THE FEDERATIVE REPUBLIC OF BRAZIL

SURVEY REPORT ON THE SUAPE COASTAL INDUSTRIAL ESTATE

April, 1976

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

The Government of Japan, in response to the request of the Government of the Federative Republic of Brazil, decided to make a survey of the Suape coastal industrial estate in the Brazil and entrusted its execution to Japan International Cooperation Agency.

The Japan International Cooperation Agency dispatched a Survey Team composed of twelve experts and headed by Dr. Sadakazu Iijima (Executive Director of the Japan Industrial Location Center) to Brazil and the site of the estate for 25 days, from January 9 to February 2, 1976.

The Survey Team received detailed information on conditions from their counterparts in agencies of the Brazilian federal government and the Pernambuco state government, such as DIPER; and also conducted surveys in the Recife Metropolitan Region, the Suape area, and comparable districts.

After returning to Japan the Survey Team analyzed the materials and data it had collected, and added technical and economic investigations. Here we submit the report of their findings.

Along with the hope that this report will contribute to social and economic development in the Federative Republic of Brazil, we also sincerely hope it will contribute to greater friendship between Brazil and Japan.

Finally, I take this opportunity to express my heart-felt gratitude to the Government of Federative Republic of Brazil and other authorities concerned for their kind cooperation and support extended to the Survey Team. We are indebted to all of them.

August, 1976

Shinsaku Hogen
President, Japan International Cooperation Agency

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LETTER OF TRANSMITTAL

Mr. Shinsaku Hogen
President
Japan International Cooperation Agency

Dear Sir:

The following report contains the findings of our study, conducted through the technical cooperation of the Japanese Government following a request from the Brazilian Federative Government.

The Japanese Government, through the Japan International Cooperation Agency, commissioned the project to the Japan Industrial Location Center.

The Center conducted the study jointly with four companies that all have broad experience in preparing development plans in Japan: The Regional Planning Union, Pacific Consultants International, Mitsui Consultants Co., and the Nomura Research Institute.

The study was conducted in the five-month period from November, 1975 to March, 1976. During this period, from January 9 to February 2, 1976, field survey was undertaken by a team of experts from the Center, the four companies listed above, the Ministry of International Trade and Industry, the Ministry of Transport, and the Japan International Cooperation Agency.

The field survey was only possible with the cooperation received from the Brazilian Government; the Pernambuco State Government; agencies operating in the area of the site, such as DIPER; the Japanese Ministry of Foreign Affairs; the Japanese Embassy in Brazil; and the Japanese Consulates General in Recife, Rio de Janeiro, and Sao Paulo.

The completed final report presented here draws both on work performed in Japan and the site survey and, taking full account of the opinions of the Brazilian side, presents its view of the Suape Coastal Industrial Estate Plan as a project for which cooperation can be extended by the Japanese Government.

In closing, we want to express our deep gratitude for the invaluable cooperation we received from many persons in the agencies involved in the Brazilian and Japanese Governments; from consulting firms in Brazil, in particular TRANSCON and APL; and from JETRO and many Japanese firms operating in Brazil.

July, 1976

Dr. Sadakazu Iijima
Leader
Japanese Survey Team for
the Suape Coastal Industrial
Estate of Federative
Republic of Brazil

STUDY OBJECTIVES AND METHODS

1. The study was conducted as technical cooperation between the Brazilian and Japanese Governments.

   (1) Period of the Study

   November, 1975 – March, 1976

   (2) Purpose of the Study

   To review and evaluate the TRANSCON report on planning for the Suape Coast Industrial Estate currently being promoted by the Pernambuco State Government, with assistance from the Brazilian Government.

   (3) Methods

   The study involved both a review of the TRANSCON report, which was conducted in Japan, and investigation in the field to confirm the report's particulars.

2. A study team was dispatched to Brazil by the Japan International Cooperation Agency between January 9 and February 2, 1976, with the following objectives.

   (1) To conduct interviews and discussions with related Brazilian entities for final confirmation of the TRANSCON report evaluation.

   (2) To investigate concretely at the site conditions in the Suape.

   (3) To collect comparative information about development districts reflecting Brazil's domestic development policies, and about facilities in major urban areas (Recife, Salvador, Sao Paulo, and Rio de Janeiro).

   (4) To conduct a comparative survey of the Aratu Coastal Industrial Estate, with the objective of confirming the feasibility of the Supae estate plan.

   (5) To conduct a comparative survey of advanced industrial zones within Brazil (the Cubatao industrial zone and the Santos port).

2-1 Members of the Survey Team and their assignments

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Leader of the Survey Team:

Dr. Sadakazu Iijima	Executive Director, Japan Industrial Location Center (Overall supervision)
Dr. Akira Konno	President, Regional Planning Union Co., Ltd. (Regional planning)
Hiroo Takizawa	Director, Industrial Location Guidance Division Ministry of International Trade and Industry (Industrial location policies)
Dr. Hiromichi Kono	Managing Director, Mitsui Consultants Co., Ltd. (Port and harbor facilities)
Akemi Iijima	Head, Kobe Investigation & Design Office The 3rd District Port Construction Bureau Ministry of Transport (Ports and harbors)
Sosuke Hitachi	Bureau of Ports & Harbors Ministry of Transport (Ports and harbours)
M. Shigeyoshi Ohara	Chief Planner, Japan Industrial Location Center (Industrial development)
Hirotaka Mano	Counsellor, Japan Industrial Location Center (Selection of industries)
Minoru Shibuya	Senior Engineer, Technical Engineering Dept. K.K. Pacific Consultants International (Infrastructure)

Kiyohiro Hori	Chief Planner, Nomura Research Institute Co., Ltd. (Development effects)
Juichi Kokubo	Official, Mining & Industrial Planning & Survey Dept. Japan International Corporation Agency (Coordinator)
Kenji Kumagishi	Official, Social Development Cooperation Dept. Japan International Cooperation Agency (Coordinator)

2-2 List of persons who assisted the Survey Team

i. Brasilia

Dr. Dilson Santana de Queiroz
Secretario Geral, Ministério do Interior

Dr. Paulo Vieira Belotti
Secretario Geral, Ministério de Industria e do Comercio

General. Newton Cyro Braga
Secretario Geral, Ministério dos Transportes

Dr. Antônio José Cerqueira Antunes
Coordenador de Planejamento Setorial da IPLAN

Coronel. Alberto Carlos Costa Fortunato
Secretario Adjunto, Ministério das Minas e Energia

Dr. José Otamar de Carvalho
Secretario de Planejamento, Ministério do Interior

Dr. Murilo Mota Filho
Coordenador de Cooperaçao Externa do Ministério do Interior

Dr. Ivanildo Barbosa
Chefe Substituto do Escritório da SUDENE em Brasilia

ii. Recife

Dr. Paulo Gustavo de Araujo Cunha
Vice-Governador do Estado, Govérno do Estado de Pernambuco

Dr. Anchieta Hélcias.
Secretario, Secretaria de Industria e Comércio, Govérno do Estado de Pernambuco

Dr. Jose Lins de Albuquerque
Superintendente da SUDENE

Dr. Roberto Cavalcanti de Albuquerque
Assistente Tecnico do Superintendente da SUDENE

Dr. Glauco Melibue
Diretor do Departamento de Saneamento Básico da SUDENE

Dr. Márcio Melo
Diretor Substitudo do Departmento de Saneamento Básico da SUDENE

Dr. Julio Araujo
Diretor Presidente, DIPER

Dr. Eric Figueiredo
Coordenador do Projeto SUAPE, na DIPER

Dr. Ilo de Barros Barreto
Diretor Administrativo, DIPER

iii. Rio de Janeiro

Dr. Alfredo Lemos de Amorim
Representante, SUDENE, Rio de Janeiro

Dr. Antonio Mourão Abissãmara
Representante, DIPER, Rio de Janeiro

2-3 Itinerary

Date	City	Place
Jan. 10	Rio de Janeiro	Arrive at Rio de Janeiro
	"	Arrange affairs with the Consulate General of Japan, Rio de Janeiro
Jan. 11	"	Survey urban, and port and harbor facilities
	Brasilia	Arrive at Brasilia

Date	City	Place
Jan. 11	Brasilia	Arrange study schedule with the Japanese Embassy
Jan. 12	"	Visit Ministerio do Interior, receive briefing and information
	"	Visit IPEA, receive briefing
Jan. 13	"	Visit Ministerio da Industria e do Comercio, receive briefing and information
	"	Visit Ministerio das Minas e Energia, receive briefing and information
Jan. 14	"	Visit Ministerio dos Transportes, receive briefing and information
	"	Survey facilities in urban Brasilia
	Rio de Janeiro	Arrive at Rio de Janeiro
Jan. 15	"	Economic survey group; Visit TRANSCON, recieve briefing and information
	"	Infrastructure survey group: Visit PORTOBRAS, receive briefing and information
Jan. 16	Sao Paulo	Arrive at Sao Paulo
	"	Pay courtesy call to Consulate General of Japan, Sao Paulo
	"	Visit Japan Chamber of Commerce and Industry, collect materials
	"	Visit JETRO, collect materials
	"	Infrastructure group surveys facilities in the Cubatao industrial zone and the port of Santos
Jan. 17	Recife	Arrive at Recife
	"	Arrange affairs with Consulate General of Japan, Recife

Date	City	Place
Jan. 18	Recife	Survey facilities in urban Recife, and the Cabo Industrial Estate
Jan. 19	"	Pay courtesy call to Director of SUDENE
	"	Visit Pernambuco state government, receive briefing and information
	"	Visit DIPER, receive briefing and information
Jan. 20	"	Economic and infrastructure groups separately receive briefings and information from officials at DIPER.
		Leader of the team and members involved with port & harbor, and infrastructure, survey the Suape site.
		Three members of the team concerned with ports & harbors arrive in the afternoon
	"	Intra group arrangements
Jan. 21	"	Spend the day at DIPER, receiving briefing and information
Jan. 22	"	Survey the Suape site from the air
	"	Survey of Suape site; field survey and by boat
Jan. 23	"	Spend the day at DIPER, collecting detailed information
		Leader of the team and members involved with urban issues survey inland industrial estates
Jan. 24	Salvador	Arrive at Salvador
	"	Survey the Aratu and Camaçari sites from the air
Jan. 25	"	Survey facilities in urban Salvador
Jan. 26	"	Visit Centro Industrial de Aratu (CIA), receive briefing and information

Date	City	Place
Jan. 26	Salvador	Survey the Aratu Industrial Estate, and port and harbor facilities
Jan. 26	Recife	Arrive at Recife
Jan. 27	"	Spend the day at Recife, collecting detailed information
		Members involved with port & harbor issues visit the Recife port and harbor bureau; industrial development-related members survey inland industrial estates
Jan. 28	"	Morning; final discussions with DIPER officials
	"	Leader of the team presents report to Consulate General
	"	Research presentation to SUDENE
	"	Return courtesy call to Vice-Governor of Pernambuco by leader of the team
Jan. 29	Brasilia	Leader of the team and three others go to Brasilia; 3 members of joint port and harbor study go to Recife; and the other five members go to Rio de Janeiro, each group to conduct its particular investigations.
		Brasilia group presents reports on finding to Japanese Embassy and Ministerio do Interior
	Rio de Janeiro	Rio de Janeiro group receives briefings and information from officials at PETROBRAS and UEB
Jan. 30		Afternoon: collect materials and complementary data, organize materials
Jan. 31	Los Angeles	Arrive at Los Angeles
Feb. 2		Return to Japan Three members of the joint port and harbor study return to Japan on February 7.

FEDERATIVE REPUBLIC OF BRAZIL

Pernambuco

GENERAL CONSIDERATIONS AND CONCLUSIONS

1. General Considerations

The Japanese Government Survey Team, acting on a request from the Brazilian Government, objectively evaluated the contents of the TRANSCON report on planning for the Suape Coastal Industrial Estate from the technical and economic standpoints; and provided technical cooperation concerning the possibilities for realizing of this plan.

The survey team conducted research at the site, and a review of the TRANSCON report. Giving attention to the following points, the team prepared this report.

(1) Principal Points for Consideration

(A) Observing that planning for the Suape Coastal Industrial Estate involves large-scale development, the team not only pursued the possibilities for implementing the projects that constitute the core of the plan--such as development of industry, tourism, and cities, but also investigated ways of attaining ideal regional development, introducing these projects into the Suape in an integrated manner.

(B) Since it is readily anticipated that the plan will have great impact in the region, the survey team gave serious consideration to the establishment of the autonomy of the region where the planning will apply.

(C) Taking a long-term perspective, the team, besides analyzing the content of the entire plan, undertook to separate the plans into two sections; those which must be undertaken as short-term plans and those which must be undertaken as long-term plans, and evaluated the over-all plan technically and economically. Therefore it is basic to the approach used here that implementation is to proceed in stages; the view that this is proper and realistic is shared by the Brazilians involved.

(D) It is noted that the Suape is close to the Recife Metropolitan Plan Region, and emphasis is given to the contribution which implementation of this large-scale project will make to development of the Recife Metropolitan Region.

Under PIN, planning is being undertaken for nine metropolitan regions (Belem, Fortaleza, Recife, Salvador, Belo Horizonte, Rio de Janeiro, Sao Paulo, Curitiba and Porto Alegre) and with the exception of the relationship of the Aratu project and Salvador, it is only in the case of Recife that the benefits of a large-scale industrial project will be obtained in metropolitan region development work.

(E) This project, being large in scale, requires a corresponding effort at the improvement of the infrastructure. Therefore close attention was paid to the portions of the

TRANSCON report dealing with infrastructure, and it is thought that the projected improvement of infrastructure is adequate in regard to the industrial and regional development goals.

(F) The major thrust of this project is in the area of industrial development. In connection with implementation of industrial development projects, an enormous amount of investment is expected to establish the foundation for industry. Therefore attention has been concentrated on attracting categories of industry which will have high investment effects.

(G) The similarity of the Suape project to the Kashima coastal estate in Japan has been noted with interest, and the Kashima precedent has been studied for clues which would be useful for Brazil.

(H) In this plan, the attention given to the prevention of pollution has been insufficient. Despite differences between the two countries, the survey team believes that Japan's experience will be of considerable value to Brazil, and related information is included in this report on the basis of this understanding.

(2) Structure of the Report

This report is structured as follows.

Part I:	Over-all plan for the Suape
Part II:	Stage I for the Suape
Part III:	Development Effects

The fields investigated are five in all: industrial development, port and harbor improvement, infrastructure other than ports and harbors, regional planning, and development effects.

Concerning development effects, from the connection with the subjects of investigation of the TRANSCON report, there was no choice but to establish many premises and hypotheses because of the shortages of data, and it was judged dangerous to refer to clear development effects at the present time; this subject is discussed in Part-III. Later, when the conditions surrounding many premises are made clear and specific, it will be necessary to investigate development effects anew.

In Part I, the location of the over-all plan and the important issue of industrial development are the central themes, and the TRANSCON reports concerning port and harbor improvements, infrastructure other than ports and harbors, and regional planning, are reviewed.

Regarding industrial development, besides the TRANSCON report, the APL report is reviewed as well.

In Part II, the concrete proposals of the Japanese survey team concerning Part I are given. These proposals include modifications of the TRANSCON and APL plans and new proposals.

The Stage I planning proposals of the Japanese survey team cover the 10 year period 1975 – 1985. Putting regional planning first is based on the viewpoint that Stage I planning must, as much as possible, be based on the long-term over-all plan.

In Part III, because of the many premises and assumptions as mentioned above, the methods associated with measuring development effects are explained.

2. Conclusions

During the five months from November 1975, the Japanese survey team reviewed the Brazilian planning proposals for development of the Suape, observed the site, listened to the opinions of informed people, then formed its opinions.

Making use of the experience gained through the many coastal industrial estates in Japan, the team is delighted to have the chance to offer advice concerning the directions for better development.

As noted in the interim presentation in Brazil, if the Suape were in Japan, it would probably be developed before any other site for an industrial estate.

Much experience is necessary in thinking about the future in the light of conditions prior to development. Compared to places like Singapore's Jurong, and Kashima and Tomakomai in Japan, from the first time the team members saw the Suape they thought conditions for industrial location were incomparable.

Of course, Japan also has experience in developing a location just because conditions were good, and there are examples where even ten years after an estate was opened there were vacant sites. The matter should be judged in an coherent manner, considering wider conditions such as developing economic trends and government policies.

However, our conclusion is that, through development proceeding by stages while a clear image of the future goal is maintained, the Suape has sufficient development potential. There is some argument about whether industrial plants or improvement of the industrial zone should come first, but looking at the question from the standpoint of the good, integrated conditions for location, we feel improvement of the region comes first. Moreover, conditions for industrial location will rapidly improve, we feel, and the area will become much more attractive for industry than other regions of Brazil.

All that remains are the formal decisions to proceed with development. The reasons for this are as follows.

(1) For Balanced National Development

The development of a nation is the sum of development of the agriculture, fishing, manufacturing, tourism, commerce and other industries, among which a balance should be maintained, but the role of manufacturing industry in the development of a modern state is exceedingly important.

The problem of how to allocate sites for industrial development within a country so as to maintain a balance, is an important one for modern states. That many countries are suffering from excess accumulation of population and industry in one region, is common knowledge.

In countries with abundant resources and countries with few; in large and small countries; in populous countries and those with small populations; in countries with ocean access and land-locked nations, in countries with severe climates and those with mild climates— development policies will differ according to the special characteristics of the country.

But in any country, development that is generally balanced regionally, is most important.

In Brazil, the heavy concentration of population and industry in the Sul is continuing, and the country is aiming for more balanced development through development of the Norte and the Nordeste.

This is the first important point concerning the Suape.

(2) Possibilities for Urbanization

When industrial site conditions are the same, it is more advantageous for a site to be close to a large city, the center for administration, culture, and information, than it is to be distant. The metropolitan area with Recife as its center is one of the nine metropolitan regional development planning policy areas in Brazil. From Recife, the number one city in the Norte and Nordeste, the Suape is only 30 – 40 km.

Close to this urban base, the potential of the region as an area suited to development of coastal industry should be evaluated highly.

(3) Unexcelled Industrial Location Conditions

Besides calm winds and waves, and extensive land that can be used, the region, with calm water interrupted by a natural reef, is endowed with conditions for industrial location that make it one of the world's best sites. Moreover, the fact that an abundance of industrial water can be attained provides the region with another advantage.

By our calculations, if there were no reef and a breakwater extending 9 km were constructed, even with differences in water depth, profile of the breakwater, and designed wave conditions, it would cost approximately ¥3 – 5 million, or US$ 10,000 – 17,000 per meter.

Thus, this site can be developed at comparatively less cost than other sites.

Because several rivers flow into the region, measures for flood control must be considered, but it is possible this will be a comparatively low expense.

(4) Industry-Location Trends.

There are applications from fertilizer and a number of other firms, which are thinking of locating here if a port is developed. If the outlook for port and harbor development is clear, additional applications are likely.

Looking at general industry location trends, largely because of the presence of Recife, the Nordeste's major city, good-quality firms are moving into this area's industrial estates.

Within the Recife metropolitan region, the ratio of traditional industry to dynamic industry–that is, firms which established in new locations–in 1950 was 80% traditional industry to 20% dynamic industry, but by 1970 traditional industry accounted for 41%, and dynamic industry had shifted to the greater part, 59%.

Within these industries, it is not a matter of supplying only regional demand; that industries are also operating in the Sul market also deserves attention.

In Brazil, basic industries are operated either by the state or by enterprises affiliated with the state.

Therefore in the future when a port is constructed at Suape and the industrial estate is created, it is believed that the situation is more advantageous than in Japan where it is necessary to rely upon private firms in securing participation in industrial estates.

(5) Potentialities through Development by Stage Planning

Land for industrial use amounting to 5,000 ha involves planning that that compares with Japan's Kashima, Fos in France, and the Netherland's Europort. It will take 20 – 30 years to complete total development.

Policies that advance development initially on a realistic scale will be extremely effective. Because in the Brazilian legal system it is possible to designate development regions and prohibit buying, selling and transfer of land, and freeze land prices, unlike the situation in Japan and other countries, it is easy to proceed by stages.

We also support proceeding by stages, based on a clear conception of the future goal and working to eliminate obstacles to the larger plan for the future. Ways of advancing Stage I planning are investigated principally in Part II of this report, where we have proposed this policy.

(6) Pollution-Free, Environmentally Sound Industrial Zone

Movements to preserve the environment are evident throughout the world, and efforts to eliminate pollution from industrial plants are proceeding.

Since the Suape will be a new industrial zone created for the 21st century, it is necessary to work toward perfection in eliminating pollution and preserving the environment.

At the Suape, it is necessary to plan from the beginning for a wide greenbelt and a beautiful industrial zone.

(7) Conclusion

(A) The premise for the Suape planning is the feasibility of developing ports and harbors. With the data available at present, we conclude that this is feasible. In port and harbor planning, however, it will be necessary to ascertain the necessity of a breakwater, its length, geological features and other matters; and to conduct boring surveys and model experiements for the port and harbor in their entirety, to ascertain the possibility of raising the reef crest elevation.

(B) This type of large-scale planning will require a great amount of capital, but our experience and thinking strongly suggests that "if the planning is good, success will follow."

Planning is decided by the federative government and the will of the locality. If the planning for proceeding with development is affirmed, capital from many nations can be attracted.

(C) Development will of course proceed with the concurrence of many agencies, but looking at the matter from a worldwide perspective, some earnest promoter will aid success from the start. We think that among the regional governor, mayors, presidents of public corporations and other officials, that some enthusiastic person who will make sure of results and pay close attention to planning is necessary.

(D) The members of the survey team believe that they would be able to contribute to implementation of the Suape project, because much experience has been accumulated in Japan in the planning and implementation of coastal industrial estates.

PART I. OVERALL PLAN OF THE SUAPE

CHAPTER 1. IMPORTANCE OF THE NORDESTE AND THE REQUIREMENT FOR REGIONAL DEVELOPMENT OF THE SUAPE

1. The Situation of the Suape in the Second PND

(1) Relation to Nordeste Development

The Federative Republic of Brazil is now in the second year of the second PND, the target of which is to achieve the gross national product of US$100 billion by 1977 and to occupy the eighth place in the Free World, and per capita income will be US$1,000. It is estimated that the labor force needed to achieve this target by 1979 will be 1.7 to 1.8 million. This would mean that approximately 40 million people will be economically active in 1980 and trade will amount to US$40 billion by that year, 15 times greater than that of 1965. While a number of problems confront a smooth execution of this Plan, it closely resembles Japan's post-war economic recovery plans.

The investment related to the Nordeste development in the second PND will be Cr$100 billion, or 60.6% of the nation's total investment of Cr$165 billion. The Nordeste thus occupies an important position in the total national development plans, along with the Norte.

In the Nordeste development scheme such local municipalities as Recife, Fortaleza and Salvador will be developed, made better organized and more efficiently coordinated among themselves, and their populations will be better adjusted.. In state capitals and sub-capitals in Nordeste, infrastructure and various social facilities will be improved in order to increase the scale of economic activities. These investment activities involving local municipalities are aimed at attracting new industries to prevent further population outflow, and at promoting existing local industries in order to gain a greater degree of independence for these regional economies.

The Nordeste will have to attempt to preserve the regions exceptionally beautiful beaches and rich historical heritage, and to harmonize the development of the region with maintenance of natural and cultural heritage.

Individual projects such as the Recife Metropolitan plan and the Polo-Nordeste plan will be carried out with these aims well in mind.

The following is a list of the Nordeste projects:

- Execution of the improvement plans for the Recife Metropolitan Region.
- Survey to be carried out for promoting the Suape Coastal Industrial Estate project.
- Execution of the improvement plans for the city of Salvador, the Camacari Petro-chemical Center and the Aratu Coastal Industrial Estate and others.

— Execution of the improvement plans for the city of Sao Luis and Itaqui's Harbor.

Among these projects the development of the Suape is recognized as a project requiring extensive surveys based on the second PND, and Cr$3 million is allocated to carry out surveys in 1975 – 1977.

The policy perspective for the regional development of Suape is said to be the building of a basis for developing the domestic market, i.e., promotion of agricultural processing by accelerating PROTERRA and introduction of modernized, coastal industries including construction of the coastal industrial estate and port and harbor.

(2) Relation to State Development Plans

Regional development of the Suape was masterminded by the state government in 1967 – 1969. Initially the plan dealt with enlarging Recife harbor (depth, 10 meters), to meet the rising demand on the harbor brought about by larger sizes of in-coming ships and larger volumes of freight it was to handle. Because the existing industrial estates had no space for future expansion, Suape thus attracted attention as a site for the new port and harbor, which was taken up in the state development plan.

Subsequently, under the guidance of SUDENE, the regional development of Suape came to be looked upon as a priority project for the Nordeste. The first survey was conducted in 1971 on the geological features of the area, to examine the feasibility of constructing a new port and harbor. The result was a report by TRANSCON, S.A., which was presented to SUDENE and IPEA in April-June 1975. The development plan of the Suape thus became a project in which federative policy was involved, and further, more detailed surveys were planned.

The change in the character of the regional development plan when it assumed national importance was accompanied by an increase in the size of the investment required. An estimate by DIPER envisages that the total investment will be more than US$200 million, composed of US$80 million for the port and harbor, US$58 million for infrastructure, US$56 million for urbanization and US$12.5 million for preparation of planning reports. About US$100 million is to be procured domestically while the other half is to be secured from abroad.

2. *The Role and Functions of the Suape*

It is already well known that Pernambuco State and especially Recife has been developed as a priority project of the country. Creation of employment opportunities and industrial development are twin policy objectives of Pernambuco State, and should be realized through development of Suape. The project as such was recognized as appropriately matching the requests of the Brazilian government.

Fortunately, the Suape can be integrated in the region to be embraced by the Recife Metropolitan Region Plan, with various advantages, as a key part of the entire project. Furthermore, it is recognized as a project making a meaningful contribution to the whole of the Nordeste.

We have examined the principal roles and functions of the Suape in the short and long terms of the state's own evaluation of the region and in relation to construction of Suape port and harbor construction of a coastal industrial estate, and tourism development. The following points are results of our examination.

(1) Principal Roles

The Suape is viewed as occupying a key position in developing the domestic market, i.e., it can be made to serve as a basis for industrial development and as a distribution center in the Nordeste by improving infrastructure and social facilities, and can also serve Paraiba, Rio Grande do Norte, Ceara, Piaui, Alagoas and Bahia states.

The Suape will serve as international port of importance for import and export trade because a large port will be constructed and industries will be attracted.

The Suape will be made to serve as a large-scale marine recreational area by utilizing and further developing the superb seaside environment, to equal Rio de Janeiro and Salvador.

The Suape can be made to serve as a new town for the long-term development of the Recife Metropolitan Region.

(2) Principal Functions

The functions of the Suape should be examined within the framework of the demand and supply structure in the long run in its course of development for further strengthening of the domestic market. At the initial stage it is thought to be able to perform its functions only with a strong policy support by the federative government.

Functions of the Suape are created in the process of achieving the objectives of Polo Nordeste, i.e., to strengthen the regional economy by promoting primary processing and to promote exports. Such primary products as sugar cane, cotton, castor-bean, sisal, tobacco, irrigated citrus, coffee and coconut in this state are said to be conductive to industrialization. By processing these commodities, agriculture in the state as well as in such other states as Paraiba, Rio Grande do Norte and Alagoas can be made more prosperous. It goes without saying that such basic products as bean, rice, corn, manioc and fruit should be grown in greater quantities.

Functions of the Suape can also be found in the process of implementation of various projects which utilize the port and harbor of Suape. It can function as a large import base from other regions of the country for wheat and such industrial raw materials as rock salt. It can be made a refrigeration and processing base for marine products such as tuna.

The process of establishing a closer relationship between the industries of the port and harbor area and inland areas can also assign some functions to this area. Through a better road network the Suape can attain closer relations with such existing inland industrial estates as Paulista, Curado and Cabo and it can also promote development of new industries in related fields.

The ultimate function of development of the Suape is to form a new urban center for the region in addition to promoting port and industrial development as strategic projects. It follows that the development of the Sto Agostinho resort area and the residential areas created as a consequence of the industrial estate should be coordinated with the growth of the Recife Metropolitan Region and should also be looked upon as "Recife New Town".

In terms of industrial development the Suape can promote sugar refining using sugar cane, production of molasses, alcohol and castor-oil (from castor-beans), yarn and textile products (from cotton), cellulose and paper (from sisal and eucalyptus), fruit juice (from fruit) and cement (from lime-stone). By utilizing the port it can facilitate import of raw materials and semi-products to promote the production of fertilizer, petrochemical products, iron and steel processing products and aluminum in close cooperation with the Aratu Coastal Industrial Estate in Bahia, the Camaçari Petrochemical Center, the Itaqui Steel Project at Sao Luis in the state of Maranhao and the Aluminu project at Belem in the state of Para. Construction of docks for ship maintenance and new ship building can be quite feasible in view of the character of the port as a fish processing base and a port of call for large convoys of ships. As a distribution center for the Nordeste, the Suape can function to import wheat from other regions of the country and to import oil products.

Thus, development of the Suape will be characterized as a seaside new town with the twin functions of production and distribution, which are absolutely essential for the future development of Recife.

3. Requirements for Regional Development of the Suape

This project is the most important one in the Nordeste, occupying an important position in the federative policies for regional and industrial development. This project also supports the execution of the Recife Metropolitan Plan and Polo Nordeste plan and will ultimately be most closely related to the final achievement of the goals of the PIN. This is the significance of the regional development in the Suape.

Generally speaking the requirements of the national policies must match regional requirements. Fortunately the requirements for the Suape's regional development are recognized as valid in the following terms.

(1) National Requirements

The Nordeste is deficient in natural resources, particularly so in the state of Pernambuco. However, the population there is as many as 30 million, or one-third of the total Brazilian population. The income level of the residents is not at all high. The federative government strongly recommends that Nordeste be developed in order to narrow the considerable regional disparities which now exist, and the development of the Suape is recognized as occupying an important place within the development plan of the entire Nordeste.

Suape is also favorably situated geographically no only to vitalize the domestic market but also to construct an international market center on the order of Sao Paulo or Rio de Janeiro. The Suape project thus is an extremely important one for the development of the entire Brazilian economy.

The Suape project commands close attention as the most important one in Polo-Nordeste.

(2) State Requirements

The state of Pernambuco has the following four major development plans, the development of the Suape occupying the foremost position:

1) The regional development plan for the Suape,
2) The irrigation project along the Sao Francisco River,
3) The Tapacura dam construction project, to provide drinking water supply for Recife, and
4) Agricultural processing projects in the state.

The state of Pernambuco looks to the Suape development project for the following:

1) Improvement of existing inland industrial estates,
2) Modernization of traditional industries such as sugar and textiles,
3) Promotion of processing of agricultural products,
4) Promotion of small and medium industries,
5) Improvement of technological standards, and
6) Promotion of exports for processed and semi-products.

The state of Pernambuco takes particular note of the geographical merits of the Suape as follows:

1) The Suape is situated at 30 to 40 km from Recife and thus can utilize the market, the labor force and other urban facilities,
2) This project is particularly effective in enhancing the potentialities of existing industries, and
3) This project is particularly effective in the execution of the Recife Metropolitan plan.

CHAPTER 2. INDUSTRIAL DEVELOPMENT

This chapter evaluates the validity of the list of industries as proposed by TRANSCON S.A. and Assessoria E. Planejamento Ltda. (APL) to be introduced to the Suape coastal industrial estate. There are some additional industries recommended by the survey team, and they will also be mentioned, along with their requirements and implications, directions of industrial location and pollution control measures to be adopted.

1. Industries Recommended by the Two Consultants

(1) Industrial Categories Recommended by TRANSCON

The TRANSCON report recommends fertilizer, aluminum and oil refining as industries to be introduced to the Suape coastal area. The reasons for recommending these industries are not specified. However, in the resume of the report, Chapter 3, Physical Plan for the First Stage, we do find some background information which may be taken as an explanation. The following is a summary of the argument presented there.

1) As development of the Nordeste was pursued as a part of PIN, the growth rate improved from 3% in 1947 – 1954 to 6.8% in 1954 – 1962, and further to 8% in 1965 – 1969. It is expected to grow at approximately 10% in the 1970s.

2) This higher growth, however, is only the first stage, which should be followed by a greater degree of independence in the development efforts of Nordeste.

3) For this purpose it is essential to have a market which can absorb a growing amount of goods and services, and to have a far higher national income.

4) The growth of the market and the national income is closely related to the growth of foreign trade, as recent trends of the entire national economy show.

5) That is to say, a larger domestic market can be secured as a result of the expanding production secter, which in turn must be supported by growth of exports.

6) It thus follows that independent development of the Nordeste must be promoted through industrial development which is export-oriented. For this purpose such representative agricultural resources of the Nordeste as sugar, cotton, fruit, palm, limestone and salt should be industrialized, and fertilizer should be used in greater quantities in order to achieve greater agricultural productivity.

7) Primary industrial products thus produced should be made the principal exports.

8) This necessitates large-scale port and harbor facilities.

9) Better port and harbor facilities make it feasible to introduce industries which utilize them.

10) In the Suape the above is entirely feasible.

The report further divides the port and harbor facilities into private and public ones. The public port and harbor facilities should be used by such kinds of businesses as sugar, wheat, molasses, alcohol and castoroil, for which there should be a terminal and storehouses, and not plants. The private port and harbor facilities should, according to the report, be used for fertilizer, aluminum refining, oil refinery, ship maintenance dock, automobile tire, machinery and metals and electric and electronic equipment industries. For fertilizer, aluminum and oil refinery, long-term demand forecasts for specified markets are provided, according to which production scales in the Suape are mentioned.

Table 2-1. Categories of industry and production scales recommended by TRANSCON

(Unit: 1,000 tons)

	1980	1985	1995	2005	Notes
Sugar	650	1,430	2,640	2,735	Terminal
Wheat	312	386	566	647	Terminal
Molasses	109	450	842	925	Terminal (export)
Alcohol	113	151	181	181	Terminal (export)
Castor-oil	30	60 (1984)	70 (1987)	80	Terminal
Cement	2,000	4,000	7,000	9,000	Terminal
Fertilizer					
NPK 15-15-15	170	170 (1984)	170 (1987)		
NPK 18-18-18		230 (1984)	506 (1987)		
NP 8-30-0	45	45 (1984)	45 (1987)		
TSP 0-42-01		70 (1984)	280 (1987)		
Aluminum refining	100	100	150	200	
Oil refinery	150	250	320	750	10^3 BPSD
(ship maintenance dock, automobile tire, machinery and metals, electric and electronic equipment, etc.)					

The TRANSCON report further proposes to construct a cement terminal (equipped with clinker mills) in the Suape. This is in order to improve the rate of capacity utilization of the existing cement plants in Nordeste (Itapessca, POTY in Pernambuco, Cimepar in Paraiba and Itapetinga in Rio Grande do Norte) from the present 60 to 70 % to a higher one by setting up a terminal, and possibly to enlarge these existing plants in future. Clinker would be transported from respective plants to the terminal in the Suape, where gypsum could be added to produce cement to be shipped out. Table 2-1 gives the breakdown of various categories with accompanying production scales.

(2) Industrial Categories Recommended by APL

APL evaluates the locational features of the Suape as follows (citing the APL memo).

1) A reef is observable along the coastline as a natural bank, securing a quiet ocean front. Immediately off the coast it is 15 meters deep, making it feasible to construct port and harbor facilities (120,000 to 130,000 DWT).

2) A large area of land is available for industrial use behind the coastline.

3) Rich water resources are available (1,100,000 m^3/d) from rivers in the area.

4) Electric power can be provided from CHESF, and trunk roads such as Federal BR-101 and State PE-60 are in service.

5) It is close to the state capital, Recife, only approximately 35 km away.

6) It is geographically close to South Africa, Europe and other parts of the Americas.

It is from these considerations that APL proposed a plan to construct an industrial complex consisting of industries of large scale and high future potential, and the port and harbor is looked upon us a main pole (polo) for the success of the industrial complex.

The proposed industrial estate is comprised of three kinds of industries in terms of the degree of dependency on the sea and inter-relations between industries:

1) Those industries directly dependent on ocean-going vessels that make port calls at the Suape for unloading raw materials and other goods.

2) Those which are related to the above but do not require the support of related industries, and

3) Those industries which are to be attracted to the industrial complex by the port and harbor and other facilities.

APL then lists the following six industries is six polo industries:

1) Fertilizer,

2) Oil refinery and petrochemicals,

3) Sugar chemicals,

4) Non-metallic minerals,

5) Machinery and metals, and

6) Electric, communications and electronic equipment.

Table 2-2 gives the breakdown of the above.

Fertilizer production will adopt the form of a complex, and is recognized by SUDENE and CDI as a priority project. It will be carried out by UEB, Sumitomo Chemical and Ataka & Co., which have already established a joint venture, Empresa Brasileira de Fertilizantes S.A. (headquarter at Recife). We proposed a production scale is the same as that of the TRANSCON report.

Aluminum refining has already been brought up in the 2nd PND as an industry to be encouraged. Alminio Nacional S.A. is undertaking a study on commercialization of refinery products. The TRANSCON report proposed the production scale of 100,000 tons in Stage I (1980), 150,000 tons in Stage II (1990) and 200,000 tons in Stage III (2005). But APL seems to propose a production of 40,000 tons.

In automobile (knocked-down commercial vehicles; diesel engines) Peugeot's Brazilian subsidiary had applied for plant site and had secured authorization by SUDENE in January 1976. It is waiting for clearance by CDI. It will produce 10,000 commercial vehicles a year (out of which 500 will be exported and 9,500 will be sold domestically) and 50,000 diesel engines (out of which 10,000 will be used for the commercial vehicles mentioned above, 20,000 will be exported to Peugeot of France and the remaining 20,000 will be domestically used).

Materials-transport vehicles are to be produced by Podoviaria Nordeste S.A. It has submitted its plan has been approved by SUDENE.

British groups has applied for permission to do steel sheet rolling and a West German group has applied for permission to produce seamless steel pipe. Rolled steel plates and sheets would be used to produce seamless and regular steel pipe. Various firms have also applied for permission to set up a ship maintenance dock and casting plant.

No applications have been filed for the oil refinery, petrochemicals, sugar chemicals and non-metallic minerals. In particular the oil refinery and petrochemicals will be up to the decisions of the enterprises under national management Petrobras S.A. and Petrobras Quimica S.A. respectively.

APL goes on to define the role of the prospective petrochemical industry in the Suape as complementing the petrochemical complex presently in Camaçari of the Aratu Coastal Industrial Estate in Salvador, Bahia State. Camaçari has little room for expansion for the production

Table 2-2. Industrial categories recommended by APL (6 Polos industrials)

1. Fertilizer
   - NPK
   - NP
   - TSP
2. Oil refinery
   Petrochemicals
   - Butadiene & derivatives
   - Toluene & derivatives
   - Methanol & derivatives
   - Xylene & derivatives
   - Tires
3. Sugar chemicals
   - Alcohol & starch
   - Cellulose & paper
   - Detergent
4. Non-metallic minerals
   - Sulfur (raw-materials for gipsita)
   - Lime products
5. Machinery & metals
   - o Automobiles
   - o Materials transport vehicles
     - Large boilers
     - Steam boilers
     - Cranes, travelling cranes
     - Industrial machinery
     - Gravimeters
     - Hydraulic valves & gauges
     - Ball bearings
   - o Steel rolling
   - o Seamless steel pipe
   - o Plain steel pipe
   - o Casting
   - o Forging
   - o Aluminum
     - Metal graphics
     - Gas bombes
     - Hand tools
     - Processing steel materials
     - Road-construction materials
6. Electric, telecommunications & electronic products
   - Copper & aluminum cable
   - Connectors & terminals for equipment
   - Fuses & regulators
   - Switches & socket
   - Control panels
   - Resistors & variable resistors
   - Insulaters
   - Transformers; reactors for lamps
   - Transformers, electric
   - Telephone bells
   - Telephone sets
   - Telephone tables
   - Telephone meters
   - Subscriber's telephone switchboards
   - Office telephone switchboards
   - Integrated circuits

Notes: The Table gives the content of the 6 polos industrials as APL envisages being introduced to Suape.

o Denotes industries which are described in greater details in terms of products, production scales, capital investments, numbers of employees and other aspects.

of butadiene, aromatics, and methanol and their derivatives but the demand for these products will grow. The Suape would fill in the expansion in demand.

It should be pointed out that many of the industries listed in Table 2-2 among the six polo industrials have a good possibility of being established as proposed.

(3) Differences in the Recommendations by the Two Consultants

Since APL adopted the methodology of reviewing the recommended industries of TRANSCON, there exist no major differences between the two lists of the proposed industries.

TRANSCON posits distributive and industrial sectors, and provides the demand forecasts for specified markets and production scales for the various categories in four stages, namely up to 1980, 1985, 1995 and 2005. In distribution it proposes terminals with storage facilities respectively for sugar, wheat, molasses, alcohol, castor-oil and cement. Here Suape would be complementing the Recife harbor in its handling of the growing volume of cargo in comming years. Regarding the industrial aspect of the Suape, TRANSCON lists fertilizer, aluminum refining and oil refinery as major items and provides production scales in stages of development. Ship maintenance dock, automobile tire, metals and machinery and electric & electronic equipment are listed but with no production figures.

APL does not look as far into the future as 2005 but goes into greater detail in defining each category as well as providing a longer list. In particular the APL memo and survey team discussions in Brazil has revealed that actual application for plant sites have been submitted from firms interested in the production of automobiles, materials-transport vehicles, steel rolling, seamless and regular steel pipe, casting, forging, and aluminum, in addition to the fertilizer complex which had also been mentioned by TRANSCON. This gives substance to the feasibility of the Suape industrial estate, as has been pointed out, and should be positively evaluated. APL confines itself to industries in its study, which TRANSCON also dealt with the distribution sector. The distribution aspect of the Suape would thus be dependent on the character of the port and harbor of the Suape in the APL version.

Table 2-3 gives a comparative view of industries as recommended by the two consultants.

2. Evaluation of Industrial Categories to be Introduced

(1) Methods for Evaluation

To introduce the appropriate industrial categories into the Suape Coastal Industrial Estate, it is desirable to utilize a policy for introducing industry that can effectively coordinate the conditions of the district with the conditions required by the industry.

The appropriateness of the industrial categories indicated by both consultants can be evaluated by investigating whether they are based on this policy.

This investigation can be made through the methods indicated in Fig. 2-1. which shows

Table 2-3. Comparison of recommended categories of industry
(Excepting commercial categories)

	TRANSCON Report	APL Memo
1. Fertilizer	☆	☆
NPK		
NP		
TSP		
2. Oil refinery	☆	○
Petrochemicals		○
Butadiene & derivatives		
Toluene & derivatives		
Methanol & derivatives		
Xylene & derivatives		
Tires		
3. Sugar chemicals	△	○
Alcohol & starch		
Cellulose & paper		
Detergent		
4. Non-metallic minerals	△	○
Sulfur (raw-materials for gipsita)		
Lime products		
5. Machinery & metals	○	○
Automobiles	△	☆
Materials transport vehicles	△	☆
Large boilers	△	○
Steam boilers	△	○
Cranes, travelling cranes	△	○
Industrial machinery	△	○
Gravimeters	△	○
Hydraulic valves & gauges	△	○
Ball bearings	△	○
Steel rolling	☆	☆
Seamless steel pipe	△	☆
Plain steel pipe	△	☆
Casting	△	☆
Forging	△	☆
Aluminum	☆	☆
Metal graphics	△	○
Gas bombes	△	○
Hand tools	△	○
Processing steel materials	△	○
Road-construction materials	△	○
6. Electric, telecommunications & electronic products	○	○
Copper & aluminum cable	△	○
Connectors & terminals for equipment	△	○
Fuses & regulators	△	○
Switches & socket	△	○
Control panels	△	○
Resistors & variable resistors	△	○
Insulaters	△	○
Transformers; reactors for lamps	△	○
Transformers, electric	△	○
Telephone bells	△	○
Telephone sets	△	○
Telephone tables	△	○
Telephone meters	△	○
Subscriber's telephone switchboards	△	○
Office telephone switch-boards	△	○
Integrated circuits	△	○
7. Ship maintenance dock	○	△

Note: ☆ Denotes categories which are recommended and given production scales and other features.
○ Denotes categories which are recommended but not given production scales and other features.
△ Denotes categories which are not specified in further breakdown.

that the base for selecting industrial categories to be introduced into a given district are the site conditions in the district and appropriateness to the site. The industrial categories chosen in this manner are then re-evaluated in terms of factors like the expectations of the district (development effects, environmental preservation) and location demand (location trends, growth). By coordinating plans with the district's physical conditions, the arrangement of industry is determined.

Because of the limited information available on district expectations and site demand, evaluation here is based on coordination of site conditions in the district and appropriateness to the site.

This coordination is conceptualized in Fig. 2-2, which shows that investigation concerns five items: industrial base, markets, manpower, resources, and natural conditions.

