) Only three urban sewage systems have final treatment, while in rural areas the majority of latrines are not acceptable.

4) The financial strain may be reduced in two ways: the design standard should incorporate financial and economic considerations; an adequate tariff structure should be recommended.

5) Specialized training for qualified engineers and additional training for professional and subprofessional staff is recommended.

National Health Plan Goals (1974 - 1980)

The main "National Health Plan Goals (1974 - 1980)" are summarized as follows:

(a) Continue water supply service to 95 percent of the urban population by means of house connections with water public service, and to 71 percent of the rural population. Some water quality improvement should proceed.

(b) Sewage service to 70 percent of the urban population should be provided.

(c) Final sewage treatment will be provided in connection with the existing sewage system, considering future requirements for water quality in emission courses.

(d) In addition to promoting the construction of water supply and sewage facilities, measurement standards should also be promoted in order to initiate programs of pollution control of bodies of water, wherever justified because of industrial development, urbanization or other factors.

(e) Similarly, a national policy on adequate garbage collection and disposal, legislation relative to ground contamination and their effective coordination should be established.

Past and projected investment projects and their source of funds are listed in the Water Supply and Sewarage Sector Memorandum. The abbreviated and general figures are listed in Table 8.8.

Three long-range alternative "proposed programme goals and costs" (1973 to 1990) were estimated in 1974 in the Memorandum. The highest goals and their costs are briefly summarized and shown in Table 8.9.

8.2.4 Industrial Wastewater Treatment

In the central plateau in Costa Rica, although the population is concentrated, diverse industries have been established because of many favorable conditions - such as climate, transportation, raw materials, labor, water etc. - exist for supporting people's lives and industrial activity.

As shown below, the number and type of industries requiring careful waste treatment may be noted in several cantons of provinces like San Jose, Alajuela, Cartago, Heredia, Puntarenas etc.

Food industry	42
Beverage, juice and drinks	8
Textile	18
Tannery	15
Various chemical industries	14
Earthenware and stoneware	10
Metal working	15
Electronics and electric parts	11
Total	105

Table 8.8 Investment Projects (1975-1980)

(million colons)

Project	Period	Domestic Investment	Foreign Investment
AyA			
Second stage metropolitan water system	1975 - 1977	162	153
" " rural water system	1975 - 1978	100	0
Third state metropolitan water system	1975 - 1980	36	0
Second stage metropolitan sewage system	1976 - 1979	213	149
Five cities (both water and sewage are included)	1975 - 1976	7	4
Fourteen cities (")	1975 - 1977	86	56
Twenty cities (")	1977 ---	130	91
IFAM			
Sewage treatment, Cartago	1976 - 1977	14.2	11.1
" " , Guanacaste	"	6.8	5.0
" " , Alajuela	"	12.1	9.3
" " , Puntarenas	"	5.8	4.5
Empresa de Servicios Publicas de Heredia	1976 - 1977	4.0	0
Ministerio de Salud			
Rural water supply pumping systems	1977 - 1979	16.5	6.0
National campaign of latrinization	1975 - 1977	15.6	0
Others: IFAM, Regulation of pluvial water in San Jose	1976 - 1980	53.0	35.0

Table 8.9 Proposed Programme Goals and Costs

	Population Served (1,000)			Unit costs	Total costs (Million colons)	
	1973	1980	1990	(Colons)	1980	1990
Water supply						
House-connection						
Urban	615	1,040	1,550	500	212.5	255
Rural	550	730	990	400	72	104
Well and hand pumps	150	250	400	200	20	30
Sewarage						
Urban	240	780	1,550	200	108	154
Rural	30	150	400	400	48	100
Sewage treatment						
Urban	-	390	775	100	39	38.5
Rural	-	-	125	200	-	25
Septic tank						
Rural	150	280	340	100	13	6
Latrine	600	620	780	50	1	8
Renovation of latrine	-	+300	+300	50	15	15
Others						
Water system improvement	-	+300	+315	150	45	47.3
Water, outside house	-	+20	+30	50	1	1.5
					574.5	784.3

The quality and volume of wastewater depend largely upon each factory. There is a wide difference of degree and of characteristics of each waste, even within the same industrial classification depending on raw materials, production processes, by-products, water use, product variety etc.

Characteristics and examples of the quality of wastewater, a brief explanation of treatment processes and their expected results are explained in Appendix 2.