Fig. 2-1. Basic flow of selection process for industrial categories to be introduced

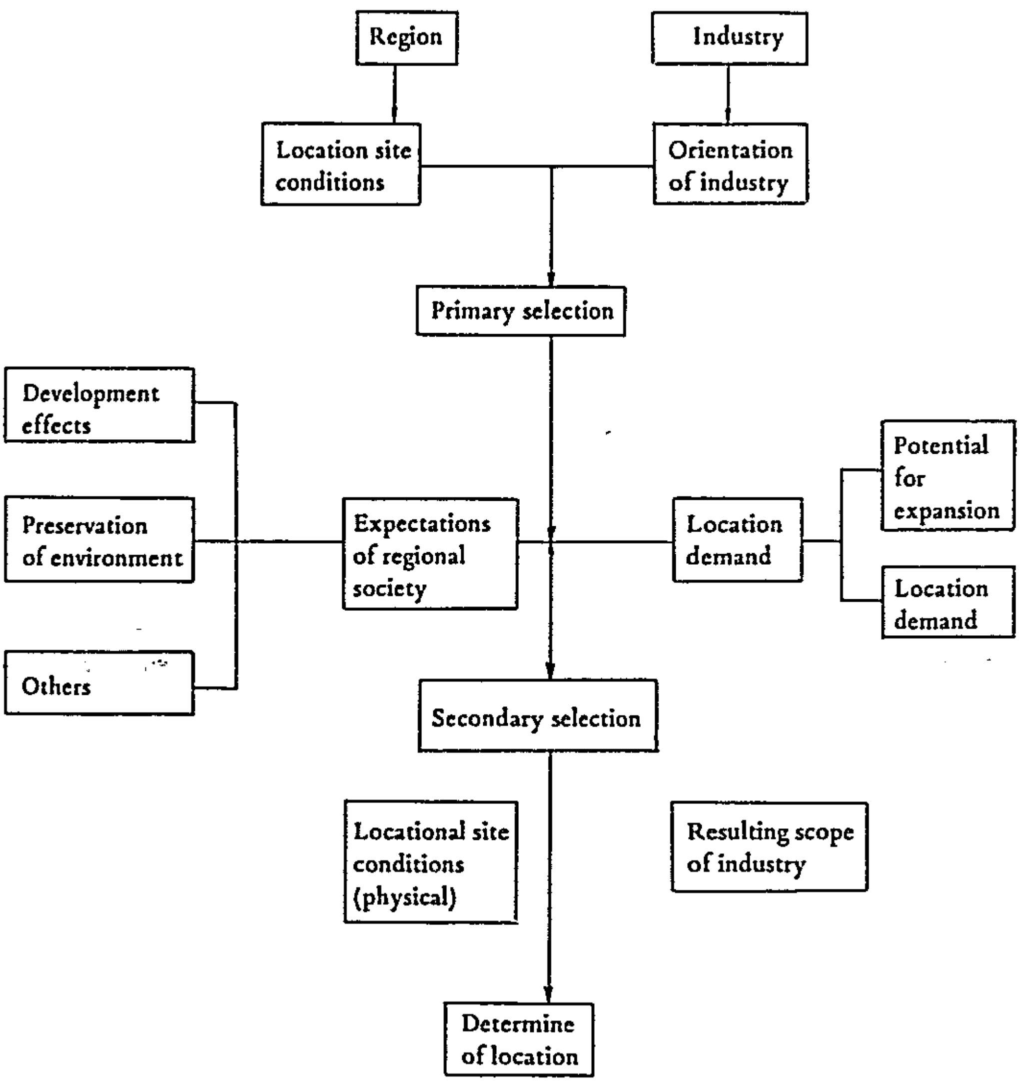
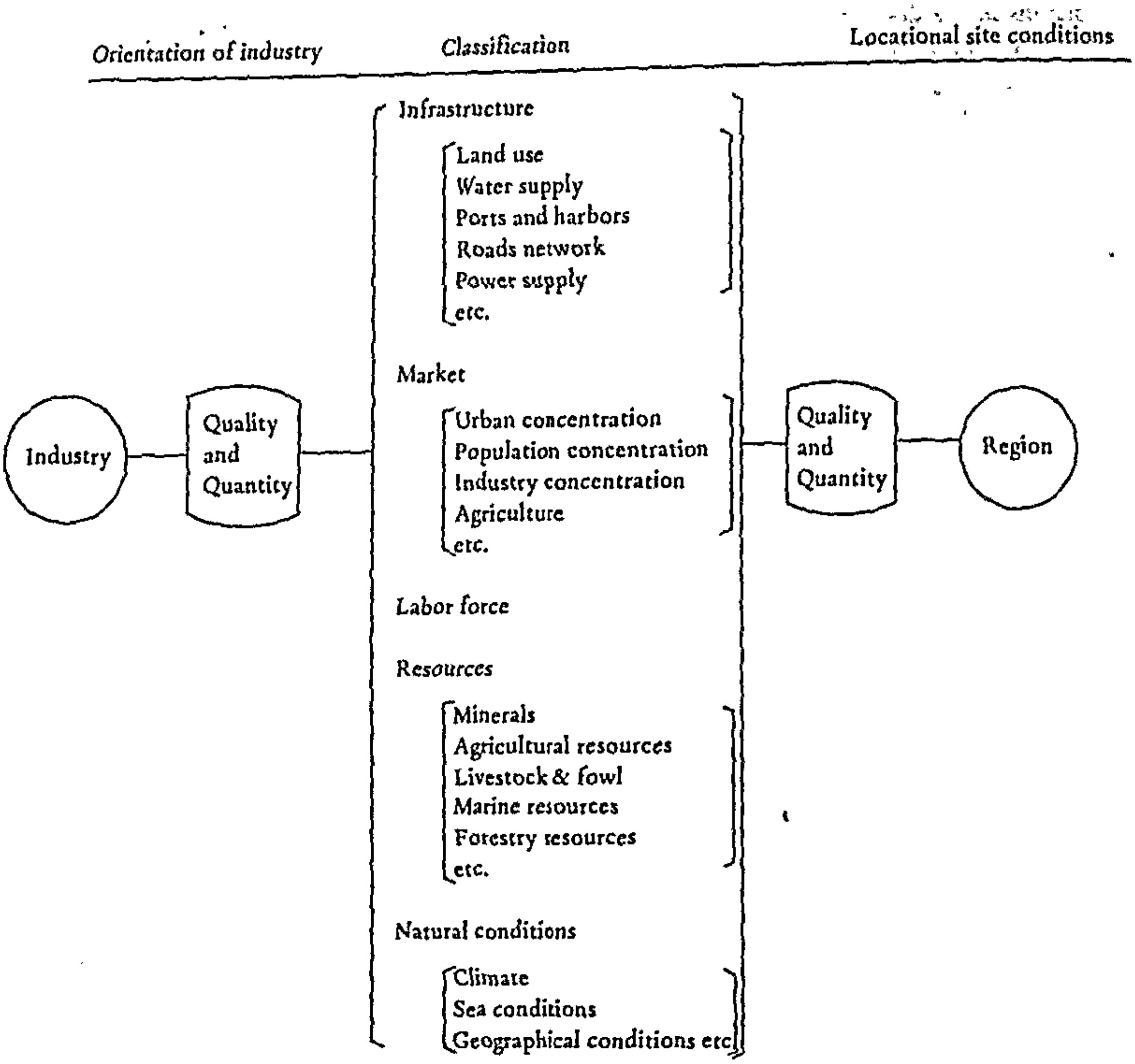


Fig. 2-2. Relationship between locational site conditions and location of industry



(2) Locational Implications of Industry

When planning to induce industries to a district, it is necessary to thoroughly understand the major factors by which each industry is oriented to a specific location. The following shows a classification of industry by such factors.

Infrastructure-oriented industry

Market-oriented industry

Labor-force-oriented industry

Resource-oriented industry

Actually, an industry may belong to two or more categories. In addition to these factors, some industries may be oriented toward a particular geographical location as often is the case for industries belonging to either the infrastructure-oriented or resource-oriented categories.

Infrastructure-oriented industry is strongly oriented toward a district wherein extensive industrial land, abundant industrial water supply and rapid transportation networks are available. A good many of process or machining industries engaged in mass production and/or manufacture of large-size products belong to this type. Representative industries are: iron and steel (blast furnace or electric furnace steel making), oil refinery, petrochemicals, paper and pulp, alumina and aluminum refining, copper smelting, lead smelting, zinc smelting, ship building and automobiles.

Market-oriented industry is strongly oriented toward being located in a district near the consumption center or where large markets exist. The markets vary according to type of industry. Broadly classified, they are urban conglomeration, population conglomeration, industrial conglomeration and agricultural conglomeration. Products dependent on urban conglomeration are those related to knowledge, information, distribution and construction. Those dependent on population conglomeration are mostly related to food, clothing and shelter. Typical industries related to urban conglomeration are automobile, electronic computer, office machine, printing and publication, ceramics and construction materials, steel processing, and the medical supplies and equipment industries, whereas for population conglomeration markets they are mostly foodstuffs, textile products, furniture and furnishings and wood processing.

Labor-force-oriented industry is strongly oriented to being located in a district wherein low-cost labor or a huge work force can be readily secured. Typical are the ship building, automobile, iron and steel, machine tools and equipment industries which demand a huge work force, while foodstuffs, textile products and machine parts industries seek low-cost labor.

Resource-oriented industry is strongly oriented to being located in an area products, agricultural products, livestock, marine products, forestry products and the like. Typical industries are blast furnace steel making, oil refinery, petrochemicals and natural gas chemicals, salt electrolysis, cement, paper and pulp, alumina and aluminum refining, copper smelting, lead smelting, zinc smelting, agricultural product processing, livestock processing, aquatic product processing and lumber processing. Of these, from blast furnace steel making to zinc smelting are typical process industries which require relatively larger scales of production in pursuit of the economies of scale, and thus require larger scale infrastructure. Most of them are also dependent on a large regional market to be profitable. Furthermore, ferrous and non-ferrous metals are mostly found in the mountainous regions of the producing areas where oftentimes the necessary infrastructure are absent. It is therefore the current worldwide trend that these industries, while strongly oriented toward resource-producing areas, are more or less inclined toward infrastructure, and ports and harbors in particular.

So it is that each industry, by what may be considered a basic principle, is locationally orientated and prone to be located in an area which meets its conditions. Accordingly, in planning to induce industries to a district, it will be necessary to analyze the locational conditions of the district and determine if these conditions will conform with the locational preference of each industry prior to starting the project.

For instance, in an area where industrial development to upgrade its socio-economic level under a development program is hoped for, but which is rather lacking in attractiveness for industries in terms of market and resources while the natural conditions are such that large scale port and harbor facilities, extensive industrial sites, abundant industrial water supply can be prepared; it is conceivable to proceed with the improvement of this infrastructure first and then start industrial development by inducing infrastructure-oriented industries. The industrial conglomeration thus resulting will induce new additions of industrial conglomeration, urban conglomeration and population conglomeration which will promote upgrading of socio-economic level in the area.

Inducement of industries to an area, however, may not actually be limited to any one type of industry as described, for conditions inherent to an area are not simple but complex. If an area possesses many of the conditions to which various industries are oriented, the process of industrial inducement will be quick. For instance, the peripheral area of a large city will have access to large markets, abound in conglomerations of population, industry and commerce, and in most instances, have an abundant water supply resource. Most of the cities will be developed near the river-mouth, and will become an attractive area for industries if port and harbor are built and industrial sites prepared; and if endowed with resources in addition, it will completely satisfy the major locational requirements of industries.

In the case of Suape, the area is inferior to Sul in terms of urban and population conglomerations. In Sul, however, large cities have already developed problems caused by overcrowding population and industry, and a policy of decentralizing the industry is being taken to solve these problems and to promote development of underdeveloped areas as well. In comparison, having the underdeveloped Nordeste and the largest city in Nordeste, namely Recife, the Suape can improve its conditions for inducing new industries if infrastructure is improved and natural resources are developed. Since there is no notable resources to speak of, as described later, it is particularly important to prepare and improve industrial infrastructure in order to construct a coastal industrial complex.

(3) Outline of the Locational Conditions

(A) Conditions of industrial infrastructure

Port and harbor: In front of the proposed site for the Suape Coastal Industrial Estate, a reef extends for about 10 km almost parallel to the coastline and provides a natural bulwark against the outer seas. The waters between the coastline and reef are calm. The water depth is said to be -15 m near the coastline. A large scale port and harbor is planned here to accommodate 80,000 DWT vessels at the outset and, eventually, 125,000 DWT vessels. Navigation channels will be built by dredging in rivers flowing into the area, and the dredged sediment will be used in reclaiming industrial sites.

Site: A nearly flat, vast site extends behind the coast line, and an industrial site of 5,300 ha (2,500 ha as sites for industries which directly require access to the port and harbor, and 2,800 ha as sites for industries which do not directly require use of the port and harbor) can be secured.

Water: The district will be dependent upon the Ipojuca-Massangana river system for its water sources, and an ultimate intake of 500,000 m^3 / day is considered possible. According to the TRANSCON report, the plan calls for securing 80,000 m^3 / day of water under the Stage I plan, consisting of 77,770 m^3 / day from the Ipojuca-Massangana river system and 2,230 m^3 / day from wells.

Electric power: Electric power supply plans call for a new substation at the Suape and expanding the 230 KV system of the CHESF's Pirapama substation in Cabo. The Suape substation will receive transmission from the Pirapama substation as well as the CELPE's Recife II substation in Recife, voltages being 230 KV, 69 KV and 13.9 KV. The capacity will reach 850 MW in 1985. The capacity of the Pirapama substation will be made 300 MW in 1985. Furthermore, if a oil refinery is located at the Suape, construction of a thermal power plant may also be considered.

Highways: Within Nordeste, the state of Pernambuco is most advanced in the development of a highway network. BR-232, traversing Pernambuco east to west, reaches Petrolina on the Bahia border, then extends a feeder line from Salgueiro which merges in Piaui with the Trans-Amazon highway originating in Paraiba. In addition, there are the south-bound BR-101, BR-104 and BR-408 running along the coastal district. All of these highways are paved with asphalt throughout the entire length. State highways are also well arranged in such a way as to link with Federative highways, so that from Recife, the Suape can be reached by going on BR-101 and branching off to PE-60 near Cabo and then on to unpaved county roads. The over-all distance is about 40 km.

(B) Market conditions

Population and urban conglomerations: According to IBGE's data, the population of Nordeste was 28,675,000 in 1970, accounting for 30.3% of the total population of Brazil of 94,509,000 of the same year. The population of the State of Pernambuco was 5,253,000, of which 2,861,000 live in urban areas. Of the urban population, the city of Recife accounts for 1,189,000.

Industrial conglomeration: Various industrial conglomerations are observed in the industrial estates at Paulista, Curado and Cabo which were created in advance with a view to promote regional development. Within Nordeste, Pernambuco is as well advanced in the area of industrial development as Bahia, and the ratio of production between the conventional industries and dynamic industries (newly located industries) has changed from 80:20 for 1950 to 41:59 in 1970.

Agricultural conglomerations: The representative agricultural products of Pernambuco is sugar cane, of which the State boasts the second largest production in Brazil. Others are onion, tapioca, cotton, sisal, kidney bean, banana, maize, tomato, castor bean, sweet potato, coconut, etc. Livestock and fowl are: chicken, cow, pig, horse, goat, sheep, etc. The importance of agriculture in the industrial structure of the state is large. As an example, 50 to 60 % of the working population are engaged in farming and livestock raising. Promotion of agriculture, cultivation of grains in particular, is one of the projects which will be further promoted and for which a sizable agricultural investment is foreseen not only in this State but throughout the Nordeste.

(C) Resource conditions

Agricultural resources of Pernambuco are as described before. In addition, in Nordeste there are pineapple, coffee, tobacco, clove, pepper, orchard, cereal and other crops which provide raw materials for the food processing industry.

As part of its energy saving policy, the Federative Government of Brazil has worked ou a scheme whereby the ratio of gasoline in the automotive fuel is lowered by adding alcohol to gasoline (gasoline 85%, alcohol 15%). As raw material for such alcohol, the government is contemplating sugar cane, sweet potato and tapioca. According to the Conselho Nacional do Petroleo (CNP) and DIPER, the demand for alcohol is forecast at 2.4 million kl in 1985, and planned cultivation of these agricultural products is said to be necessary.

The mineral resources of the state are, limestone, gypsita, phosphate rock, rock salt, tungsten ore and chromium ore. Deposits of iron ore, coal, bauxite, copper, lead and zinc found in the Norte area are hardly seen in this state.

Lime deposits are present in the sea-bed (continental shelf within the sphere of Recife). Gypsita is deposited in large quantities at Ouricouri, about 600 km from Recife. This is the raw material of sulfur and gypsum for manufacturing fertilizer. Phosphate rock is deposited in the north of Olinda which neighbors Recife.

In addition to the above, the mineral resources of each state of the Nordeste area are as follows:

- Bahia: Petroleum, natural gas, copper, lead, apatite, graphite, fluorite, iron ore, asbestos, mica, talc powder, chromium ore, mineral water, magnesite, barium and beryl.
- Ceara: Chromium ore, manganese, gypsita, magnesite, copper, graphite, quartz, beryl, schist, rock salt.
- Rio Grande do Norte: Tungsten ore, lithium, gypsita, tin, rock salt, brine salt.
- Paraiba: Fluorite, brine salt.
- Alagoas: Petroleum, natural gas, asbestos, apatite, rock salt.
- Cergipe: Petroleum, natural gas, potassium salt, rock salt, evaporite stone.

(D) Labor conditions

There is much open and hidden unemployment, and outflow of surplus labor from the agricultural sector is also anticipated in the wake of progress in modernization. Thus, labor supply is abundant. Furthermore, wage levels are low. (According to the classification of wages by bracket, ranging from US$25 or lower to US$382 or higher, in Pernambuco for fiscal 1972, 122,627 workers, or 63.3% of the total workers (193,593) excluding agricultural laborers, fall into the bracket between US$26.7 and US$66.6. (US$1 equals CR$ 6. Source: data from the information documents center of the Ministerio do Trabalho e Previdencia Social.) For this reason, there is great possibility that even already employed persons will be ready to seek a more favorable job if given the opportunity. Accordingly, no problem is foreseen in securing necessary labor.

(E) Geographical position

Pernambuco is located in the easternmost edge of Brazil, lying approximately midways between the Norte, the area that is abundantly endowed with mineral resources, and the Sudeste which constitutes the largest market in Brazil. The state is also the closest to Europe and South Africa.

(4) Assessment of the Type of Industry to be Induced

Following the previously described approach, locational requirements of each industry to be induced were reviewed and checked for conformity with the locational conditions at the Suape, and also it was studied whether the industry can be induced in the near future or should be induced on a long-term basis. The results are as shown in Table 2-4, which indicate that every industry planned for inducement is assessed as appropriate from the longer range point of view for the reasons listed below.

(A) Fertilizer

1) High dependency on utilization of the port and harbor.

2) Produces products useful in promoting agriculture in the Nordeste.

3) Utilizes gypsita which is one of the few resources of the State of Pernumbuco.

4) Requires much labor.

5) Places emphasis on geographical position vis-a-vis raw material sources along with the utilization of the port and harbor since most of the materials are imported.

Progress has already been made toward realizing the plan, as an application for entry has been submitted to the SUDENE, and it is therefore recommended that this industry is attracted at an early date.

Table 2-4. Checklist and evaluation for site suitability by industrial category, as per TRANSCON and APL

	Main factor influencing location							Evaluation	
	Industrial infrast-ructure*	Market: Urban con.	Market: Indust. con.	Market: Agri. con.	Resources	Labor	Geography	Short-term	Long-term
Fertilizer	x			x	x		x	x	
NPK									
NP									
TSP									
Oil refinery	x	x	x		x		x	x	
Petrochemicals	x	x	x		x		x		x
Butadiene derivatives									
Toluene derivatives									
Methanol derivatives									
Xylene derivatives									
Automobile tires									
Sugar chemicals	x				x				x
Alcohol & starch									
Cellulose & paper									
Detergent									
Nonmetallic minerals									
Sulfur & ammonium sulfate			x		x				x
Lime products			x		x				x
Machinery, metals									
Automobiles and diesel engines	x	x	x			x	x	x	
Material transport vehicles		x	x			x		x	
Large boilers		x	x			x			x
Steam boilers		x	x			x			x
Cranes; travelling cranes		x	x			x			x
Industrial machinery		x	x			x			x
Gravimeter			x			x			x
Hydraulic valves & gauges			x			x			x
Ball bearings		x	x			x			x
Steel rolling	x	x	x			x		x	
Seamless steel pipe	x	x	x			x		x	
Plain steel pipe	x	x	x			x		x	
Casting		x	x			x		x	
Forging		x	x			x		x	
Aluminum refining	x	x	x		x	x	x	x	
Metal graphics						x			x
Gas bombes									x
Hand tools						x			x
Rust preventing treatment of steel		x	x						x
Processing of steel materials		x	x						x
Road construction materials									x
Ship maintenance dock	x					x	x	x	
Electricity, communication equipments, electronic equipment									
Copper; aluminum cables	x	x	x			x			x
Connectors & terminals		x	x			x			x
Fuses; regulators		x	x			x			x
Switchers; sockets		x	x			x			x
Control panels		x	x			x			x
Resistors; variable resistors		x	x			x			x
Insulators		x	x			x			x
Repeaters for transformers & lamps		x	x			x			x
Transformers		x	x			x			x
Telephone bells		x				x			x
Telephone sets		x				x			x
Telephone tables		x				x			x
Telephone meters		x				x			x
Subscriber's switchboard		x				x			x
Office switchboards		x				x			x
IC, special microcircuit technology						x			x
Dials, panels		x				x			x

Note: Circle indicates strong orientation

*: Here, port & harbors only.

(B) Oil refinery

1) High utilization of the port and harbor.

2) For the time being the urban conglomeration at Recife and industrial conglomeration at Cabo can be counted on to be good markets, and the Suape, too, will be so in the future.

3) Places emphasis on the geographical position vis-a-vis crude oil sources along with the utilization of the port and harbor since crude oil will be brought from overseas.

Materialization of this plan is contingent on the judgment of PETROBRAS, but in order to expedite the Suape coastal industrial development it is one of the key industries recommended for early inducement.

(C) Petrochemicals

1) High utilization of the port and harbor.

2) Like the oil refinery, urban conglomeration and industrial conglomeration can be counted on as markets.

3) For receiving material and shipping products, great importance is attached to the geographical position along with the utilization of port and harbor.

This plan is contingent on the judgment of PETROBRAS QUIMICA, but since construction of petrochemical complexes are already under way at the Camçari district in the Nordeste area and at the Rio Grande district in the Sul area, it is advisable that for the Suape the industry be induced on a long-term basis.

(D) Sugar chemicals

1) High utilization of the port and harbor.

2) Will promote agriculture by its use of the representative products such as sugar cane and sweet potato.

3) A great deal of importance is attached to the geographical position along with the utilization of the port and harbor since products will be sold to markets throughout the nation.

This is a project on which the CNP is working. Since it is still under deliberation, it will be appropriate to consider this industry for inducement on a long range basis.

(E) Non-metallic minerals

1) The fertilizer complex can become the marketing outlet.

2) Will effectively utilize the limited natural resources of the State of Pernambuco. A survey of natural resources development will be necessary in the future.

Since the fertilizer complex will import the sulfur it needs from overseas at least at the outset, this industry is appropriate for inducementon a long-term basis.

(F) Automobile, steel plate rolling, seamless steel pipe, plain steel pipe, aluminum refining

1) High utilization of the port and harbor

2) For the time being, the urban conglomeration at Recife and industrial conglomeration at Cabo, and the Suape too in the future, can be counted on as markets.

3) Demands either a huge labor force or low cost labor.

Particularly as automobile and aluminum refining have the characteristics of being oriented toward a wide regional market, the geographical position as well as port and harbor utilization assume a great deal of importance.

Since applications for entry have already been filed by business enterprises for all of these industries, they are appropriate for inducement on a short range.

(G) Industries other than those enumerated above as well as those belonging to electric apparatus and telecommunication equipment and electronics equipment are common in their strong orientation to labor availability. Since a number of plants in the same or similar categories have already been located in the industrial complex at Cabo, Curado, Paulista, etc., all of these industries are considered appropriate for inducement. Since every one of these are inland-oriented industries and do not particularly orient toward the coastal nature of Suape, they may start locating themselves in the inland area of Suape as soon as the surplus capacity at the existing inland industrial estates is down to an insignificant level.

(H) Ship maintenance

1) Can take full advantage of its geographical position of being located on the coastal and ocean going routes.

2) High utilization rate of the port and harbor.

3) Vessels entering and leaving the Suape will automatically constitute a market for the maintenance dock.

It is reported that inquiries for entry have already been received. To promote development of Suape, repair docks should be induced at an early period.

3. Suggestions for Inducement of Other Industries

In the preceding paragraphs, the results of screening only those industries proposed in the TRANSCON and APL reports have been presented.

However, from the standpoint of effectively utilizing the locational advantages of the Suape, particularly the characteristics of a coastal industrial estate, it seems advisable to consider some additional types of industries. Also, regarding the petrochemical industry proposed in the APL report, formulating a complex for further integration is deemed desirable. By the same token, the automobile and aluminum refining industries should, it is desired, seek formulation of an integrated complex centered around them. In this section, new proposals for petrochemicals, automobile and aluminum refining will be presented along with suggestions for additional types of industry to be attracted from the standpoint of fully utilizing the advantages of a coastal industrial estate.

(1) Petrochemical Industry

The demand for petrochemical products in Brazil has been increasing rapidly. For instance, according to the forecast by the Ministerio de Planejamento e Coordenaçao Geral, the annual rates of increase between 1975 and 1980 are: 1.12% for PVC, 1.25% for polyethylene, 1.86% polypropylene, 1.17% for polyester, etc. Meanwhile, IPEA (Institute de Planejamento Economica e Social) forecasts supply shortages in the year 1980 of 1,340,000 tons of ammonia, 580,000 tons of ethylene, 200,000 tons of benzene and 104,000 tons of xylene.

The scale of the petrochemical industry in Brazil is at a level of 458,000 tons in terms of ethylene production in 1975, and the breakdown of petrochemical product output by state in 1971 was 74% in Sao Paulo, 24% in Bahia, 1.8% in Rio de Janeiro and 0.2% for all other states combined. Centers of the industry are Sao Paulo in the Sudeste and Bahia in the Nordeste. Sao Paulo has a complex, at Capuaba in the suburbs of Sao Paulo city, which primarily consists of the 300,000 TPY ethylene center of the Petroquimica Uniao Co. which has been in operation since 1972. Bahia has a petrochemical plant in operation in the Aratu Coastal industrial estate; another complex is under construction in Camacari and will include a 380,000 TPY ethylene center of Campanhia Petroquimica Camaçari. While construction of a complex at Camaçari is thus being expedited in order to meet increasing demand, a third complex is being planned for Rio Grande of the Sul with a view to supplement the one at Sao Paulo.

APL characterizes the petrochemical plant planned at Suape as supplementing the complex at Aratu in the same way that the Sao Paulo and Rio Grande complexes are related. Products are to be butadiene, aromatics, methanol and their derivatives. Details of derivatives have not yet been determined except for synthetic rubber, which will be derived from butadiene and eventually be processed into automobile tires.

Petrochemical industry is an organic chemical industry, which by using as its raw material the hydrocarbons contained in petroleum or natural gas, extracts ethylene, propylene, butane, butadiene and aromatics by separating and refining the hydrocarbons and then processes them into various derivatives. For this industry, continuous, integrated production is technically and commercially advantageous. For this reason, the petrochemical industry takes the form of a complex wherein various derivatives plants are collectively located in the same compound centered around a naphtha cracking plant and operated as a continuous processing line. This is common to any petrochemical complex in the world.

It seems that aromatics are planned as the main product of the petrochemical industry planned for the Suape. Ethylene and propylene derivatives which account for the majority of the petrochemical products are not included.

Since the petrochemical industry is capable of attaining the economics of scale, production facilities and complexes are becoming larger in scale. Because port and harbor facilities, industrial sites and industrial water which a complex uses are by necessity required to be of a large scale, it is more advantageous to locate such complexes in a coastal area than in the inland. (In Japan, most petrochemical complexes are located in coastal areas.)

Accordingly, at the Suape, it is more desirable to induce a fully integrated petrochemical complex comprising both ethylene and propylene derivatives as well.

This means that the one at the Suape should not be characterized as a complex that merely supplements the petrochemical complex at Camaçari, but ought to become the petrochemical complex of the Nordeste equivalent to the one at Camaçari in order to meet future demands for petrochemical products.

The integrated complex will consist of ethylene, propylene, butane-butylene, aromatics and top gas systems. Since details of respective derivatives and their production scale can only be dtermined on the basis of forecasts for future demand in Brazil and by reviewing expansion programs and such of other complexes, in this report we refrain from going into specific details. However, in light of economies of scale and worldwide trend in planning of petrochemical complexes, it is advisable that the scale of the naphtha cracking facilities should be 400,000 TPY in terms of ethylene production for one line, which is considered to be the minimum economic scale, and that a complex composed of two lines of this 400,000 TPY ethylene capacity naphtha crackers is appropriate. As reference, see the attached flow chart for the petrochemical complex model planned for construction in a new large-scale industrial base in Japan by 1985.

(2) Aluminum Refining and Automobile Industries

Applications for entry to the Suape have already been made by Alminio Nacional S.A. for aluminum refining and by Peugeot S.A., Brazil for automobiles.

In case of aluminum refining, industries which process locally-produced aluminum ingots tend to cluster around the aluminum refinery to formulate a vertically integrated complex, as per the schematic diagrams in Fig. 2-3.

Likewise, even in case of automobile assembly (CKD or SKD), a certain number of parts manufacturers are likely to locate themselves in the vicinity of the assembly plant. In case of a fully integrated assembly plant, there are many instances where a large number of parts manufacturers will cluster together to form a complex. See the schematic diagram in Fig. 2-4.

So in the Suape too, there is reason to believe that, in the long run, each industry will form a complex of its own.

Particularly in the automobile industry, if the plan applied for Peugeot progresses from CKD to SKD, and finally to an integrated assembly plant, the trend for formation of a complex will be further accelerated.

The following types of industry are proposed for the aluminum complex:

Plate
Diecasting
Foil
Wire rod
Extruded products
Shaped building materials
Industrial products
Sundries for daily use

For the automobile complex, automobile parts industries are proposed.

(3) Suggestions from the Standpoint of Fully Utilizing a Coastal Industrial Estate

The largest advantage of the Suape is its locational conditions which facilitate forming a large-scale coastal industrial estate. Accordingly, it is appropriate to primarily attract coast-oriented industries to this estate.

The distinctive features of coast-oriented industries are that they:

1) Utilize ports and harbors

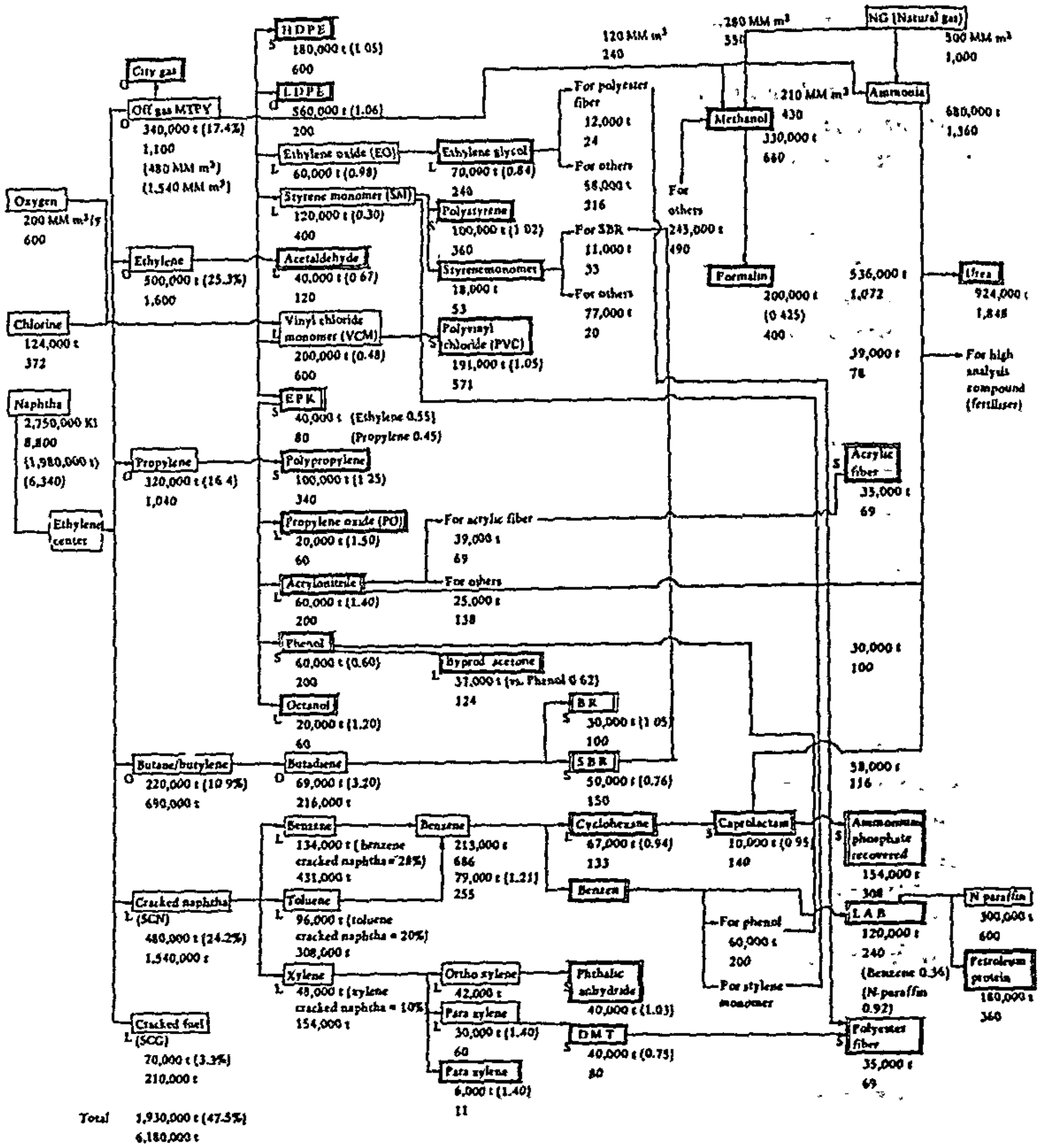
2) Utilize sea areas

3) Utilize oceanic resources

The type of industry which utilizes port and harbor are those which make considerable use of vessels for bringing in raw materials and fuels and shipping out products. In Japan, the main industries belonging to this category are: iron and steel, the oil refinery, salt electrolysis, aluminum refining, copper smelting, lead smelting, zinc smelting, paper and pulp, flour milling, oil expression, assorted feed, corn starch, lumber processing and the like which are highly dependent on materials from overseas; iron and steel, petrochemicals, automobile and such industries which export in large quantities; and iron and steel, the oil refinery, petrochemicals, chemical industry, cement, glass, ship building, automobile, heavy machinery and the like which handle heavy goods.

Fig. 2-2 Schematic diagram of petrochemical/gas chemical complex (ethylene capacity 1.6 million tpy)

Fig. 2-2. Schematic diagram of petrochemical/gas chemical complex (ethylene capacity 1.6 million tpy)



Note 1. ▭ Final products shipped out
▭ Intermediate products

2: O = Gas, L = Liquid, S = Solid.

Source: Survey Report on Development of Tomakomai East Large Scale Industrial Base (Japan Industrial Location Center, March, 1971)

Fig. 2-3. Conceptual layout of aluminum complex

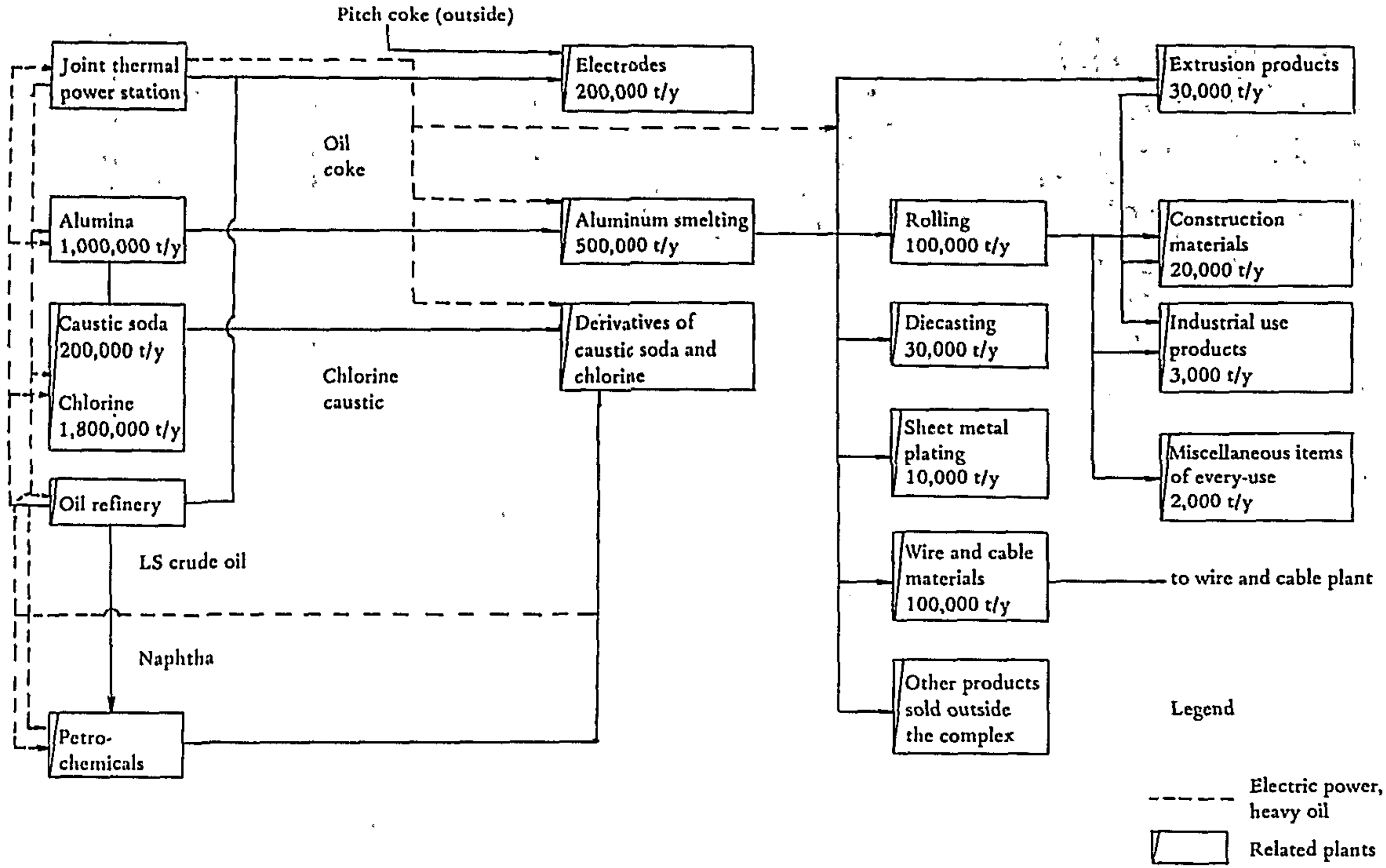
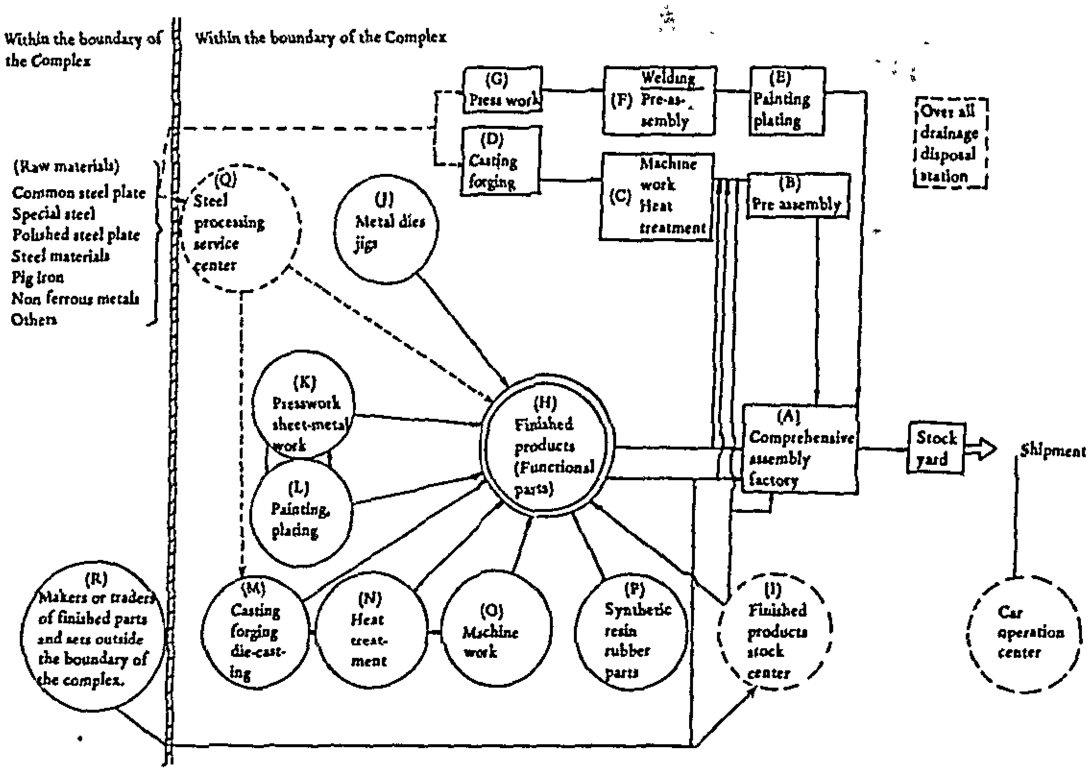


Fig. 2-4 Conceptual layout of automobile industry complex



Legend:
- ▭ Maker's factory
- ◎ Specialized maker of parts
- ○ Sub-contractor

Related establishment within the boundary of complex.
Flow of parts
Flow of raw materials.

Notes:

(A)	Final assembly of fittings to passenger cars, and inspection.
(B)	Installation of engines and transmission shafts
(C)	Working (heat treating) of parts for engines, transmission, axles, etc.
(D)	Materials of the parts of engines, transmission axles, etc.
(E)	Body coating (plating)
(F)	Fixing and welding of the body and frame.
(G)	Press work of the body and frame.
(H)	Factories to manufacture finished parts (functional parts), by integrated processes, or sub-assembly plants (for example, engine parts, seats, driving devices, interior fittings, etc.)
(I)	Stock center of finished parts.
(J), (K), (L), (M), (O)	Factories cooperating with the makers of finished parts (functional parts).
(P)	Formed parts of plastics, and rubber parts.
(Q)	Factories to process steel materials within the complex.
(R)	Makers of parts outside the complex. (For example, makers of tire tubes, electric equipment, glass, paint, car radios, lamps, etc.)

The types of industry which utilizes area fronting on the sea are: iron and steel, the oil refinery, petrochemicals, thermal power generation and the like which use large amounts of sea water for cooling; iron and steel, the oil refinery, petrochemicals, paper and pulp, thermal power generation and the like which discharge effluent into the sea; and those industries which, like ship building, must utilize the sea surface for the convenience of their manufacturing processes.

The type of industry which utilizes the oceanic resources are the oil refinery, natural gas chemicals and marine product processing.

Citing Japan as an example, industries which fall into the coast-oriented category are summarized in Table 2-5. In Japan, most key industries are located along the coast since the industrial belts were formed around ports and harbors. In other countries of the world industries such as iron and steel, the oil refinery and petrochemicals which are considered typically coast-oriented industries in Japan are not necessarily located along the coast. Nevertheless, most industries in the table have the rationale for being located in the coastal area rather than in the inland area in operating production activities. In Brazil, it is anticipated that these industries will, even though they may be currently located inland, start to move into the coastal area in the event a coastal industrial estate is prepared.

Tables 2-6 through 2-8 show what industries are actually located in Kashima, Mizushima and Tomakomai areas in Japan. The main types of industries in each of the three areas are as follows:

Kashima:	Iron and steel (blast furnace and electric furnace steel making), oil refinery, petrochemicals, thermal power plant, chemical machinery and equipment, assorted feed, edible oil, agricultural chemicals and chemical fertilizers.
Mizushima:	Iron and steel (blast furnace and electric furnace steel making), oil refinery, petrochemicals, synthetic fibers, thermal power plant, ship building, automobile, chemical machinery and equipment, heavy equipment, assorted feed, flour milling, edible oil, fabricated cement products, oil terminal and cement terminal.
Tomakomai:	Iron and steel (electric furnace steel making), alumina-aluminum refining, oil refinery, petrochemicals, thermal power plant, paper mill, chemical fertilizers, lumber processing, steel processing, chemical machinery and equipment, assorted feed, oil terminal and cement terminal.

Of the above, the Tomakomai area is planned to be expanded by construction of a new port to be excavated in the adjoining land and developing an industrial base of 10,000 ha, wherein iron and steel (blast furnace steelmaking), oil refinery, petrochemicals, aluminum refining, copper, lead and zinc smelteries, automobile, and thermal power plants and their related industries as well as urban-area-oriented industries are planned to be attracted. When completed, the Tomakomai area will be one of the largest industrial bases in Japan (Table 2-9).

In the Suape, among industries suggested by the TRANSCON and APL, those considered to be the coast-oriented type are fertilizer, the oil refinery and petrochemicals. Most

Table 2-5. Categories of coastal industry in Japan

Foodstuff
- Meat products
- Seafood canning
- Seaweed processing
- Fish sausage
- Processed seafood products
- Frozen seafoods
- Other seafoods
- Sodium glutamate
- Flour milling
- Sugar refining
- Feedstuffs
- Vegetable oils
- Animal fats & oils
- Edible oils & fats processing

Wood & wood products
- General lumber
- Veneer
- Barrel staves
- Wood chips
- Plywood
- Particle board

Pulp, paper & paper processing
- Soluble pulp
- Paper pulp
- Paper
- Machine-made Japanese paper
- Cardboard
- Corrugated board

Chemicals
- Ammonium ferilizers
- Calcium cyanamide
- Phosphatic fertilizers
- Other chemical fertilizer
- Soda industry
- Compressed & liquified gases
- Salt
- Other inorganic chemicals
- Basic petrochemical products
- Fatty intermediates
- Methane derivatives
- Fermental products
- Coal tar
- Cyclic intermediates, synthetic dyestuffs & organic pigments
- Plastic
- Synthetic rubber
- Other organic chemicals
- Rayon fibers
- Acetate fibers
- Synthetic textiles
- Fatty acids
- Hydrogenated oil
- Glycerin
- Soap & detergent
- Surface active agents
- Paint

Petroleum & coal products
- Oil refinery
- Lubricating oil
- Cokes

Rubber products
- Automobile tire tubes

Non-metallic mineral products
- Sheet glass
- Sheet glass processing
- Cement
- Cement products
- Enamelware
- Asbestos
- Gypsum

Iron & steel
- Blast furnace steel rolling
- Other blast furnace steel
- Ferro-alloy
- Coverter steel rolling
- Open hearth furnace steel rolling
- Electric furnace steel rolling
- Hot rolling
- Cold rolling
- Cold rolled steel shapes
- Steel pipe and tube
- Re-rolled steel
- Cold finished steel bars
- Pipe and tube drawing

Wire drawing
- Tin plates
- Galvanized steel sheets
- Coated steel pipe
- Coated steel wire
- Miscellaneous coated steel
- Iron and steel shearing & slitting

Nonferrous metals
- Copper primary refining & smelting
- Lead primary refining & smelting
- Zinc primary refining & smelting
- Nickel primary refining & smelting
- Aluminum primary refining & smelting
- Titanium primary refining & smelting
- Uranium & thorium primary refining & smelting
- Other nonferrous metals primary refining & smelting
- Aluminum secondary refining & smelting
- Aluminum alloy rolling
- Electric wire and cable

Metal manufacturing
- Metal building materials
- Tin plate for cans
- Other metal products

General machinery & equipment
- Boilers
- Steam turbines & hydraulic turbines
- Pumps & fittings
- Air compressor
- Gas compressor
- Blower
- Cargo handling equipment
- Industrial ceramics
- Chemical machinery & equipment

Electric machinery & equipment
- Generators and other rotating machines
- Transformers
- Switchgear, switchboard & electrical control equipment

Transport equipment
- Automobiles
- Auto chassises W/wheels
- Metal boat building & repair
- Wood boat building & maintenance
- Small water craft building & maintenance
- Marine engines

Table 2-6. Industries located in the Kashima coastal industrial zone

Industrial category	No. of enterprises	No. of workers	Area (10,000 m²)
Balanced compound feedstuff	2	303	50
Elemental feedstuff	1	130	5
Vegetable oils & fats	1	360	17
Foodstuffs	4	793	72
Nitrogenous & phosphatic fertilizer	1	130	11
Balanced compound fertilizer	1	N.A.	3
Soda industry	2	315	28
Compressed & liquefied gases	2	77	6
Basic petrochemicals	1	2,500	154
Fatty intermediates	6	1,104	76
Cyclic intermediates; synthetic dyestuffs & organic pigments	2	*1,000	72
Plastics	3	* 300	44
Synthetic rubber	4	1,640	93
Other organic chemical industry	3	* 190	33
Surface-active agents	1	67	2
Agro-chemicals	1	N.A.	3
Aromatics	1	N.A.	7
Chemical industry products not otherwise classified	1	N.A.	42
Chemical industry	29	7,323	574
Oil refinery	1	695	246
Cokes production	1	387	18
Other oil products & coal products	1	N.A.	0.3
Oil products; coal products	3	1,082	264.3
Sheet glass	2	1,123	89
Fresh concrete	2	92	6
Enamelware	1	N.A.	10
Lime products	1	67	5
Non-metallic mineral products	6	1,282	110
Blast furnace steelmakers doing rolling	1	10,160	627
Ferro-alloys	1	320	12
Hot rolling	2	N.A.	18
Steel pipe	1	1,560	46
Production of other steel products	1	560	22
Iron & steel not otherwise classified	1	90	1
Iron & steel	7	12,690	726
Chemical machinery & equipment	2	* 90	5
Machinery & equipment repair	1	1,100	1
General machinery & equipment	3	1,190	6
Total	52	24,360	1,752

Note: Asterisk indicates that the actual number of workers is greater than the total number shown because of lack of employment figures from some companies.

N.A.: Not available.

Table 2-7. Industries established in the Mizushima estate

	No. of establishments	No. of workers	Site area (m^2)
Flour	1	80	33,057
Formula feed	4	300	66,035
Vegetable oil	1	435	134,319
Starch	1	250	82,642
Foodstuffs subtotal	7	1,065	316,053
Soda industry	3	385	297,825
Pressurized & liquified gas	2	77	31,043
Basic petrochemicals	4	2,050	1,959,143
Basic petroleum products; intermediates	1	358	173,900
Fatty intermediates	6	1,599	994,812
Fatty intermediates, soda industry	1	103	202,772
Methane derivatives	1	25	11,550
Cyclic, intermediates, etc	3	133	377,419
Plastics	4	763	773,114
Plastics & other organics	1	41	74,000
Synthetic rubber	1	110	68,309
Other organic chemicals	1	22	7,155
Synthetic textiles	1	1,509	408,388
Gelatine, adhesives	1	72	6,720
Chemical industry subtotal	30	7,202	5,386,150
Petroleum refining	2	1,580	2,876,005
Cokes	1	750	950,000
Other petroleum products	1	95	106,919
Hydrocarbon subtotal	4	2,425	3,932,924
Cement products	8	518	251,811
Firebrick	1	26	30,000
Enamelware	1	250	61,000
Asbestos products	1	183	15,188
Nonmetallic mineral subtotal	11	977	357,999
Blast furnace steel rolling	1	11,000	11,471,521
Ferroalloy	1	245	107,450
Open-hearth furnace steel & rolling	1	1,157	480,858
Galvanized sheets	1	200	146,165
Shearing & slitting	2	364	29,084
Large steel structures	1	234	42,827
Iron & steel subtotal	7	13,200	12,277,905
Tin for cans	1	92	38,845
Metal products subtotal	1	92	38,845
Freight transport vehicles	1	57	25,000
General machinery & equipment subtotal	1	57	25,000
Automobiles & parts	1	6,700	867,026
Metal boat building & repair	1	1,200	225,759
Marine engines	1	1,271	446,565
Transport equipment subtotal	3	9,171	1,539,350
Thermal power generation	3	522	1,336,210
Electric power subtotal	3	522	1,336,210
City gas	1	70	35,264
City gas subtotal	1	70	35,264
Silos etc. (foodstuffs)	2	126	52,966
Tank yard	2	—	45,660
LPG import terminal	1	0	33,000
Limestone depot	1	—	48,893
Cement service station	4	43	99,958
Warehousing (steel)	1	13	33,071
Distribution subtotal	11	182	313,548
Reprocessed oil	1	3	4,867
Other subtotal	1	3	4,867
Grand total	80	34,966	25,564,115

Table 2-8. Industries established in the Tomakomai estate

	No. of establishments	No. of workers	Site area (m^2)
Meat products; formula feed	1	230	79,103
Formula feed	5	131	208,091
Formula feed; veg. oils & fats	1	90	40,397
Foodstuffs subtotal	7	451	327,591
General lumber	12	380	185,700
General lumber; plywood making	4	650	418,500
Wood, wood products subtotal	16	1,030	604,200
Paper	1	103	66,000
Pulp, paper, paper products subtotal	1	103	66,000
Phosphate fertilizer	1	120	153,000
Other chemical fertilizer	2	132	99,000
Soda industry	2	25	241,264
Other inorganic chemicals	1	120	307,000
Basic petrochemical products	2	420	355,688
Fatty intermediates	1	210	309,079
Methane derivatives	1	50	10,200
Other organic chemicals	2	135	100,790
Chemicals subtotal	12	1,237	2,032,121
Petroleum refining	1	530	1,297,301
Hydrocarbon subtotal	1	530	1,297,301
Glass processed materials	1	40	3,300
Glass containers	1	150	106,116
Nonmetallic mineral subtotal	2	190	109,416
Electric furnace steel; rolling	1	102	80,852
Steel pipe	1	160	113,733
Steel processing; steel products	6	1,783	940,094
Steel subtotal	8	2,045	1,134,679
Aluminum, primary refining	1	1,290	2,185,866
Aluminum & aluminum alloy rolling	1	300	154,392
Nonferrous metal subtotal	2	1,590	2,340,258
Tin plate for cans	2	113	19,039
Other metal products	3	78	41,864
Metal products subtotal	5	191	60,903
Other general industrial machinery & equipment	1	210	33,000
Machinery & parts production & repair	2	70	38,758
General machinery & equipment subtotal	3	280	71,758
Other plastic products	1	9	500
Other manufacturing subtotal	1	9	500
Tank yard	5	84	183,495
Gas depot	1	15	24,081
Cement & grains storage; tanks	1	21	38,300
Molasses tank	1	4	3,290
Cement bagging; cement mixing	3	18	144,696
Distribution subtotal	11	142	393,862
Thermal power generation	2	211	576,440
Power subtotal	2	211	576,440
Grand total	71	8,009	9,015,029

Table 2-9. Scheme for Industrial Development of Tomakomai East Industrial Project for 1985 – 1995

Category	Production	Value of Shipments (¥100 million)	Site Area (ha)	Water Used (1,000 m³/d)	Workers (persons)	Notes
Steel	20 million t/y	8,596	1,700	600	10,000	Site includes 1.5 million kW power plant & site for secondary processing of steel
Oil refinery	1 million B/D	4,258	760	100	1,000	Site includes 1.5 million kW power plant & site for storage of a 60 day supply of oil and products
Petro-chemicals	1.6 million t/y	6,437	800	780	6,500	Includes gas chemicals & electrolytic industry
Nonferrous metals		5,125	830	220	15,600	Includes rolling mill
Aluminum	1 million t/y	3,640	700	190	13,000	
Copper, Lead & Zinc	240,000 t/y 60,000 t/y 150,000 t/y	1,485	130	30	2,600	Includes sulfuric acid plant
Automobiles	500,000 vehicles/y	2,500	400	30	8,000	Related industries are considered to be only those directly related to formation of the estate
Others		6,084	2,030	290	8,900	
Power	3 million kW	–	150	–		Of the total 6 million kW of new power generation, the steel mill and petroleum refinery are to use 1.5 million kW each
Total		3,300	6,670	2,020	50,000	

of these industries were chosen after forecasts had been made for future demand. Accordingly, the conclusions reached are considered to be highly reliable.

As stated above, however, there are many other coast-oriented industries besides those cited by the two consulting firms. If industrial utilization of resources in the Nordeste or brought from other places is contemplated in the coastal area of Suape, there are a number of industries which may be considered appropriate for attraction to this district.

In other words, of the resources of the Nordeste, those shown in Table 2-10 can be considered for industrialization. In order to realize such industrialization, a survey of reserves and the quality for each resource is necessary, and it is premature to immediately link the mere existence of resources to industrialization. The following industries suggested are those which in general can be realized in relation to these available resources, and which also have the coast-oriented characteristics:

Copper smelting (copper rolling, copper alloy, and electric wire are possible as related industries);

Lead smelting

Zinc smelting

Brine electrolysis (to be included in the petrochemical complex)

Meat products

Canned sea foods

Fish meat, ham and sausages

Frozen marine products

Vegetable oils and fats

Animal oils and fats

Assorted feed

Of these, it is to be noted that smelting of copper, lead and zinc yield sulphuric acid as a by-product and the acid can be the basis for development of a fertilizer complex. Thus, the smelteries can be combined with a fertilizer complex, suggested by both consulting firms, as per the schematic diagram in Fig. 2-5.

In addition to the above, the following industries are suggested.

Ship building dock (shipyard)

Table 2-10. Resources of the Nordeste

Agricultural products
- Cotton
- Maize
- Feijao
- Pepper
- Sugar cane
- Tapioca
- Cacao
- Castor bean
- Sisal hemp
- Rice
- Coconut
- Coffee
- Banana
- Tobacco
- Pineapple
- Babasu coconut
- Dende coconut
- Carnauba wax
- Foodgrains
- Sesame
- Orchard fruits
- Vegetables
- Cloves

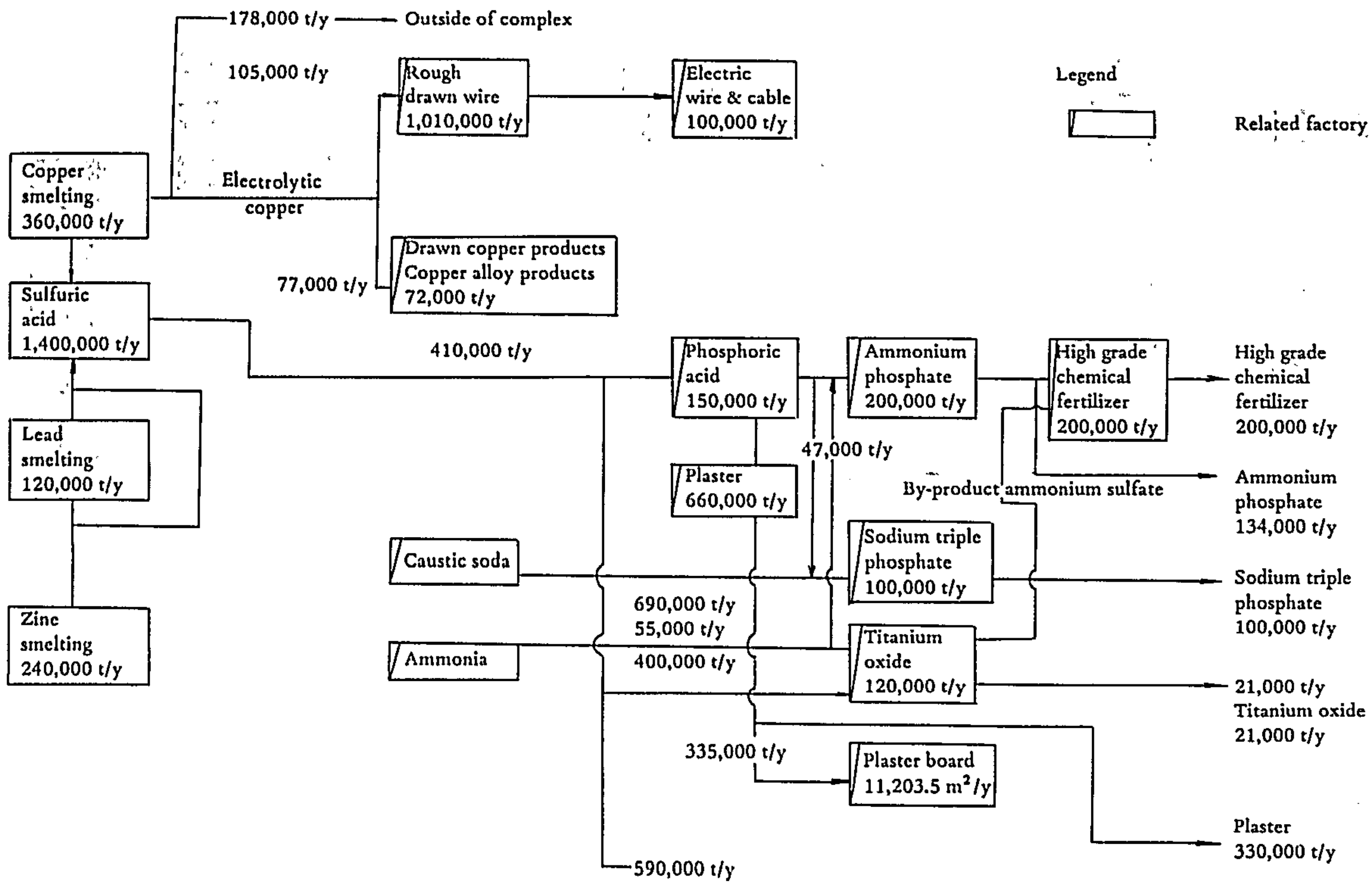
Livestock & fowl
- Cattle
- Hogs
- Horses
- Mountain goats
- Chickens

Forestry products
- Eucalyptus
- Cashew
- Jacaranda

Marine products
- Shrimp
- Lobster
- Red sea bream
- Mackerel
- Whale
- Flying fish
- Seaweed
- Freshwater fish

Mineral products
- Petroleum
- Tungsten ore
- Magnesite
- Phosphate rock
- Gypsum
- Asbestos
- Barium
- Sea salt
- Iron sand
- Evaporite stone
- Iron ore
- Limestone
- Chrome ore
- Fluorspar
- Rock salt
- Natural gas
- Copper
- Quartz
- Mica
- Beryl
- Manganese
- Lithium
- Tin
- Talc powder
- Potassium salt

Fig. 2-5. Conceptual layout of the copper, lead, zinc complex



Thermal power plant

The ship building dock is closely related with the maintenance dock suggested by the Brazilians, and the thermal power plant will play a supplementary role to the hydropower generating system in meeting future demand.

Furthermore, although blast furnace steel making may also be considered in relation to a coastal industrial estate and resources, it is not realistic to consider this industry for the Suape for some time to come since one such project is under study for the Sao Luiś Itaqui district in Sao luiś, Maranháo, and another project will be materialized at the Vitória Tubarao district, in Vitória, Esírito Santo.

Newly suggested industries are summarized in Table 2-11.

Table 2-11. Industrial categories newly proposed for the estate

Category	Relation to resources
Nonferrous metals	
Copper refining*	Industrialization of mineral resources
Lead refining	
Zinc refining	
Chemicals	
Salt electroysis	Industrialization of mineral resources
Foodstuffs	
Meat products	Industrialization of livestock production
Canned seafoods	Industrialization of seafood production
Fishmeat sausage	
Frozen seafoods	
Vegetable oils & fats	Industrialization of agricultural products
Animal oils & fats	
Formula feed	
Others	
Shipbuilding dock	
Thermal power generation	

Note: Asterisk (*) indicates related products such as drawn copper products, copper alloy and copper wire are included

4. Overview and Parameters of Industries to be introduced

The categories of industries to be introduced to the estate, with the addition of those recommended by the survey team, are shown in Table 2-12. The parameters of major industries are shown in Table 2-13.

The values of production of fertilizer, oil refining, automobile tire, steel plate rolling, seamless steel pipe, plain steel pipe, casting, forging, aluminum refining, automobiles, materials transport vehicles, and the ship maintenance dock were taken from the TRANSCON and APL reports

In all cases, these are based on a long-term view of supply and demand, and for all the scale has been determined concerning the industries proposed by the survey team, the volume of production recommended for petrochemicals is 800,000 t/y, in view of the naphtha balance derived from the economical scale o;the naphtha cracking unit (400,000 tons of ethylene) and the scale of petroleum refining (250,000 BPSD). For other categories, the standard scale used when new plants are built was used.

Among the parameters other than production scale, that is raw materials, transport mode, factory or plant site and number of employees, the survey team made use of the reports submitted by the two consultants, as well as information obtained in discussions at DIPER and APL. Where information was insufficient, reference was made to Japanese precedents. Japanese precedents were used in all cases for industrial water (including process and drinking water), and power.

Although the cement terminal (and clinker mill) has the nature of being a commercial entity from the viewpoint of this project, since it is included in the estate in the TRANSCON report, it is included in Table 2-12.

5. Location of Industry

(1) Objective

The objective in locating industries to be introduced should include the following:

1) Assuring that the various types of industrial activities run smoothly
2) Achieving the smooth utilization of related facilities for each type of industry
3) Providing rational land utilization and
4) Achieving harmony with the existing environment in the region.

When planning the layout, it is essential to consider the relations between the characteristics of each industry and the land utilization plan (position of industrial land, subdivisions, locations of peripheral areas, etc.) and industry-related facilities (the port, roads, etc.) as well as the relation to natural conditions (especially wind direction) from the standpoint of pollution control.

(2) Industrial layout concepts

It is essential first to determine the characteristics of each type of industry. The industrial layout can be considered as follows with respect to these characteristics:

1) The same and similar types of industry should be located in the same areas as much as possible to assure rationalization of production, common pollution control measures and common utilization of industry-related facilities.
2) Industries which require a concentration of production (industrial complex) and linkage with distribution facilities should be located in the same areas as much as possible.
3) Coordination with the industry-related facilities must be considered in close connection with the type of industry from the standpoint of utilization of harbors, roads, railways,

etc. In the case of industries which use large amounts of sea water for cooling purposes and industries which have large amounts of purified effluents to be released into the sea, the proximity to the sea must be considered in the layout.

4) From the standpoint of anti-pollution measures, industries can be classified into those which have centralized treatment and those which employ individual treatment. Industries which employ centralized treatment are to be located in the same areas.
5) With respect to the utilization of utilities, the centralization of utilities must be investigated objectively and the industries which will use such centralized facilities will be located in the same area for more efficient utilization of the utilities.
6) Industries which are closely related to other industries to be established in the estate must be arranged with careful consideration to this relation.
7) The layout of industries which might generate dust or fumes must take into consideration the wind direction in the area, the provision of wind-breaks and the relation with industries for which the influences of the dust or fumes would result in considerable deterioration in production conditions.

(3) Directions in Determining Locations

The following points related to determination of industrial locations require particular attention in the case of the Suape estate.

- Relationship to that port and harbor
- Relationship to railways
- Relationship to the use of sea water
- Relationship to drainage
- Relationship to other industries

Industrial locations are classified as follow.

- Coastal sites
- Hinterlands of the coast
- Inland

Therefore, (1) industries which have a strong relation to the port and harbor, and the use of sea water, and which discharge a great volume of drainage, are located in the coastal sites, (2) industries having a close relationship to those in (1), such as by being a supplier of raw materials or belonging to the same category of industry, are located in the hinterlands, or inland. Further, (3) industries which in the past were thought to be properly located in coastal areas are located either in the coastal area or, if there are no reasons to do otherwise, in the coastal hinterlands. Then, (4) other industries are located inland, and (5) industries closely related to railways are located near the railway route noted in the TRANSCON report.

Although the cement terminal (and clinker mill) has the nature of being a commercial entity from the viewpoint of this project, since it is included in the estate in the TRANSCON report, it is included in Table 2-14.

6. Pollution Control at the Suape Coastal Industrial Complex

Careful consideration must be given to pollution control in keeping with industrial development in the Suape. In recent years, the greater scale of industrial production in many countries has given rise to large amounts of industrial effluents which are greatly increasing pollution and constitute a major social problem.

In Japan, interest in pollution control has rapidly increased and at present, one of the most severe legal systems in the world is being prepared. The development of pollution control techniques is progressing and pollution control systems are being established.

Currently, in the Suape there is no pollution caused by industry but as industry expands, the inevitable problems of pollution will have to be faced. In particular, Recife is leeward of the prevailing wind from the Suape and air pollution could spread over a wide area.

An outline is given here of pollution control measures for the oil refinery and petrochemicals and aluminum refining industries which consume large amounts of energy and and cause considerable contamination because of the nature of the raw materials and processes they use.

(1) Oil refinery

A. Air pollution control

The main causes of air pollution are the sulfur and nitrogen oxides (SO_x and NO_x) produced during combustion in the furnaces and boilers and the tail gas from the desulfurization equipment. SO_x can be eliminated by using low-sulfur fuels, providing a stack gas desulfurizer and building tall stacks. NO_x can be eliminated by providing stack gas dinitration equipment, using improved combustion techniques such as burning at low temperature and use of multi-stage combustion techniques, exhaust gas recycling equipment and other improvements in combusion equipment.

B. Water pollution control

The main sources of water pollution include waste water from processing operations, from desalters, off-site tanks and heating coils, and flushing of both on-site and off-site pumps, from location. Where drum containers are cleaned and shipped, from tank draining, and from tanker ballast. The polluting substance in these cases is oily muds. In order to prevent pollution from these sources, the waste water should be sent to a buffer tank, then to a oil separator to coagulating pressurized flotating equipment, an activated carbon absorber and then through a guard basin before being discharged. Other sources of water pollution include condensate from boilers, and the like, as well as waste water from hydrogen and other plants. In these cases the waste should be sent through a guard basin before being discharged.

Table 2-12. Industries recommended for the Suape

Designation	Report where recommended: Brazil	Report where recommended: Japan
Chemical industry		
Fertilizer	x	
NPK	x	
NP	x	
Triple superphosphate	x	
Oil refinery	x	
Petrochemicals	x	
Ethylene derivatives		x
Propylene derivatives		x
Butadiene derivatives	x	
Toluene derivatives	x	
Xylene derivatives	x	
Methanol derivatives	x	
Synthetic textiles		x
Salt electrolysis		x
Automobile tires	x	
Sugar chemicals		
Alcohol & starch	x	
Cellulose & paper	x	
Detergent	x	
Iron & steel		
Steel rolling	x	
Seamless steel pipe	x	
Plain steel pipe	x	
Processing of steel materials	x	
Casting	x	
Forging	x	
Nonferrous metals, nonmetallic minerals		
Aluminum refining	x	
Aluminum sheets		x
Aluminum diecastings		x
Aluminum foil		x
Aluminum wire & cable		x
Extruded aluminum prods		x
Drawn aluminum prods		x
Industrial aluminum prods		x
Home-use aluminum prods		x
Copper-aluminum electric wire	x	
Copper refining		x
Lead refining		x
Zinc refining		x
Drawn copper prods		x
Sulfur & ammonium sulfate	x	
Lime products		
Machinery		
Automobiles, diesel engines	x	
Auto parts		x
Material transport vehicles	x	
Ship maintenance dock	x	
Ship building dock		x
Gravimeter	x	
Large boilers	x	
Machinery		
Steam boilers	x	
Cranes, travelling cranes	x	
Industrial machinery	x	
Hydraulic valves & gauges	x	
Ball bearings	x	
Metal graphics	x	
Hand tolls	x	
Road construction materials	x	
Gas bombes	x	
Connectors & terminals for equipment	x	
Fuses, regulators	x	
Switchers, sockets	x	
Control panels	x	
Resistors, variable resistors	x	
Insulators	x	
Transformers; reactors for lamps	x	
Transformers	x	
Telephone bells	x	
Telephone sets	x	
Telephone tables	x	
Telephone meters	x	
Subscriber's telephone switchboard	x	
Office telephone switchboard	x	
Integrated circuit	x	
Foodstuffs		
Meat products		x
Canned marine prods		x
Fishmeat ham & sausage		x
Frozen marine prods		x
Vegetable oils & fats		x
Animal oils & fats		x
Balanced compound feedstuffs		x
Others		
Thermal power station		x
Cement terminal* (with clinker mill)	x	

* The cement terminal is included here because it is within the estate, and even though it is primarily a trade-related enterprise.

Table 2-13. Major aspects of the planned final stage of major industries to be established in the Suape

Category of industry, & product	Production Scale (t/y)	Raw materials: Designation	Raw materials: Quantity	Raw materials: Sources	Means of transport: Material: Maritime	Means of transport: Material: Over-land	Means of transport: Products: Maritime	Means of transport: Products: Over-land	Plant site (ha)	Industrial water (Fresh water) m^3/d	Power (kW)	Workers (person)
Fertilizer	1,000,000 t/y	Phosphate rock	784,780 t/y	Morocco	1,421,206		400,000	600,000	50	83,700	18,600	408
				Florida								
NPK (NPK 15-15-15)	170,000	Ammonium sulfate	212,780	Overseas								
(NPK 18-18-18)	505,000											
NP (NP 8-30-0)	45,000	Potassium chloride	193,491	Overseas								
Triple superphosphate	280,000	Ammonia	48,780	Aratu								
(TPO-42-0)		Urea	181,375	Aratu								
Oil refinery	750,000 BPSD (35,200,000 Kl/y)	Crude oil	38,250,000 Kl/y	Overseas	38,250,000 Kl/y		24,640,000 Kl/y	10,560,000 Kl/y (Within Suape 7MKl)	750	90,000	190,000	1,500
Petrochemicals (Ethylene)	800,000	Naphtha	3,100,000 t/y	Suape		3,100,000	2,700,000	1,150,000	400	265,000	544,000	4,000
Ethylene derivatives	Prod scale	Salt	300,000 t/y	Nordeste	300,000							
Prophylene derivatives	for all											
Butadiene derivatives	derivatives											
Toleune derivatives	3,850,000 t/y											
Xylene derivatives												
Methanol derivatives												
Synthetic textiles												
Salt electrolysis												
Automobile tires (Passenger car)	1,500,000 /y (5,700 /y)	Synthetic rubber	5,630 t/y	Suape		5,630 t/y	1,710	3,990	15	1,000	1,200	1,000
Rolling of steel sheet	1,260,000 t/y	Billets	1,280,000 t/y		1,280,000		378,000	882,000	40	37,000	6,000	2,885
Tin plate	290,000											
Cold-rolled bobbins & thin sheets	270,000											
Hot-rolled bobbins & thin sheets	450,000											
Thick sheets & plates	250,000											
Seamless steel pipe	250,000	Pellets	240,000	Tubarao within	240,000							
(electric)		Scrap steel	72,500	Auto Plants	39,500	33,000	192,500	57,500	50	38,000	56,630	993
Plain steel pipe	24,000	Cold rolled steel	26,600	Suape & elsewhere		26,600	4,800	19,200	5	50	300	331
		Hot rolled steel										
Processing of steel materials	500,000	Thick sheets & plates, etc.	510,000	Outside Suape	260,000	250,000	100,000	to shipyards, etc. 400,000	20	200	3,000	500
Casting	12,600	Pig iron	10,760	Nordeste		10,760		12,600	4	130	6,700	330
		Sand										
Forging	12,000	Steel sheet	17,150	Suape	-	17,150	8,400	3,600	4	100	800	300

Table 2-14. Determinants of locations of industries in Suape

Designation	Source of reports where recommended		Factors requiring special attention				General area of location			
	Brazil	Japan	Use of port	Usage of seawater	High volume of effluent	Relation to other industries	Proximity of railway	Coast	Hinterlands of coast	Inland
Chemical industry										
Fertilizer	o		o	o	o	Petrochemicals; use sulfuric acid byproduct of refining Cu, Pb and Zn	o	o		
NPK	o									
NP	o									
Triple superphosphate	o									
Oil refinery	o		o	o	o	Petrochemicals, thermal power	o	o		
Petrochemicals	o		o	o	o	Petroleum refining fertilizer	o	o		
Ethylene derivatives		o								
Propylene derivatives		o								
Butadiene derivatives	o									
Toluene derivatives	o									
Xylene derivatives	o									
Methanol derivatives	o									
Synthetic textiles		o								
Salt electrolysis										
Automobile tires	o		o			Petrochemicals; automobiles			o	o
Sugar chemicals			o	o	o		o	o		
Alcohol & starch	o					Petroleum refining				
Cellulose & paper	o									
Detergent	o									
Iron & steel										
Steel rolling	o		o			Autos, shipbuilding,	o	o		
Seamless steel pipe	o		o			machinery	o	o		
Plain steel pipe	o					Steel rolling			o	
Processing of steel materials	o		o			Steel rolling } Autos,	o	o		
Casting	o					Steel rolling } shipbuilding,			o	o
Forging	o					Steel rolling } machinery			o	o
Nonferrous metals, nonmetallic minerals										
Aluminum refining	o		o		o	Aluminum processing	o	o		
Aluminum sheets		o				} Aluminum refining,			o	o
Aluminum diecastings		o							o	o
Aluminum foil		o							o	o
Aluminum wire & cable		o							o	o
Extruded aluminum prods		o							o	o
Drawn aluminum prods		o							o	o
Industrial aluminum prods		o							o	o
Home-use aluminum prods		o							o	o
Copper-aluminum electric wire	o								o	o
Copper refining		o	o	o	o	Copper refining	o	o		
Lead refining		o	o	o	o	Fertilizer	o	o		
Zinc refining		o	o	o	o		o	o		
Drawn copper prods		o				Copper refining				o
Copper alloy prods		o								o
Sulfur and Ammonium sulfate	o					Fertilizer			o	o
Lime products	o								o	o

Designation Designation	Source of reports where recommended		Factors requiring special attention						General area of location	
	Brazil	Japan	Use of port	Usage of seawater	High volume of effluent	Relation to other industries	Proximity of railway	Coast	Hinterlands of coast	Inland
Machinery										
Automobiles, diesel engines	o		o			Auto parts, steel rolling	o	o		
Auto parts		o				Autos			o	o
Materials transport vehicles	o								o	o
Ship maintenance dock	o		o			Steel rolling		o		
Ship building dock		o	o					o		
Large boilers	o		o					o	o	
Steam boilers	o								o	
Cranes, travelling cranes	o		o					o	o	o
Industrial machinery	o								o	o
Gravimeter	o									o
Hydraulic valves & gauges	o								o	o
Ball bearings	o									o
Metal graphics	o									o
Hand tolls	o									o
Road construction materials	o									o
Gas bombes	o									o
Connectors & terminals	o								o	o
Fuses, regulators	o									o
Circuit breakers, sockets, switches	o									o
Resistors, variable resistors	o									o
Plated metal, insulaters	o									o
Transformers, reactors for lamps	o									o
Transformers, transformer housings	o									o
Rollers, bells & protective parts for telephone equipment	o									o
Telephone sets	o									o
Telephone tables	o									o
Telephone meters	o									o
Subscriber's telephone switchboard	o									o
Office telephone switchboards	o									o
Dials, panels	o									o
IC, special microcircuit technology	o									o
Foodstuffs										
Meat products		o							o	
Canned marine prods		o	o					o		
Fishmeat sausage		o	o					o		
Processed seafood prods		o	o					o		
Frozen marine prods		o	o					o		
Vegetable oils & fats		o							o	
Animal oils & fats		o							o	
Balanced compound feedstuffs		o	o					o		
Others										
Thermal power station		o		o	o		o			
Cement terminal (with clinker mill)	o		o				o			

Category of industry, & product	Production Scale (t/y)	Raw materials: Designation	Raw materials: Quantity	Raw materials: Sources	Means of transport: Material: Maritime	Means of transport: Material: Over-land	Means of transport: Products: Maritime	Means of transport: Products: Over-land	Plant site (ha)	Industrial water (Fresh water) m^3/d	Power (kW)	Workers (person)
Aluminum refining	200,000 t/y	Alumina	400,000	Amazon	618,000		70,000	130,000	70	7,000	190,000	1,500
		Cokes	140,000	America								
				Europe								
		Coal	8,000	Santa Catalina								
		Pitch	60,000	Sao Paulo								
				Minas Gerais								
		Quartz	4,000	America								
				Europe								
			6,000	Japan								
		Aluminum floride	618,000	Sao Paulo								
Aluminum sheet	50,000	Aluminum slab	51,000	Suape		51,000	10,000	40,000	17	3,000		1,000
Aluminum building materials	3,600	Extruded aluminum prods.	3,670	Suape		3,670	720	2,880	2	200		150
Diecastings	3,000	Aluminum ingots	3,060	Suape		3,060	600	2,400	2	330		200
Copper, aluminum electric wire	20,000	Aluminum poles	7,700	Suape		7,700	4,000	16,000	5	3,600		300
		Copper poles	10,400	Suape		10,400						
Copper refining	120,000 t/y	Copper concentrate	540,000		780,000		576,000	144,000	70	29,500	91,000	1,200
Lead refining	40,000	Lead concentrate	80,000									
Zinc refining	80,000	Zinc concentrate	160,000									
Sulfuric acid	480,000											
Automobiles									60	500	3,000	1,567
Commercial vehicles (CKD)	10,000 v/y		10,000 t/y	Ex-region	10,000 t/y		500 t/y	9,500 t/y				
Diesel engines	50,000 v/y		15,000 t/y	Ex-region	15,000 t/y		12,000 t/y	3,000 t/y (within auto plant)				
Materials transport vehicles			24,260 t/y	Ex-region	24,269 t/y			24,260 t/y	40	100	1,000	1,016
Three-wheel vehicles	2,520 v/y											
Trailers	669											
Dump truck	648											
Tank trailers	67											
Wooden truck bodies	848											
Ship maintenance dock	70,000-100,000 DW dock								30	500	5,000	800
Ship building dock	500,000DW dock	Steel materials etc.	400,000 t/y	Ex-Suape	140,000 t/y	260,000 t/y			120	4,800	15,000	3,600
*Cement terminal	9,000,000 t/y	Clinker Gypsum	9,000,000 t/y	Nordeste	9,000,000 t/y		9,000,000 t/y		100			
Total			17,906,930 t/y 38,250,000 Kl/y		14,127,960 t/y 38,250,000 Kl/y	3,778,970 t/y	13,459,230 t/y 24,640,000 Kl/y	3,500,930 t/y 10,560,000 Kl/y	1,754	564,710	1,132,230	23,580

C. Treatment and disposal of wastes

The main wastes include sludge from atmospheric distillers, tanks and oil separator, catalysts, soda and sulfuric acid discharged from the oil refinery, and waste soda from gas cleaning equipment. These can be combatted as follows: in the case of sludge, by burning; in the case of used catalysts, by burning, or burying. Burning methods include vertical-type multi-stage furnace, rotary kiln, fluid bed and flush drier.

(2) Petrochemical plants

A. Air pollution control

The main sources of air pollution include gas produced as by-products when burning fuel for furnaces heaters, reactors, reformers, and the like, as well as the SO_x and NO_x produced when burning oil for on-site power generation. The gas produced as a by-product contains no sulfur, so there is no need for concern regarding SO_x from this source. Rather, problems of pollution arise from the NO_x contained in the gas; and from the NO_x and SO_x contained in heavy oil. Another problem involves disposition of harmful gases omitted during processing operations. To reduce SO_x pollution arising from this gas, use of low-sulfur fuel, desulfurization equipment and high-level stacks are recommended. To reduce NO_x, it is effective to employ denitration equipment, burning fuels at low temperatures, multi-stage combustion, recycling of exhaust gases and making other improvements in the burning equipments. The harmful gases include hydrogen chloride and chlorine but they can be treated until they are completely harmless.

B. Water pollution control

The main sources of water pollution are waste water from process operations, containing primarily PH, COD, SS and oily muds. The contents of such waste water is quite varied, and also includes traces of cyanide, phenol, hydrochloric acid and chromium. Where there is a mercury electrolysis plant, the waste water contains mercury. Ways of treating these pollutants are as follows: coagulating pressurized floating activated sludge → aggregation and filtration → activated carbon or coagulating pressurized floating → activated sludge → aggregation and filtration → activated carbon ozonization.

C. Treatment and disposal of wastes

Typical wastes of petrochemical plants include polymers, catalysts, waste soda and oily muds. Polymers can be treated by burning; the oily muds, catalytic agents, some catalysts, clay and dehydrating agents can be buried.

(3) Aluminum smelting plants

A. Air pollution control

In the case of alumina the main sources of air pollution are SO_x and NO_x from heating furnaces and dehydrating agents. In the case of aluminum, hydrofluoride gas from electrolytic furnaces, SO_x and NO_x from driers, and SO_x and NO_x from casting equipment. These pollutants from alumina operations can be treated with a multicyclone, and the hydrofluoride gas from aluminum operation can be eliminated through use of an alkali cleaning device. Others can be treated by the multicyclone.

In addition, when the plant has its own thermal power generating plant, there is the problem of pollution by SO_x. Such pollution can be eliminated by the same methods as mentioned for the oil refinery and petrochemical plants.

B. Water pollution control

In the case of alumina, the main sources of water pollution are water used in washing operations in the case of aluminum, waste water containing thickener, which also contain PH, COD, SS and oily muds. Wastes from aluminum operations also contain fluorine. Waste water from alumina operations is treated by neutralization, followed by aggregation and sedimentation. Aluminum wastes is treated by aggregation and sedimentation, followed by use of an oil separator.

C. Treatment and disposal of wastes

The main waste solid pollutant is red muds (composition: 30% Fe_2O_3, 20% Al_2O_3 and 15% SiO_2). 1 to 1.2 tons of this material is produced for each ton of alumina produced. Thus in the case of an integrated plant producing alumina from bauxite, and producing aluminum from alumina, 2 to 2.4 tons of red muds will be produced for each ton of aluminum. This is disposed of by burying or dumping.

7. Relation to Other Regional Projects

The Suape project will be the second coastal industrial development project in the Nordeste, after the one at Aratu. Here, our study is confined to the question of whether a competitive relation exists between the Suape project and projects being planned elsewhere. Specially, we are concerned with Aratu, Itaqui and Belem.

A. Aratu

The Aratu Coastal Industrial Estate is in the suburbs of Salvador, Bahia. It has an area of 436 km^2. In Stage I (1975) the harbor will have a depth of 12.0 meters and will be capable of accommodating vessels of 60,000 DWT class, after which, during Stage II the depth will be increased to 20.0 meters and capacity will be expanded to 100,000 to 150,000 DWT. As of June, 1973, 170 enterprises have been established in the estate of which 50 are engaged in production, in heavy industry, chemical industry and light industry. Inland from the estate, in Camaçari, construction of a petrochemical plant with the capacity of 380,000 tons of ethylene is proceeding.

Seven years have passed since work was begun on the Aratu estate. Success thus far has been to the extent of 30% attainment of initial goals. A considerable area of land has yet to be sold. There is, however, already a considerable agglomeration of industry, as noted above, and work has been proceeding on the improvement of the port and harbor, and other infrastructure.

Because of these reasons, those industries which have not yet applied for a location in the Suape estate will look upon Aratu as the most desirable coastal estate in the Nordeste. It will become even more attractive as the development of its infrastructure proceeds, and also when the natural resources endowments in the area are taken into consideration.

Consequently, Aratu is considered to be a formidable rival of Suape in attracting industry.

Nevertheless, in the near future, sites at the estate will become filled, if progress continues at the present rate. This will mean that another large-scale industrial estate will become essential for the continued development of the Nordeste economy, and the competition between the two estates will eventually be replaced by a cooperative, supplementary relationship.

B. Itaqui

Itaqui is on a peninsula west of Sao Luis, Maranhao. The entire peninsula has been designated as industrial land and a steel mill using a blast furnace, and related plants, are to be built here. The blast furnace project, which would be of central importance to the Itaqui development program, has been studied by the Nippon Steel Corporation and SIDERBRAS. Itaqui possesses a port other than the one which would be used by the industries on the peninsula; it has a water depth of 17 meters and the average tidal range is 3.66 meters, which means that large vessels may berth there.

Itaqui is to be limited to the steel mill and related plants and because the Suape estate is to have a variety of industries, the two are not competitive. Although there would be a steel mill at Suape, it would be based on proximity to resources (iron ore and coal) and this would not be competitive with Itaqui.

While it is said that the conditions of industrial infrastructure at Itaqui are suitable to a blast furnace steel mill, if this provides the trigger for an early move to make the project into a more comprehensive one, in view of the extensive endowments of resources in the region, this could become competitive with the Suape project.

C. Belem

At Vila do Conde, west of Belem, Para, ALBRAS is to build an alumina and aluminum refinery and it is planned that the port here will be made to be capable of accommodating 250,000 DWT vessels.

The Belem project at the present time is confined to the alumina-aluminum refinery plan and thus is not competitive with Suape, similar to the case with Itaqui. While aluminum refining has been proposed for Suape, this has been planned by Alminio Nacional S.A. and there would not be competition with enterprises in this region. Regarding the source of metal ingots, considering that the TRANSCON report anticipates that they would be obtained from Belem, for the most part there would not be a competitive relationship between the two projects.

However, in the case of Belem also, if the aluminum project serves as a trigger to expand the project and make it more comprehensive, in view of the vast resource endowments in the Amazon area this project would become competitive with Suape.

In any event, it is important to note that the Suape project has been identified as being of national strategic importance, as the second coastal industrial project in the Nordeste.

CHAPTER 3. INFRASTRUCTURE PLAN

1. Outline of the Suape and Natural Conditions

The following outline of the Suape and local natural conditions have been compiled on the basis of the TRANSCON Report, the South America Pilot Vol. 1, published for the Hydrographic Department, Admiralty, London, information obtained from Pernambuco State University, data obtained at the site, etc.

(1) Outline

Suape is a coastal region 30 - 40 km to the south of Recife, the capital of Pernambuco State. In terms of administrative areas, it is directly to the south of metropolitan Recife and contains two municipalities, Cabo and Ipojuca. The Cabo district already has many factories because of the favorable topography, well-developed infrastructure, SUDENE tax privileges, etc. This industrial area is being established along the state highway (PE-60).

The area to be developed in accordance with this plan covers 325.7 sq. km from 8°14′ to 8°29′ S. Lat and from 34°56′ to 35°6′ W. Long. It was designated as a development area by a state decree in June, 1973. The maximum widths of the area are 27 km from north to south and 16 km from east to west. Of this 325.7 sq. km, the planned industrial estate will cover 53 sq. km.

The Suape is covered with sugar cane and coconut palms with a swampy zone about 4 km wide and 0 - 1.6 m above sea level along the coast. There are three rivers in the region, the Massangana, Tatuoca and Ipojuca, with water depths of 2 - 5 m. Four kilometers in from the coast, there is a wide hill 5 - 25 m above sea level. In the low, swampy area, there are a few hills with heights of about 25 m above sea level. It is planned that these will be levelled and the earth will be used to fill low land. North of Suape is an east-west range of hills; with these at the center approximately one quarter of the area including these hills is to be left for recreation areas and forest preserves.

In the offing of the Suape coast, there is a reef which runs in a straight line for about 10 km from Santo Agostinho Point to Cupe Point and the reef forms a natural breakwater. The sea depth within the reef is 2 to 5 m but outside the reef, the depth suddenly drops to about 14 m.

Metropolitan Recife which includes the Suape has tropical climate and high humidity. From October to March, the maximum daily temperature exceeds 30° C. There is little rainfall during this period and the humidity is around 70%. Cool weather occurs from April through September and during this period the maximum daily temperatures are nearly 30° C. This is the rainy season when the humidity exceeds 80%. From such meteorological data, it would appear that living in this region is difficult but actually, it is quite endurable because a wind blows inland from the Atlantic throughout the year. Tables 3-1 and 3-2 show the general weather conditions for Recife.

The Nordeste is normally a dry area where droughts occasionally occur. A coastal

Table 3-1 Meteorological data in Pernambuco

Month	Pressure (mb)	Air (degrees Celsius) Mean Max.	Mean Min.	Highest Deg.	Highest Date	Lowest Deg.	Lowest Date	Mean	Relative humidity	Cloud amount (1-10)	Rainfall Monthly total	24-hr max. Amount	24-hr max. Date	Evaporation (mm)	Hours of sunshine	Wind Direction	Wind Force
1	1,012.2	30.2	23.5	31.8	16	21.0	16	27.1	76	6.4	81.5	23.2	25	131.3	264.8	SEE	2
2	1,011.1	30.7	23.6	31.8	18	21.6	4	27.4	69	6.7	108.3	54.0	25	132.5	218.4	SE	3
3	1,010.5	30.9	23.7	32.8	7	23.0	1.5.31	27.5	79	6.0	201.3	43.6	23	-	258.2	SE	2
4	1,010.7	29.6	23.9	31.3	14	22.3	24	26.3	86	7.6	770.4	165.3	22	69.5	167.5	SE	2
5	1,011.9	26.5	22.7	31.4	8	20.0	20	25.7	85	6.4	313.0	76.9	24	69.6	218.9	SE	6
6	1,012.7	28.2	22.9	29.7	20	21.4	23	25.0	87	7.0	585.6	94.1	21	51.6	153.1	SE	2
7	1,013.8	28.1	22.2	30.2	23	20.1	28	24.7	85	8.9	492.6	162.0	21	84.7	197.1	SE	2
8	1,014.2	28.6	21.3	29.4	16	18.4	30	25.2	79	5.2	107.1	35.9	2	-	282.9	SE	3
9	1,014.2	28.2	21.3	29.6	30	19.6	4	24.8	78	5.5	200.4	35.8	9	113.9	226.6	SE	3
10	1,011.4	29.2	21.9	30.3	14	19.7	29	25.8	76	4.7	118.5	59.6	2	153.4	285.8	SE	3
11	1,011.4	30.5	21.8	31.8	21	19.2	9	26.5	72	4.3	23.7	12.3	24	174.9	306.8	E	3
12	1,011.2	30.5	22.5	31.3	15	20.2	25	26.7	73	5.4	65.6	29.3	22	173.8	283.7	E	3
Ann. avr.	1,012.1	29.5	22.6	32.8	Mar. 7	18.4	Aug. 30	26.1	79	6.0	2,998.0	165.3	Apr. 22	1,155.2	2,863.8	SE	3

Table 3-2 Climate at Recife

Place - Recife, Lat. 8°04' S., Long. 34°53' W. Height above mean Sea Level, 97 feet (29m6).
Climatic Table compiled from 2 to 56 Years'Observations, 1887 to 1942

Month	Pressure at MSL	Air temperature Mean of				Relative humidity		Mean cloud amount (oktas)		Rain		Wind direction — Mean of observations at 0700, 1400, 2100 — Percentage of observations from									Mean wind speed		No. of days with gale	No. of days with fog or mist*
	Mean	Daily max.	Daily min.	Highest in each month	Lowest in each month	0700	1400	a.m.	p.m.	Average fall	No. of days with 0.04 in. or more	N	NE	E	SE	S	SW	W	NW	Calm				
	mb.	°F	°F	°F	°F	%	%			in.											knots			
January	1,012	86	77	89	72	77	69	5.5	4.6	2.1	5	1	7	46	40	3	1	0	1	1	7	-	-	1
February	1,012	86	77	89	72	81	70	6.2	5.1	3.3	8	1	5	41	44	4	1	1	1	2	6	-	-	0
March	1,012	86	76	89	72	81	71	5.9	4.8	6.3	10	2	7	35	38	7	3	2	2	4	6	-	-	2
April	1,012	85	75	89	72	83	73	5.8	4.8	8.7	14	1	3	22	44	13	6	4	3	4	6	-	-	0·7
May	1,013	83	74	87	70	84	74	6.7	5.8	10.5	16	1	2	16	45	19	9	3	0	5	6	-	-	1
June	1,015	82	73	85	69	84	75	6.7	5.9	10.9	17	0	1	12	44	24	12	2	1	4	7	-	-	2
July	1,016	80	71	83	68	83	75	6.5	6.1	10.0	18	0	2	9	40	30	13	2	0	4	7	-	-	4
August	1,016	81	71	83	87	82	73	6.4	5.5	6.0	13	0	1	12	47	25	10	2	0	3	7	-	-	1
September	1,015	82	73	85	69	78	70	5.5	4.3	2.5	8	0	4	32	45	12	3	1	0	3	7	-	-	0.7
October	1,014	84	75	87	71	75	67	4.8	3.6	1.0	4	1	10	45	35	5	1	0	1	2	7	-	-	0
November	1,012	85	76	88	72	74	68	4.9	3.5	1.0	5	1	15	54	25	2	1	0	1	1	7	-	-	0.3
December	1,012	85	77	88	72	76	67	5.1	3.9	1.1	5	2	15	45	33	2	1	0	1	1	6	-	-	0
Means	1,013	84	75	90'	67''	80	71	5.8	4.8	-	-	1	6	31	40	12	5	1	1	3	7	-	-	-
Totals	-	-	-	-		-	-	-	-	63.4	123	-	-	-	-	-	-	-	-	-	-	-	-	12
Extreme values	-	-	-	94††	64††	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
No. of years' observations	36	27-31		26-30		11		11		56	10	11									11	-	-	4

Authorities: Rio de Janeiro: Boletim Meteorológico. Rio de Janeiro: Boletim Mensual.

Standard of time: 45° W. meridian. Meteorological Office, Air Ministry

· Mean of highest each year
·· Mean of lowest each year
† Highest recorded temperature
†† Lowest recorded temperature
* Days on which visibility *falls below 2,000 meters at time of morning observation*

Source: South American Pilot Vol. 1, published for the Hydrographic Department, Admiralty London forest about 100 km wide is parallel to the shore. The amount of rainfall is higher nearer the coast, where it is more than 1,500 mm annually and where the droughts are less damaging than inland.

Temperature changes near the coast are also slight and farther away from the coast where the forests are less dense, the inland climate of hot days and cool nights prevails.

Since Brazil has no volcanic regions, there are no records of earthquakes of tsunami.

(2) Winds

As can be seen in Tables 3-3 and 3-4, the winds in the Recife are all sea winds consisting of prevailing easterly and southerly winds. The compass orientation of the coastline is NNE to SSW. Wind velocity averages 3.0 – 4.0 m/s and there is little variation due to season or wind direction. The maximum recorded wind velocity during the last 10 years at Guararapes Airport, Recife, was 15.43 m/s.

Therefore, the winds in the Recife are comparatively calm and even though the winds in the Suape differ slightly, there appears to be no problems with respect to port planning. However, it will be necessary to observe coastal wind conditions in the Suape in future.

(3) Waves

Observations of waves were carried out from June to August, 1974, mainly by the Institute for Research of Hydrographical Survey of the Department of National Port and Navigation of the Brazilian Ministry of Transport. In this survey, an ultrasonic type automatic wave recorder was placed at a point 17 m deep and 1.5 km distant from Santo Agostinho Point and the wave directions were also measured concurrently by means of a transit.

Tables 3-5 and 3-6 show the wave characteristics of the region as compiled from the results of these measurements.