In each case, it is necessary when planning to take into account the maximum emission conditions as well as average quality and quantity of wastewater emitted depending on the production process, and to know special pollutants including poisonous materials discharged possibly from the factories, if an efficient treatment process and plant are to be designed. Experimental tests, even field tests, are thus needed to confirm that the treatment process will be analytically adequate and that the plant size will be sufficient once the plant is completed and in use.

There are several important points to be considered when the treatment process is being planned. Comparison of alternative processes, equipment and chemicals should be considered.

Various featuers requiring careful attention are pointed out more generally in the following reference to food industrial waste.

General Features to Be Considered in Wastewater Treatment of Food Industries

Wastewater from food industries contains various nutritional elements, sugar, starch, amino acid, protein, oil, fat etc., almost all kinds of waste emitted in food processing can be comparatively easily treated through biochemical treatment, in the form of lagoons, oxidation ditch or activated sludge.

Basically attention is usually paid both to planning and to operation, that is:

(a) The waste may easily become septic and generate offensive odor, in case an appreciable amount of organic materials are contained.

(b) The volume of waste depends on the amount of industrial water used and the production process. In order to reduce the waste load, it is necessary to reconsider changes or improvements in the production process and the method of water use, for instance, using cascades or recycling as much as possible.

(c) Both the quality and the quantity of the waste fluctuate widely depending on production processes. Such fluctuation may lessen

treatment results to some degree, but usually it is best to allow for a sufficient volume in the waste-receiving tank in order to assure a uniform flow into the treatment plant and stabilize the process as far as possible.

(d) Usually a larger receiving tank should be provided with some agitation device to prevent the waste from becoming septic and to distribute suspended materials evenly.

(e) These wastes often contain oil and fat, either independent or emulsified. If oil forms a separate layer or scum by aeration or floatation, the oil and/or fat can be easily separated, collected and burnt if not recoverable. If a fatty solution is creamy and sticky, it can be mollified by applying steam or heat, and thereby facilitating handling.

(f) In the case of suspended materials, usually it is better to separate them by allowing settling before submitting them to biochemical treatment. Sludge from both primary and final (biochemical) treatment is usually difficult to dehydrate mechanically. Thus it is more convenient to discharge it on farmland without dehydration or composting. If it is discharged on farmland, it must be mixed into the soil without coming into contact with plant roots, thereby avoiding to become septic masses of sludge. If the soil condition is appropriate, the organic sludge can be effectively used as fertilizer.

(g) If the waste is a highly concentrated soluble material, for example, fermented, distillery, or some pharmaceutical waste etc., it can be recovered for some animal feed after evaporation and concentration.

(h) If the recovery of some materials from concentrated organic waste, is not so attractive, the anaerobic digestion (mehane fermentation) process could be applicable; methane gas might be recovered as a fuel gas to some degree.

(i) The waste water constituents should be checked to find recoverable materials in order to reduce the degree and the load of wastewater, and to save or to compensate the cost and expense of the treatment and final disposal.

In inorganic waste treatment, the main process is the separation of suspended or soluble inorganic substances; in the former, suspended materials can be separated comparatively easily, by the use of sedimentation with or without chemical coagulation and filtration. But in the latter case, soluble inorganic materials are usually very difficult to separate; chemical precipitation reaction and ion exchange or evaporation processes are applicable but are quite expensive.

Sometimes, the dilution of wastewater or treated effluent is needed. However, the dilution of wastewater is not a treatment according to the physical principle of the conservation of materials, because dilution does not entail the removal or separation of any materials from the waste.

The pollutant should not be emitted or diffused in a poisonous or unstable state, but should be removed from the waste as far as possible. In case of organic materials, such pollutants should be decomposed to their final stage, i.e., CO_2, H_2O, N_2 etc. Practically, this decomposition reaction could be attained by using micro-organisms and thereby be recycled as a natural food, as part of the biological life cycle.

It seems somewhat inadequate or unfair that public sewage water need not have final treatment, but the industrial waste from factories should be controlled strictly in its treatment. It is rather necessary to determine some standards showing permissible limit of waste discharge for both direct discharge into public water and discharge into public sewers or sewage treatment plants. Also consideration should be given to furnishing some combined waste treatment facility in an industrial park, in which several private factories would be joined under the guidance and planning of governmental officials. A common basis of regulations, standards and cost systems should be applied.