Table 3-3 Wind direction and velocity at Recife (1931-1960)

Direction	Number	Frequency (%)	Mean velocity (m/s)
N	2	0.2	4.3
N E	87	7.9	2.7
E	255	23.3	2.8
S E	492	44.9	3.2
S	177	16.2	3.7
S W	21	1.9	2.6
W	3	0.3	1.9
Calm	59	5.3	-

Source: TRANSCON Report

Table 3-4 Wind observations (Recife: Guavarapes Airport)

Month	1966 - 1975 Direction	1966 - 1975 Mean monthly velocity (m/s)	1966 - 1975 Max.velocity (m/s)	1975 Direction	1975 Mean monthly velocity (m/s)	1975 Max. velocity (m/s)
1	120° (ESE)	3.65	11.32	90° (E)	3.45	11.32
2	"	3.40	10.29	"	3.19	8.23
3	"	3.19	10.29	120° (ESE)	2.98	10.29
4	90° (E)	2.98	10.29	90° (E)	2.93	7.72
5	150° (SSE)	3.19	13.38	180° (S)	3.60	13.38
6	180° (S)	3.55	12.86	"	3.60	12.86
7	150° (SSE)	4.12	15.43	150° (SSE)	4.22	15.43
8	120° (ESE)	3.96	13.38	120° (ESE)	4.53	10.29
9	"	4.27	12.86	"	4.73	11.32
10	"	4.06	10.29	80° (E)	4.32	7.72
11	90° (E)	3.96	11.83	100° (E)	4.27	7.72
12	"	3.86	10.29	90° (E)	4.48	7.72
Average	90° (E)	3.81		120° (ESE)	3.70	

Source: TRANSCON Report

Table 3-5 Wave observations

	Measurement observations	Max. frequency
Cycle (T)	5 - 10 sec	7 sec.
Max. wave height (Hmax.)	1.5 - 3.8 m	2.7 m
Significant wave height (H 1/3)	0.9 - 2.4 m	1.6 m
Wave direction & angle	117° - 168°	130°(SE)

Note: Wave direction taken clockwise from North

Source: TRANSCON Report

Table 3-6 Frequency of wave generation (%)

Cycle	Ts (sec)	5	6	7	8	9	10
	%	1.3	24.0	52.0	18.7	2.7	1.3

Max. wave height												
	Hmax(m)	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5
	%	4.0	2.7	4.0	4.0	4.0	4.0	1.3	1.3	6.7	6.7	8.0
	Hmax(m)	2.6	2.7	2.8	2.9	3.0	3.2	3.3	3.4	3.7	3.8	
	%	10.7	12.0	8.0	2.7	8.0	2.7	2.7	2.7	1.3	2.7	

Significant wave height									
	H 1/3(m)	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6
	%	1.3	4.0	6.7	6.7	5.3	2.7	12.0	16.0
	H 1/3(m)	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4
	%	13.3	9.3	10.7	2.7	4.0	1.3	1.3	2.7

Wave direction													
	αo	115	120	125	130	135	140	145	150	155	160	165	17[illegible]
	%	0.8	3.9	13.4	33.1	17.3	14.2	8.7	1.6	1.6	3.9	0.8	[illegible]

Source: Brazil government materials

as can be seen from these tables, the predominant waves observed during the measurement period had a direction of SE, a period of 7 seconds and a significant wave height of 1.6 m. If such wave conditions prevail throughout the year, the sea is rather calm, comparing with those in Japanese ports and the sea conditions in relation to port construction are therefore quite good.

(4) Tidal current

The current was observed during the same period as the waves at points P_1 (depth of 12 m), P_2 (depth of 14 m) and P_t (point where a radioactive tracer was inserted, depth of 13 m) as shown in Fig. 3-1. The winter tidal current outside the Suape reef is weak with a velocity of 0.4 m/s on the sea surface and 0.1 m/s on the sea bed. The tides have little effect on the current compared with the wind and waves. The main tidal direction is up toward the north, parallel with the reef.

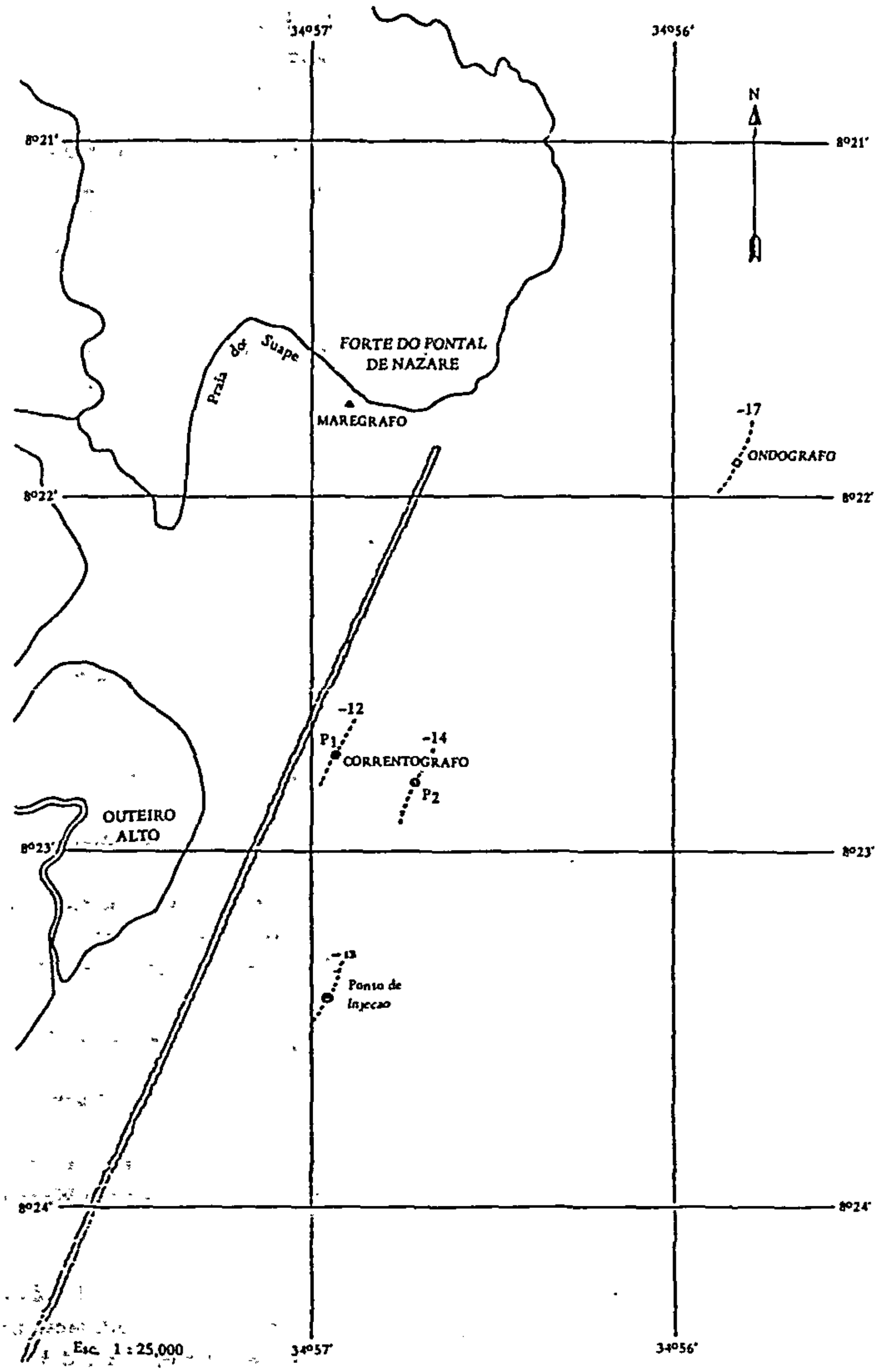
(5) Littoral drift

According to the TRANSCON Report, the sea bed material in the Suape consists almost of sand and the survey showed clearly that the bed materials do not move. It is concluded that the bottom sand will not be moved by waves at a depth of 13 m.

(6) Sea level

The sea level has been measured by means of a tidal gauge installed inside the Suape lagoon. According to the results of simultaneous observations in Recife harbor in January and February, 1974, it was reported that the sea level at the spring tide in Recife is 15 cm higher than in Suape lagoon, with a time lag of within 30 minutes. The reason for this difference is probably because the measuring staff

Fig. 3-1 Points of measurement of current



was located inside the lagoon which had a narrow opening and it is highly probable that there is no major difference between the sea levels of Suape and Recife harbor.

Fig. 3-2 shows the relation between the CNG (land) and DNPVN standard (harbor) levels and the levels of the standard points in Recife harbor and the Suape. According to the Suape sea level observation records, they indicate regular double day tide.

Table 3-7 shows the highest and lowest sea levels for each month in 1975 as extracted from the tide tables of Recife harbor. These data indicate that the highest and lowest levels occur on the same day of each month and generally continue for two or three days. This also gives support to the highly regular sine waves. Even with a tidal range of about 2.8 m at spring tide, the range at neap tide is only 1.0 m.

According to the Recife harbor observation, the sea level in the harbor is 3.10 m at anomalous high tides, 2.60 m at normal spring high tides and 1.12 m of mean sea level. These values should be very close to those in the Suape.

(7) Geological features

The TRANSCON Report states that according to the geological features of the Suape there would be no difficulties in carrying out harbor works or coastal industrial site reclamation work. The report states:

1) The geological features are generally good and the land can serve as a reliable foundation
2) The depth of the bedrock varies from a maximum of 70 m to only about 6 m near the reef at the mouth of the Massangana River.
3) Within the range of the survey conducted except the reef, the bottom materials are sand and clay and dredging works seem possible.
4) The depth of the bedrock outside the reef is from 25 to 50 m in general although there are points where it is only 17 m or as deep as 70 m.
5) The Precambrian layer is exposed in a direction perpendicular to the reef but it is at a distance from the land and there are several faults parallel to the reef.
6) The reef between the Cupe Point and the Gamboa coast has a thickness of approximately 9 m.
7) Dredging works seem possible in all areas except for the upstream part of the Massangana River.
8) The afore-mentioned observations will have to be supplemented by further test boring in the future.
9) In relation to the problem of dredging, it is felt that land reclamation work for the Suape Coastal Industrial Estate, except in the upstream section of the Massangana River, is possible.

However, thorough borings and soil tests have not yet been performed and except for a few places, these results are based on jet borings. From the boring data obtained, presumed soil survey positions and sections of the soil layers have been prepared as shown in Figs. 3-3 and 3-4. These drawings show that the soil (on land) in the Suape consists of sand and clay. The soil in the areas of

Fig. 3-2 Sea level relations

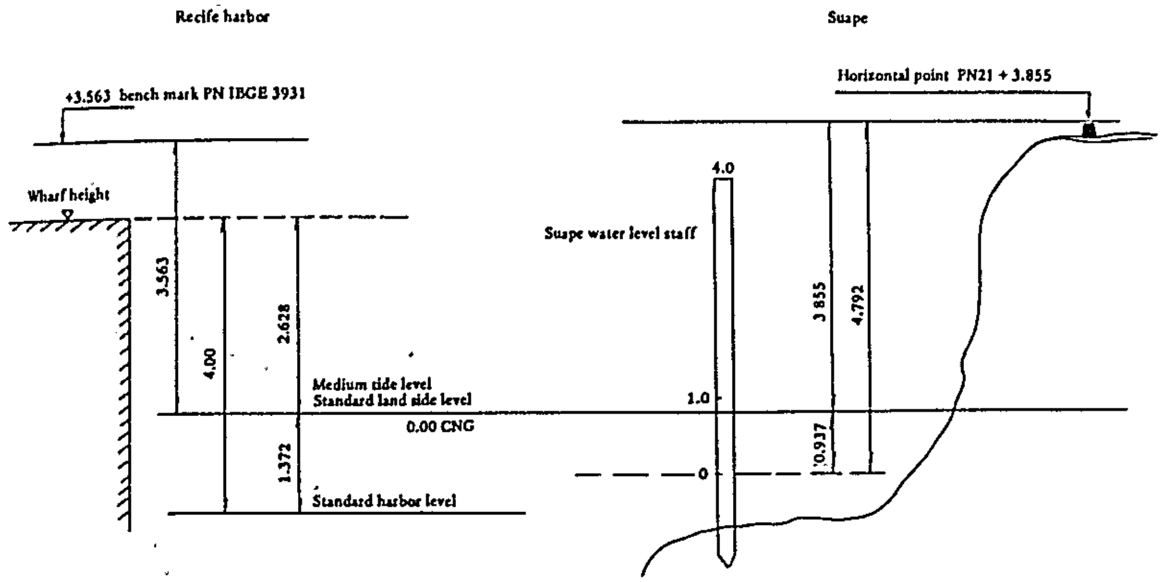


Table 3-7 Recorded highest and lowest sea levels for each month at Recife, 1975

(Unit: meter)

Month & day	Highest (m)	Lowest (m)	Notes
1/28	2.6	- 0.1	
2/26	2.6	- 0.2	
3/26	2.6	0.0	On 3/26, 27 and 28, for 3 days
4/25	2.5	(26th) 0.6	On 4/24, 25 and 26, for 3 days
5/25	2.4	0.2	
6/10	2.3	0.2	On 6/10, 11 and 12, for 3 days
7/11	2.5	0.0	
8/9	2.6	- 0.1	
9/6	2.6	- 0.2	On 9/6 and 9/7, for 2 days
10/5	2.5	- 0.2	
11/2	2.4	0.0	Continued on 11/2, 3 and 4; both daily tides were the same.
12/2	2.3	0.0	Continued on 12/2 and 12/3

Notes: 1. At neap tide, low water 0.5 to 0.7 m; high water, 1.5 to 1.7 m.
2. Two tides of regular sine waves; for each month highest and lowest tides were on the same day.

Fig. 3-3 Location plan of geological investigation sites S = 1/25,000

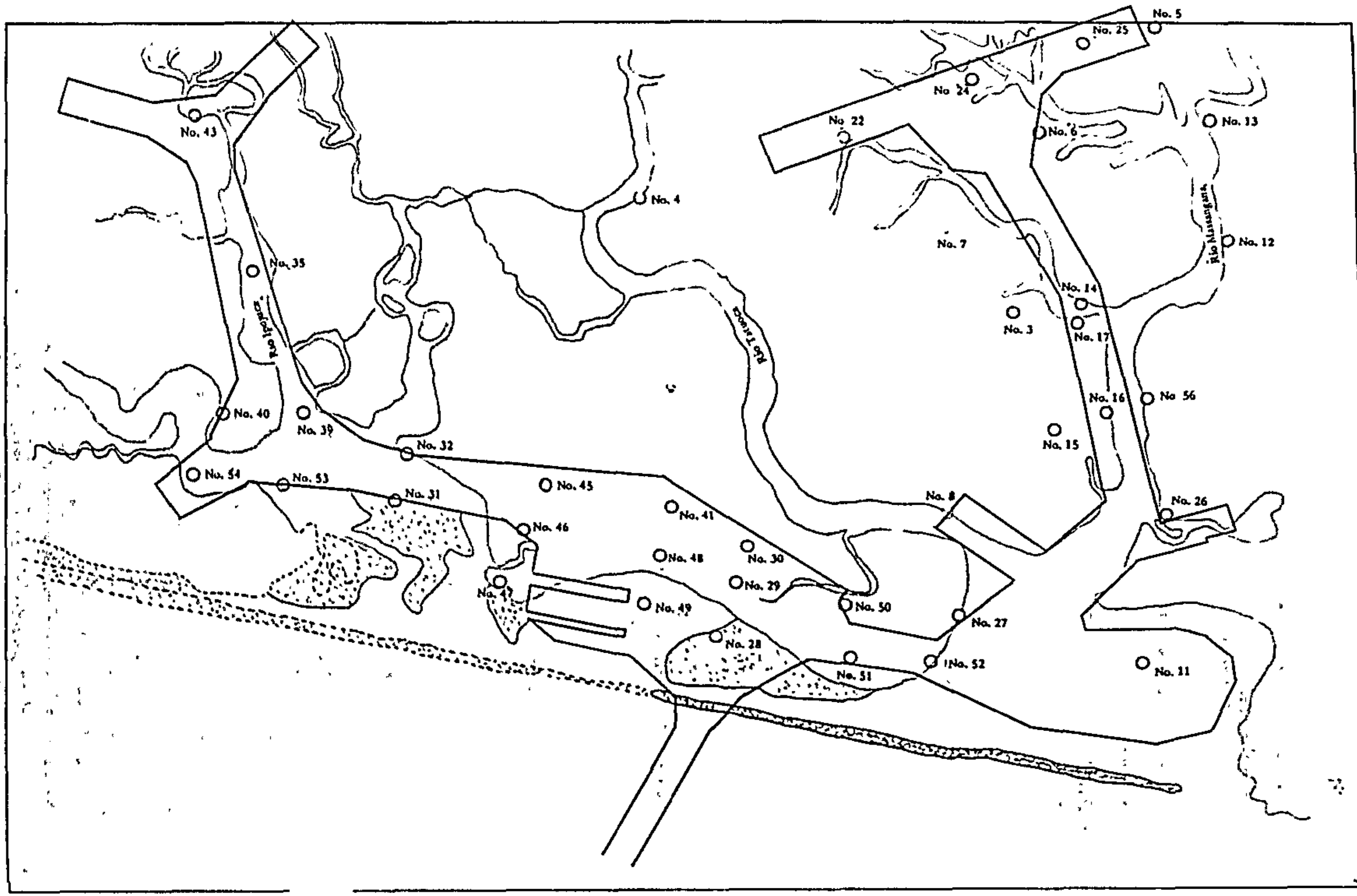
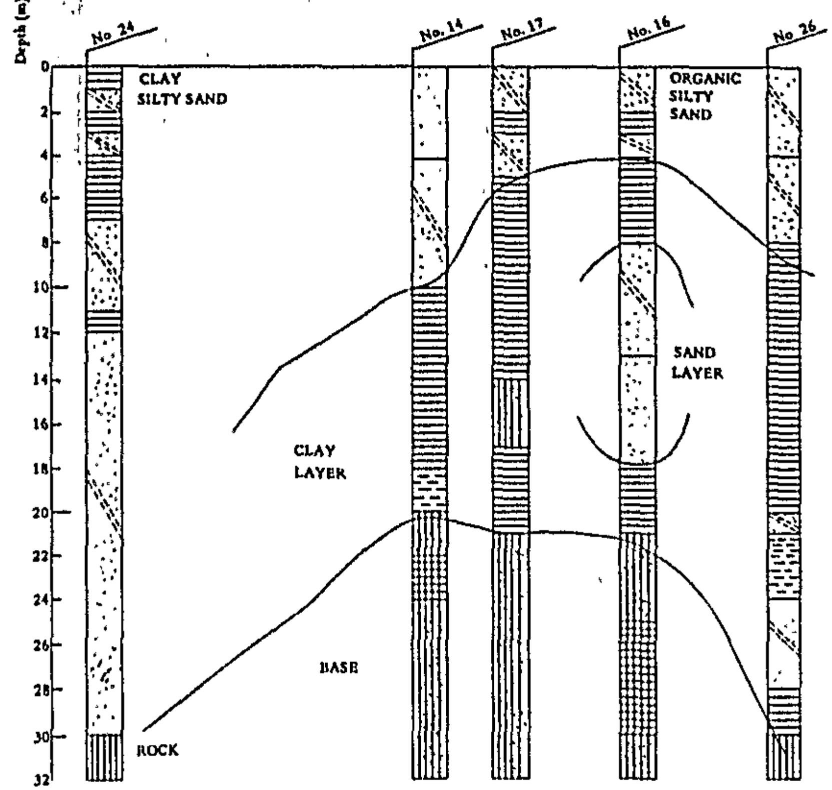


Fig. 3-4 (1) Soil profile--Section A (Massangana River) H = 1/25,000



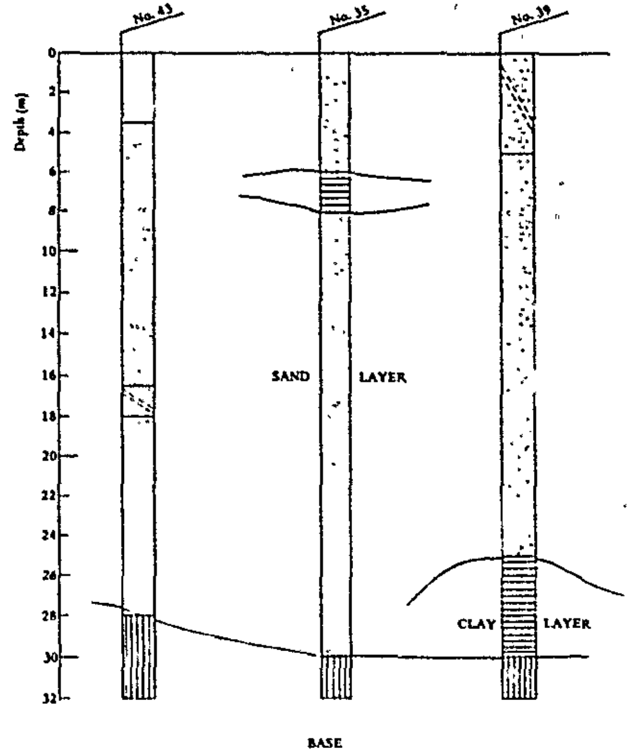
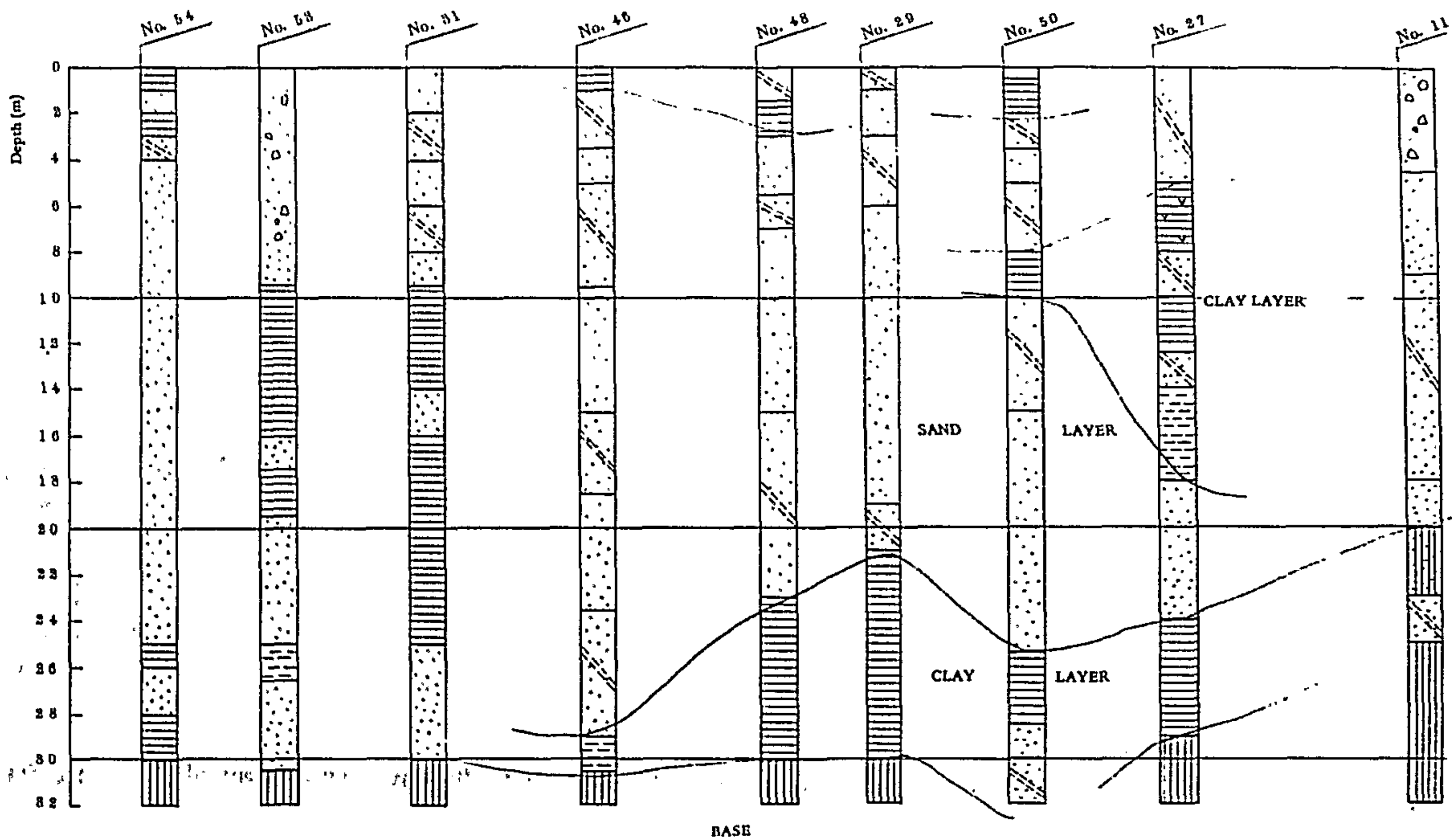


Fig. 3-4 (2) Soil profile--Section B (Ipojuca River) H = 1/25,000

Fig. 3-4 (3) Soil profile-section C H = 1/25,000



dredging for the port facilities is mainly clay in the northern channel (Massangana River) and sand in the southern channel (Ipojuca River).

These are the main geological characteristics of the Suape region. They will serve as the technical basis for the civil engineering work involved in the Suape industrial port plans. Another point of interest is the sandstone reef which runs for 10 km in a straight line and forms the Suape lagoon. The crown width of the reef is 10 to 20 m and its elevation is approximately that of the mean sea level. The same type of reef is utilized as the breakwater in Recife harbor but at Suape the reef is much larger in scale than Recife reef. This reef consists of a flat sheet of sandstone several meters thick based on sand but its origin is not clear. In any case, this is a favorable natural condition for port construction.

(8) The river systems, water quality and rivers discharging into the lagoon

The main river systems associated with the Suape are that of three rivers, the Pirapama, Massangana and Ipojuca. The Pirapama River is the main source of Recife's water supply and it also supplies industrial water for Cabo. The Massangana River has two tributaries, the Tabatinga and Gangri Rivers. The Tabatinga can also be used as a water supply source. The Ipojuca is one of the largest rivers in Pernambuco State and has a total length of 245 km. It flows from west to east along a geotectonic line and can be utilized as the main source of water for the Suape.

The Suape and Merepe mangrove areas act as blood control reservoir of the Ipojuca River.

The water in these rivers contains a high concentration of iron but the physical, chemical and bacteriological characteristics appear to be within limits permitted by most nations.

The Massangana, Tatuoca and Ipojuca Rivers flow into Suape lagoon which is planned as the inner harbor and it is intended to utilize the channels of the Massangana and Ipojuca Rivers as the artificial channels for the harbor after dredging.

Both the Massangana and Tatuoca Rivers seem likely to function as drainage channels of neighboring area or a part of the lagoon and it would appear that their effect on the inner harbor during flood can be neglected. However, the effects of the Ipojuca River with a catchment area of approximately 3,500 sq. km on the harbor cannot be overlooked. It is reported that the flood discharge is 1,100 cu.m/sec. Under such conditions, some measures will have to be taken and such means as the construction of flood control basins and the direct release of the flood water into the sea area are being considered.

(9) Connecting roads and railways

National Highway 101 from Recife passes through Cabo and State Highway PE-60, which starts in Cabo, is adjacent to the planned area. Both highways are two-lane concrete roads and they are able to withstand use by heavy vehicles as trunk roads accommodating heavy truck traffic. There is also an unpaved single lane road for sugar cane transport which branches off State Highway PE-60 and runs through the area. The railway in the region is a meter gauge LTS line of the northeastern network of the Brazilian national railway which connects Recife with Maccio via Cabo. Currently, there are four round-trip freight runs and five round trip passenger runs a day and it is possible to haul 1,200 t. of freight using a Diesel locomotive.

2. Port Planning

(1) Summary of the port-related sections of the TRANSCON Report

The port sections in the TRANSCON Report take up the natural conditions of the planning area (natural conditions related to the port), in 'Book I, Data on Local Physical Conditions,' as well as 'Book II, Part I, Port Planning Studies' and 'Book IV, Part I, Port System.' The contents of these sections can be divided into general port planning studies and considerations of the various aspects of the port system.

(A) Port planning studies

Types of ships: First, the relation between the increase in the sizes of ships and shipping costs for such types of ships as conentional cargo ships, container vessels, barge carriers, passenger liners, tankers, bulk carriers, combination ships, coasters (cabotage), RO/RO ships and LASH ships was investigated in accordance with recent trends in these different types of ships. According to these results, there is a limit to the decrease in shipping costs in accordance with the increase in sizes of ships.

The types and sizes of ships to be considered in the planning of Suape port are studied for conventional cargo ships, bulk carriers, combination ships and tankers. The following tonnages are estimated for State I of the plan:

Conventional cargo ships:	15,000 - 22,000 DWT
Bulk carriers and combination ships:	125,000 DWT
Tankers - crude oil:	135,000 DWT
- oil products:	60,000 DWT

Special facilities related to port activities: The special facilities related to port activities being investigated are ship maintenance facilities and fishery facilities.

Suape is in an ideal location for the provision of maintenance services for tankers using Atlantic lanes between the Middle East and Europe via the Capa of Good Hope. Therefore, Suape will require at least some level of ship maintenance facilities. Future construction of drydocks in cooperation with shipping companies and shipyards should be investigated.

The results of investigations concerning making Suape into a base for the fishing industry have indicated the possibility of the development of tuna fishing. The construction of fishing port facilities, mainly related to tuna, has been suggested as follows.

The concept for Suape Port based on institutional viewpoint
The concept for Suape Port based on operational viewpoint

The concept for Suape Port: In the basic concept for the layout of Suape Port, the sandstone reef which stretches in a straight line for about 10 km will be utilized as a natural breakwater and the basic plan to excavate a harbor. Thirteen layout alternatives with different openings for the harbor entrance in the reef; the provision of one or two harbor entrances, various layouts of the inner channels, etc. and other variations were prepared. After comparative investigations, the final layout shown in Figs. 3-5 and 3-6 was selected. According to this plan, there will be one harbor entrance, the inner channels will be formed by dredging the rivers flowing into the Suape harbor and north and south channels will be constructed.

Dimensions of channels and mooring basin of the Suape harbor: Dimensions of the depth, width and radius of curvature of ship channels, mooring basins, inner channels, etc. and the scales of turning basins, anchorage for waiting ships, etc. for each type of ship on the basis of subdivisions in the ship channels and mooring basins were obtained by utilizing data from Bulletin No. 16 concerning the 23rd conference of PIANC in Ottawa in 1973 (the report of the Tanker Committee), the November, 1968 issue of the Dock and Harbour Authority, Tidal Hydraulics published by the US Army Engineer Corps, etc.

The water depth was calculated by considering the maximum draft, squating, wave effect, keel clearance necessary for manoeuvering, sounding error, siltation and dredging accuracy.

The widths of fairways and channels will be 350 to 400 m from the examples of Europort, Netherlands, with a securing distance of 75 to 100 m between both large and small passing ships when the channel is for two-way navigation and five times the width of the ship when the channel is one-way. The widths of the inner channels are calculated by the following formulas depending on whether the channel is one-way or two-way and whether or not there are ships moored on one or both sides of the channel.

Table 3-8 Widths of inner channels

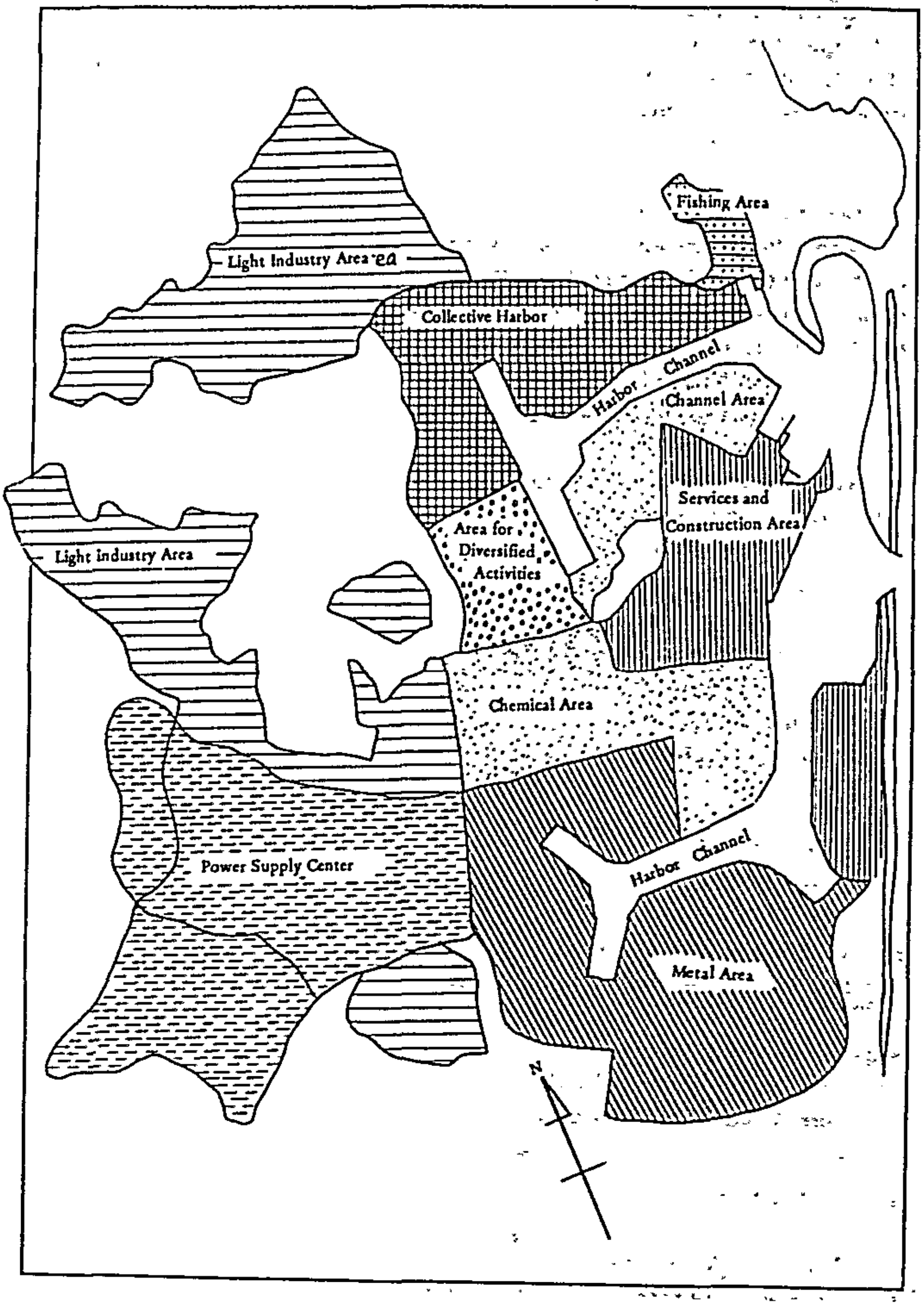
	One-way	Two-way
Ships mooring on both sides of channel	5.8B + 50	8.6B + 50
Ships mooring on one side only	5.3B + 25	8.1B + 25
No ships mooring	4.8B	7.6B

Note: B is the width of the ship

(B) Port system

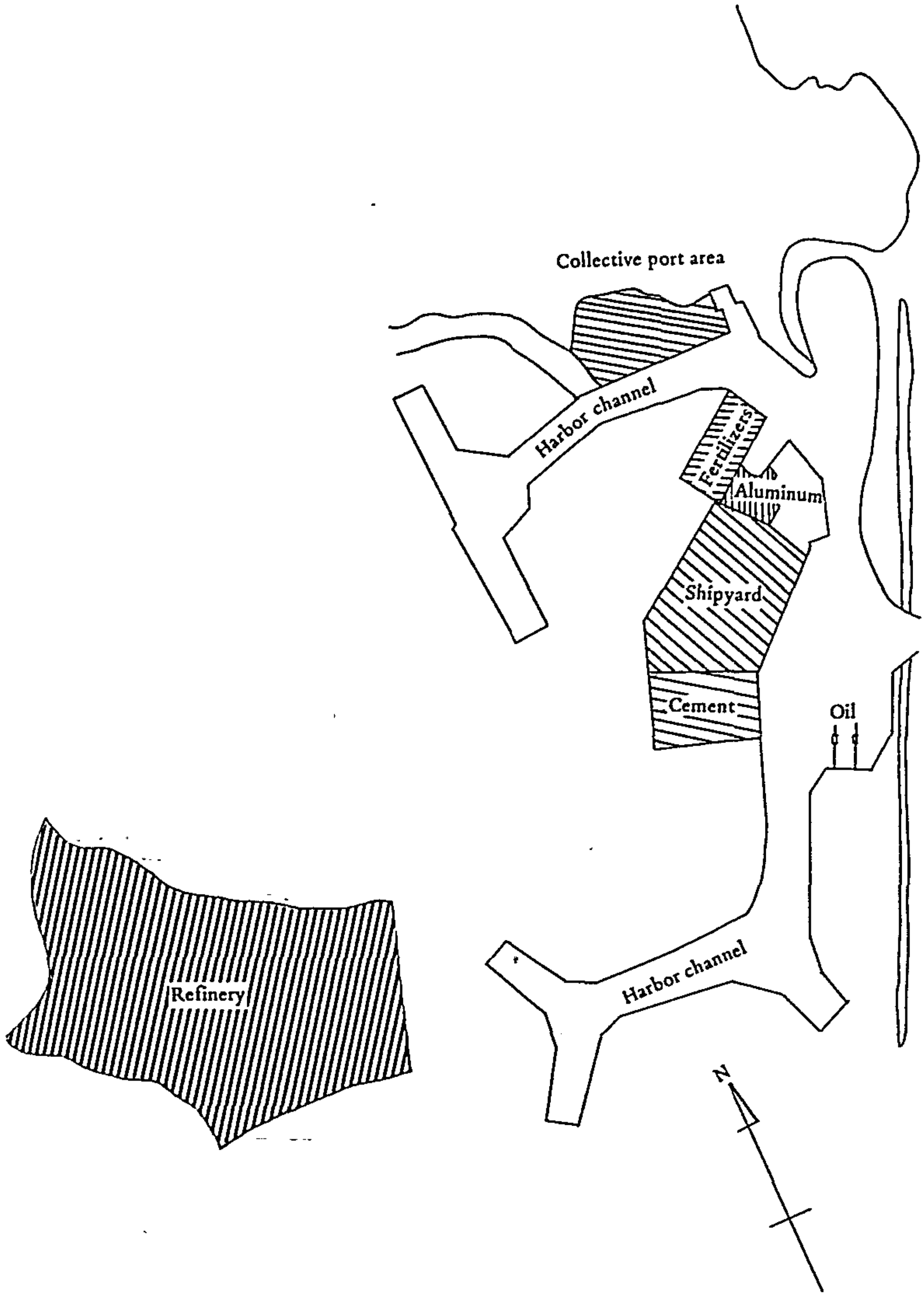
The port system is described in detail, including calculations of construction costs from basic data. However, since there are still not sufficient fundamental data from the overall standpoint and many items such as layout plans are left to be investigated, there is an impression that these results are still incomplete. The details of the port system are as follows.

Fig. 3-5 Overall use zoning of the harbor area



Source: TRANSCON report, Resume.

Fig. 3-6 Scheme on the location of pioneer activities at 1st stage



Source: TRANSCON report, Resume.

Determination of the scale of channels and mooring basins: The specifications for the depths, widths, etc. of ship channels, mooring basins and inner channels were investigated and the values set are almost the same as the dimensions of channels and mooring basins of Suape (see (6) above) of the port planning studies.

Construction of the port entrances: For the construction of the port entrances, the soil conditions were inferred on the basis of data estimated from borings at points in the location of the proposed inner channels and very rough stability calculations were performed. Sectional plans of the entrances were made and the construction of costs were estimated.

Port protection works: On the basis of the same concepts as in the previous section, construction costs for raising the height of the reef, providing two breakwaters for the harbor entrance and closing of the reef between Santo Agostinho to the north to protect the port were estimated.

Dredging plan: The dredging works are classified into nine zones including the entrance channels and the inner harbor; there are also 15 land reclamation areas. In the first stage of the plan for land reclamation, part of the land (about 40% of the total land to be reclaimed) will be raised to the elevation of +4.0 m (reclaimed land thickness of 2.7 m; the same as the height of the Recife harbor wharf), another part (50%) will be raised to +2.8 m (reclaimed land thickness of 1.5 m; about the same as the spring tide level) and the remainder (10%) will be left untouched for future reclamation. The basic policy is to use only sand for reclamation.

The volume of dredging will be 92 million cu. m in the first stage and 167 million cu. m for the total. The type and capacity of dredger will be selected in accordance with operation costs, period, etc.

Consideration for dimensioning the coastal industrial estate
Physical plan of the coastal industrial estate
Physical plan of the port and harbor facilities in the coastal industrial estate

In the above three cases, the plans are based on specialized marine terminals for different materials such as sugar and wheat. The estimation of the amount of cargo handled in the port and the types of ships in the first stage are shown in Tables 3-9 and 3-10, respectively.

Table 3-9 Estimated volume of cargo handled in the port

Year	1980	2005
Collective Port	Approx. 1,800,000 t	Approx. 6,000,000 t
Private terminals	Approx. 16,000,000 t	Approx. 41,000,000 t

Table 3-10 : Types of ships entering Suape port

	Types of ship	Draft
Wheat	Max. 60,000 DWT	- 13.50
Sugar	Max. 125,000	- 16.50
	Others 20 - 30,000	
Alcohol: vegetable oils	25,000	- 10.00

The scale of port facilities for wheat, sugar, vegetable oils, etc. were studied, assuming a maximum berth utilization rate of 50% and as a result, four berths are planned.

The design criteria in general are described for these four berths.

Suggestions for fishing facilities and special shipping facilities: Studies have been performed concerning fishing harbor and facilities for RO/RO and LASH ships. In the case of the fishing harbor, preparing for the development of a fishing industry in the future, warehouses and a fish market must be constructed in the first stage, and large scale tuna fishing boats, fish processing plants, repair and supply facilities and accommodations for sea men must be considered in the second stage. In the case of RO/RO and LASH ships, the basic handling facilities must be provided especially for LASH because LASH ships cannot be accommodated in Recife Port.

Navigational aids: To make Suape a large-scale, modern port, it will be necessary to assure safe navigation and convenience in entering and leaving the harbor and berthing by providing radar, VHF and other navigational aids. The use of tugboats for entering and leaving the harbor should be considered and for the time being, two 1,500 HP tugboats will be needed. Facilities for fuel and water supplies and small traffic boats for miscellaneous use will also be required.

Overall budget: The overall budget based on the construction costs for four items, i.e. construction of the harbor entrance and breakwater, dredging and land reclamation, the Collective Port with four berths and the navigational aids, will be approximately Cr $ 1 billion.

(2) Cargo handled by the harbor

(A) Amount of cargo handled according to the TRANSCON Report

According to the TRANSCON Report, attempts are made to study various types of industry in the Suape Coastal Industrial Estate, including heavy and chemical industries, in keeping with the situation in the country as a whole and the special characteristics of the Nordeste. As a result, the following types of industry have been selected for cargo handling in Suape harbor:

For the Collective Port: sugar, wheat, molasses, alcohol and vegetable oils

For the private terminals: fertilizer, oil refining, aluminum refining and cement

The first stage for the above types of industry will be from 1980 to 2005 and the amounts handled in the port are estimated as shown in Table 3-11.

Table 3-11 Amounts of cargo handled in Suape port (TRANSCON Report)

	1980	2005
Collective Port	1,814	5,964
Imports	612	1,345
Exports	1,202	4,619
Private terminals	15,701	41,258
Imports	10,456	26,810
Exports	5,245	14,448
Total	17,515	47,222
Imports	11,068	28,155
Exports	6,447	19,067

(Unit: 1,000 tons)

As can be seen in this table, the amount of cargo to be handled in the port in 1980 is estimated at about 17.5 million tons (11 million of imports and 6.5 million of exports) and by the end of the first stage in 2005, it should rise to approximately 47 million tons (28 million of imports and 19 million of exports). Table 3-12 shows estimates of the amount of cargo handled in the port each year for each type of industry.

(B) Amount of cargo handled in the port according to the types of industry as proposed by the Survey Team

At Recife, the Survey Team found out that APL had investigated the selection of industries to be introduced into the Suape Coastal Industrial Estate separately from the study by TRANSCON. Table 3-13 shows the amount of cargo to be handled in Suape Port as estimated for

Table 3-13 Amount of cargo to be handled in the port (estimates of the Survey Team)

(Unit: 1,000 tons)

	1st stage	final plan
Collective Port	1,814	5,964
Imports	612	1,345
Exports	1,202	4,619
Private terminals	18,156	84,189
Imports	10,018	48,554
Exports	8,138	35,635
Total	19,970	90,153
Imports	10,630	49,899
Exports	9,340	40,254

Table 3-12 Projected cargo flows through the port (In 1,000 tons)

		1980	1981	1982	1983	1984	1985	1990	1995	2000	2005
Collective Port		1,814	2,043	2,298	2,582	2,898	3,255	4,249	5,519	5,734	5,964
Imports		612	642	673	705	739	775	954	1,176	1,257	1,345
	Wheat	612	642	673	705	739	775	954	1,176	1,257	1,345
Exports		1,202	1,401	1,625	1,877	2,159	2,480	3,295	4,343	4,477	4,619
	Wheat	300	316	333	351	369	389	487	610	652	698
	Sugar	650	761	891	1,044	1,222	1,430	1,944	2,640	2,686	2,735
	Molasses	109	170	235	302	374	450	634	842	883	925
	Alcohol	113	120	127	134	142	151	165	181	181	181
	Vegetable Oils	30	34	40	46	52	60	65	70	75	80
Private Terminals		15,701	15,585	15,470	15,315	15,311	20,256	24,523	27,987	31,927	41,258
Imports		10,456	10,528	10,601	10,681	10,765	13,004	15,500	17,655	20,655	26,810
	Phosphate Rock	30	78	117	157	197	393	785	785	785	785
	Sulfur	13	23	34	45	56	108	213	213	213	213
	Potassium Chloride	48	55	69	88	111	133	193	193	193	193
	MAP	56	63	72	82	92	61	-	-	-	-
	Crude Oil	8,000	8,000	8,000	8,000	8,000	8,000	8,000	10,000	12,000	16,000
	Cryolite	2	2	2	2	2	2	2	3	3	5
	Aluminum Oxide	200	200	200	200	200	200	200	300	300	400
	Coke	70	70	70	70	70	70	70	105	105	140
	Coal	4	4	4	4	4	4	4	6	6	8
	Pitch	30	30	30	30	30	30	30	45	45	60
	Fluoride	3	3	3	3	3	3	3	5	5	6
	Clinker	2,000	2,000	2,000	2,000	2,000	4,000	6,000	6,000	7,000	9,000
Exports		5,245	5,057	4,869	4,634	4,546	7,252	9,023	10,332	11,272	14,448
	Cement	2,000	2,000	2,000	2,000	2,000	4,000	6,000	7,000	7,000	9,000
	Petroleum Derivatives	3,245	3,057	2,869	2,634	2,446	3,152	2,587	2,917	3,857	5,033
	Fertilizers					100	100	436	415	415	415
Total Imports		11,068	11,170	11,274	11,386	11,504	13,779	16,454	18,831	21,912	28,155
Total Exports		6,447	6,458	6,494	6,511	6,705	9,732	12,318	14,675	15,749	19,067
Total Cargo Flow		17,515	17,628	17,768	17,897	18,209	23,511	28,772	33,506	37,661	47,222

the Stage I and the final stage of the plan respectively on the basis of the types of industry proposed by the Survey Team (refer to Part I, Chapter 2, Industrial Development) utilizing the results of an interview with APL personnel. As in the case of the TRANSCON estimates, the amount of cargo to be handled is given separately for the Collective Port and for the private terminals of the industries to be established in the area. Ordinary general cargo handled at the public wharves is not included.

According to Table 3-13, the amount of cargo to be handled in the Stage I will be about 20 million tons (10.5 million of imports and 9.5 million of exports) which is about 2.5 million tons higher than the TRANSCON estimates for 1980 shown in Table 3-11. Most of this cargo will be from steel-related industries which the Survey Team selected as a new industry to be introduced into the region.