In Japan, regulation standards permitting final waste discharge into the public sewage treatment plant are issued as in (Table 8.10). The wastewater discharged into public sewers should be pre-treated to meet the standards.

8.3 Air Pollution

Air pollution is generated from two possible sources, stationary sources and moving sources. Obviously, industries, including municipal ones as garbage and refuse incineration, are stationary sources, but, automobiles or vehicles driven by engines are moving sources.

Usually, larger scale industries such as thermal electric power generation plants and iron and steel industries have blast or other furnaces and are responsible for the larger portion of air pollution vis-a-vis the fuel consumption, including coal.

Almost all large scale industries, including electricity generation, iron and steel etc., have adopted some form of pollution reducing equipment such as dry type or wet type gas scrubber, gas washer, dust collector, electric precipitator etc., to reduce pollutants such as sulphur oxides (SOX), CO, dust, hydrocarbon (HC) etc. As far as the SOX pollutant is concerned, the level of pollution has certainly been decreased in almost all industrial countries, including Japan. SOX contents are also controlled or reduced by emission regulation standards requiring the use of low sulphur content fuel, monitored usually in some Japanese cities.

Table 8.10 Regulation Standards of Wastewater

Case A -- The total volume of sewage water is sufficiently proportionate to that of industrial wastewater before reaching the final treatment plant.

Case B -- The ratio of total volume of industrial wastewater to that of sewage water is considerably high.

		Case A	Case B
Temperature (°C)	Less than	45	40
pH		5.9	5.7 -- 8.7
BOD (ppm)	Less than	600	300
Suspended solids (ppm)	" "	600	300
Oil (ppm)	" "	300	50
Iodine consumption (ppm)	" "	220	220
Phenols (ppm)	" "	100	50
Cyanide as CN (ppm)	" "	-	2
Chromium (ppm)	" "	-	3

Garbage and refuse incineration plants are a major source of air pollution in Japan. Recently, they are required to have equipment for reducing dust, poisonous gases, SOX, CO, HCL, Cl_2 etc. On the other hand, it is important to reduce the absolute amount of domestic garbage and refuse themselves because the incineration process consumes fuel (energy), will always cause some air pollution and is costly.

In Costa Rica population is concentrated in the Meseta Central; accordingly many automotive vehicles are used in the surrounding area of San Jose city. Their number and type will surely increase in the future.

Air pollution caused by moving sources generates photo-chemical oxidant hazards on bright sunny days. In order to estimate the amount of each pollutant in each region of a city, it is necessary to know the emission factor of each component (CO, SOX, NOX, HC) from various emission sources, especially when considering characteristic features of each source with or without pollution control equipment (Table 8. 11).

The amount of pollution emission from automotive vehicles can be estimated by using data of fuel consumption for various kinds of fuels - gasoline, diesel fuel, LPG etc. - and multiplying them by the emission factor.

For example, the percentage share of emission from each source in central Japan, Tokyo and the three prefectures of southern Kanto, are depicted in Table 8.11.

The objective of this survey is to estimate the total amount of emission from each source, and thereby calculate or extrapolate the extent or share of each emission source.

Of course, the actual conditions and characteristics of pollution emission are much more complicated. For instance, the distribution of stationary sources are not uniform in their location; wind conditions in each season are also not constant for diffusion, etc. Consequently, the contribution of each source to the actual air pollution in an area could not simply and fully be explained only by this survey. However, the extrapolated data on proportions of each emission source would suggest new directions of further surveys for air pollution control in later stages.

Sampling data taken from July 1975 to March 1976 compared with those taken from March 1971 to December 1973 at the No. 1 Monitoring Station in San Jose are reported to show clearly that air pollution has increased. The cause is attributed to the increased number of automotive vehicles and of industries.

The basic policy of abating air pollution should recognize that the most important point in solving this pollution problem is to minimize the emission at its source as much as possible. The diffusion of emitted materials does not mean that these poisonous gases are neutralized in the atmosphere. For example, if the concentration of

Table 8.11 Air Pollutants by Source in Tokyo and Surrounding Area

		Moving source, Automobile	Power plant	Industry	Incineration of garbage & refuse	Home & commercial use	Industrial solvent	Petro-Industry	Total
CO	1970 (%)	93.0	0.1	0.0	6.3	0.4	-	-	100
	1975 (%)	85.2	0.0	0.1	14.1	0.5	-	-	100
HC	1970 (%)	57.3	0.1	1.3	0.7	0.6	25.1	14.8	100
	1975 (%)	51.2	0.1	2.1	1.7	0.9	26.7	17.2	100
NOX	1970 (%)	39.0	21.5	31.0	0.8	2.6	5.1	-	100
	1975 (%)	41.1	15.2	34.6	1.5	2.7	4.9	-	100

These data are calculated on the basis of several general assumptions.

emitted gases is too high, it could cause irritation to human respiratory organs and finally illness. A photo-chemical effect could result such as occurred in Kawasaki City, Japan. Even if the concentrated emission is comparatively weak, the emitted SOX and NOX in the air could cause rain water or atmospheric moisture to be acidic, and thus cause serious metalic corrosion. Already diffused materials such as dust, mist or poisonous gases, or any sort of atmospheric emission, cannot be removed by any devices or equipment.

The emission effects from automotive sources, especially in urban areas, cannot be overlooked in the future. Manufacturers of automobiles the world over are making some effort to invent appropriate devices for eliminating the emission of poisonous elements in order to meet emission standards. It will become necessary, therefore, to use cars having adequate anti-pollution equipment.

On the other hand, if the amount of traffic would reach the level of over-crowding, the number and kind of automobiles in crowded areas and streets should be restrained, possibly by an automatic computerized signal system, upon consideration of characteristic features of streets and land to be used for residential, commercial, business, or industrial areas. This type of control can also effectively abate noise pollution.

Furthermore, some buffer zone separating a residential area and a main road is effective in noise abatement. For example, a green belt more than ten meters wide lessens both noise and air pollution.

8.4 Solid Waste Treatment

In more advanced countries, it is said that the valued amount of domestic garbage and refuse is nearly proportional to peole's income. (See Appendix 3.) Almost all municipalities, especially in larger cities throughout the world, are now struggling with solid waste treatment.

Problems mainly consist of the following:

(a) The increased volume year by year, diverse mixture of materials, various moisture contents of these materials and characteristic features of garbage and refuse depend on local conditions.

(b) Often these wastes contain poisonous materials of various origins - such as, heavy metals, various chemicals, stable organic compounds like PCB, plastics which generate toxic or corrosive gases when burnt etc.

(c) Partial recovery and reuse of waste materials dependent upon their classification must be decided.

(d) There are transportation problems of refuse collecting in heavy traffic conditions, especially in the central area of larger cities.

(e) In designing and operating incineration plants, there are problems with:

i) moisture content vis-a-vis energy consumption and smouldering in incinerators,

ii) contents of incombustible materials,

iii) contents of high heat content materials, that are related to the percentage of plastics, oils, fats etc. (The temperature of the inside wall of the incinerater rises abnormally high.)

iv) contents of halogenous compounds, like vinyl chloride plastics which generate corrosive and poisonous gases after decomposition when burnt.

One of the principal problems of solid waste treatment is first to reduce the volume. Therefore, it seems important at the initial collection stage to get the effective cooperation of citizens to separate the contents into glasses and bottles, metals, paper, kitchen garbage, incombustible materials such as bricks, concrete blocks, sand, gravel etc. It is also necessary to require the cooperation of some manufacturers in recycling and reusing their waste or refuse.

Unfortunately, modern industrial production systems do not seem to use adequately their recovered raw materials for the following reasons:

(a) Economical -- The acquisition of, or recovery of, raw material is almost fixed by economy-of-scale and cost factors;

(b) Technological -- The degree of purity or composition of raw materials and their products are already fixed in the production process. But, recovered materials generally are not similar to presently used materials. Therefore, the possibility of impurities arising in their products is greater than in the case of using raw materials.

(c) It is difficult and costly to change or to modify the production process and flows in using abnormal raw materials, in other words, it is necessary to use continuously, constantly and with little variation raw materials in the production process.

Probably using recovered materials in place of raw materials in industry might be promoted by scheduling and controlling waste materials to meet production conditions. Either the production process could be changed gradually or new production processes could be developed, such as realization of recovered paper in the paper industry.

It is necessary both to develop new techniques and innovations and to accustom people's thinking to using recovered materials. Usually, people are likely to compare former products produced from raw materials with the recovered and reprocessed materials. The latter will be accused of containing many impurities, being weak, costing more etc. Customs, habits, and thinking do not change easily!