The amount of cargo to be handled by the time of the final plan should expand greatly because of such factors as the increased scale of oil refining and the petrochemical industry which the JICA Mission proposes to introduce. The total is estimated at approximately 90 million tons (50 million of imports and 40 million of exports) which is about 1.91 times greater than the TRANSCON estimate (47 million tons) for the year 2005. Table 3-14 shows the amounts of cargo to be handled in the port for each type of industry.

(3) Investigations of ship types

To determine the types of ships to be used in the Suape industrial port, TRANSCON investigated recent trends in conventional cargo ships, barge carriers, passenger liners, tankers, bulk carriers, combination ships, coasters, RO/RO ships and LASH ships on the basis of the types and sizes currently in operation and under construction (orders given). The argument has also appeared that, considering the relation between the type and size of ships and the operating costs, the decrease in the operating costs as the size of the ship increases is limited. From the results of these investigations, the following types of ships and tonnages were used in the Suape harbor design for the first stage plan.

However, in these investigations for the determination of type and size of ships, no consideration was given to the relation between the types of industries to be established in this area and the amounts of resulting cargo to be handled. Therefore, the type and size of the ships to be handled in the port was examined only with respect to trends of each type of ship with no consideration given to scales, layout, etc. of industries in the Suape port region.

Therefore, this is only usable as a guideline of the maximum ship tonnage for port design purposes. In the future, it will be necessary to investigate the types and sizes of ships to be handled considering the scales and types of industries to be introduced in keeping with Suape characteristics, the amount of cargo handled in the port in relation to these industries, the port facilities and conditions in the countries supplying raw materials, the berth utilization rate, etc. in order to obtain an overall evaluation. As an example, Table 3-16 shows standard sizes of ships for various types of industries in Japan.

Table 3-14 Volumes of cargo handled at port in the final stage

Category	Scale of production	Site area (ha)	Volume of cargo handled by port (t)		
			Raw material	Product	Total
Fertilizer	1,000,000 t/y	50	1,421,206	400,000	1,821,206
Oil refinery[1]	750,000BPSD	750	34,425,000	22,176,000	56,601,000
	(35,200,000KL/y)		(38,250,000KL/y)	(24,640,000KL/y)	(62,890,000KL/y)
Petrochemicals[2]	Ethylene equivalent 800,000 t/y	400	300,000	2,700,000	3,000,000
Automobile tires	1,500,000 piece/y ≈5,700 t/y	15	-	1,710	1,710
Iron & steel related industry: Rolled steel plate	1,260,000 t/y	40	1,280,000	378,000	1,658,000
Seamless pipe	250,000 t/y	50	279,500	192,500	472,000
Plain pipe	24,000 t/y	5	-	4,800	4,800
Secondary processing[3]	500,000 t/y	20	260,000	100,000	360,000
Casting	12,600 t/y	4	-	-	-
Forging	12,000 t/y	4	-	8,400	8,400
Total	2,058,600	123	1,819,500	683,700	2,503,200
Aluminum-related industry: Aluminum refining	200,000 t/y	70	618,000	70,000	688,000
Aluminum rolling	50,000 t/y	17		10,000	10,000
Aluminum building materials	3,600 t/y	2		720	720
Diecastings	3,000 t/y	2		600	600
Copper &.alum. wire	20,000 t/y	5		4,000	4,000
Total	76,600 t/y	26		15,320	15,320
Nonferrous metals	720,000 t/y	70	780,000	576,000	1,356,000
Automotive industry: Automobiles		60	25,000	12,500	37,500
Cargo transport vehicles	4,752set/y	40	24,620		24,620
Total		100	49,620	12,500	62,120
Shipbuilding: Repair dock	7-10 10^4 DWT	30			
Building dock	50 10^4 DWT	120	140,000		140,000
Cement	9,000,000 t/y	100	9,000,000	9,000,000	18,000,000
Industrial port total		1,854	48,553,326	35,635,230	84,188,556
Collective port: Sugar				2,735,000	2,735,000
Wheat			1,345,000	698,000	2,043,000
Molasses				925,000	925,000
Alcohol				181,000	181,000
Vegetable oil				80,000	80,000
Total			1,345,000	4,619,000	5,964,000
Cargo handled at Suape Port			49,898,326	40,254,230	90,152,556

Note: For breakdown of raw materials by destination, see Table 2-13. 1. 1Kl=0.9t. 2. All derivatives, 3,850,000 t/y 3. For sale to shipyard.

Table 3-15 Types of ships to use the collective port

Type of ship	Tonnage
Conventional cargo ships and freighters	15,000 - 22,000 DWT
Bulk carriers and combination ships	125,000 DWT
Tankers - crude oil	135,000 DWT
- oil products	60,000 DWT

Table 3-16 Standard ship sizes for various types of industry in Japan

Industry		Maximum ship size	Average size	Origin
Oil refining	Crude oil	200,000 - 450,000		Middle East, Indonesia
	Oil products			
Petrochemicals	Raw materials	Transshipment base		Australia
		12 - 160,000		
	Industrial salt	Kashima 60,000		
	Products			
Iron & steel	Raw materials	Iron ore		
		20 - 350,000	80,000	Brazil
(all processes)		Coal 110,000	50,000	Australia
	Products	Export 50,000	10 - 30,000	
		Domestic 4,000	1 - 2,000	
Automobiles	Products		20 - 30,000	
Aluminum refining	Raw materials		20 - 30,000	Australia
	Products			

Considering port facilities and conditions in export and import countries, the maximum and average sizes of ships entering the Collective Port are proposed as shown in Table 3-17.

(4) Studies of port facilities

(A) Required number of berths

In the TRANSCON Report, there is no explanation about the types of industry to be established which will use private terminals and only the required number of berths for the Collective Port are calculated.

The required number of berths is calculated from the following formula on the basis of the numbers of ships of several classes normally entering the port, the time each ship occupies a berth, the number of days the berths are operated each year and the rate of utilization of the berths.

$$\text{Required number of berths} = \frac{(\text{Number of ships entering port annually}) \times (\text{Time ship occupies berth [days/ship]})}{(\text{Berth utilization rate}) \times (\text{Annual number of days of operation})}$$

Note: The 'time ship occupies berth' includes the mooring and idle time as well as the loading and unloading time.

Table 3-17 Characteristics of ships using the Collective Port

Cargo	Type of shipping	Vessels	DWT	Cargo voyage (t)	Length (m)	Beam (m)	Draft (m)	Depth (m)
Wheat	Brazilian (Avr.)	Cargo ship	10,000	8,000	165	24.3	8.0	9.1
	(Max.)	"	15,000	12,000	210	28.5	9.5	10.6
	(Max.)	Bulk carrier	25,000	20,000	165	22.0	9.0	10.5
	Foreign (Avr.)	Bulk carrier	38,000	30,000	184	25.0	10.2	11.5
	(Max.)	"	60,000	48,000	217	31.0	12.2	13.5
Sugar	Sacks	Cargo ship	25,000	20,000	257	33.0	10.9	12.0
	Foreign (Avr.)	Bulk carrier	80,000	64,000	240	34.0	13.3	14.5
	(Max.)	"	125,000	100,000	278	40.0	15.3	16.5
Liquid cargo	Veg. oil	Cargo ship	15,000	12,000	210.5	28.5	9.5	10.6
	Alcohol	Tanker	25,000	20,000	164	24.5	10.9	12.0
	Molasses	"	38,000	30,000	190.5	27.4	11.6	12.7

However, at present it is not clear how many ships of each class will enter Suape Port, what sorts of the cargo handling equipment will be installed, etc. and therefore, the calculation of the required number of berths (required length of berths) for each type of industry has been calculated on the basis of the standard cargo handling capacity per berth in Japan. Table 3-18 shows the calculations of berth lengths for the private terminals according to the types of industry established in the Suape Coastal Industrial Estate. According to these results, the total length of wharves required, including dolphins and jetties, is as follows:

Stage I	approx.	2,500 m
Final stage	approx.	11,000 m

However, this calculation of the required berth length is only a rough estimate to determine the necessary scale of the Suape port and this values of the handling capacity of the private terminals can vary considerably depending on the set conditions. Therefore, in the future, further detailed studies will be required for each of the private terminals on such conditions as the size and number of ships entering and leaving the port, the specifications of the proposed cargo handling equipment, the number of days of operation and the actual operating time per ship.

As the required number of berths for the collective port, the construction of the four berths is proposed in the TRANSCON Report. According to this report, sufficiently smooth cargo handling can be expected because the maximum berth utilization rate will be (at the time of the final plan) 50% as shown in Table 3-19.

Table 3-18 Calculation of number of berths needed

		Size of ship		Cargo handled per berth 10^3 t	Cargo volume 10^3 t		Required No. of berths		Req. length of Quay (m)		Notes
		DWT	Berth length		Stage I	Final	Stage I	Final	Stage I	Final	
Fertilizer		25,000	210	500	276	1,820	1	4	210	840	
Petroleum refining	Crude	135,000	420	1,000KL/y 10,000	7,650	38,250	1	4	420	Both sides 960x2=1920	In final stage, 480 m, for 200,000 DWT
	Prods.	10,000	165	2,000	6,337	24,640	4	13	660	2,150	
Petro-chemicals	Raw mat. (Ind.salt)	20,000	200	1,000	-	300	-	1	-	280	Berth for 60,000 DWT ships
	Prod.	10,000	165	250	-	2,700	-	11	-	1,820	
Steel-related		30,000	210	600	880	2,503	2	4	480	960	
Aluminum refining		25,000	210	600	349	688	1	1	310	310	Berth for small ships (100 m) added
Non-ferrous metals		25,000	210	500	-	1,356	-	3	-	630	
Cement	Raw mat.	20,000 - 40,000	200 - 260	2,000 - 3,000	2,000	9,000	1	3	200	780	Stage I 20,000 DWT 2,000,000 t/B Final 40,000 DWT 3,000,000 t/B
	Fin. prod.	20,000 - 40,000	200 - 1,260	2,000 - 3,000	2,000	9,000	1	3	200	780	
Total									2,480	10,450	

Table 3-19 Berth utilization rates in the Collective Port for various types of industry

		Stage I (1980)	Final stage (2005)
Sugar	bulk	18%	38 %
	bags	10	42
Molasses		6	36
Alcohol		9	14
Vegetable oils		2	6
Wheat	imports	35	39
	exports	12	27
Total		92	202
Average utilization rate per berth		23%	50.5%

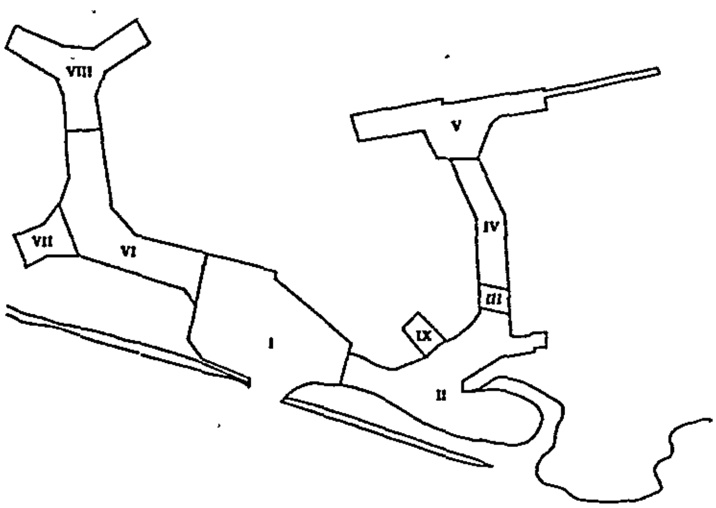
Source: TRANSCON Report, 'Port System'

The above four berths are planned for 125,000 DWT, 80,000 DWT, 60,000 DWT and 25,000 DWT respectively. The total wharf length needed will be about 1,000 m.

(B) *Dimensions of water area*

The water area of the harbor is classified into nine sections shown in Fig. 3-7 and the ship size, water depth and width for each section have been compiled accordingly. An outline can be given as follows.

Fig. 3-7 Subdivisions of the inner harbor



Ships to be handled in each section: The size of the ships entering the each section (basin and channel) and the kinds of cargo handled for each section have been planned as shown in Table 3-20.

Table 3-20 Types and sizes of ships for each harbor section

Section	Industry		Ship
Area I	Oil, Cement) Terminal		135,000 DWT
II	Fertilizers	1986	60,000 "
	Phosphate ores	After	125,000 "
III	Wheat imports		60,000 "
			80,000 "
IV	Wheat exports		25,000 "
			63,000 "
V	Containers, etc.	Containers	45,000 "
		Bulk	50,000 "
VI	Iron and steel		135,000 "
VII	Oil products		60,000 "
VIII	Bulk		50,000 "
IX	Aluminum & fertilizer		25,000 "

Required water depth: The required depths of the channels and mooring basins have been planned by adding the keel clearance to the draft of the ships concerned. The keel clearance is considered including squatting, the influence of waves, the keel clearance necessary for manoeuvering ships, sounding error and dredging error. The depths of the each section have been planned on the basis of these concepts as shown in Table 3-21.

The standard keel clearances are normally as follows:

Open sea channels	20% of draft
Outer harbor channels	15% of draft
Inner harbor channels	10% of draft

The water depths in the TRANSCON Report are considered to be suitable for fulfilling the required conditions.

Widths of channels: The widths of the access channel and the inner harbor channels have been planned as follows:

Access channel:	five times the ship width of the maximum ship size in consideration of one-way navigation
Inner channel:	The width of the inner harbor channels shall be the required width (5.8B + 50m) in the case of one-way navigation of the largest ship for the area when ships are at mooring on both sides of the channel.

As can be seen in the figure shown here, the section of the channel shows a dredging slope of 1 : 5 and pier head line is the toe of slope. On the basis of the above concept, the channel

Table 3-21. Criteria and definition of depths for channels and anchorage

Harbor district	Typical ship DWT	Max. Draught (m)	Squatting (m)	Effect of wave (m)	Net pilot draft (m)	Tolerances (m)	Nominal depth (m)	Stage I	Final stage	Notes
Access channel	135,000	16.50	1.30	0.85	0.50	0.70	20.00	o		Tanker
I	135,000	16.50	0.30	–	0.50	0.60	18.00	o		Tanker
II	60,000	12.20	0.30	–	0.50	0.30	13.50	o		Combination vessel (Phase 1)
	125,000	15.30	0.30	–	0.50	0.30	16.50	o		Combination vessel (Phase 2)
III	60,000	12.20	0.30	–	0.50	0.30	13.50	o		Bulk carrier
	80,000	13.30	0.30	–	0.50	0.30	14.50		o	Bulk carrier
IV	25,000	9.0	0.30	–	0.50	0.20	10.00	o		Bulk carrier
	63,000	12.20	0.30	–	0.50	0.20	13.50		o	Bulk carrier
V	50,000	11.50	0.30	–	0.50	0.20	12.50		o	Container ship Bulk carrier
VI	135,000	16.20	0.30	–	0.50	0.30	17.50		o	Ore carrier
VII	60,000	12,80	0.30	–	0.50	0.30	14.00		o	Tanker
VIII	50,000	11.50	0.30	–	0.50	0.30	12.50		o	Bulk carrier
IX	25,000	9.00	0.30	–	0.50	0.20	10.00	o		Freight vessel

width is planned as in Table 3-22.

Miscellaneous: It is planned that the harbor entrance will have a width of 320 m and a depth of 20 m, same as in the case of the entrance channels. From the harbor entrance it is about 1,200 m to the opposite coast line, so that ships of the 210,000 DWT class can stop even when entering the harbor at a speed of 5.5 knots. Ships of the 370,000 DWT class can also enter the harbor since the VLCCs can turn without tugboats if the turning basin has a radius of 2.3L. Area II is planned as partially anchorage area for waiting ships where quarantine, berthing and exit control and customs inspections can be performed so that demurrange will be reduced compared with waiting offshore outer harbor.

Table 3-22. Width and depth of channels

District	Size of typical ship	Width (m)	Water Depth (m)	Stage I	Final stage	Max. size vessel for two-way traffic
Access channel	135,000	320	20.0	o		
I	135,000	1,200 (Turning basin)	18.0	o		
II	60,000 125,000	320	13.5 16.5	o o		50,000 DWT
III	60,000 80,000	250	13.5 14.5	o	o	20,000 DWT
IV	25,000 63,000	250	10.0 13.5	o	o	20,000 DWT
V	50,000	250	12.5		o	20,000 DWT
VI	135,000	320	17.5		o	50,000 DWT
VII	60,000	250	14.0		o	20,000 DWT
VIII	50,000	210	12.5		o	Barge
IV	25,000	180	10.0	o		Barge

(5) Industrial and harbor layout

According to the current dredging plan, the total length of the waterline will be approximately 30 km at the final stage and about 8 km at the first stage. However, the required length of berths for the types of industry presently proposed is 3.5 km in the first stage and 12 km in the final plan, including the length of the berths of the collective port. Therefore, the waterline is long enough to permit the construction of new public berths, the introduction of new types of industry, etc.

The industrial and harbor layout will be based on the following concepts:

1) The industrial layout will be based on the types of industry to be introduced into the Suape as shown in Table 2-14.

2) Each coastal industry will have its own private terminal.

3) The berths for crude oil tankers in the final plan are considered accommodating ships of the 200,000 DWT class so they will be offshore sea berths. However, in the first stage of the plan, there will be berths inside the harbor for ships of the 135,000 DWT class.

4) According to the results of surveys performed to date, the number and sizes of ships entering the harbor and the scale of the facilities such as the channels, anchorage basins and the necessity and scale of the protective structures such as breakwaters are not clear. Therefore, tentatively the plan for these facilities is based on the TRANSCON Report, and further considerations will be given in this report on technical problems which must be studied in the future.

Fig. 3-8 shows the industrial and harbor layout at the final stage based on the above concepts.

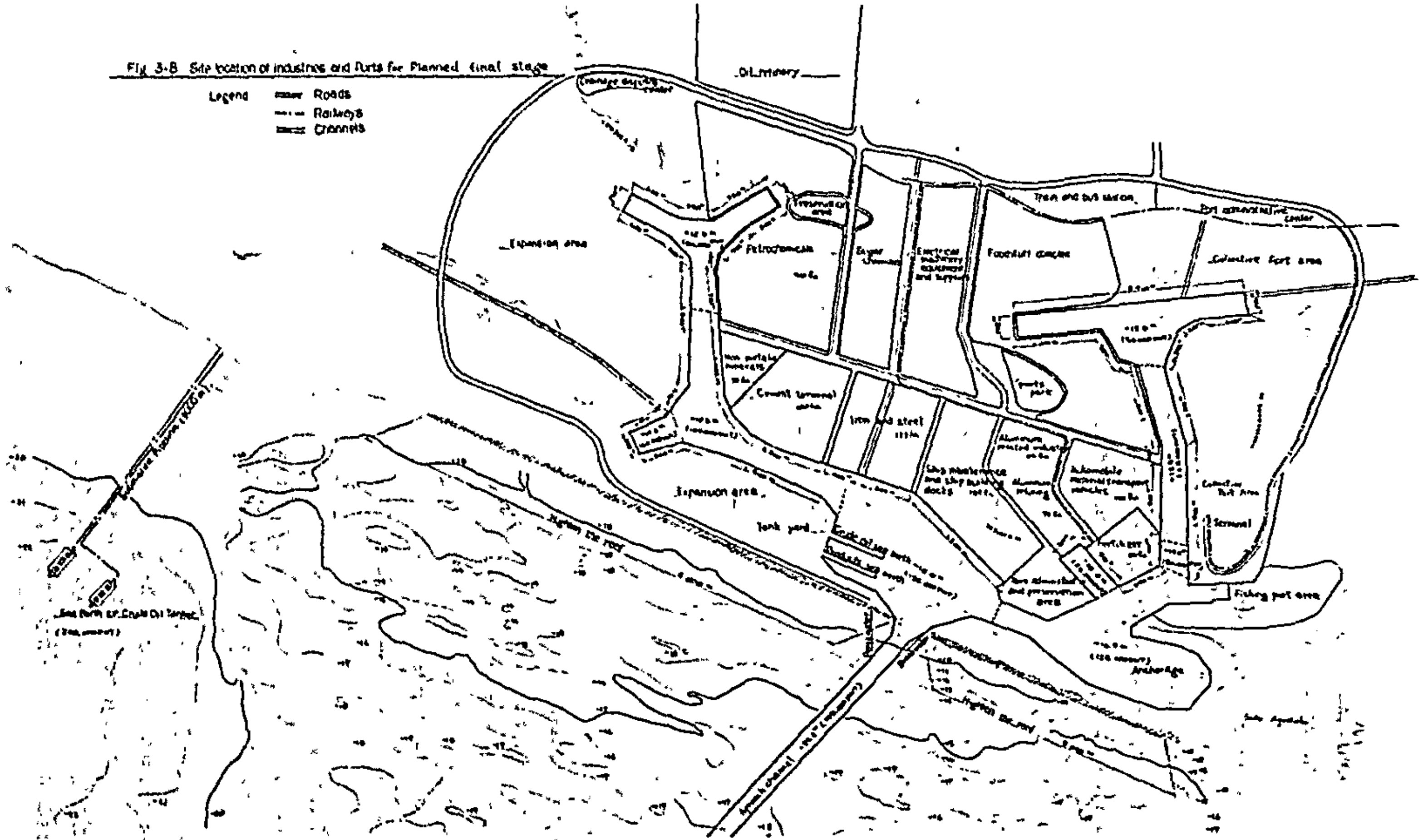
(6) Dredging of channels and mooring basins and land reclamation for factories

The maximum depth of dredging for channels and mooring basins will be -20 m for the harbor entrance channels and -18 m for the inner channels according to the present plan. The soil condition up to a depth of 20 m consists mainly of sand in the Ipojuca river area, while in the Massangana River the sea bed is mainly clay interspersed with sand. The soil to be dredged for the channels and mooring basins consists of sand, clay and small amounts of sandstone and it is assumed that the dredging will be easy. TRANSCON planned to use drag suction dredgers and cutter suction dredgers but the use of grab dredgers should also be considered.

The dredging and land reclamation plan is as shown in Fig. 3-9. In the first stage, the dredging will be mainly in the center channel. Of the 15 reclamation areas, four will be built up to a prescribed height and eight up to the spring tide level to balance the amount of soil.

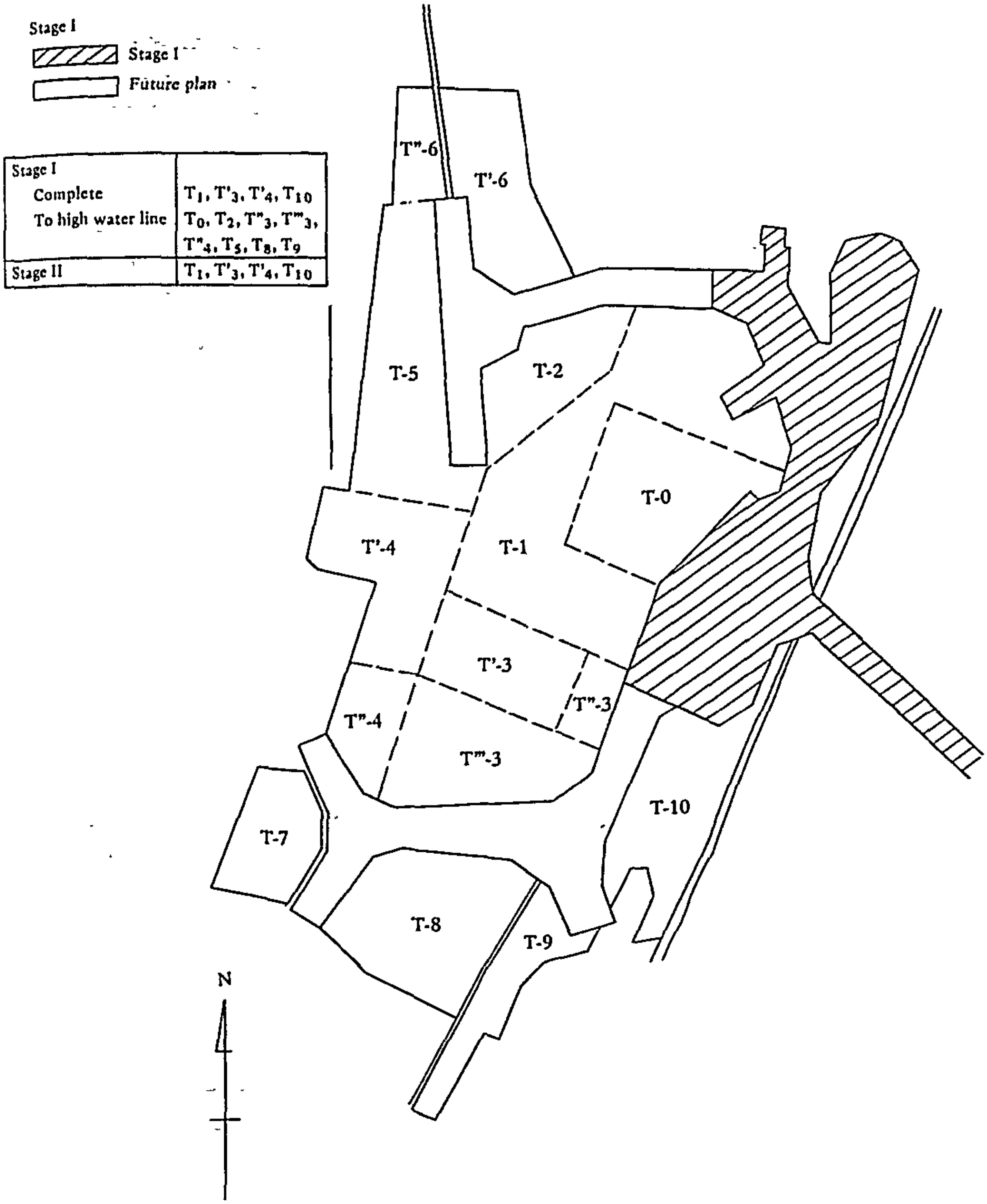
Table 3-23 shows a comparison of the amount of soil dredged for the channels and mooring basin and the amount used for land reclamation. The total amount of soil to be dredged will be approximately 170 million cu. m of which 120 million cu. m will be sand, 40 million cu. m clay and one million cu. m sandstone. The amount to be dredged in the first stage has been calculated as approximately 80 million cu. m. For the industrial layout proposed by the Survey Team, the southern end of the center channel (cement terminal area) will require extension of the channel by about 750 m and further dredging of about 6 million cu. m is estimated.

Fig. 3-8. Site location of industries and port for final stage



1. Oil refinery	2. Future expansion	3. Petrochemicals	4. Sugar chemicals
5. Machinery	6. Food stuff complex	7. Bus & railways station	8. Port Administration Center
9. Collective Port area	10. Collective Port area	11. Automobiles & materials transport vehicles.	
12. Aluminum processing	13. Aluminum refining	14. Ship maintenance & building dock	15. Iron & steel processing
16. Cement	17. Nonferrous metal	18. Petroleum tank yard	19. Petro-products shippingberth
20. Preservation area	21. Port Administration area	22. Fertilizer	23. Fishing port area
24. Anchorage area	25. Reef, elevation raised	26. Breakwater	27. Reef, elevation raised
28. Crude carrier berth	29. Approach channel		

Fig. 3-9. Dredging and reclamation plan



Stage I	
Complete	T_1, T'_3, T'_4, T_{10}
To high water line	T_0, T_2, T''_3, T'''_3, T''_4, T_5, T_8, T_9
Stage II	T_1, T'_3, T'_4, T_{10}

Source: TRANSCON report

Table 3-23 Amounts of soil in dredging and reclamation

(Unit: 1,000 cu. m)

	Soil to be dredged	Soil for land reclamation
Total	167,110	81,223
Stage I	90,917	54,564
Stage II	76,193	26,659

The land to be reclaimed for factories will have an area of about 2,600 ha, of which abo 1,000 ha is to be completed in Stage I and approximately 1,300 ha is to be built up to the spring tide level. The amount of soil necessary for this reclamation will be 55 million cu. m in the Stage I and 27 million cu. m in the Stage II, for a total of 81 million cu. m. The excess soil from the dredging which is not used for reclamation will be thrown away offshore except for some sand which will be used to build up the reef.

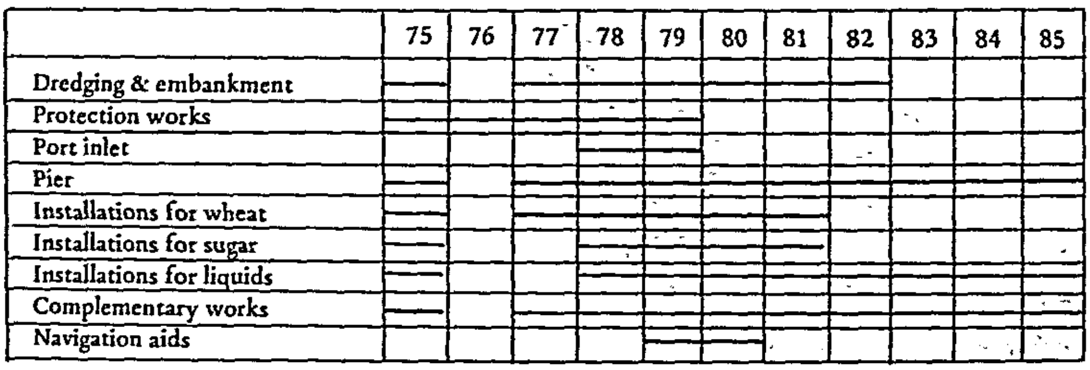
The most suitable dredgers for the amount and the nature of soil and the operating distances have been selected on the basis of a calculation of the operating costs of certain types of drag suction and cutter suction dredgers. The costs of the dredging work were then calculated. According to these calculations, the average unit price for dredging and land reclamation will be Cr $ 6.48/cu. m. This is a little cheaper than the unit cost using pump dredgers in Japan and there will probably be some increase in the actual costs.

The first stage industrial layout proposed by the Survey Team differs from the above-mentioned Stage I land reclamation area but there will be sufficient soil available to cope with the change in the reclamation area.

(7) Work schedule and construction costs

In the work schedule and investment plan in the TRANSCON Report, only the first stage plan has been studied for the port. Fig. 3-10 shows the work schedule for harbor construction. The first stage of the harbor construction has been planned to cover 11 years.

Fig. 3-10 Harbor construction schedule



The total harbor construction costs are estimated as Cr $ 1 billion which is 50% of the total project investment for infrastructure of approximately Cr $ 2 billion. The port budget is as follows:

Dredging and land reclamation	Cr $ 462,234,000
Dredging of access and inner harbor channels and land reclamation	
Collective Port	Cr $ 378,183,000
Terminals and berths for sugar, wheat and vegetable oils	
Protective facilities	Cr $ 86,137,000
Raising and extending the reef, breakwater and port entrance protection	
Navigational aids	Cr $ 25,000,000
Signals, buoys, VHF, tugboats, etc.	
Total	Cr $ 951,554,000

This harbor budget does not include the construction costs for the industrial port (private terminals).

(8) *Opinions concerning the TRANSCON Report (Port)*

(A) *Brazil industrial port concept*

Strictly speaking, there are still no coastal industrial areas in Brazil of the type which have been developed in Japan. The close connection between industry and the waterline such as in Kashima harbor which can be cited as a model has not been achieved in actual fact. This is probably due to national and historical differences between Japan and Brazil. It is only natural that concepts concerning coastal industrial areas in Japan, which depends on imports of raw materials most of which are processed and then reexported as finished products will differ from those in Brazil which has a climate and customs very different from Japan's, which is self-sufficient for the necessities of life.

It goes without saying that the layout in a manufacturing plant must assure minimum transport costs from the intake of the raw materials up to the shipment of the finished products and it is no exaggeration to say that costs in the manufacturing industries are determined by transport charges. If both the raw materials and the finished products have to be shipped by sea, then the factory should have its own wharves, and secondary land transport should be planned to make considerable savings for both incoming and outgoing shipments. For this reason, all companies seeking to enter a Japanese coastal industrial estates make great efforts to secure and utilize the waterline.

In Brazil, the degree of dependence of industry on sea transport is unclear but since the country has a 3,000 km coastline and most of the cities are located on the coast, it appears that the dependence on marine transport is high even though many natural resources are located inl.

In the Suape industrial port plan in the TRANSCON Report, there are noted specialized marine terminals for sugar export and wheat import which are called the Collective Port. However, these are not private terminals; they are collective terminals designed to handle only one commodity. They are also some distance away from the factories. In the TRANSCON Report, there is a reference to the establishment of types of industry which will require private terminals in Suape but in Brazil, most of the terminal facilities in industrial ports are collective terminals which handle one type of commodity as mentioned previously and secondary land transport between factories does not seem to be much of a problem.

In the Aratu port of the Aratu Industrial Estate which the Survey Team visited, raw materials such as various types of ores are unloaded by the same unloader at the wharves which are still under construction, carried by belt conveyor to a large open storage yard and stacked by what appeared to be a common stacker or reclaimer (not clear because it was still being assembled). Then, these materials are to be distributed to the various factories by truck. Outgoing shipments and exports are handled in the reverse order.

Such an arrangement is probably rational and economical in the Aratu Industrial Estate because of its size (about 400 sq. km) and the types of industry located there but at the time of completion, it is planned that the port will handle 12 million tons annually, including ships of the 100,000 DWTclass. If this type of coastal industrial estate is also being considered for Suape, the construction of the port will then be different from that of Kashima. Therefore, the character of the Suape industrial port will be decided by the selection of the industries to be developed in the estate.

(B) Concept of the image plan and the resulting staged plan

In the TRANSCON Report, a wide range of problems related to the toypes of industry to be established, the regional plan, the land utilization plan, the infrastructure plan including the port, etc. are covered. However, to obtain an over-all understanding and also to explain the mutual relations between the various parts, it would be better to divide the overall report into an image plan and a part concerning actual development measures to be taken, and join the two together by an item correlating the two parts.

(C) Amount of cargo handled in Brazilian ports

Table 3-24 shows the amount of cargo handled by Brazilian ports extracted from data obtained from PORTOBRAS with the cabotage for coastal shipping calculated. Table 3-25 shows the amount of cargo handled in Japanese ports.

In comparisons of Japan and Brazil from these tables, Brazil handled approximately 180 million tons of cargo in its ports in 1974, while Japan handled 2,630 million tons in 1973. Although Brazil has an area 23 times that of Japan and almost the same population, it handles only 1/15 of the cargo in its ports.

Table 3-24 (1) Cargo volumes handled at Brazilian ports, by registry of vessel

(Unit: ton)

		1972	1973	1974
Arrivals	Foreign	35,580,907	48,301,229	56,989,834
	Brazilian	17,273,399	19,593,077	21,109,892
	Total	52,854,306	67,894,306	78,099,726
Departures	Foreign	47,351,264	65,117,201	79,672,727
	Brazilian	10,142,316	12,877,665	18,667,154
	Total	57,493,580	77,994,866	98,339,881
Total	Foreign	82,932,171	113,418,430	136,662,561
	Brazilian	27,415,715	32,470,742	39,777,046
	Total	110,347,886	145,889,172	176,439,607

Table 3-24 (2) Cargo volumes handled at Brazilian ports, by cargo type (grain or general cargo)

(Unit: ton)

			1972	1973	1974
Arrivals	Grain	Solid	13,412,692	14,354,891	16,314,159
		Liquid	32,583,255	44,498,495	51,007,657
	General cargo		6,858,359	9,040,920	10,777,910
	Total		52,854,306	67,894,306	78,099,726
Departures	Grain	Solid	39,816,779	54,383,323	73,000,644
		Liquid	8,789,684	11,970,058	16,534,680
	General cargo		8,887,117	11,641,485	8,804,557
	Total		57,493,580	77,994,866	98,339,881
Total	Grain	Solid	53,219,471	68,738,214	89,314,803
		Liquid	41,372,939	56,468,553	67,542,337
	General cargo		15,745,476	20,682,405	19,582,467
	Total		110,347,886	145,889,172	176,439,607

Source: PORTOBRAS

Table 3-24 (3) Quantities and ratio of general cargo and grain

(Unit: ton and %)

		1971	1972	1973	1974
Grain	Solid	52,281,061	53,229,471	68,738,214	89,314,803
	Liquid	30,919,162	41,372,939	56,468,553	67,542,337
	Total	83,200,223	94,602,403	125,206,767	156,857,140
General cargo		12,206,322	15,744,476	20,682,405	19,582,467
Total		95,406,545	110,347,886	145,889,172	176,439,607
Ratio	Grain	87.2	85.7	85.8	88.9
	General cargo	12.8	14.3	14.2	11.1

Table 3-24 (4) Past records and projections of cargo volume handled at port

(Unit: ton)

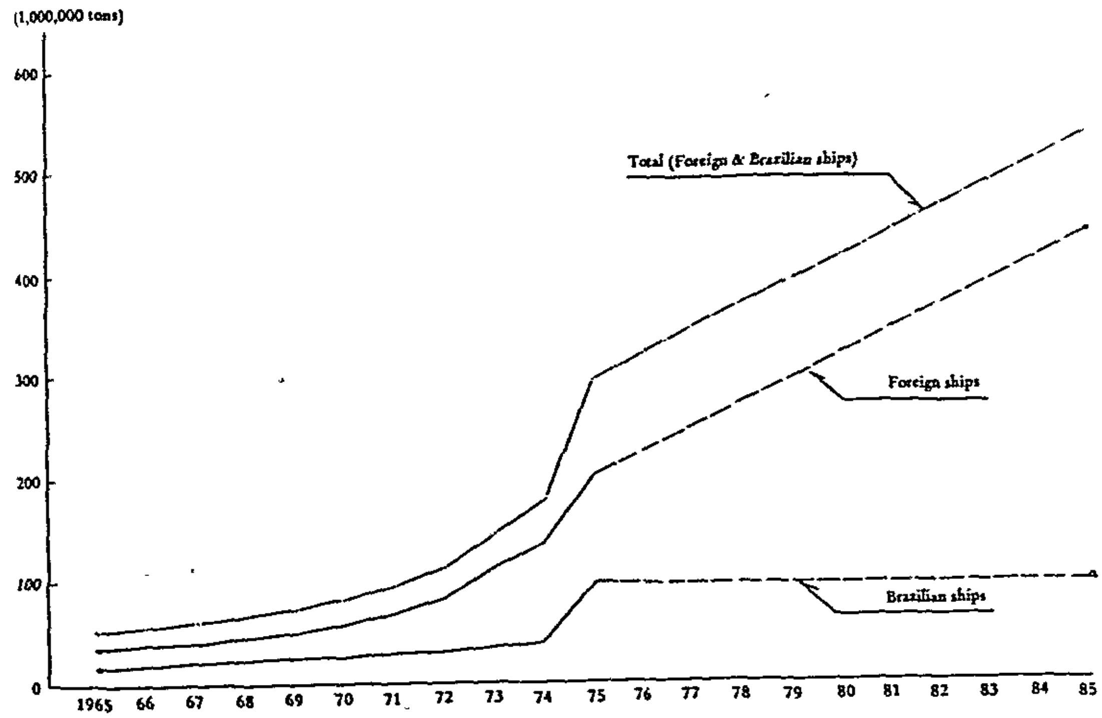
	Foreign ships			Brazilian ships			Total
	Imports	Exports	Total	Imports	Exports	Total	
1965	18,039,804	17,567,989	35,607,793	10,760,855	5,428,370	16,189,225	51,797,018
1966	19,358,339	18,935,039	38,293,378	12,917,041	6,043,316	18,960,357	57,253,735
1967	18,844,947	20,322,866	39,167,813	14,690,399	6,648,035	21,338,434	60,506,247
1968	22,728,984	22,436,023	45,165,007	16,223,658	7,394,122	23,617,780	68,782,787
1969	19,375,954	28,972,401	48,348,355	15,499,793	8,792,651	24,292,444	72,640,799
1970	20,865,618	37,507,929	58,373,547	14,458,098	9,046,480	23,504,578	81,878,125
1971	24,495,065	44,142,899	68,637,964	16,804,308	9,963,876	26,768,184	95,406,148
1972	35,593,018	47,357,831	82,950,849	17,275,100	10,121,755	27,396,855	110,347,704
1973	48,301,242	65,117,958	113,419,200	19,593,084	12,878,217	32,471,301	145,890,501
1974	54,989,834	79,672,727	136,662,561	21,109,892	18,667,154	39,777,046	176,439,607
1975			199,239,792			96,299,213	295,539,005
1976			223,201,352			96,299,221	319,500,573
1977			247,162,912			96,299,230	343,462,142
1978			271,124,472			96,299,239	367,423,711
1979			295,086,032			96,299,247	391,385,279
1980			319,047,591			96,299,257	415,346,848
1981			343,009,151			96,299,266	439,308,417
1982			366,970,711			96,299,275	463,269,986
1983			390,932,271			96,299,283	487,231,554
1984			414,893,831			96,299,292	511,193,123
1985			438,885,391			96,299,301	535,154,692

Table 3-25 Volume of cargo handled at Japanese ports

Million Ton		1965	1968	1970	1972	1973
Total		808.2	1,360.2	1,852.5	2,224.5	2,630.6
	(1)	320.2	540.7	672.4	729.0	1,004.8
	(2)	488.0	819.5	1,180.1	1,495.5	1,625.8
Export		29.9	43.6	59.9	74.7	78.9
	(1)	22.4	32.0	41.9	47.7	47.2
	(2)	7.5	11.6	18.0	27.0	31.7
Import		211.8	353.4	493.0	548.0	647.7
	(1)	54.1	86.5	98.4	95.5	116.3
	(2)	157.7	266.9	294.6	452.5	531.4
Cabotage (except ferry)		515.7	723.0	883.4	992.2	1,153.3
	(1)	220.7	302.3	318.2	332.1	381.3
	(2)	295.0	420.7	565.2	660.1	772.0
Ferry		50.8	240.2	416.2	609.6	750.7
	(1)	23.0	119.9	213.9	253.7	460.0
	(2)	27.8	120.3	202.3	335.9	290.7

(1) Public berth (2) Private terminal

Fig. 3-11 Past record and projections of cargo volume handled at port (Brazil)



Although there are probably statistical problems because of different ranges and bases of classification, 73% of the cargo handled in Japan is handled by domestic shipping while only 22.5%, the reciprocal of the Japanese percentage, is in Brazil. In the future it is predicted in the above data of PORTOBRAS that Brazilian domestic shipping will remain at the same level with an expansion rate of zero. However, after the oil crisis, it is said that the stress will gradually shift from trucks which are convenient but have a high fuel consumption to large scale transport by railway and ships.

If there is an occasion for changing the basic concepts behind economic planning in Brazil, shifts to marine transport and an increase in goods transported by cabotage might occur and such changes would naturally have some effect on the Suape port development plan.

3. Plans for Infrastructure Other Than the Port and Harbor

(1) Scope of Review of TRANSCON Report

The preliminary survey on the Suape Project was commissioned by DIPER to TRANSCON, which submitted an interim report in 1975. The company, at the same time, undertook the detailed design of a portion of the highway system and water supply system, and is reported to have completed same as of January, 1976.

Review of the proposed project was made on the basis of the TRANSCON report as well as data obtained through on-the-spot surveys and hearings in Brazil.

Items reviewed in respect to infrastructure other than port and harbor are as follows:

Highway System
Railway System
Water Supply System
Flood Control System
Power Supply System and Telecommunication System

The sewerage system was reviewed to the extent of the contents of the Resume.

(2) Outline of the Highway System

(A) Outline of the plan

The highway system in the proposed site for the Suape Coastal Industrial Estate includes provision of roads within the residential and industrial districts covered by the project, provision of a road network to connect both districts, and access roads to connect these roads to the regional arterial highway of the area. Highway construction work will be done in stages, but the TRANSCON report limits itself to the first stage program only as outlined below:

Road length:

Designation	Length
Main Access	1.60 km
Main Distribution Trunk	5.60
Port Road 1	5.30
Port Road 3	2.57
Port Road 4 (Part)	4.07
Port Road 5 (Part)	2.60
Townsite Access 1	3.75
Townsite Circuit	3.70
Secondary Access to the Refinery	1.78
N.S. of O. Access (ZR1)	1.15
Access to the Cement Plant	1.20
Road 1 (ZR2)	2.40
Road 2 (ZR2)	1.50
Road 3 (ZR2)	2.20
Road 4 (ZR2)	0.70
Road 5 (ZR2)	2.00
Total	42.12 km

(B) Approaches for planning

Estimation of traffic volume: Estimate of generated traffic is roughly broken down into two categories: the commuters' traffic between the residential and industrial districts and freight traffic from and to the industrial district. The estimated traffic volume is arrived at by adding intra-district traffic to these two major traffic flows. The TRANSCON report, however, does not clearly specify the method of estimation.

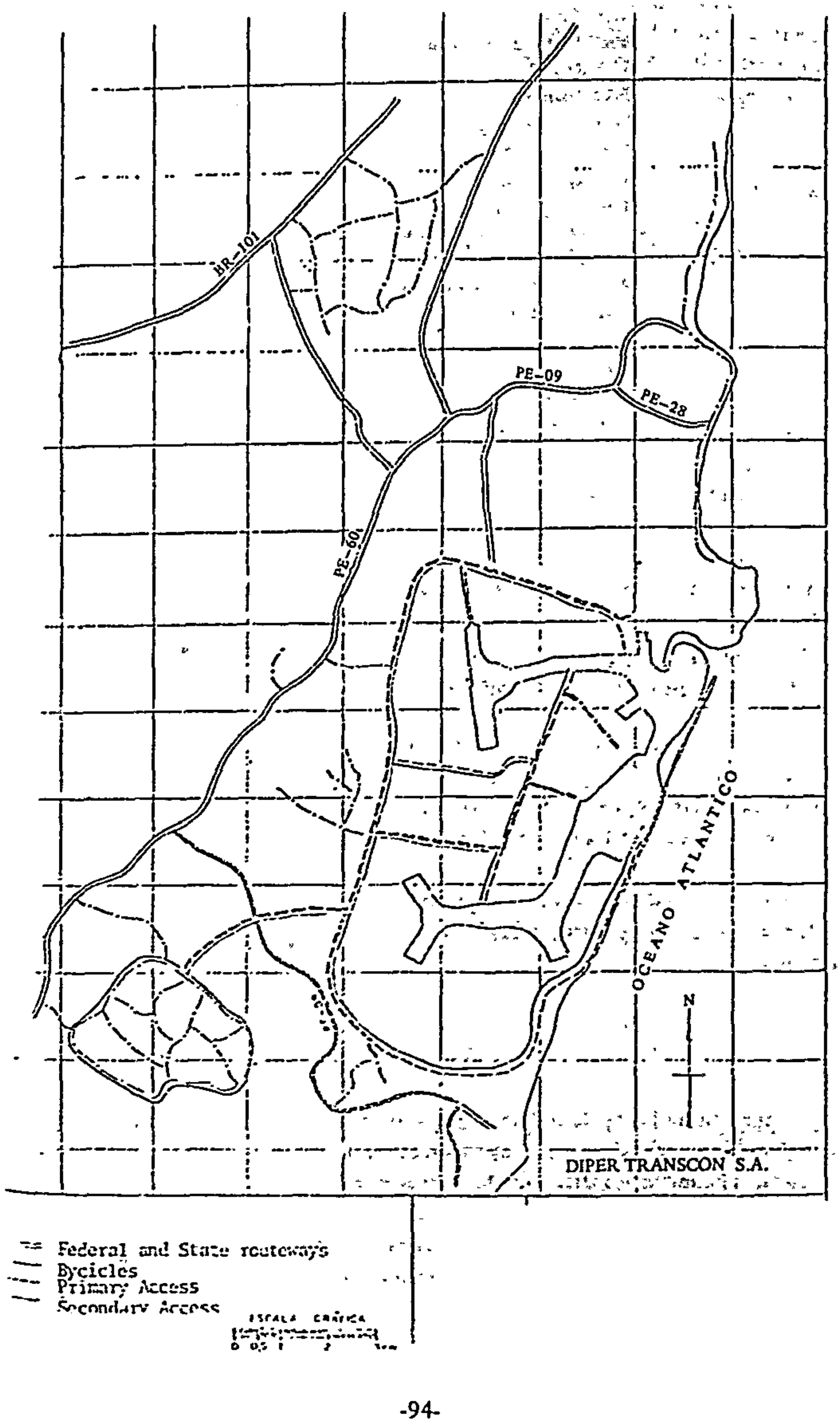
The commuting traffic between the residential and industrial districts has peak hours twice daily, in the morning and evening. Since freight vehicles in these hours are not many, the number of traffic lanes is primarily determined on the basis of commutation traffic volume with some provision made for freight vehicles.