Recently, however, people who previously easily wasted scarce resources, are beginning to change slightly to conserve energy and resources as much as possible. It is more and more important to use resources carefully because it is gradually becoming difficult to find locations appropriate and adequate for disposing waste materials. Often when some waste materials are disposed, they are apt to cause other pollution problems which adversely affect people. Consequently, it is important to find new combinations of recovery and disposal of waste materials even if such is difficult and time-consuming in establishing new customs.

Various investigations and tests on the treatment of garbage and refuse, including recovery of resources and energy, are being made throughout the world in various fields and sectors, both governmental and private.

Several typical considerations are shown as follows:

(a) With regard to incineration, various heat recovery devices and heat utilization are being tested, e.g. heat recovery for use in local heating and recreational use, generating electricity, or industrial use.

(b) Whatever processes or uses are selected, it is first important to classify various materials indicated above.

(c) Pneumatic transportation of garbage and refuse through piping is one consideration.

(d) Organic solid wastes can be recovered for use as fertilizer and soil conditioners; but it seems better to use them, for example, as natural compost by fermentation or natural land fill.

(e) To reproduce them for animal feed.

(f) To generate combustible gases from organic wastes anaerobic digestion or gassification through burning with controlled air feed.

(g) The treatment of various poisonous materials and gases, regulating heavy metals, and avoiding random dispersion and decomposition of stable organic compounds such as PCB, PCP etc. should be handled with the utmost care.

(h) An effective and adequate combination of various methods to meet local conditions should be sought.

Poisonous Materials in Solid Wastes

In industrially advanced countries, especially in urban areas, poisonous heavy metals are often contained in sewage water and domestic garbage. After sewage treatment, heavy metals which have submerged in the sludge are often disposed with the sludge or garbage into the soil or landfills. If poisonous heavy metals are contained therein, they are apt to contaminate the soil. If landfills are used for disposal of solid wastes, it is necessary to avoid soil contamination. If the land is for farm use, the waste materials should be buried deeply, thereby avoiding the poisonous materials returning to their recyclement in the food chain of plants and animals, including man.

Poisonous heavy metals are always contained in sewage sludge and household garbage. People habitually carelessly dispose anything, no matter whether the contents are poisonous materials, such as shards of broken thermometers (Hg), fluorescent lamps (Hg), Braun tubes (Cd), pieces of broken radios etc.

Neither national nor municipal government has yet proffered any concrete devices for final and safe treatment of collected mixed wastes. Government should have a clear policy prohibiting disposal of any kind of poisonous materials. It is necessary to set and to propagate various environment control standards, as far as poisonous materials are concerned, on the other hand, all citizens should understand and cooperate with government policy in separating poisonous materials from other household waste and garbage. In order to assure cooperation on this point, the government should undertake a PR campaign repeatedly and earnestly to inculcate a complete understanding of the source of toxic materials, their common existence and use, and their harmful effects on the human body and life in general. (See Appendix 4.)

It is also important to inform citizens in each area how the separately collected toxic wastes are being treated safely with the citizens' cooperation. For example, the Environmental Protection Agency in Canada has issued and widely distributed a pamphlet which both explains quite plainly the concrete plans of pollution abatement in the areas of air, water and solids, and also describes in understandable language what should be done cooperatively by all citizens to keep the surrounding environment clean and thereby accomplish a national goal.

8.5 Traffic Noise Control

The control of noise pollution is similar to that of air pollution, especially in densely populated areas. Noise is generally generated from automotive vehicles and affects some residential areas especially at night or areas along main streets and highways in cities. Because noise is the most common cause of pollution, it accounts for the largest number of pollution related complaints.

The Japanese government (through the Environmental Agency) has drawn up various measures designed to control traffic noise at its source.

Theoretically, if noise is reduced by three phons at its source, the area affected by such noise is reportedly halved. Actually, however, this theoretical relationship naturally does not work as is implied in the case of traffic noise. Nevertheless, it is obvious that reducing the level of noise at its source has an extremely important effect in reducing traffic noise.

Noise control measures related to automotive vehicles may be applied in the following way:

(a) Improvement of motor vehicles:
Structural improvements designed to reduce noise from the engine, cooling fan, air intake, exhaust and tires.

(b) Improvement of road structure:
Erection of walls to block off noise and buffer zones and improvement of road pavement by making embankments and ditches consistent with the topography of a given area.

(c) Traffic control:
Establishing and controlling speed limits on all vehicles, designating lanes for large vehicles and systematizing traffic signals.

8.6 Conservation of Nature

Obviously human beings are part of nature, participating in various natural activities and receiving various benefits from nature. However, they have greatly affected nature in various ways, sometimes completely changing the surrounding nature and even inflicting substantial damage. Ecological principles teach us that human effects on the natural environment are unreversible to a large extent. Consequently the conservation of nature and co-existence of different life forms should be a sine qua non condition for human survival as a part of the natural environment.

Although Costa Rica is approximate to the equator, its climate at higher altitudes is moderate and comfortable. On the other hand, in coastal areas especially on the Pacific coast, the climate is much warmer and the land tends to be arid.

According to plans for the Gran Puntarenas Project, the area surrounding the central urban zone of Puntarenas Peninsula, El Roble to Barranca, Caldera and Esparta are to be developed over a lengthy period of time. The conservation of nature is also an important item of long-range planning and execution. In relation to the development project, the surrounding area including the Nicoya Peninsula should be cultivated with sufficient plants and water for recovering adequate

vegetation in the area. The area should be planted with plant species that will form a suitable basis for intra-related vegetation. For this purpose, a present vegetation map and a potential vegetation map must be prepared without neglecting landscape management.

In the construction of business, highway, industrial and residential areas, the top soil should be replaced or redistributed if a surplus exists after completing construction; an adequate and stable ecological system of vegetation should be recultivated and conserved in accordance with carefully drawn present and potential vegetation maps.

In order to cultivate both underground and surface water, the surrounding areas of upstream rivers should be well foliated.

8.7 Economic Consideration of Environmental Affairs

In Costa Rica, environmental affairs have so far been neglected. But, there is little wonder that people are unaware of environmental deterioration during rapid economic progress, especially with regard to industrialization and urbanization.

Distinct from mere hygienic degradation, environmental problems are usually considered to stem from man-made causes -- pollution or contamination caused through production processes and consumption of goods and services. Generally speaking, market prices reflect only internal or privately borne costs of supplying goods and services. From a social point of view, the concept of cost should include not only internal or private costs but also external or social costs. External costs reflecting externalities are not apt to be evaluated duly on the market.

Modern economies have enjoyed such free goods as air, water and other many environmental resources without paying their costs. The term "gift of nature" represents their free supply. Contemporary man has come to be disturbed by various kinds of waste emitted by himself. Pollution is one of the major exacerbating points associated with environmental degredation.

The market mechanism does not always provide adequate signals for rationally allocating scarce resources. That is "market failure." It is responsible for misallocation and misuse of increasingly scarce natural resources. Should environmental equality be preserved, market failure must be rectified through internalizing external costs. Market prices must be boosted necessarily to the extent that external costs are internalized. The extent of increased costs depends upon the quality of the environment which people wish to maintain. Internalization of external costs means conversion of implicit costs into explicit ones.

The value of environmental quality cannot be directly assessed through the market mechanism and human judgement. For the time being,

pollution-abatement costs must be considered proxy for the minimum cost of environmental protection. Estimates of abatement costs vary according to different conditions -- physical, social, economic etc. Presently available data suggest that the national total cost of abating major pollutants would account for only one to five percent of G.D.P. of respective countries.