The estimated lane capacity is based on the method indicated in the Highway Capacity Manual. In assessing traffic volume, all vehicles are converted into passenger cars at the following ratios:

1 bus	=	3 cars
1 truck	=	5 cars

Generation of bicycle traffic is also anticipated within the residential district and between the residential and industrial districts. For this reason, provision of a bicycle lane is planned for all related roads. The bicycle traffic volume, however, has not yet been estimated.

It is anticipated that 90% of commuters from the residential districts will utilize buses when Stage I program is completed, and installation of bus stops is planned along all related roads.


BR-101
PE-09
PE-28
PE-60
OCEANO ATLANTICO
N
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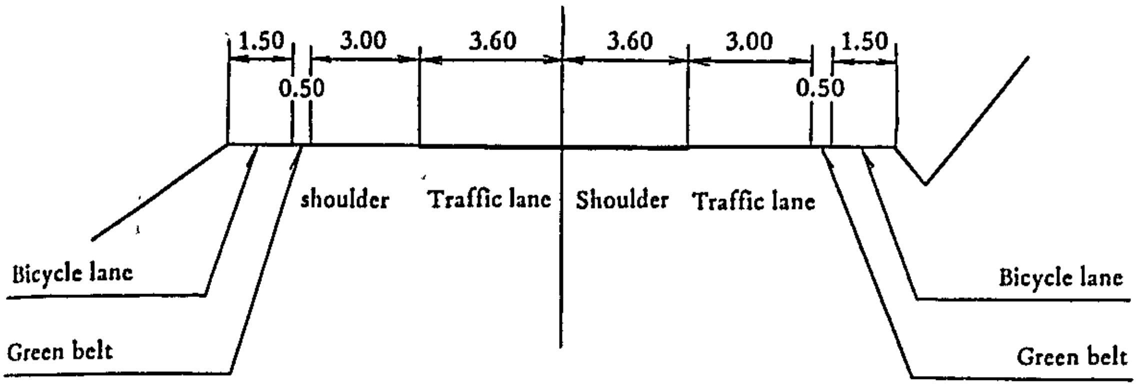
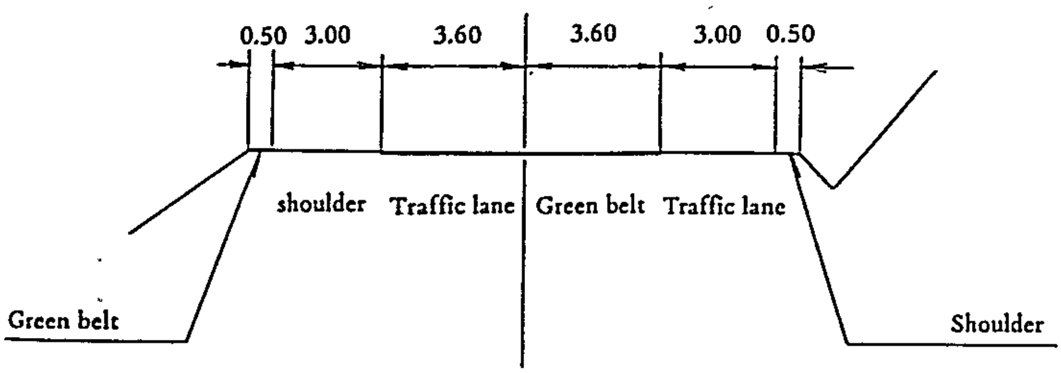
Federal and State routeways
Bycicles
Primary Access
Secondary Access

Typical cross section of roads

Port route & subsidiary distribution road



Primary access road



Federative government geometrical design standard for highways

Applicable to improvements

	Terrain	Class			
		0	I	II	III
1. Design speed (km/h)	Flat	100	100	80	60
	Rolling	80	80	60	40
	Mountainous	60	60	40	30
2. Minimum turning radius of curve (m)	Flat	430	340	200	110
	Rolling	230	280	110	50
	Mountainous	160	220	50	30
3. Maximum longitudinal gradient (%)	Flat	3	3	3	4
	Rolling	4	4.5	5	6
	Mountainous	5	6	7	8
4. Stopping sight distance (m)	Flat	150	150	100	75
	Rolling	100	100	75	50
	Mountainous	75	75	50	–
5. Passing sight distance (m)	Flat	650	650	500	350
	Rolling	500	500	350	175
	Mountainous	350	350	175	–
6. Traffic lane width (m)	Flat	7.50	7.00	7.00	7.00
	Rolling	7.50	7.00		
	Mountainous	7.50	7.00	6.00	6.00
7. Shoulder width	Flat	3.00	2.50	2.00	1.50
	Rolling	2.50	2.00	2.00	1.20
	Mountainous	2.00	1.50	1.20	1.00
		1.50	1.00	1.00	0.80
8. Right-of-way width (m)	Flat	–	50	30	30
	Rolling	–	70	40	30
	Mountainous	–	80	50	50

Federative government geometrical design standard for highways

New construction

	Terrain	Class 0	Class I	Class II	Class III
1. Design speed (km)	Flat	120	100	80	60
	Rolling	100	80	60	40
	Mountainous	80	60	40	30
2. Minimum turning radius of curve (m)	Flat	570	380	230	130
	Rolling	380	230	130	50
	Mountainous	230	130	50	30
3. Maximum longitudinal gradient (%)	Flat	3	3	3	4
	Rolling	4	4.5	5	6
	Mountainous	5	6	7	8
4. Stopping sight distance (m)	Flat	210	150	110	75
	Rolling	150	110	75	50
	Mountainous	110	75	50	–
5. Passing sight distance (m)	Flat	730	650	500	350
	Rolling	650	500	350	175
	Mountainous	500	350	150	–
6. Traffic lane width (m)	Flat	7.50	7.20	7.00	7.00
	Rolling	7.50	7.20		
	Mountainous	7.50	7.20	6.50	6.00
7. Shoulder width (m)	Flat	3.50 3.00	3.00	2.50	2.00
	Rolling	2.50	2.50	2.00	1.20
	Mountainous	1.00	1.00	1.00	0.80
8. Right-of-way width (m)	Falt	–	60	30	30
	Rolling	–	70	40	40
	Mountainous	–	80	50	50

Basic design:

Route selection was made on the basis of a 1:10,000 map enlarged from a 1:30,000 aerial photographs.

DNER'S Regulation No. 3602 was used for geometrical design standard. According to this standard, the minimum curve radius is 380 m, and the maximum longitudinal gradient is 2%. (Class "0")

For Port Access Roads, Class "1" standard was used. The minimum curve radius is 245 m, and the maximum longitudinal gradient is 3%.

The Mission is informed that there is a separate volume containing the plan and profile for each road, but since it is not on hand, the survey team was unable to review same.

Regarding earthwork, the slope is 1:1 for cutting and 3 (Horizontal):2 (Vertical) for filling, with the exceptions, however, for special places.

A typical cross section is shown for the proposed earthwork transversing the mangrove area near the seashore.

The pavement design is based on the traffic projected for 20 years. Although the design is based on the C.B.R. value, no specific design method is indicated. It is likely, however, that the AASHO design method was used. For surface layers, the idea seems to be that of applying two layers of asphalt emulsion at the outset and changing to bituminous concrete as the traffic volume increases.

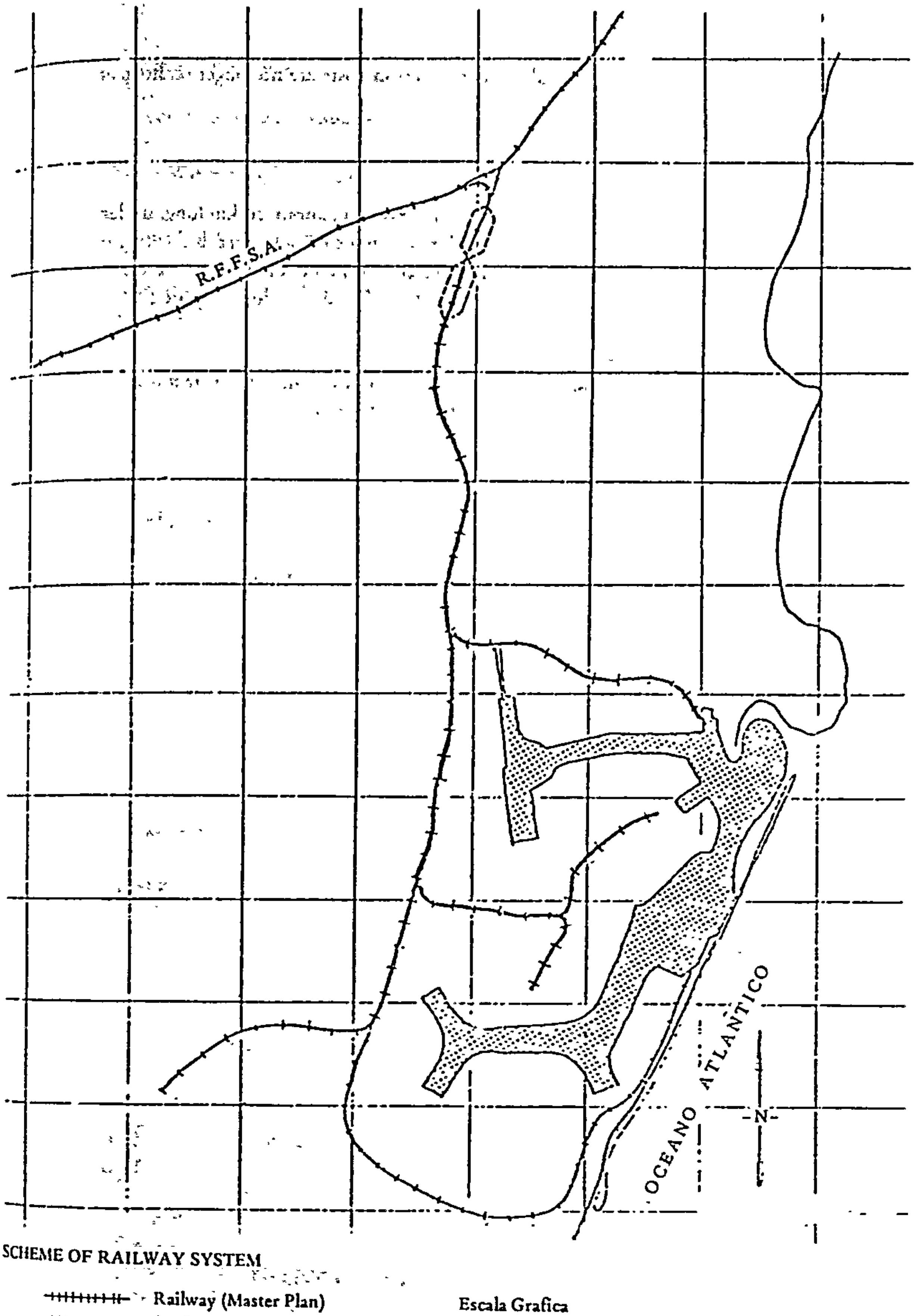
Six bridges are to be built, and while their span and length are shown, neither location maps nor information as to type of bridges are available.

The following drainage facilities are planned:

Caves and Grade Culverts	Benches
Deep Drains	Protection Ditches
Gutters	Plant Coverings

Cost of highway construction:

Givil work	Cr $ 21,329
Drainage Facilities	6,395
Pavement	35,623
Bridges	4,799
Total	Cr $ 68,146 (US$ 1 = Cr $ 8)



SCHEME OF RAILWAY SYSTEM

Railway (Master Plan)
1st Stage

Escala Grafica
0 0.5 1 2 3km

DIPER
TRANSCON S. A.

As of the present time, the above construction costs are no longer realistic and need to be modified.

(3) Railway System

There is a plan to build a new, single track railway, about 26 km long, under the Suape Project. This railway is planned as a feeder line leading to Suape Port, branching off at nearby Cabo located west of Recife, of the Federative Government Railway (R.F.F.S.A.) which connects the northern and southern coasts of Brazil. The plan also includes about 14 km total track length in the marshalling yard.

The following shows major design conditions and volume of construction work. (Reference may be made to the plan, "Scheme of Railway System.")

(A) Design conditions

	(Maximum gradient)	(Minimum horizontal curve radius)
Main track	5%	350 m
Port sidings	5%	245 m

(B) Volume of work

Clearing area

Earthwork

(filling)	(cutting)	(borrowing)
1,289,000 m^3	465,000 m^3	850,000 m^3

Tracks

main and branch: about 26 km
marshalling yard: about 14 km

Bridges (width 5.10 m)

Span	10 m	18 m	21 m	40 m
Number	One	One	One	Two

Estimated total construction cost

Main and branch lines Cr $ 29,000,000

Marshalling yard Cr $ 30,000,000

(Note): Since above estimate is as of October 1974, substantial revisions will have to be made.

(4) Outline of Water Supply/Flood Control and Harbor Purification Water

(A) Hydrological summary

Source of water: Sources of water for this project are the Gurjan River, Pirapama River, Massangana River, Ipojuca River and underground water, as follows:

1) Gurjan River

A tributary of the Pirapama River and downstream of Cabo, the Gurjan River is one of the water supply sources for the city of Recife. The catchment area at the location of the dam from which water is supplied to Recife City is about 114 km^2 and her regulated discharge is estimated to be about 115,000 m^3/day. Of this total, about 65,000 m^3/day is supplied to Recife City, and the balance of 55,000 m^3/day or so will be available for use at the Suape Coastal Industrial Estate.

2) Pirapama River

One of the major sources of water in this region, the Pirapama River is anticipated to have a minimum regulated discharge of about 340,000 m^3/day. Six months of consecutive observation performed in 1974 recorded the minimum discharge of 2.8 m^3/sec which occurred in February and a flood discharge of 66,080 m^3/sec which occurred in July.

3) Massangana River

Upstream of this river are the Tabatinga and Gangri Rivers. Base discharge of 0.3 m^3/sec is reported at the proposed dam site of this river.

4) Ipojuca River

One of the largest rivers in the State of Pernambuco, the Ipojuca has a catchment area of 3,539 km^2. Originating 800 m above sea level on the borders of the Serra das Porteiras and Serra das Guaibas, this river has a channel 245 km long and its coefficient for the shape of catchment area is 0.05. This river flows through the proposed site for the Suape Coastal Industrial Estate into the proposed location of the harbor and will become an important source of industrial water when dammed about 20 km upstream of the project site. The Suape and Merepe swamps have been performing the role of a natural reservoir, protecting against floods of rivers. Therefore, solution of the flood problem is a prerequisite to construction of an industrial estate at this particular location. The change of river basin from the Ipojuca River to the adjacent Bita River not only serves to control floods but also increases water supply as a secondary effect.

5) Underground water

A preliminary survey of underground water was carried out in relation to the Suape Coastal Industrial Estate Project. Currently, one well exists north of the proposed industrial estate and is being utilized. In the south, two wells in the city of Nossa Senhora do O are already in use. One is 63 m deep (yield, 100 m^3/h) and the other is 80 m deep (140 m^3/h), and well water is priced at Cr $ 0.11 per cubic meter as of April 1974 according to the TRANSCON report. There are a few wells in the Jaboatão Industrial Estate along the Federative Highway BR-101 north of Suape. These wells, however, have depths ranging between 80 to 100 m and yield ranges between only 6 to 18 m^3/h. Not only are they far from the point of utilization compared to those in the city of Nossa Senhora do O but they also have low yields. In addition, one 150 m deep well was drilled at a ceramics plant near Cabo city, but its yield is not known.

6) Water quality

The quality of water from the above sources has been checked several times in the past. According to analyses made in 1967, 1968 and early 1974, the water quality of the Pirapama River and Ipojuca River is reported acceptable by international standards. Thus, there is no particular problem in treating these waters, including high iron content and salt in the Ipojuca River which can be successfully treated. Particularly the water from the north well is recognized as good for drinking (see the plan, "Scheme of water supplying system").

Water discharge:

1) Existing information

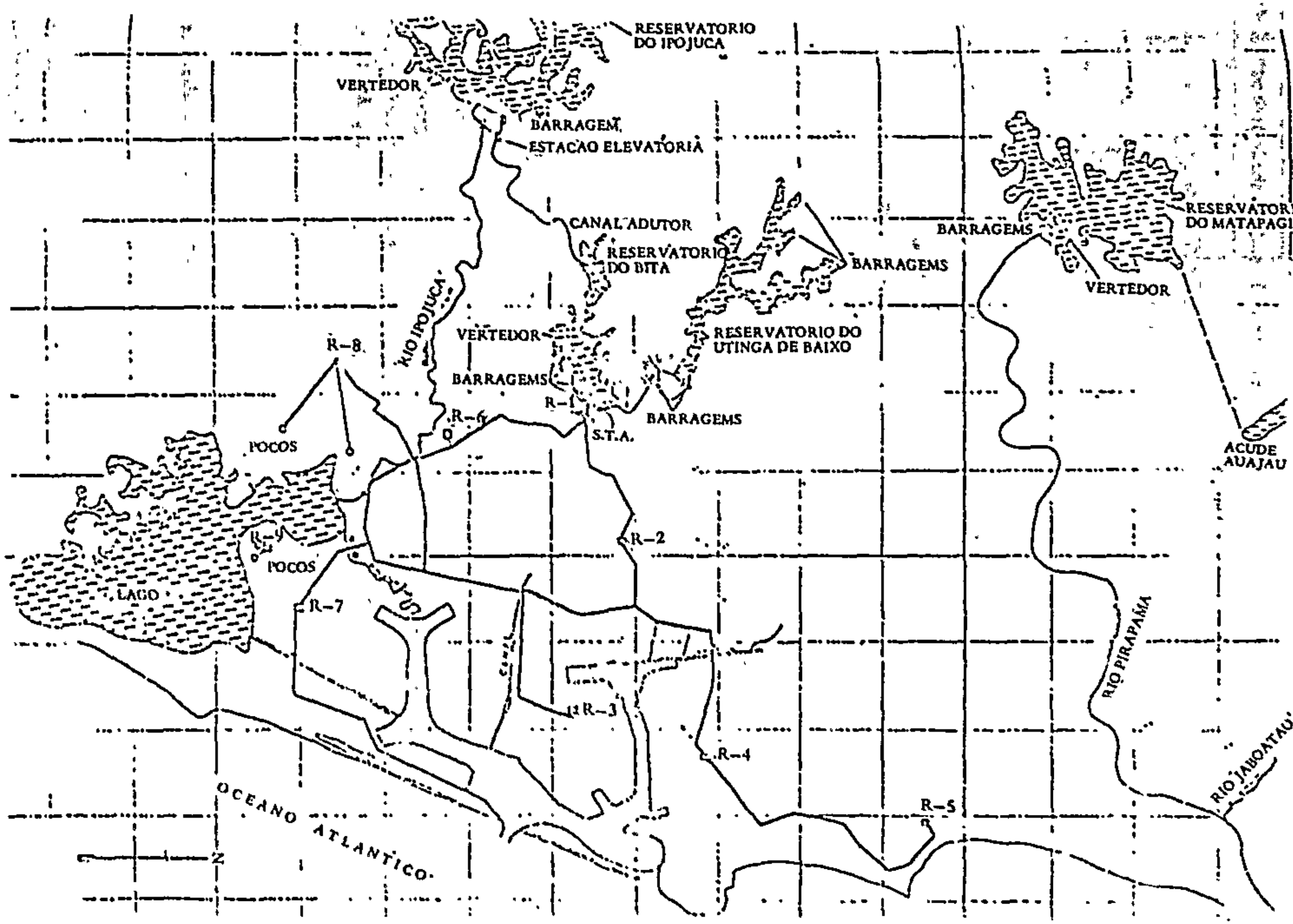
Existing information on river hydrology is limited. Although long-term observation data at limited locations are available, they are not satisfactory to determine monthly and yearly mean rainfall. As for data to obtain the correlation between rainfall and discharge, those recorded by the only observatory in Ipojuca are available.

2) Climate

The climate in the area downstream of the Ipojuca River is warm and humid, with an annual mean temperature of 23°C and annual mean relative humidity of 83%. In the Zona do Agreste, upstream on the Ipojuca, belongs to the semi-arid zone and the annual mean temperature is 27°C and the annual average relative humidity is 75%. The annual mean rainfall is 1,469 mm in the Pirapama catchment basin, and 882 mm in the Ipojuca catchment basin.

Forecast daily rainfall was studied by various statistical approaches on the basis of data over the past 53 years or so provided by the Escada Observatory.

SCHEME OF WATER SUPPLYING SYSTEM DIPER TRANSCON S.A.



Forecast Amount of Maximum Daily Rainfall (Unit: mm)

(Recurrent interval in years)	(Baisen Method)	(Pearson Method III)	(Gumbell Method)	(Cho Method)
5	106	102	107	106
20	145	149	153	145
100	180	202	204	183
1,000	241	274	277	235
1,000	297	344	349	285

In the TRANSCON report, estimates based on Gumbell's method are employed because of their consistency with the actual observations.

3) Discharge

Base discharge

The arid season in this area is January through February. According to the TRANSCON's preliminary survey, the base bed flows are as follows:

Ipojuca	(Enganho Tabocas)	1.5 m^3/sec
Ipojuca	(Enganho Maranhao)	3.0 m^3/sec
Pirapama	(Enganho Matapagipe)	2.0 m^3/sec
Massangana	(Enganho Tabatinga)	0.3 m^3/sec

The above figures had to be accepted only because there is no other reliable data although the Survey Team feels somewhat uneasy since these figures are relatively large compared to those for Japan. Further investigation and thorough study will be in order since the base flow is an important factor to form a basis for the water supplying scheme to the industrial estate and others.

Flood

Flood was calculated by the unit hydrograph method for a probability of occurring once every 100 years as follows:

Ipojuca River	(Enganho Tabocas)	800 m^3/sec
Ipojuca River	(Enganho Maranhao)	1,100 m^3/sec
Bita River	(Dam site)	240 m^3/sec
Utinga de Baixo River	(Dam site)	86 m^3/sec
Algodoais River	(Site of Proposed Railroad)	100 m^3/sec
Jamsim River	(Site of Proposed Railroad)	40 m^3/sec
Prego River	(Site of Proposed Railroad)	85 m^3/sec
Massangana River	(Including the Utinga Dam and proposed railroad)	150 m^3/sec

(B) Water supply facilities

1) Estimate of water supply requirement

According to the TRANSCON report, the required water supply is estimated by area, and water consumption for each area is calculated on the basis of the scale of industry by type, standards, population and other factors for port and harbor, subsidiary facilities and residential districts.

Cabo District

The district covered includes the northern part of the green district between the port and harbor and Cabo city but excludes the seashore. The requirements of the Cabo district is about 70,000 m^3/day.

	Area (ha)	Unit water supply (m^3/day/capita)	Amount of water supply (m^3/day)
Industrial districts			
ZI-3	633.00	30	18,990
ZI-E	176.67	30	5,300
Residential districts			
ZRE-Cabo	274.00	20	5,480
ZRE-Ponte de Carvalhos	168.38	20	3,370
ZRE-Novas area oeste Cabo	341.67	20	6,830
ZR3-Navas areas Gurjan	211.67	20	4,230
ZR3-Navas areas Gurjan BR-101	661.00	20	13,220
ZR3-Navas areas Gurjan Boa Vista	567.00	20	11,340
Total			68,760

Nossa Senhora do O District

The estimate covers a population of 16,661 and an area of 135 ha including the residential district of the city, and the estimated amount of water is 2,500 m^3/day on the basis of 150 liters/day/capita unit consumption.

Refinery District

The estimate is 43,200 m^3/day for the planned production.

Industrial District

The estimate is 240,000 m^3/day for the industrial district, excluding the oil refinery district.

District	Population	Area (ha)	Unit water supply (m^3/d/c)	Amt. of water supply (m^3/d)
Industrial districts				
ZI-1 Industry related to port	–	2,045.00	50	102,250
ZI-2 Industry not related to port	–	1,905.00	50	95,250
ZI-3 Independent industry	–	1,425.00	30	42,750
ZI-4 Service/support industry	–	385.00	30	11,550
Port and harbor districts				
ZP-1 Cargo port	–	703.33	10	7,033
ZP-2 Fishing port	–	86.67	50	4,333
Administrative districts				
ZCA-1	–	73.33	10	733
ZCA-2	–	33.67	10	337
ZCA-3	–	45.00	10	450
Residential districts				
ZR-2 Boasica	81,400	626.67	170	13,840
ZR-4 Pontal do Cupe	4,500		150	675
Praia de Gaibu	3,400		200	680
Praia de Pedras				
Petras	3,300		150	495
Praia de Itaprama	2,200		150	330
Praia de Daiva	2,800		150	420
ZRE-Ipojuca	8,400		150	1,260
ZRE-Camp	7,500		100	750
Total				283,136
	(Refinery district)			-43,200
Grand total				239,936

2) Basic concept for the water supply system

The water supply system must be reviewed in consideration of various factors such as available water sources, discharge, location, the convenience of users, topography and transportation. Facilities matching the target year requirements of a project must be reviewed on the basis of a planning perspective for a distant future.

In this project, interrelations with the Recife District is important and an overall plan integrating the interests of both should be mapped out. In other words, water supply to Recife City cannot be disregarded, while the effects on Cabo City, Ipojuca City, Nossa Senhora do O City and the Ponte dos Carvalhos District must also be considered. In the master plan of this project, the water supply system was reviewed for each of the three districts.

The first is the district adjacent to Cabo City along highways BR-101 and PE-60, where some plants have already either selected their sites or are under construction. Water supply facilities have also been installed, and any future planning must considered in relation with water supply to Cabo City.

The second is the district covering Suape industrial district and the green area between the Suape industrial port and Cabo City. This district is demarcated by the Atlantic Ocean to the east, Highway PE-60 to the west and a parallel line passing through Cupe Point to the south.

The third is the residential district at Nossa Senhora do O district.

The water source to the first Cabo district is the catchment basin of the Pirapama River. Compesa has concluded a contract to prepare the master plan for water supply to Cabo City.

The second district is the main object of the Suape Project intended for industrial development (industrial district and its sub-areas). Since existing data for this district are few, TRANSCON has begun collecting data at eight observatories since February 1974. Also, TRANSCON has prepared a 1/10,000, 5 m contour map since the one available in 1/25,000 was not satisfactory for detailed review. Water can be supplied to this district from the Pirapama and Manoel Gonçalves Rivers or from the Matapagipe Reservoir. This method, however, involves not only a longer distance but also a higher cost compared to water supplied from either the Ipojuca or Massangana Rivers.

There are three topographically suitable locations for water supply reservoirs near the proposed industrial estate. In addition to water supply, these reservoirs can play an important role in controlling floods.

Bita and Utinga de Baixo reservoirs are the closest to the industrial estate, and can be fully utilized as its water supply sources. The Ipojuca Reservoir is primarily planned as a flood control reservoir but it can also serve to make up for the shortfalls in the former two reservoirs.

The Bita Reservoir is formulated by earth dams at four locations and stores water from tributaries of the Cangari and Massangana Rivers, with its surplus water flowing downstream into the Ipojuca basin. Water level of the reservoir is H.W.L. 45 m and L.W.L. 40 m, and the regulated water intake is calculated to be 420 liters/sec. (36,300 m^3/day).

The Utinga de Baixo Reservoir is formulated by earth dams at five locations and accumulates water from the Massangana River tributary, the Utinga de Baixo River and the Boa Esperança River. Water levels of the reservoir are H.W.L. 65 m and L.W.L. 59.5 m, and regulated water intake is calculated to be 400 liters/sec. (34,600 m^3/day). Surplus water, according to the plan, will be permitted to flow downstream into the Piraja basin to help supply the Bita Reservoir.

The Ipojuca Reservoir, as stated earlier, is primarily planned for flood control purpose, but if water between E.L. 24.7 m and E.L. 27 m are assumed to be usable, an intake of about 500,000 m^3/day will be possible. Because of its low water level, however, it will be necessary to pump up water more expensive than water from Bita and Utinga de Baixo.

Raw water will be treated by a modular system, and assuming a capacity of 75,000 m^3/day for each module, four modules in all are planned. Each module will be equipped with chemical plant, rapid coagulant, flocculator, decanter and half-filter; the rate of filtration is planned to be 300 m^3/m^2/day.

The third district, though small in area, is important from the point of view of water supply because it will provide housing for the first people coming in to develop the industrial estate. The projected population is 7,136 in FY 1980, 11,290 in FY 1985, 12,785 in FY 1990 and 14,861 in FY 1995. The district is considered physically incapable of accommodating more than 17,000 people.

Water to this district will be supplied from two wells with a combined capacity of 4,500 m^3/day which should be ample to meet the estimated requirement of 2,500 m^3/day for the projected population. Underground water will be treated by providing chlorinators at pumping stations.

3) Water supply system in Stage I

The required water supply in Stage I is estimated to be 80,000 m^3/day as shown below:

Industrial District

Refinery	43,200 m^3/day
Aluminum Plant	1,200
Fertilizer Plant	24,000
Cement Plant	3,850
Tire Plant	

Administrative District	1,520

Residential District

ZR-1 N.S. do O	2,230 m^3/day
ZR-2 Boasica	2,765
ZR-4 Praia de Gaibu	680
Total	79,445 m^3/day

Of this 80,000 m^3/day, 2,230 m^3/day to N.S. do O will be supplied from wells in this district, while the balance of 77,770 m^3/day is planned to be supplied from the Massangana-Ipojuca system. Accordingly, the amount of water intake from the Ipojuca Reservoir will be as follows:

$$77{,}770 - (36{,}300 + 34{,}600) = 6{,}870 \text{ m}^3/\text{day}$$

Notes: 36,300 m^3/day: intake from the Bita Reservoir
34,600 m^3/day: intake from the Utinga de Baixo Reservoir

Meanwhile, 2,765 m^3/day to the residential district at Boasica is currently under study, the underground water could be utilized.

4) Volume of work and estimated construction cost for Stage I program

To show the approximate scale of work under Stage I program of the TRANSCON report, volume of work and estimated construction costs are summarized below:

(1) Bita Reservoir

Work	Earth volume (m^3)	Volume of rock (m^3)	Construction cost (Cr $)
No. I dam	72,315	3,360	520,858.00
No. II dam	84,087	3,360	595,845.00
No. III dam	7,440	480	55,994.00
No. IV dam	9,915	450	71,760.00
Spillway	20,250	47,250	464,530.00
Site	172 ha		250,000.00
Total			1,966,987.00

(2) Utinga de Baixo Reservoir

Work	Earth volume (m^3)	Volume of rock (m^3)	Construction cost (Cr $)
No. 1-A dam	128,573	2,987	872,537.00
No. 2-A dam	35,325	1,995	260,770.00
No. 2 dam	11,188	252	75,783.00
No. C-1A waterway	23,125		72,844.00
No. C-2A waterway	4,910		15,467.00
No. 3 auxiliary dam	1,144		7,287.00
No. 4 auxiliary dam	1,160		7,390.00
No. 5 auxiliary dam	1,467		9,345.00
Site		232 ha	348,000.00
Total			1,669,423.00

(3) Utinga de Baixo - Bita waterway

Work	Earth volume (m^3)	Volume of rock (m^3)	Construction cost (Cr $)
Waterway	38,351	525	225,805,000.00

(4) Ipojuca Pumping Station

Work	Quantity	Unit cost (Cr $)	Amount (Cr $)
Pump, motor (auxiliary)			80,000
Pipeline	600 m	400	240,000
Civil work	80 m	2,000	160,000
Total			480,000

(5) Ipojuca-Bita waterway

Work	Quantity	Unit cost (Cr $)	Amount (Cr $)
Waterway	6,000 m	150	900,000

(6) Water storage tank, pumping station, banking and Boasica service reservoir

Work	Quantity	Amount (Cr $)
Well (80 m)	2	637,064
Pumping station	2 x 50 HP	611,400
Pipeline	2 x 300 m - ϕ200 mm	1,381,764
Service reservoir (R - 7)	2 x 500 m^3	474,600
Total		3,104,828

(7) Sub-total of water storage items	Cr $ 1,966,987
Bita Reservoir	1,669,423
Utinga de Baixo Reservoir	225,805
Utinga de Baixo-Bita Waterway	480,000
Ipojuca Pumping Station	900,000
Storage Well	3,104,828
Subtotal	Cr $ 8,347,043

(8) Purification plant (Eta), including Bita-Eta waterway

Work	Volume	Amount (Cr $)
Purification Plant	Capacity 75,000 m^3/day	6,125,811

(9) Distribution main, Eta-Refinery

Work	Quantity	Amount (Cr $)
Distribution main	4,500 m ϕ600 mm	4,489,205

(10) Distribution main, Eta-No. 2 Service Reservoir (R-2)

Work	Quantity	Amount (Cr $)
Distribution main	4,500 m ϕ500 mm	3,961,890

(11) No. 2 Service Reservoir (R-2)

Work	Volume	Amount (Cr $)
Service Reservoir	Capacity 2 x 5,000 m^3	4,647,404

(12) Peak Load Service Reservoir (R-3, R-4)

Work	Volume	Amount (Cr $)
Service Reservoir	Capacity 5,000 m^3 (each)	4,647,404

(13) Subtotal of service reservoirs and distributing main (recapitulation)

Distribution main, Eta-Refinery	Cr $ 4,489,205
Distribution main, Eta-No. 2 Service Reservoir	3,961,890
No. 2 Service Reservoir (R-2)	4,647,404
Peak Load Service Reservoirs (R-3 and R-4)	4,647,404
Subtotal	Cr $ 17,745,903

(14) Distribution Main

Work	Quantity	Amount (Cr $)
Distribution pipeline	11,600 φ450 mm	7,611,572
Distribution pipeline	800 m φ600 mm	798,000
Total		8,409,572

(15) Service pipe network (Residential and Administrative Districts)

Work	Quantity	Unit Cost (Cr $)	Amount (Cr $)
Service pipe network	7,500	162,000	1,215,000

(16) Service pipe network, Nossa Senhora do O

Work	Quantity	Unit Cost (Cr $)	Amount (Cr $)
Service pipe network	12,000	162,000	1,944,000

(17) Service pipe network, Boasica

Work	Quantity	Unit Cost (Cr $)	Amount (Cr $)
Service pipe network	2,000 x 17	130	4,420,000

(18) Service pipe network, off-site

Work	Quantity	Unit Cost (Cr $)	Amount (Cr $)
Main	6,500 m	270	1,657,000
Branches	1,000 m	162	

(19) Subtotal of water distribution facilities

Distributing Main Pipeline	Cr $ 8,409,572
Service Pipe Network (Residential & Administrative Districts)	1,215,000
Nossa Senhora do O	1,944,000
Boasica	4,420,000
Off-Site	1,657,000
Sub-total	Cr $ 17,645,572

(20) Grand Total

Water Storage	Cr $ 8,347,043
Purification	6,125,811
Service Reservoir & Distributing Main	17,745,903
Service Pipe Network	17,645,572
Grand Total	49,864,329

(C) Flood Control Measures

1) Summary

River basins which require flood control measures in this project are the Ipojuca River, Merepe basin and a basin of the sub-system consisting of the Massangana, Jasmim, Algodais and Prego Rivers.

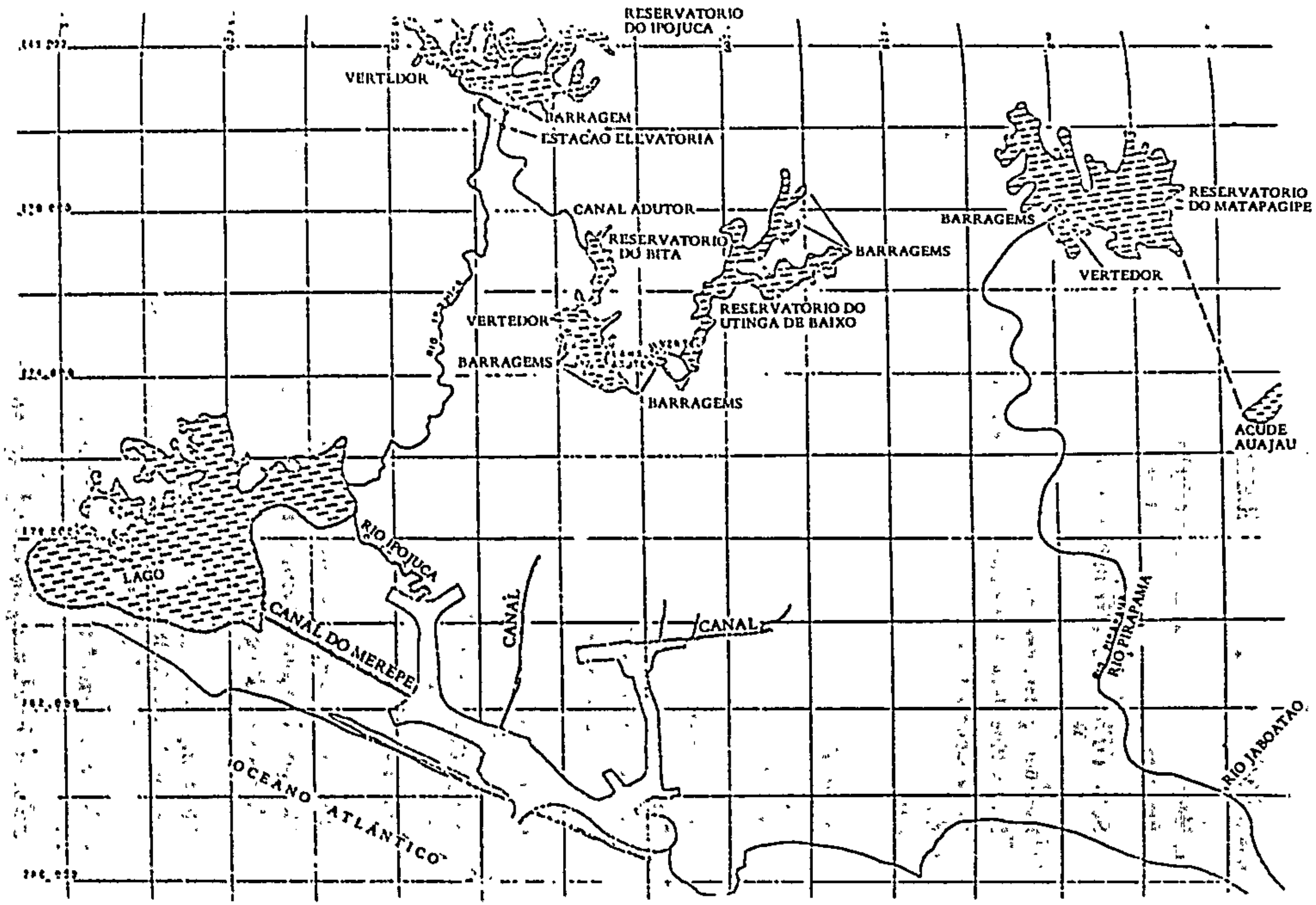
Most important of all is the Ipojuca River with a catchment basin of 3,500 km^2, of which one-fifth is a pluvious wooded region near the seashore.

The second largest is the Merepe basin with a catchment area of 900 km^2.

Most of the Massangana Basin is regulated by dams and the water stored is discharged to the Ipojuca Basin.

In the TRANSCON report, flood control measures are studied primarily for the Ipojuca River. Analysis of rainfall was made on the basis of the Gumbell's method and the probable amount of maximum rainfall per day was calculated as one in 100 years and once in 1,000 years, which resulted in 135 mm and 183 mm respectively.

OVERALL CONCEPTION FOR FLOOD CONTROL DIPER TRANSCON S.A.



The flood control measure for the Ipojuca catchment basin is to erect a flood control dam upstream to regulate flood run-off according to the plan prepared by TRANSCON.

TRANSCON ahs studied four alternative plans for this dam, but it is difficult to judge relative advantages because of lack of a detailed description of each alternative. The plan to be adopted, however, will likely have a decisive advantage over the others in regard to construction cost.

2) Estimated cost of construction related to flood control

Merepe water channel	Cr $ 2,400,000
Prego-Algodoais-Jasmim-Massangana water channel	2,400,000
Ipojuca channel	50,000
Cement channel	600,000
Bridges on the state road PE-9	3,750,000
Lake weirs and counter-weirs	2,000,000
Dike road (PE-9)	7,395,000
Acquisition of land in the lake area	630,000
Damming of the Ipojuca River	21,532,500
Total	Cr $ 40,757,500

Volume of work and construction cost for the Ipojuca Dam

Volume of work

Spillway	Excavation	Earth & sand	186,700 m^3
		Rock	46,600
Free descent	Excavation	Earth & sand	616,000
		Rock	204,000
Dam	Embankment	Earth & sand	1,317,034
		Rock	250,000

Construction cost

Excavation	Cr $ 7,368,300
Dam	9,236,500
Drain pipes	3,750,000
Land acquisition	1,177,500
Total	Cr $ 21,532,500

Scale of work for water channels, bridges and others

Water channel

Ipojuca River	Clearing	25,000 m²
Cemented water channel	Civil work	150,000 m³
Coastal dike	Mouth of the Merepe River	120,000 m³
Coastal dike	Massangana and other rivers	120,000 m³

Bridges

Ipojuca River	115 + 105	115 m
Merepe River		80 m
Dike road (PE-9) width: 7.20 m, unpaved		15 m

(D) Purifying water for the newly excavated port

In the TRANSCON report, countermeasures against pollution in the newly excavated port were not studied. This problem is now a major social issue in Japan.

Fortunately for the Suape project, the Ipojuca River flows into the proposed site for the excavated port in the south, while the Massangana River flows into the proposed site for the port in the north, so that by utilizing these rivers stagnant water in the excavated ports is made to flow into the ocean and purifies the port water in the process.

In the TRANSCON report, the base discharge of the Ipojuca River is estimated to be 3 m^3/sec at Engenho Maranhao and flood discharge with one chance in 100 years is estimated to be 1,100 m^3/sec.

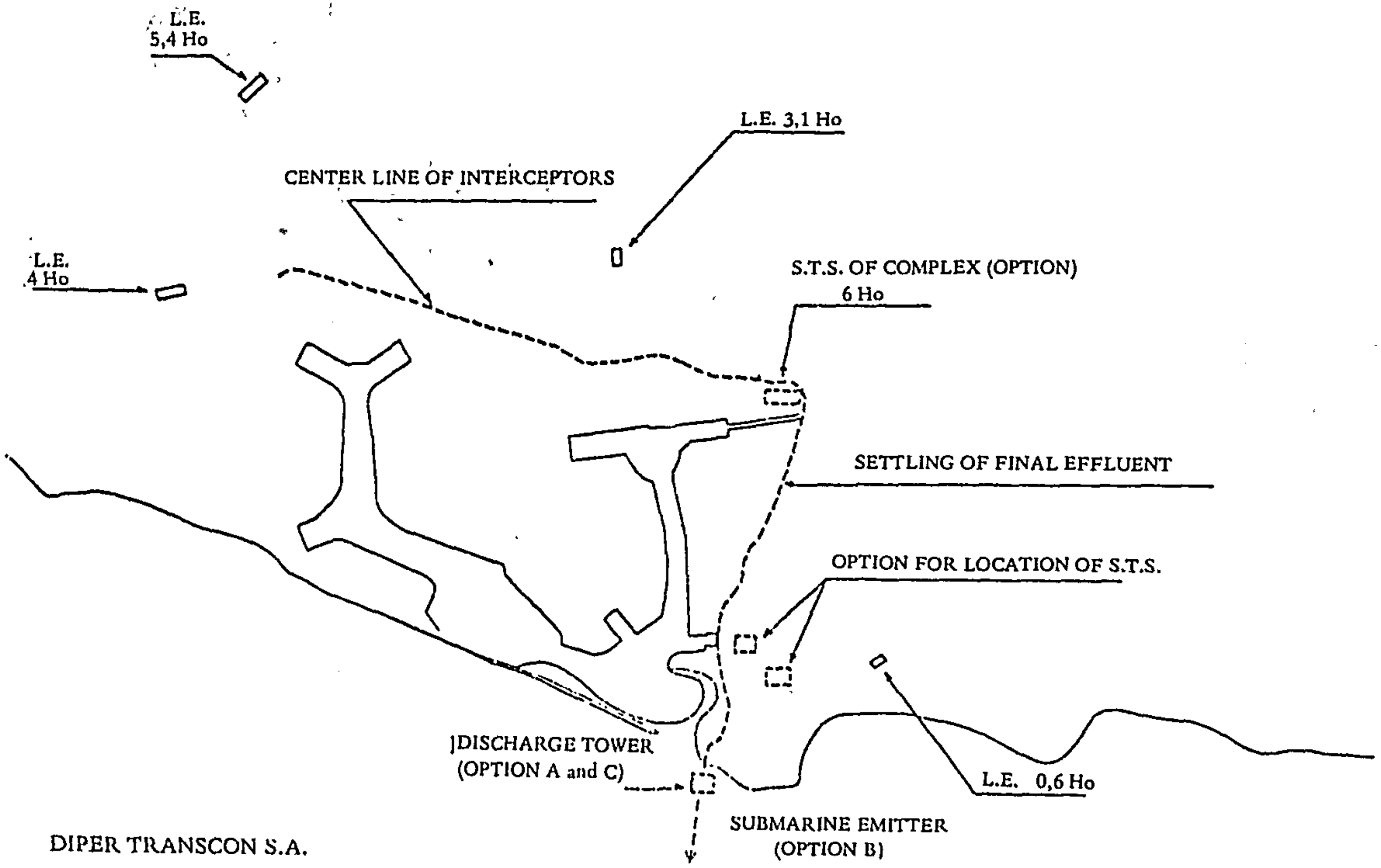
According to the above base flow, the portion of water supply required for Stage I (industrial complex) required from the Ipojuca River will merely be 6,870 m^3/day so that most of its discharge can be utilized for preventing port pollution.

No problem is foreseen in supplying water for preventing pollution in the excavated port in the south as far as Stage I is concerned. The location of inlets and method of flowing cleansing water into the excavated port, however, will require separate study.

For the northern excavated port, the plan calls for pouring in the water of the Massangana River. However, since the base flow of this river is only 0.3 m^3/sec at Engenho Maranhao, it is doubtful that it will have the capability of supplying cleansing water in normal times after supplying 88% of the water requirements to the industrial complex from Bita and Utinga de Baixo reservoirs on this river. Only in cases of sizable rainfall or flood can the water of this river flow into the port. Further detailed review of the subject will be necessary as lack of detailed data on river discharge precludes appropriate judgment on the matter. Depending on circumstances, there may be a need for digging a driving channel from the Ipojuca River to the Northern excavated port so that cleansing water may enter the harbor.

SEWAGE DISPOSAL SYSTEM

Stabilizing Lagoon



DIPER TRANSCON S.A.

From the viewpoint of preventing pollution, it is desirable that water of the Ipojuca River be made to enter the excavated port. However, this may involve the following problems. One of the problems is the large flood discharge of the Ipojuca River by which a large amount of water may stream past the front of the wharves, impeding port functions and depositing large amounts of sediment in the harbor which, in turn, may possibly result in filling in of navigating channels and anchorages. Another problem lies in the basic conception regarding cleansing water. As a rule, only the necessary volume of water should be made to flow into the excavated port as cleansing water, and any flood flow should be guided to some other location by an entirely separate channel. This basic conception is particularly important and requires thorough investigation and research. A similar study is necessary with respect to the relation between the Massangana River and the northern excavated port.

(5) Electric Power Supply and Communication Systems

(A) Electric power facilities

Generation, transmission and distribution

The large scale industrial estate at Suape will become a large consumer within the power supply grid of CHESF. The power supply plan to this industrial complex was decided on the basis of figures for the Aratu industrial complex, and its eventual power requirement is considered to be about the same as for Aratu.

Electric power to the southern Recife district is being supplied from CHESF's Pirapama substation of Cabo city, which has been responsible for the supply to the industrial complex developed in the Cabo district since 1961.

Transmission to the district is made by two systems, CHESF and CELPE. The 230 KV transmission by CHESF system is made through two circuits leading to the Pirapama substation, branching off from the main circuit between Angelim and Recife. While CHESF transmits 230 KV from the Recife II substation to Pirapama substation a few miles away, CELPE from there on distributes power in 69 KV and 13.8 KV. CELPE's 69 KV system which branches off at Pirapama is interconnected with the 69 KV lines transformed at Bongi and Mirueira.