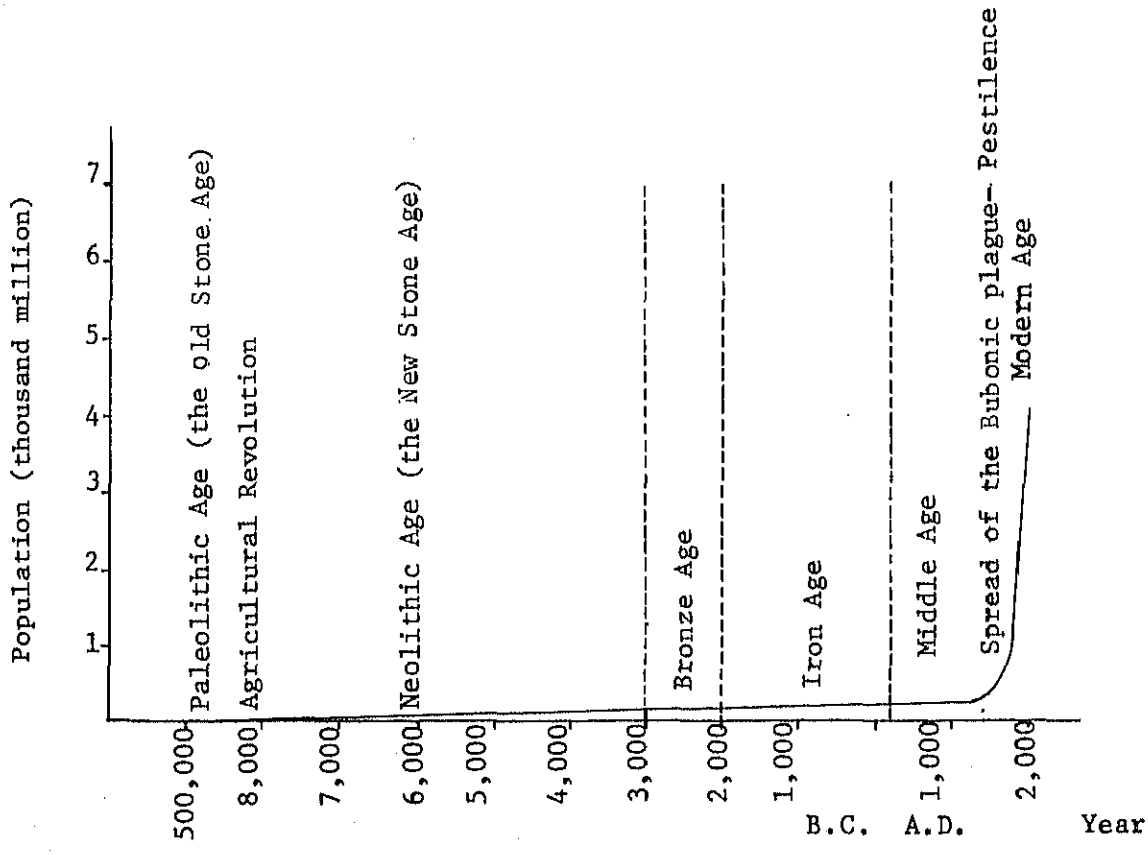
In order to transfer environmental arguments into quantitative terms, a desirable level or standard of environmental quality should be defined. These standards should be established on the basis of various criteria with regard to health, property, nature and other factors valuable to human beings.

8.7.1 Causes of Recent Environmental Disruption

Causes of environmental disruption are attributed mainly to the following factors:

(a) Figure 8.2 shows the world population increase. The coefficient increase in population is most noticeable in this century, due to the decreased death rate resulting from medical progress.

Figure 8.2 The World Population Increase



Source : Population Bulletin, Vol. 18, No.1
"Plan for Introduction to Environmental Science" by P.W. Foster, 1972.

(b) Especially after World War II, the rate of improvement and the development of various new technologies have accelerated rapidly; industries have been able to deal with various materials quicker and in larger capacity.

(c) Consequently, industries have come to pursue the so-called scale merits, operating factories on economies-of-scale, using machines and equipment having larger capacity, faster speeds and more accurate automatic control devices. Recent increases of various industrial production in industrially advanced countries are shown in Appendix 1.

(d) Social advancement and centralization of population have occurred rapidly in almost all countries. Population increase is much higher in areas surrounding older central urban zones, i.e., in newly developed bed towns; more than 10 percent of the total population is centered in almost all capital cities of smaller countries. Every city has some information center, which performs various human activities such as administration, marketing, business, education etc. Although high population densities impede transportation severely, air pollution and noise, for instance, more adversely affect the price of materials necessary in life. In spite of these poor living conditions, questionnaire data reveal that the great majority of citizens wish to live in urban areas. The population of Tokyo proper shows a gradual decline over the past six years. It is deplorable that in many cases adequate city planning has come too late, that is, the rate of population increase is faster than that of urban infrastructure development, for social and economic reasons.

(e) Transportation has also been hastened in aviation, railroads, highways and can carry a greater volume of both men and materials.

(f) Innovated technology seems to be "doubled-edge sword," that is for example:

i) The faster the speed of automotive vehicles, the more energy is consumed, and the more noise pollution is increased!

ii) The larger the capacity and the higher the combustion temperature and efficiency, however, the more NOX is increasingly generated.

iii) The more automated, the more phenomena are estranged from human relations and the more human alienation occurs.

iv) The more specialized the technology, the more difficult it becomes for laymen and unrelated specialists to understand the specialized vocabulary. Specialization separates more finely special fields and technologies and makes it further more difficult to communicate with each other.