It is the very short distance between the Recife II and Pirapama substations that makes stable transmission of 180 MW on 230 KV circuit possible, and it is therefore believed future increases in load at Suape can be adequately met. Furthermore, CELPE's 13.8 KV distribution system is capable of supplementing their 69/13.8 KV substations at Pirapama and Cabo.

The capacity of the 69/13.8 KV transformers in CELPE's distribution system in this district is, 10,000 KVA for Pirapama and 5,000 KVA for Cabo. By adding new transformers and making other changes, this capacity can be increased to 30,000 KVA at Pirapama and to 10,000 KVA at Cabo. These expansions are scheduled in the original plan.

Total generating capacity of CHESF system was 1,893,000 kW in 1974, and is expected to reach as much as 2,483,000 kW by 1977.

CHESF's 230 KV transmission system to the Recife district has been further strengthened by addition of the fourth circuit between Paulo Afonso and Angelim, and (three circuits) between Angelim and Recife, are now in operation.

From Angelim, two 230 KV circuits are connected to Campina Crande, where substations at Goianinha, Mirueira, Recife and Pirapama are mutually connected to form a ring. By this mutual connection, between Angelim and Recife, transmission capacity and reliability are remarkably improved.

The adjustment to the 230 KV transmission system connecting Goianinha, Mirueira, Recife and Pirapama will become possible starting 1975 with the operation of the new Recife II substation (500/230 KV).

However, the above generating capacity may be compelled to decrease in time of low water or flood in the backlands, high water at Paulo Afonso or for other reasons. At the time of minimum discharge, a 24% reduction in generation is shown, while at the time of flood, reduction in generation is contained within 5% owing to the proper steps taken by CHESF. In 1975, CHESF's supply capacity will become even larger when the Mocoto Reservoir is filled to capacity. For transmission to Recife, a 500 KV extra high voltage line will be adopted between Paulo Afonso and the new 500/230 KV substation at Recife stated previously.

In relation to the Suape project, CHESF is contemplating expansion of the 230 KV system and installation of a 230/69/13.8 KV substation at Suape. By 1985, capacity of the Suape substation is anticipated to be 850 MW and that of Pirapama, 300 MW. For transmission, three voltages, namely 230 KV, 69 KV and 13.8 KV will be used for complete separation of supply sources to different type of users.

Demand for electric power

Electric power consumers and their demand forecast shown in the TRANSCON report are as follows:

Electric Power Consumer	Annual Demand (MWH)	Maximum Demand (MW)	Annual Demand (MWH)	Maximum Demand (MW)
Oil refinery	160,000	36	250,000	60
Clinker mill	94,000	12	188,000	24
Fertilizer complex	13,400	2.5	28,000	5.4
Aluminum plant	3,600,000	514	5,600,000	800
Port facilities				
Collective port	900	0.4	1,600	0.7
Oil terminal	5,300	1.38	5,240	1.36
Urban area	3,600	0.8	7,200	1.5
Total	3,877,200		6,080,340	

Scale of the project

1) Suape substation

Approximate area required:	about 223 m x 125 m
Voltage:	230/69/13.8 KV
Frequency:	60 Hz
Transforming capacity:	230/69 KV 50 MVA 69/13.8 KV 5 MVA
230 KV transmission line:	5 circuits Recife II & Pirapama - Suape 4 circuits Aluminum plant - Suape 1 circuit Oil refinery - Suape 1 circuit Stand-by
69 KV transmission line:	1 circuit Clinker mill - Suape 1 circuit Fertilizer complex - Suape 1 circuit Stand-by
13.8 KV distribution line:	7 circuits are connected to a 13.8 KV bus, of which 2 circuits will be used for distribution in 1980.
Equipment:	Transformer, reactor, capacitor, circuit breaker, facilities for transmission and distribution, and others.

2) 230 KV transmission line

- About 50 km between sending end buses to the Recife II substation and Suape substation.
- Forecast maximum power: 540 MW in 1980, 850 in 1985
- Rating: 230 KV, 60 Hz, 0.85 power factor
- Cable: ACSR 636 MCM MIN (CHESF specification)
- Structure: Per CHESF specification, metal poles for 3-phase 2-circuit single core cables, and concrete poles for 3-phase single circuit multiple-core cables.

3) 69 KV transmission line

o Transmission from the Suape substation to each of the fertilizer complex and clinker mill.

o	Extension:	Fertilizer complex	4.5 km
		Clinker mill	4.0 km
o	Forecast maximum power:	Fertilizer complex	2.5 MW in 1980
			5.4 MW in 1985
		Clinker mill	12 MW in 1980
			24 MW in 1985
o	Rating:	1.0 power factor, 60 Hz	
o	Cable:	ACSR #4/0 AWG	

4) 13.8 KV distribution line

Two main lines will be installed using concrete poles per CELPE specification with 80 m maximum span, and CAA aluminum wire for cable.

(B) Communication

1) Telephone

Local calls within the district and long distance calls will be considered here, and a central exchange with 1,000 circuit (forecast) capacity will be installed. Telephones will be for private and public use, and a long distance service center will also be considered. PBX (private branch exchange) and PABX (private automatic branch exchange) will be provided in plants and office areas.

Telephone lines within city areas will be buried underground, with connection facilities at predetermined intervals.

2) Transmission and reception

Due to the necessity for radio communication on a UHF band, Recife, Cabo and other cities will be mutually connected and then linked to the telephone exchange on the side of Suape.

3) Radio

Radio broadcasting will be implemented for communication and liaison between cities as well as for the benefit of local residents.

4) Multiplex system

Expansion of the multiplex system up to 60 voice channels is contemplated. Telephone system, telex, telegraph and rental channels for customers and others are covered under this system.

5) Others

Other facilities such as HI-FI programs, data transmission, private lines (closed circuit TV, etc.), nautical and aeronautical controls, communication facilities for radio and TV are also contemplated.

(C) Estimated budget

1) Electric power supply

Substation	33,011,256
Transmission, 230 KV	46,580,991
Energy tie, 230 KV	7,500,000
Third feeder	18,500,000
69 KV transmission line (fertilizers & cement)	1,637,807
13.8 KV distribution	465,946
	Cr $ 107,696,000

2) Telecommunication

Telephone system	9,500,000
Transmission system	1,600,000
Telegraphic system	160,000
	Cr $ 11,260,000

(6) Review of Each System

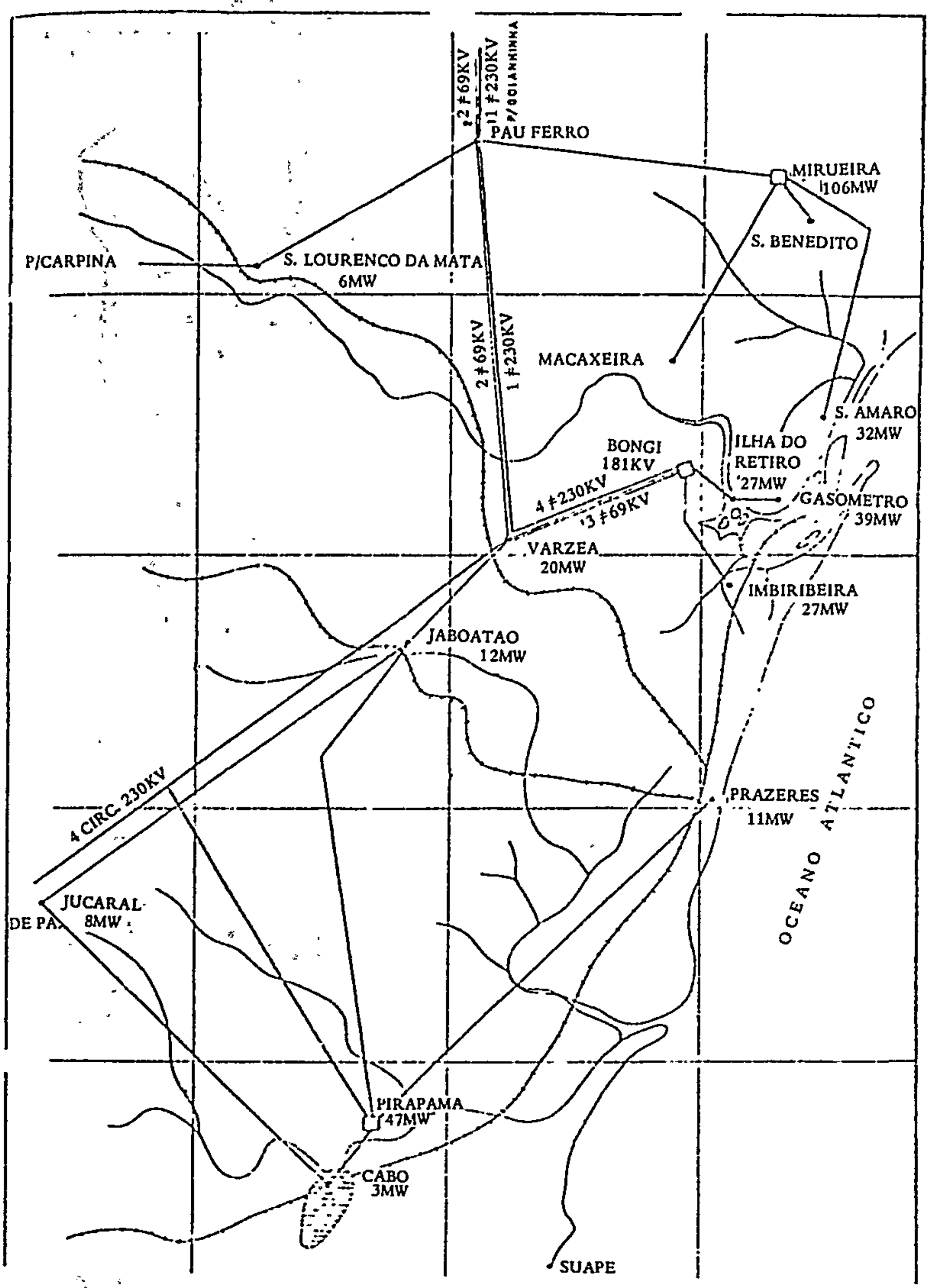
(A) Roads

Federative government standards on geometrical design for highways

The standards are similar to those for Japan, Europe and America, but a comments are given below:

1) Minimum radius of horizontal curve

In Japan, the minimum radius of horizontal curve for design speeds of 120, 100, 80,



PRESENT SITUATION OF THE ELECTRIC POWER SUPPLY

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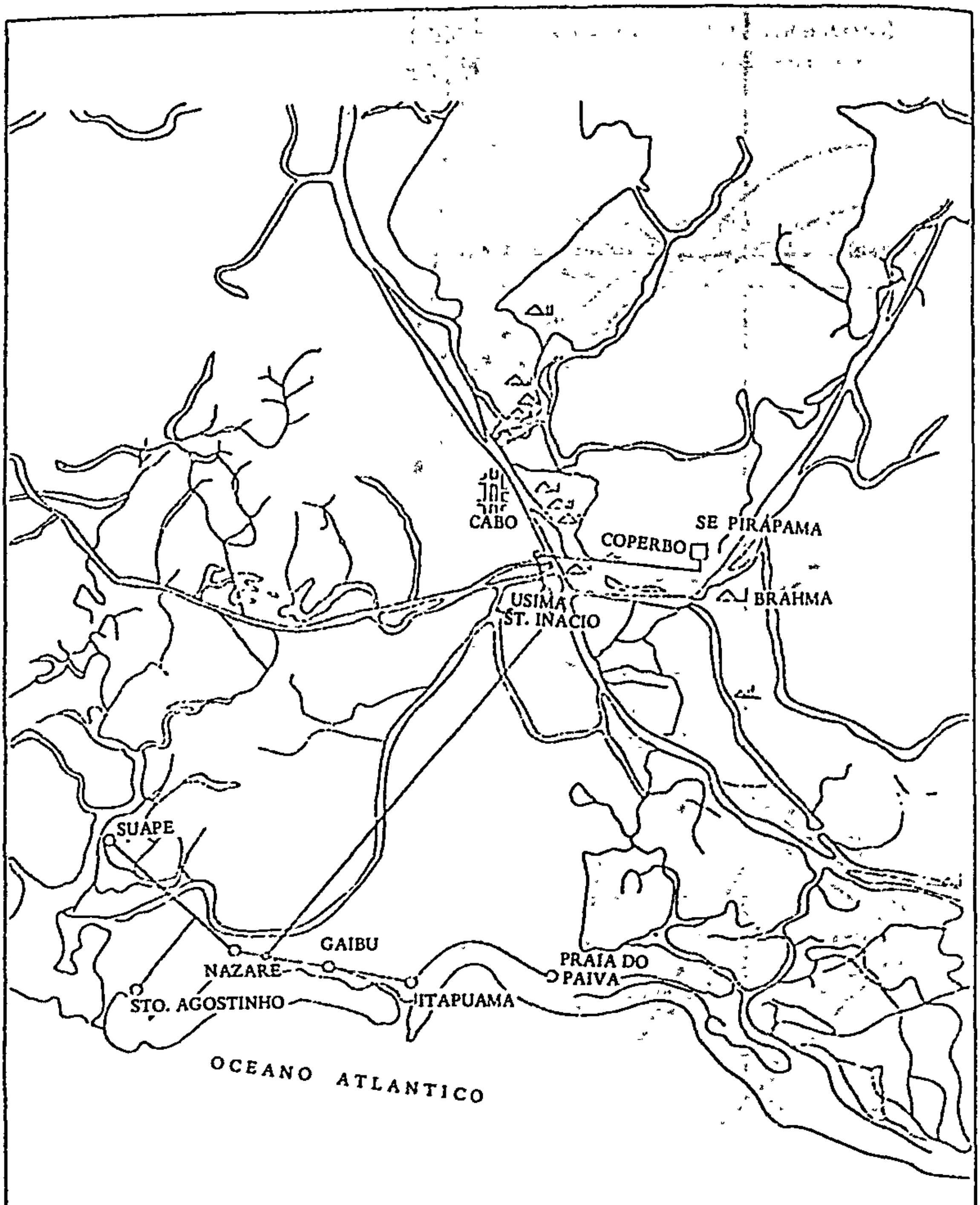

CELPE'S 13,8KV FEEDER AT SUAPE AREA

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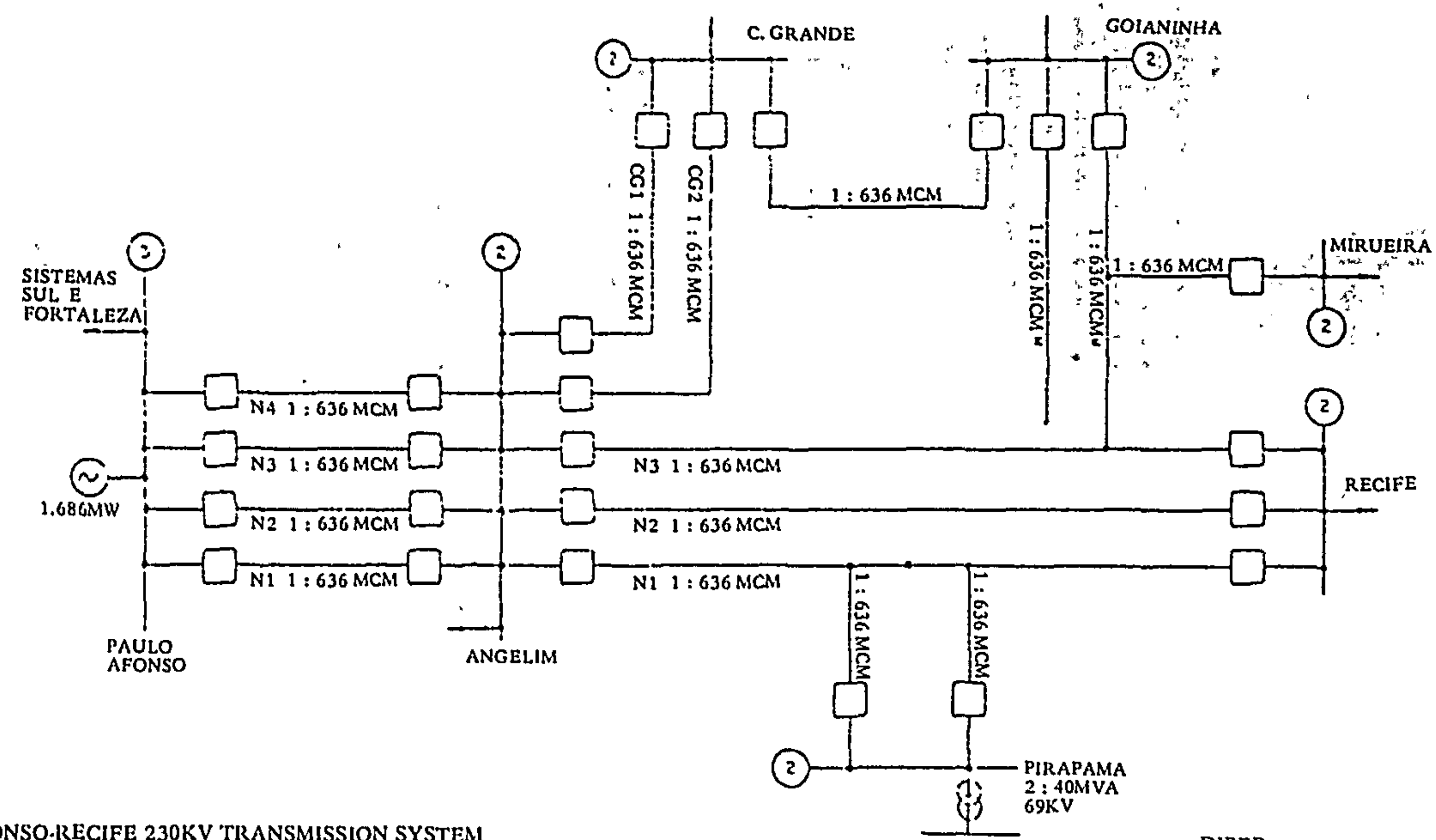


PAULO AFONSO-RECIFE 230KV TRANSMISSION SYSTEM
SIMPLIFIED SINGLE-WIRE DIAGRAM AT THE END OF 1974

DIPER
TRANSCON S. A.

60 and 40 km/h are, 710, 460, 280, 150 and 60 m respectively while in Brazil, they are as low as 570, 380, 230, 130 and 50 m respectively. Although those figures may be accepted for certain special reasons, they are, by Japanese standards in general far too small.

2) Maximum longitudinal gradient

There must be a certain correlation between the maximum longitudinal gradient and design speed. In the Japanese design standards, for instance, they are 2% for 120 km/h, 3% for 100 km/h, 4% for 80 km/h, 5% for 60 km/h and 7% for 40 km/h. In Brazil, however, there is total absence of any definite correlation between the two. Their gradient is 3% for 120 km/h and for 100 km/h, it varies according to the type of ferrain (3% for flat and 4% for rolling terrain). Likewise, for 80 km/h, it is 3% for flat, 4.5% for rolling, and 5% for mountainous terrain; for 60 km/h, it is 4% flat, 5% for rolling, and 6% for mountainous terrain.

With the above exceptions, the design standard generally seems satisfactory. In the future, however, it will be advisable to prepare design standards for such design details as transition curve, widening in curve, superelevation, vertical curve, compensated grade, climbing lane and others.

Earthwork

The slope of 3:2 stipulated for filling seems too steep. In actual earthwork, decision should be made in consideration of the height of filling, engineering characteristics of materials used, and other factors.

Bridges

While the number of bridges and their span and width are shown, neither information as to type of bridge nor location are clearly specified. A survey to determine types and locations will be required. The content of the highway plan covers Stage I only and does not refer to subsequent stages and eventual targets. Detailed review is not possible due to lack of description on all design processes and reference data and materials used.

It should also be necessary that the Federative Highway BR-101 between Cabo and Recife should be improved and made a 4-line highway with dividing strip.

(B) Railways

While any review of comment on the railway system for the Suape project should be reserved until such time as a modified plan reflecting the final conclusions of studies by TRANSCON and APL becomes available, it can be said at this early stage that a railway line between Cabo and the Suape port is absolutely necessary for the following reasons:

1. A bulk transportation system of goods and materials is a must in consideration of

the scale of development planned at Suape.

2. In Brazil, the railway has been assigned increased importance as a means of long distance, bulk transportation of goods and materials, and investments for improvement of existing lines as well as construction of new lines are already under way.

This new railway plan will have to be judged from the viewpoint of future regional plans and industrial siting. The marshalling yard planned at the Cabo junction with the LTS line, in particular, will have to be checked for its consistency with other plans of the Railway Bureau which include a plan for a cargo (container) terminal near BR-232, 15 km west of Recife as well as construction of a new line between the Terminal and Cabo as its Phase I program.

Construction methods to cross swamp area and drainage in the marshalling yard deserve detailed study in determining the detailed plans.

(C) Water supply and flood control

Planning approaches employed

TRANSCON's planning approaches appear to be generally reasonable from a hydrological viewpoint when judging the data obtained to date. Due to limited reference materials, short observation periods and infrequency of observed data, it is inevitable that their planning figures should not be too reliable. To supplement this deficiency and to avoid gross errors, it will be necessary to make comparative studies of existing material and data for localities and catchment areas similar to Suape, making such comparisons as flood discharge and base discharge per unit area of catchment area.

Probability calculations of rainfall are made by various statistical approaches, however, despite its vital importance, the TRANSCON report does not clarify the coefficient of run-off after subtracting evaporation, transpiration, infiltration and the like from rainfall. This matter remains to be thoroughly reviewed by collecting survey data not only for this region but extensively throughout Brazil.

Flood discharge of each river is figured on the basis of study by the unit hydrograph method. However, as the figures do not relate to past records, it will be necessary to make a study of past records by making reconnaissance trips to the actual sites and obtaining information from neighboring inhabitants.

Regarding the water supply system, evaluation is difficult since the report describes conclusions alone. Strategically, however, the TRANSCON proposal seems reasonable in terms of topographical conditions and in its relations with the industrial estate development.

One comment is, that geological features of subsurface strata and engineering properties of bedrock must be investigated as a next step since they are quite important in constructing a dam.

Also, the unit construction cost shown in the TRANSCON report seems too low for estimating the cost of various structures. Cost of the dam in particular will be several times more than the amount given.

Comment on the water supply and flood control measures

It is impossible to render one's judgement as to the soundness of this plan because of insufficient basic data for computation and a question of reliability.

The contents of the TRANSCON study however appear to be appropriate so far as the basic thinking is concerned, and it is believed the quantitative figures which now pose some questions can eventually be resolved by modifications after thorough surveys.

If the conclusions of the TRANSCON report are accepted, 300,000 m^3/day water supply will be made possible at a very low construction cost of Cr.$ 46,500,000. Should the water supply condition be really as favorable as the report says, then the Suape Coastal Industrial Estate project is endowed with a superior locational advantage in water supply.

Regarding the cleansing water for the excavated port, no particular problem is foreseen for the southern port. For the northern port, however, a detailed study is necessary. Flood-ways for the Ipojuca and Massangana rivers also need further review.

(D) Sewage and waste water disposal plans

Details of this plan remain unknown, although the basic thinking to described in the resume of the TRANSCON report, according to which, industrial effluent will be discharged into the sea after primary and secondary treatment.

Disposal of industrial effluent is a vital issues in Japan, and much efforts at technical development are now in progress. The Suape also faces this important problem especially as tourism development is planned nearby the proposed point of discharge, so that a study of the methods and facilities for treating industrial waste water must be made.

With respect to discharge diffusion, simulated model experiements and other studies will be necessary in order to establish a clear-cut countermeasure.

(E) Electric power supply and communication systems

The electric power supply and communication systems for the Suape project planned by TRANSCON seems reasonable; however, following factors on electric power supply system must be reexamined in the next step of study.

1) Consumption by users (by month, by year)

2) Electric power required during construction

3) Fluctuation of demand

4) Power factor of load

5) Type and location of users

6) Time to start operation

7) Construction plans for the whole district

8) Future increase in production and power demand forecast by each types of user

9) Current status and future plans for CHESF and CELPE

10) Special conditions imposed by each user

In the communication system, due consideration must be paid to such properties as construction cost, safety, reliability, flexibility, simplicity and others. Although construction cost is an important factor in proceeding with plans, lower cost will not necessarily be the predominant factor in comparing and deciding on various alternatives.

Although it is difficult to clearly evaluate qualities of safety, reliability and simplicity, efforts in making proper and imparitial judgement is hoped for in deciding their values.

For system reliability in particular, efforts should be made to always secure stable supply by considering to shorten the duration of service interruption due to accidents and maintenance works. As for electricity for instance, one of the methods will be to have multiple supply sources.

The system also needs to be highly flexible allowing for ready changes and expansions as required to cope with future increases in demand.

(7) Review of construction cost

The estimated construction costs shown in the TRANSCON report are as of October 1974, and should be modified to reflect subsequent price increases.

A comparison of the exchange rates for October 1974 and January 1976 is as follows:

October 1974	1 U.S.$ = 7.3 CR$
January 1976	1 U.S.$ = 9.42 CR$

While the rate of inflation during the above period was about 10% for Japan and the United States, it was about 40% in Brazil.

Price comparisons were made on construction materials, fuels, labor and construction equipment for Rio de Janeiro and Japan as of January 1976 (see tables following Section (9) below). It is obvious that prices are higher in Brazil except for those of gravel, sand, dynamite and some equipment, while labor cost is lower than in Japan by about 60%.

For large scale construction such as the Suape project, labor cost is considered to account for about 20% of the total, with most of the construction cost being spent on materials and equipment. On this basis, overall cost will likely be equal or more than that for Japan; thus the estimates in the TRANSCON report should be reappraised.

For instance, for the embankment work in dam construction, TRANSCON's estimate when converted into Japanese yen is ¥ 300/m^3 while in Japan, it will cost ¥ 3,000/m^3. According to this cost difference it seems that TRANSCON only estimated the cost of piling earth into the shape of a bank only.

In case of a dam, however, it is necessary to build a levee body of ample strength, durability and with water tightness, for which materials with the proper density, composition and water content must be selected. This will entail costs beyond those of moving earth.

In any event, the construction cost estimates given in the TRANSCON report would have to be increased by a factor of a few times.

(8) Review of the construction schedule

Improvement of infrastructure must be planned to conform with the basic ocnstruction schedule for plants and ports.

For effective use of capital, on the other hand, it is desirable that construction be completed in as short a period as possible to enable early operation of plants so that investment can be recovered quickly.

Particularly when prices are rapidly increasing as witnessed recently, the rate of recovery on investment deteriorates as the construction period is prolonged, thus lowering the economic efficiency.

According to the TRANSCON report, the total cost of construction is estimated at CR$ 2,030 million (about 65 billion yen), and the construction period is about 10 years for major works such as highway, railway and port, etc. and about 20 years for completing drainage and other appurtenant works.

From a macroscopic viewpoint of the overall project, it is to be desired that given a cost of this scale, Stage I should normally be completed within an eight-year construction period, by 1983.

TRANSCON seems to have allocated work evenly over the years; however, work should be executed when and where as deemed necessary.

(9) Comment on the TRANSCON report with respect to the infrastructure

TRANSCON's master plan for infrastructure other than port and harbor does not present any technical problems in implementation. An in-depth study of the following technical points is recommended in the next step.

Comparison of construction material cost (Jan., 1976)

Materials	Specs	Unit	Rio de Janeiro market Cr $	Rio de Janeiro market Yen	Japan(Tokyo) Yen	Notes(Difference compared to Japan)
Cement		t	540.00	17,220.00	9,700.00	+ 78%
Straight asphalt	85/100	t	1,050.00	33,600.00	23,600.00	+ 47%
Cutback asphalt	CM-30	t	1,190.00	38,080.00	31,000.00	+ 23%
Gravel	Crushed	m^3	90.00	2,880.00	3,000.00	- 4%
Sand		m^3	70.00	2,240.00	3,000.00	- 25%
Lumber (pine)		m^3	2,000.00	64,000.00	62,000.00	+ 3%
Boards	½ inch	m^2	40.00	1,280.00	648.00	+ 98%
Reinforcing Steel		t	3,900.00	124,800.00	70,000.00	+ 78%
Dynamite	60%	kg	15.50	496.00	620.00	- 20%
Percussion caps		pcs	7.50	240.00	29.00	+ 728%
Ready mixed asphalt		m^3	3,930,00	125,760.00	-	-
Ready mixed concrete	TC=225kg/km^2	m^3	3,351.00	107,232.00	-	-

Comparison of fuel cost (as of Jan., 1976)

Fuel	Specs	Unit	Rio de Janeiro market Cr $	Rio de Janeiro market Yen	Japan(Tokyo) Yen	Notes
Gasoline		ℓ	3.20	102.40	102.00	+ 1%
Diesel oil		ℓ	1.37	43.84	53.00	- 17%
Grease		kg	19.20	614.4	249.00	+ 147%
Engine oil		ℓ	16.70	534.4	228.00	+ 134%
Power cost		kW	0.78	24.96	15.00	+ 66%
Water cost		m^3	2.40	76.8	60.00	+ 28%

Comparison of construction equipment costs (Jan. 1976)

Equipment	Specs	Rio de Janeiro Life in years	Rio de Janeiro Basic cost (1,000 Yen Cr$ 1,000)	Japan (Tokyo) Life in years	Japan (Tokyo) Basic cost (1,000 yen)	Notes
Dump truck	8t diesel		7,680 240	4	3,630	+ 112%
Off-highway dump truck			28,352 886			
Bulldozer	CAT D8H		51,200 1,600	5	33,000	+ 55%
Shovel	CAT 941		15,712 491			

Equipment	Specs	Rio de Janeiro Life in years	Rio de Janeiro Basic cost (1,000 Yen Cr$ 1,000)	Japan(Tokyo) Life in years	Japan(Tokyo) Basic cost (1,000 yen)	Notes
Shovel	CAT 955		19,584 612	5	8,360	- 134%
Clamshell	FIAT 990		26,880 840			
Shovel loader	CAT 977		29,120 910	6	14,000	+ 108%
Plate grader	CAT 120		13,472 421	6	8,630	+ 56%
Sheep foot roller	12t 165 ps		15,552 486	7	(5,130)	+ 203%
Tandem roller	10t		6,560 205	7	8,070	- 19%
Tire roller	142 ps		10,208 319	7	5,710	+ 79%
Batcher plant	60 m^3/h		25,600 800	7	50,600	- 49%
Asphalt plant	40 m^3/h		19,200 600	6	104,000	- 82%
Motor scraper	15 m^3 CAT 621		51,584 1,612	7	54,800	- 6%

Comparison of labor costs (8-hour day, as of Jan., 1976; per day)

Job title	Rio de Janeiro market			Japan (Tokyo)		Notes(Difference compared to Japan
	Cr $/hr. Labor cost	Cr'$ Hours	Cr $	Yen	Yen	
Foreman	200x1.89*=37.80	8	302.40	9,676.80	8,160	+ 19%
Skilled laborer	5.7x1.89=10.77	8	86.16	2,757.12	6,500	- 58%
General	2.86x1.89=5.41	8	43.28	1,384.96	3,810	- 64%
Earth worker	4.0x1.89=7.56	8	60.48	1,935.36	5,600	- 65%
Machine operator	6.2x1.89=11.72	8	93.76	3,000.32	6,800	- 56%
Truck operator	5.6x1.89=10.58	8	24.54	2,708.48	6,500	- 58%

Notes:
1. Asterisk (*) for the value of 1.89 as the local hourly wage includes allowance for vacation, union dues and 13 months pay.
2. Costs are as of January, 1976.
3. The conversion rate in January, 1976 was US$ 1 = Cr$ 9.42.

(A) Treatment of weak ground

Since the district will be developed by reclaiming a mangrove lagoon, there will be a complex soil condition wherein a mixture of clay with organic content and earth is used for filling. Hence, it will be necessary to select an optimum method for weak ground treatment (including experiments) for the foundation work of heavy and or vibrating structures, and for construction of highways and railways.

(B) Stable power supply

According to CHESF, it is said that in terms of capacity, there will be no problem in power supply to this district even in the future. But, since there is some doubt as to stable power supply, study of a joint captive power generating plant is recommended.

(C) Anti-pollution measures

Pollution caused by industrial activities and the functioning of urban communities must be prevented by all means. Particularly the treatment of industrial effluent and industrial wastes, and city sewage as well as the method of discharge and diffusion of treated water should be studies in detail including simulated model experiments.

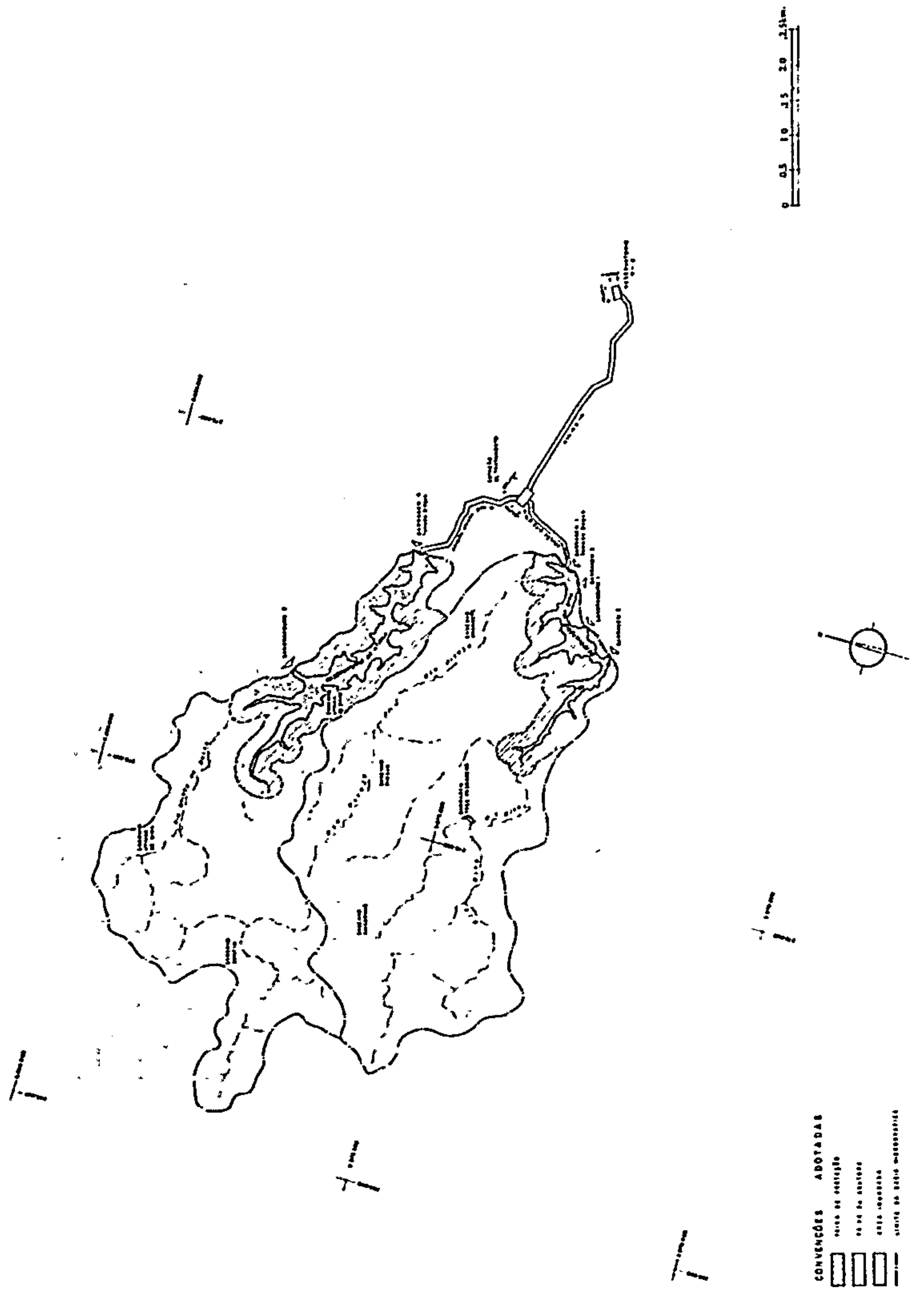
(D) Flood control and drainage plans

Since the data related to rivers in this region are scant and fluctuation in annual rainfall are also noted, sufficient margin for changes should be allowed in the drainage plan for the newly reclaimed land. Regarding flood control for all rivers, special review with emphasis on safety factors and safety measures are also required.

In addition to the above, due consideration should be paid to the following points for the plan as a whole:

1) The plans for each infrastructure must be closely coordinated. At the same time, it is necessary to establish an appropriate time schedule for the planned infrastructure improvements.

2) Improvements of infrastructure are indispensable in proceeding with the Suape project. Accordingly, construction of the minimum infrastructure requirements such as waterworks, sewerage, highway, power supply and the like must be started at an early time.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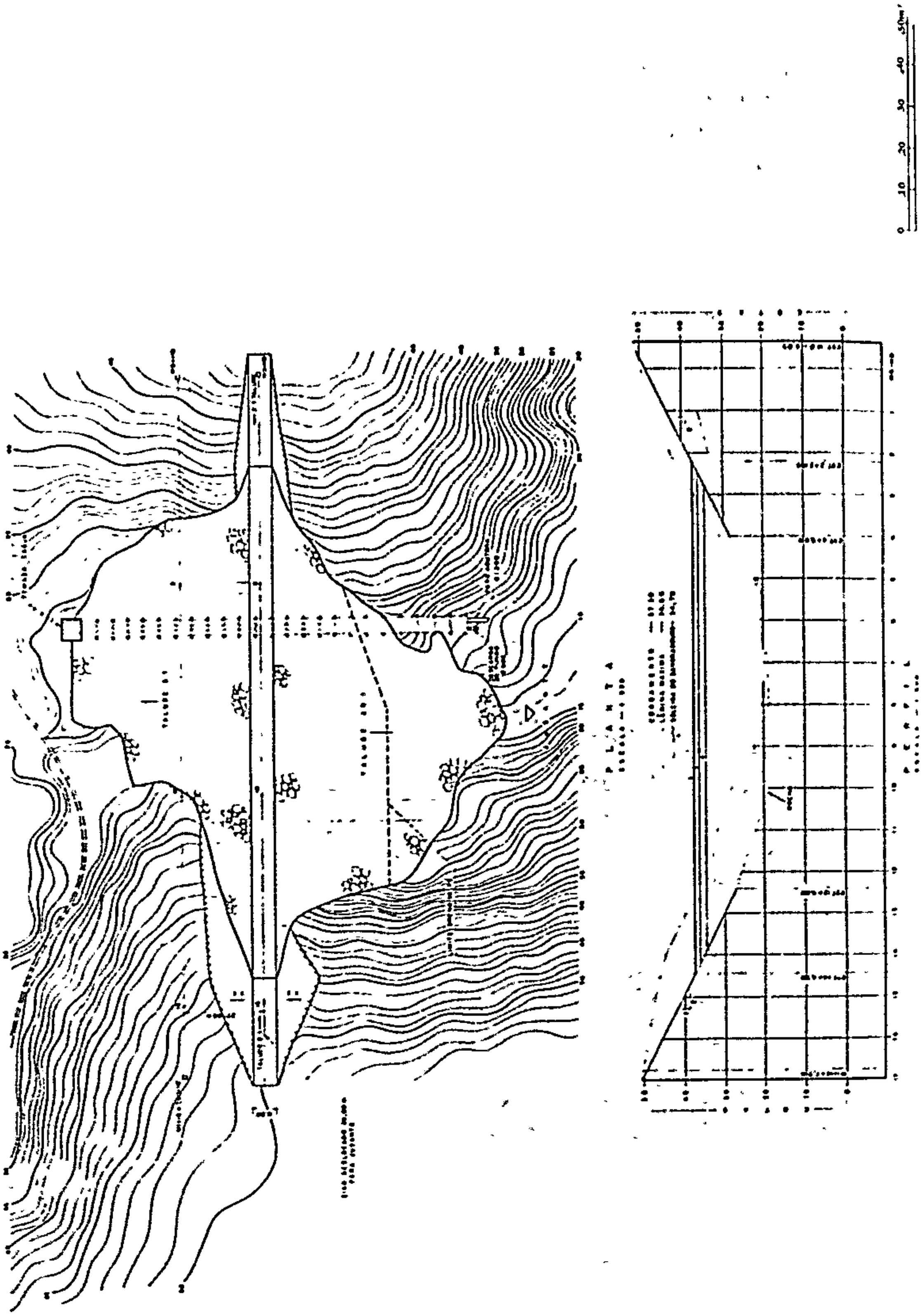
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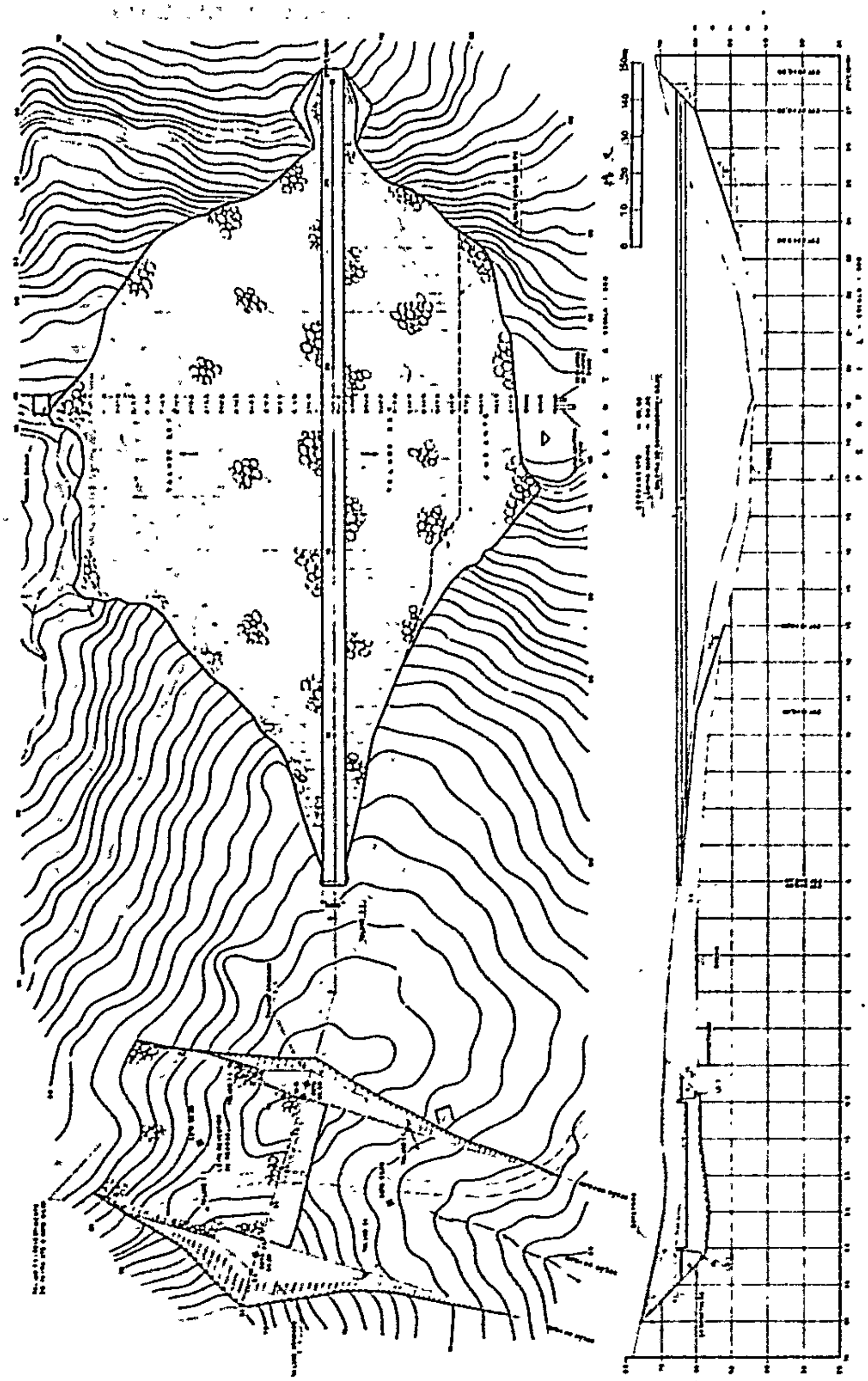
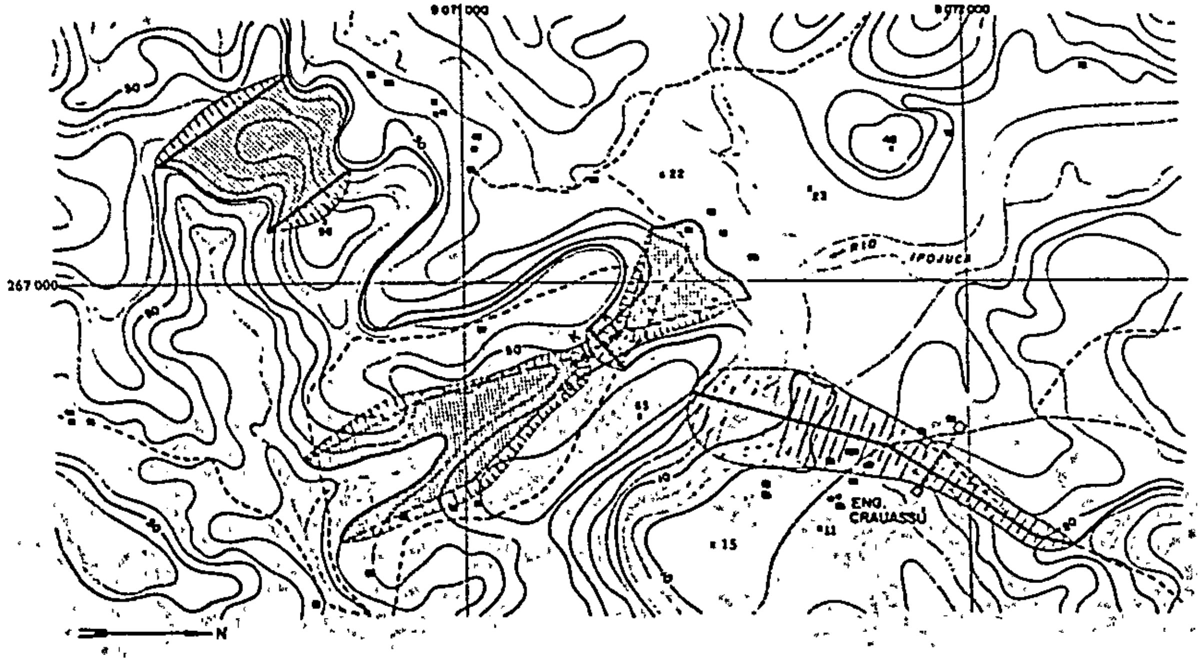
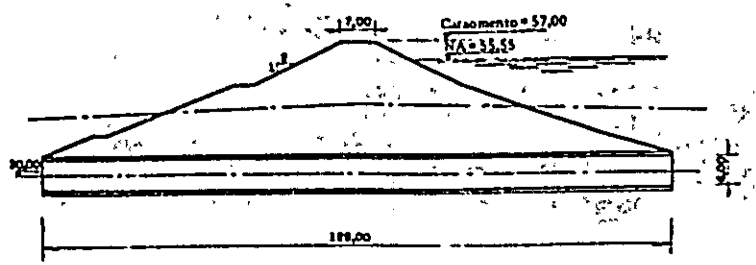


MAP 3. UTINGA DAM

MAP 4. IPOJUCA DAM





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CHAPTER 4. RELATIONSHIP WITH REGIONAL PLANNING

1. Relationship between the Recife Metropolitan Plan and the Suape Development Plan

(1) Regional Planning Concept in Relation to the Suape Development Plan

As was mentioned earlier, the development of Suape is a strategic project designed to develop the Nordeste as a self-contained area. In considering the contents of the Suape Development Plan, all development projects in the region related to Suape should be thoroughly examined, and the measures for the hinterland in such a way that will help promote development of the Suape should be taken, while at the same time it is important to conceive of the framework that will link the contents of the Plan directly with the other development projects. It is especially important to connect the Suape with the major production centers of the goods such as sugar, cotton, and limestone to be shipped from Suape Port, and the hinterland cities, and industrial areas, so as to become the distribution center for products handled at Suape Port, and to develop networks of roads and railway lines for such a purpose.

In the area along BR-101 that connects Natal, João Pessoa, Recife, Maceio and Aracaju with the coastline, population and industry are concentrated. This road is considered the most important axis for the development of Suape. In order to extend the impact of littoral development inland and to accelerate the development of backward agricultural and forested areas, it is vital that this area be connected with BR-232 and BR-230, national transport arteries (see Fig. 4-1).

When Suape Port starts to function, the Nordeste will have two key ports – Recife serving a large population agglomeration and Suape serving a large industrial agglomeration. The latter thus far has been considered an auxiliary port for the congested Recife Port, but in the future it is expected that the two ports will come to have different functions due to the difference in the nature of the hinterland each serves. As income and the volumes of traffic and freight increase in the future, it will be necessary to functionally differentiate the axis of transport that connects the two ports with inland growth pole areas into a physical distribution axis and a human activity axis. In the future it may be desirable to establish, aside from BR-232 and BR-230, two axes of transport (an urban axis and a physical distribution axis) which connect Recife and Suape ports with the inland and to conceive of a ladder-form regional development system in which growth centers along the two axes will be connected with one another.

In Pernambuco State which extends for 720 km in the east-west direction but for only 150 to 200 km in the south-north direction, it is especially necessary to establish the key axes. We propose that BR-232 connecting Recife Port with points inland be established as a human activity axis and the route starting from Suape Port and leading to Palmares and Petrolina (for the development of limestone resources) by way of BR-101, as shown on Fig. 4-2, be established as a physical distribution axis, so that the efficiency of investment may be maximized.

Fig. 4-1 National Road Network in the Nordeste

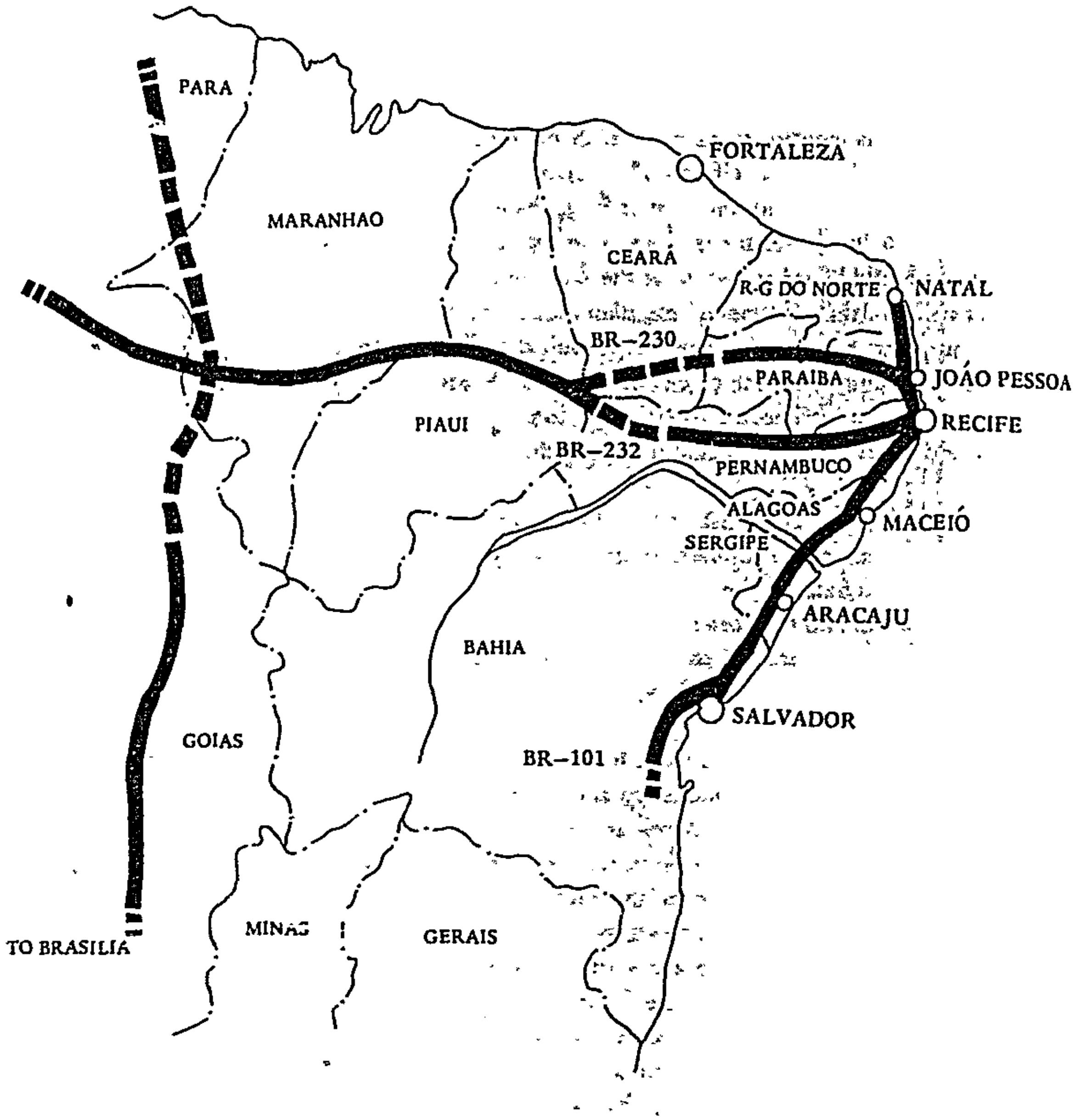
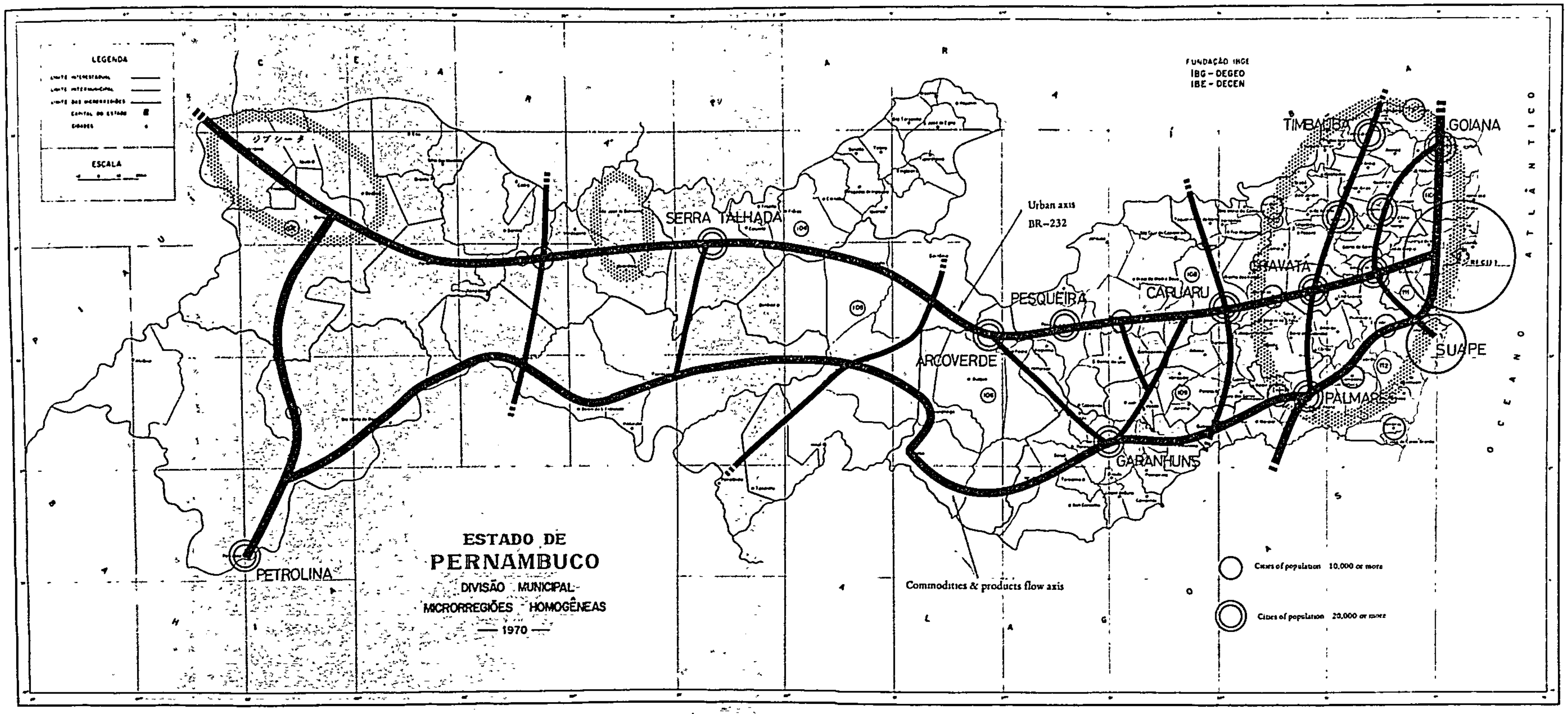


Fig. 4-2 Recife and Suape Ports and Related Inland Transport Systems



It will be necessary to re-examine the specific location of the proposed routes in the light of actual circumstances, but it is desirable to complete the transport arteries as soon as possible and to develop a by-pass for the congested BR-101 to give support to the development of Suape from the hinterland.

(2) Recife Metropolitan Plan and Development of Suape

The tendency for the Brazilian population to concentrate in cities is striking. To cope with the overgrowth of cities and the increase in regional economic and social imbalance, and to promote regional development, the Brazilian government designated nine urban areas as Metropolitan Regions (see Table 4-1). Recife City, about 40 km north of the proposed site for Suape Port, has a population of 1,060,000 (1970 census) and is the largest international city in the Nordeste. The Metropolitan Plan, designed to develop Recife City as the growth center of the Region, is now in preparation. The Recife Metropolitan Region (RMR) comprises an area 30 to 40 km from the center and some part of it overlaps with the Suape Development Region (see Fig. 4-3). In the TRANSCON Report the Suape Development Plan and the Recife Metropolitan Plan are dealt with separately, and the relationship between the two plans is not clear. It is necessary to clarify this point at the outset.

(A) Urban Structure

According to the data in the Recife Metropolitan Plan, 1,790,000 persons (about 35% of the population of Pernambuco State) lived in the RMR in 1970; it is expected that the RMR population will increase to 2,490,000 in 1980 (see Tables 4-2 and 4-3). According to the trend of intra-urban population movement, the population of central cities is no longer dominant and the doughnut phenomenon is already taking place. The ratio of the Recife City population to the RMR population dropped from 64% in 1960 to 59.2% in 1970, while that of the Jaboatao, 10 km from Recife, increased from 8.6% to 11.2% and that of Olinda, from 8.9% to 11.0%. It is said that traffic congestion and increasing crime in Recife caused many of its citizens to move to the quieter Olinda City. But it is also said that the greatest cause of the doughnut phenomenon is flood damage, not necessarily over congestion. Over-all, the population of Recife is increasing, with the new in-migration exceeding the out-migration.

Such cities as Cabo, Moreno, and Igarassu, 30 km from Recife, experienced small increases in population between 1960 and 1970, but the ratios of the populations of these cities to the RMR population did not register any significant change. In the three-year period from 1970 to 1973, however, the rates of population increase in cities in the RMR, with an exception of Moreno (2%) exceeded that in Recife (12%) (see Table 4-4). The population increase in the RMR is rapid. In Brazil unskilled workers from rural areas migrate to towns on the fringes of large cities, thus adding to the population of satellite cities. This tendency is expected to continue unabated and the area 30 km from Recife will see a tremendous population increase in the future.

At present the built-up area of Recife comprises the area within the radius of 10 km from central Recife, and industrial development is taking place in a radius of 10 to 20 km, dis-

Fig. 4-3 Recife Metropolitan Region and Suape Development Area

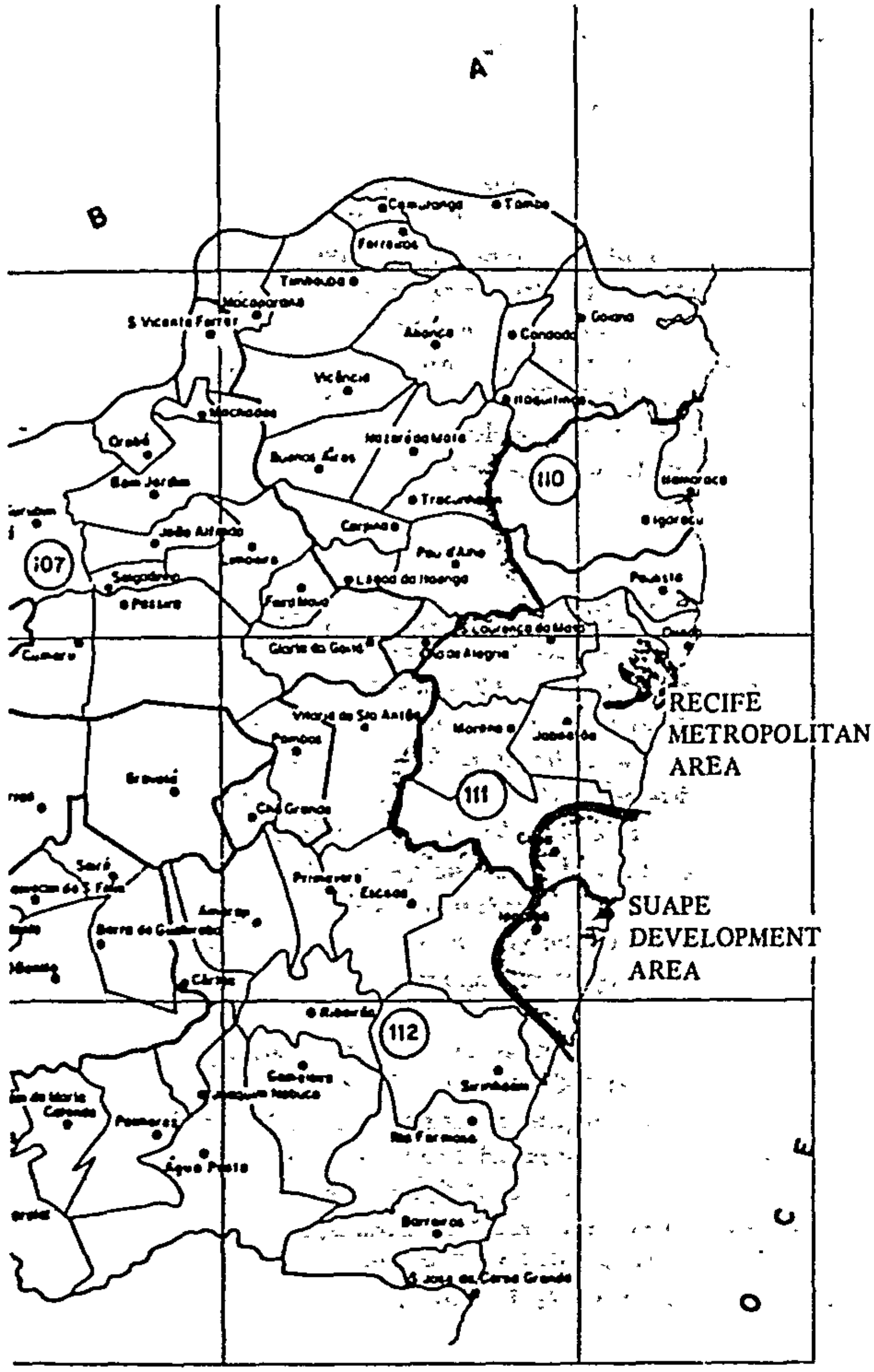


Table 4-1 As regioes metropolitanas Brasileira, segundo variaveis socio-economicas selecionadas 1970

Regiao metropolitana	Populacao			Crescimento populacional (1960/70)	
	Total	Nucleo	Periferia	Absoluto	Devido a Migraçao (%)
Belem	655,901	633,374	22,527	233,253	34.8
Fortaleza	1,037,798	857,980	179,818	383,153	49.6
Recife	1,791,322	1,060,621	730,621	550,839	62.6
Salvador	1,147,821	1,007,195	140,626	408,022	45.0
Belo Horizonte	1,605,829	1,235,030	370,799	709,157	66.9
Rio de Janeiro	7,068,323	4,251,918	2,816,405	2,226,369	67.0
Sao Paulo	8,139,730	5,925,615	2,215,115	3,352,485	68.5
Curitiba	821,089	609,026	212,063	296,372	70.9
Porto Alegre	1,531,257	885,545	645,712	494,764	81.4

Source: Fundacao de Desenvolvimento da Regiao Metropolitana do Recife – FIDEM

Table 4-2 Regiao metropolitana do Recife: Area E populaçao por municipio 1970

Municipios e regiao	Area		Populaçao			
	Valor Absoluto (km^2)	% sobreo total	Urbana	Rural	Total	Densidade ($hab./km^2$)
Cabo	451	20.5	40,284	35,545	75,829	163.13
Igarassu	487	22.1	31,391	23,628	55,079	113.09
Itamaraca	65	3.0	4,087	3,030	7,117	109.49
Jaboatao	234	10.6	185,833	15,142	200,975	858.87
Moreno	189	8.6	17,681	13,523	31,204	165.10
Olinda	29	1.3	187,128	9,214	196,312	6,770.40
Paulista	207	9.4	62,481	7,578	70,059	338.44
Recife	209	9.5	1,046,415	14,288	1,060,701	5,075.12
S.L. da Mata	330	15.0	74,435	19,581	94,016	284.89
RMR	2,201	100.0	1,649,733	141,589	1,791,322	813.86

Fonie: FIBGE

Table 4-3 Population Projections, Metropolitan Recife Region

	1975 urban population	1980 urban population
Cabo	50,557	83,234
Igarassu	38,081	48,553
Itamaraca	5,653	7,770
Jaboatao	250,470	304,919
Moreno	19,502	20,872
Olinda	229,440	273,659
Recife	1,215,840	1,410,301
Paulista	70,648	78,402
Sao Lourenço da Mata	95,921	118,101
RMR – Urban	1,976,112	2,345,811
RMR – Rural	136,0	144,6
RMR – total population	2,112,100	2,490,400
Pernambuco total population	5,725,700	6,352,700
Nordeste total population	32,822,200	37,395,600

Source: Recife Metropolitan Region Plan

Table 4-4 Population Growth Rates of Cities in a 50 km Radius of Recife

	Population growth, 1970 – 1973	
Recife	12%	
Jaboatao	17	15 km
Olinda	21	10 km
Sao Lourenço da Mata	21	15 km
Cabo	13	30 km
Paulista	11	15 km
Igarassu	14	30 km
Moreno	2	25 km
Itamaraca	7	35 km

Source: IBGE, Recife branch

couraging new migrants from entering the built-up area. Industrial estates in Curado and Paulista, both Recife suburbs, are examples of such industrial development, but these industrial estates have already reached their limits. It will be necessary to develop new industrial estates in the area 30 km from Recife (see Fig. 4-4).

Brazil's productive activity and population are now concentrated in the Sao Paulo - Rio de Janeiro – Belo Horizonte belt. The main target of regional development is to create greater balance in the region by increasing productive activity in regional cities such as Recife, by stopping the outflow of population from rural areas through investing capital in satellite cities and hinterland cities, and by modernizing agriculture, forestry and stock farming. The fundamental ideas of the Recife Metropolitan Plan are based on the approach outlined above. Cabo City, located 30 km from Recife and comprising part of the Suape development area, with its 900-ha industrial estate, is considered as a key strategic urban growth center together with Moreno, Jaboatao, Sao Lourenço da Mata, Paulista, and Igarassu (see Fig. 4-5).

The development of Suape is taking place on the border of the Recife Metropolitan Plan area. Suape exceeds the Cabo industrial estate by far in terms of the size of the development area, amount of investment, and impact of development on the region. Rather than a satellite city sharing the function of Recife Port, Suape should be a key growth center which guides a group of cities in the RMR and their productive activity. If Suape development is taken into account, the present RMR Planning Area is too small; it should be expanded to include at least Ipojuca City; and furthermore, the whole RMR should be planned as a multi-nucleared area with Recife and Suape ports as two of its centers.

(B) Transportation

The present transport system in the RMR is a network of highways - BR–101, BR–232, and BR–408, and three railway lines all radiating from Recife City. It is important to develop the route connecting key development areas with Suape Port. The most necessary and efficient routes to be developed are that connecting the two-ports with each other and those connecting principal satellite cities in the RMR such as Cabo, Jaboatao (Moreno), Sao Lourenço da Mata, and Paulista with one another. The development of the coastal route connecting the two ports is now beginning from the Recife side. If this route is extended to Suape, it will not only become a direct link between the two ports but serve as a by-pass for BR–101. It is also possible to construct a road connecting cities with beaches and resorts to promote tourism, depending on the selection of the route. We propose that for multi-purpose use the construction of the planned PE–9 be started as soon as possible and that in the future a new route be developed along the coast and several possibilities of making it into a sight-seeing or a toll road be examined.

A loop road around Recife City is now planned in the area 5 to 10 km from the city center. In view of the need to develop satellite cities, to cope with the population increase, a loop road alone at such a short distance from the center will not be adequate. From the viewpoint of long-range planning, it will be important, first, to develop a loop road in the area 15 - 20 km from the center so that it may promote industrialization and growth center development and, then, to develop a loop national railway line in the area 30 km from the center, relating it

Fig. 4-4 Existing Conditions of the Recife Capital Region

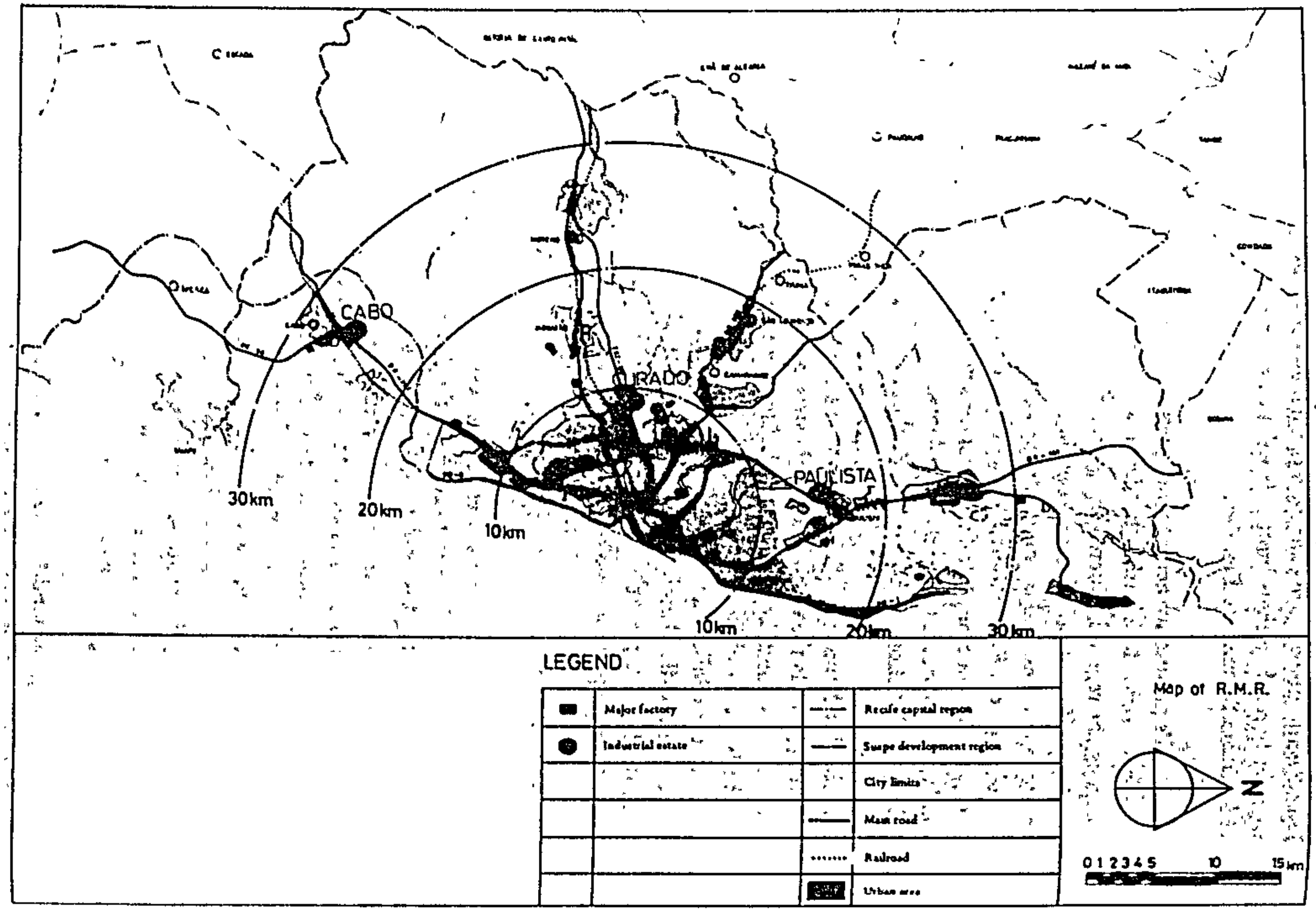
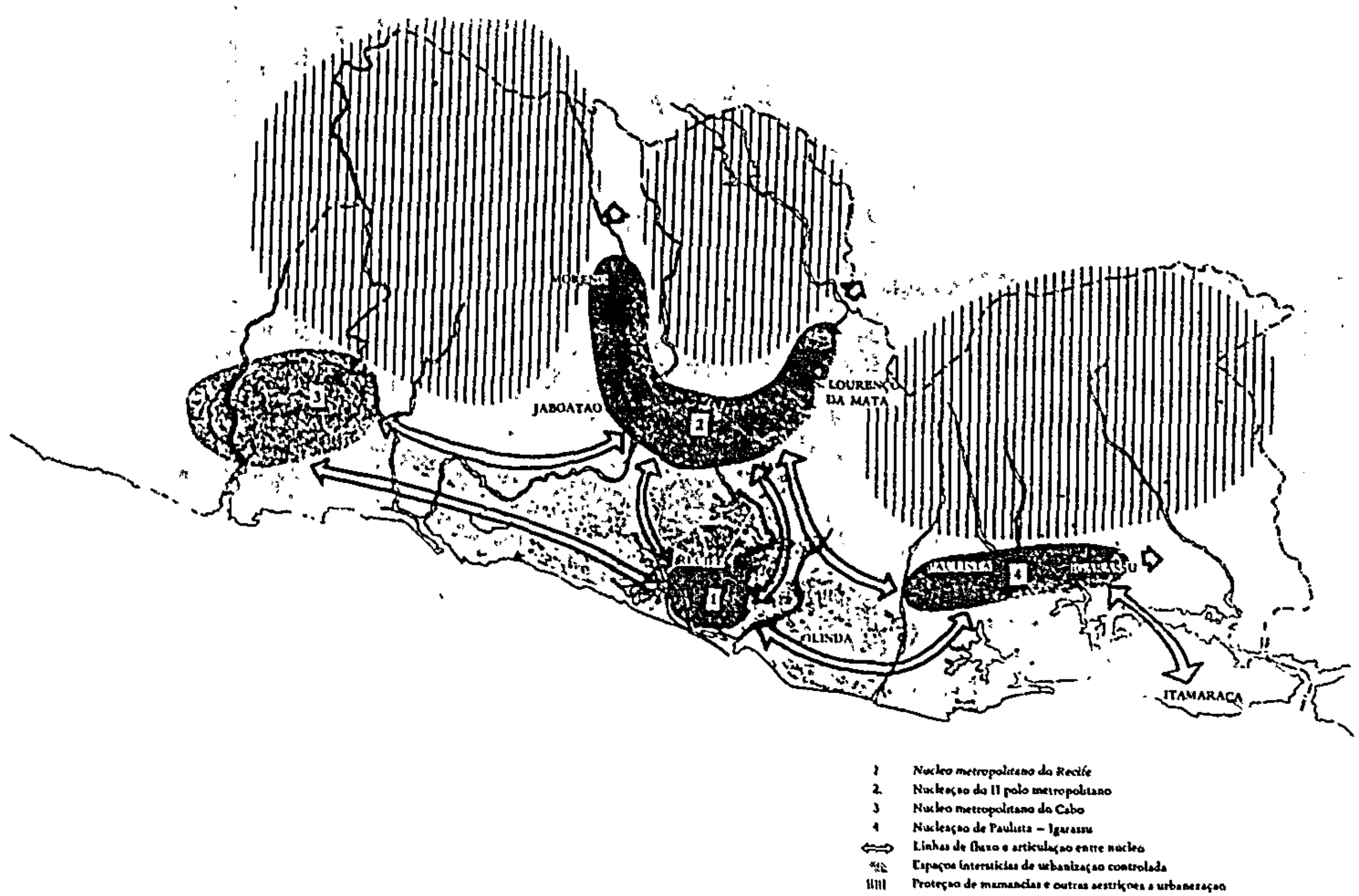


Fig. 4-5 Recife Metropolitan Plan for Urban Development Area



to the Suape development (see Fig. 4-6 and 4-7).

(C) Industrial Development

It is necessary to develop the industrial estate in Suape not as a closed, self-contained industrial estate but one designed to diffuse development effects across the hinterland by constructing the routes proposed above. The TRANSCON Report proposes for the Suape area an industrial complex development comprising various types of inland-type industry to be naturally located there due to large-scale capital investment in both land development and production facilities in addition to the types of industries that need direct access to port facilities and their related industries. In Japan, in planning for the East Tomakomai Industrial Port in Hokkaido (see the material mentioned later), not only littoral-type industries but also many related industries and inland-type industries are introduced. Therefore the idea of allocating land for inland-type industries in the Suape area should not be denied. If, however, there is an idea to improve and strengthen the satellite cities in the RMR and to develop inland areas, it is desirable to develop industrial estates in the satellite cities and inland areas to the maximum possible degree, not concentrating in the Suape area all the industries likely to be located in the RMR and in the Nordeste, and to create the regional development system in which these industrial estates and the Suape area will be functionally differentiated. Many industries serving large markets have already been located in the peripheral area of Recife. Parts of those industries should be relocated in such cities as Cabo, Jaboatao, Moreno, Sao Lourenço da Mata, Paulista, and Igarassu, which should be developed as satellite cities, and to develop the wide-area markets and industrial estates in line with the exploitation of mineral resources and the processing of agricultural products in the peripheral area, will be an extremely effective development strategy for the Recife Metropolitan Region Plan (see Fig. 4-8).

In promoting the Suape development project, it is expected that a comprehensive plan on the regional scale, supportive of the development of Suape, will be drawn up.

(3) Urban Infrastructure Development in Cabo

The Suape development area covers the two cities of Cabo and Ipojuca. The role of Cabo City in the Recife Metropolitan Plan is to prevent the outflow of population into the RMR by way of improving urban infrastructure (with emphasis on industrial development). Ipojuca City is not included in the RMR Planning Area, but its role should be similar to that of Cabo City. Not dependent on Recife, it should maintain self-contained urban activity.

Those who migrate to the peripheral area of large cities are often low-income people and many of them need public assistance for their livelihood. They are essential source of the labor force for the industry. In spite of the population increase, however, these cities lack the potential for the proportionating growth of urban development and their improvement of the urban infrastructure is lagging behind. The rate of employment in the urban population of Cabo City is 22.8%, much lower than that in Recife City (29.5%) (Source: FIBGE CDPE, 1970, Table 48). Cabo City has a supply of electricity with a limited supply of city water but has no sewerage and drainage systems. The urban population in Cabo City, however, is rapidly

Fig. 4-6 Newly Proposed Routes Linking Key Outer Cities with Suape Port

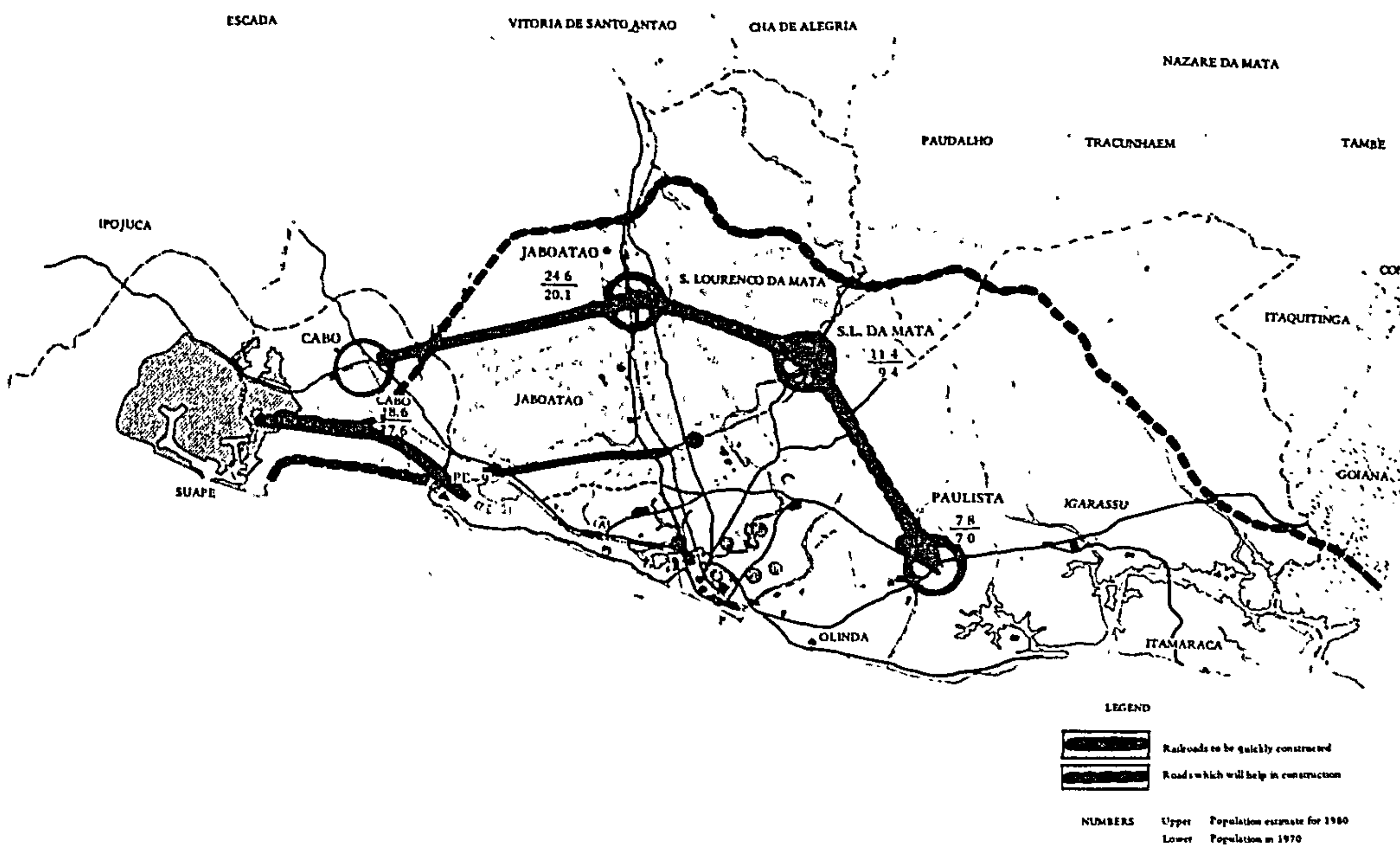


Fig. 4-7 Conceptual Plan of Recife Region Railroads

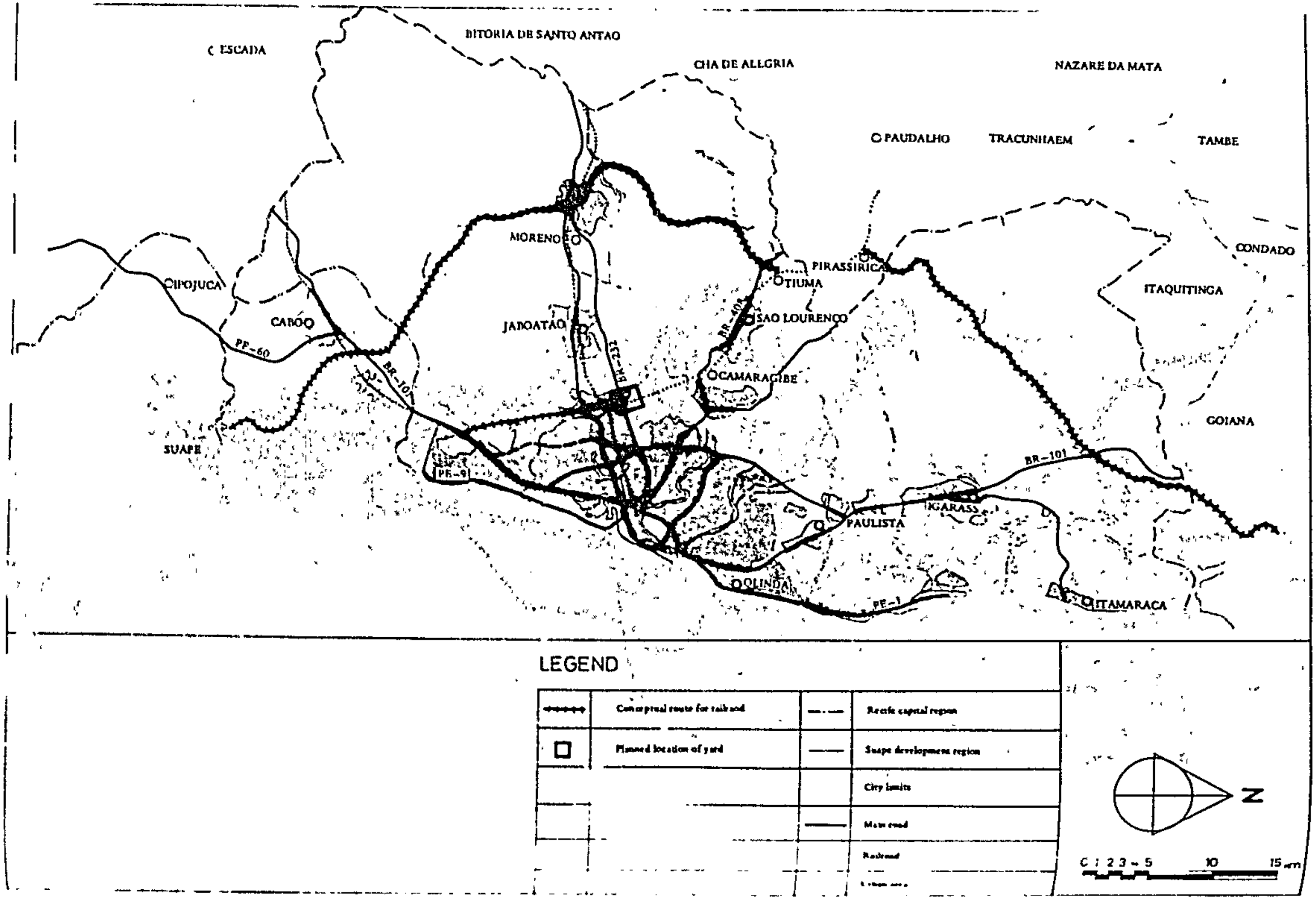
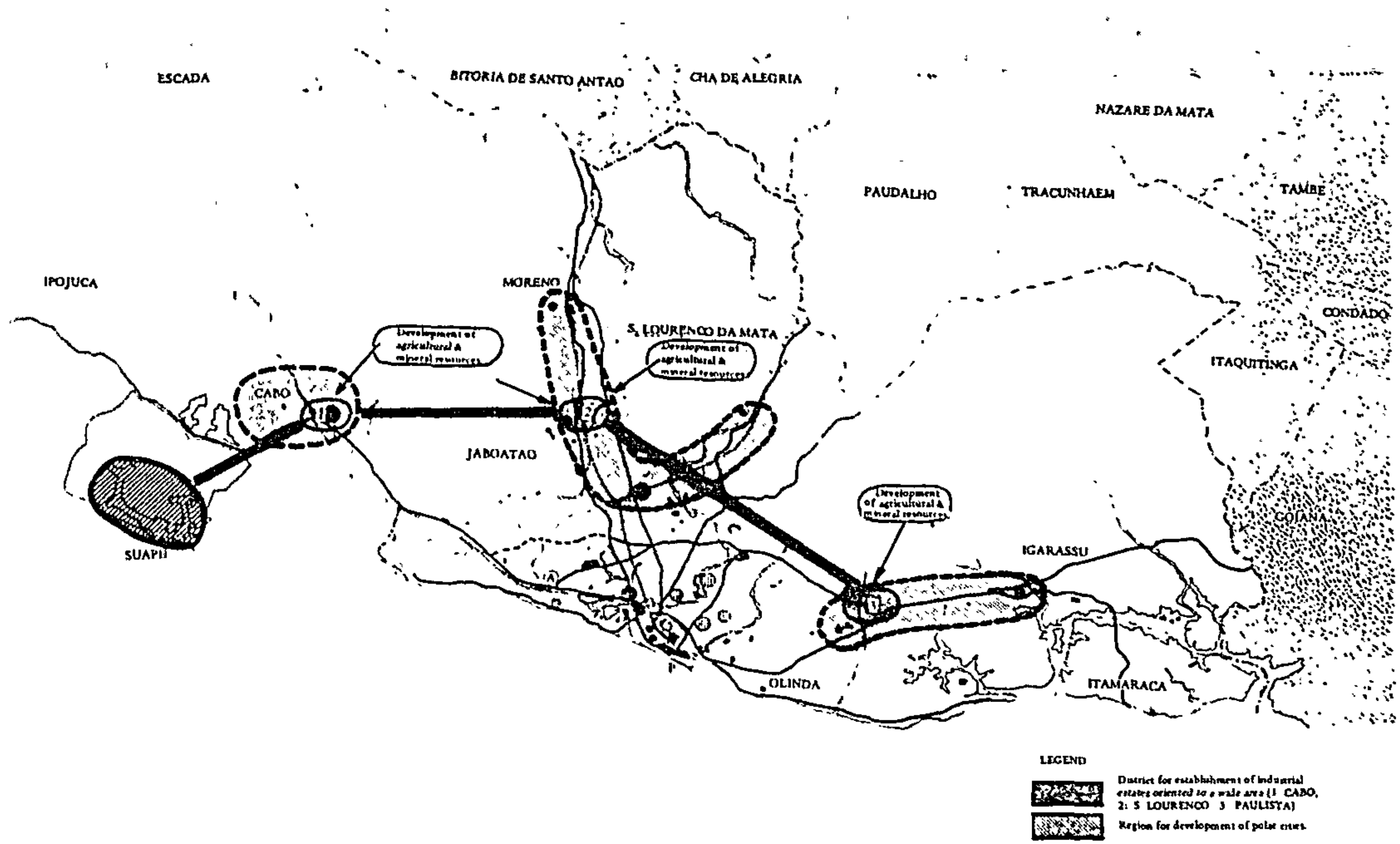
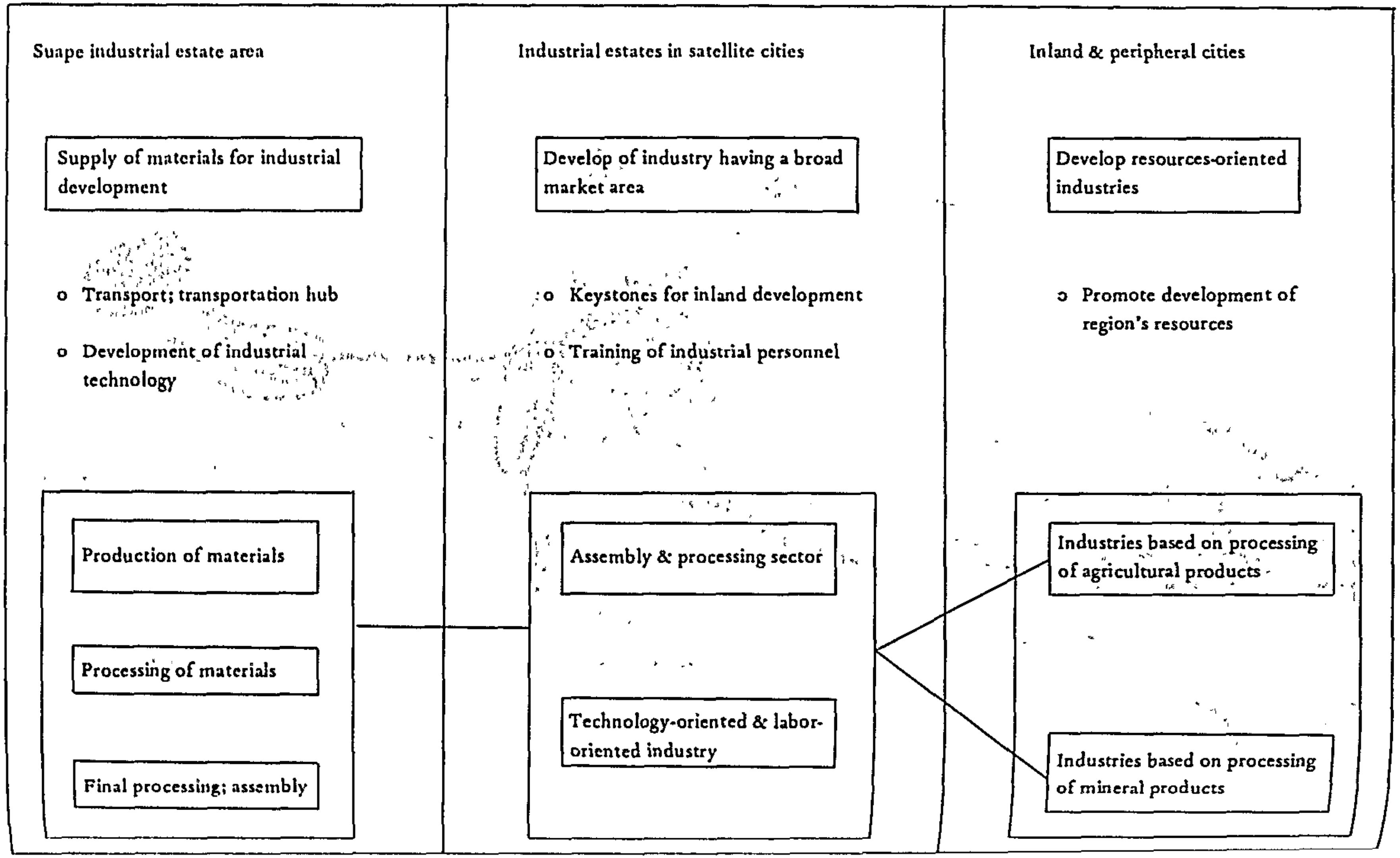


Fig. 4-8 Conceptual Plan for Regional Improvement in Accordance with Industrial Development



Conceptual Intra-Regional Linkage



increasing due to the development of the industrial estate. It is expected that even if there were no Suape development, the population in the city's built-up area in 1980 would increase to 83,234, twice the level in 1970 (Source: Recife Metropolitan Plan), and it would further increase to 213,263 in the year 2000 (TRANSCON Report). The TRANSCON Report says that the Suape development will generate a population of 234,472, of which 71% will live in the development area and the remaining 29% will live in the existing cities, and that Cabo City as a whole will accommodate 75,560 and the built-up area of the city will absorb 23,569.

Based on the above data, the population of Cabo City in the year 2000 will be about 300,000, more than four times the 1970 population. In order that Cabo City may fulfill the role of a self-contained satellite city on the fringe of the RMR, it is urgent that the city develop residential land, renew the central business district, and construct the infrastructure supportive of such areas. The Suape development which will involve construction of infrastructure through public investment provides Cabo City with a golden opportunity for urban development. It is necessary to draw up a long-range master plan for the city as one of the most important development areas in the RMR and to provide the support for its urban development.

The TRANSCON Report says that urban construction in Cabo will accommodate the natural increase in the city's population and the proportion that cannot be accommodated in the two areas mentioned above but does not specify the date for starting construction. Cabo City is likely to receive the greatest impact from the Suape development, judging from the geographical considerations. In order to prevent sprawl, it is necessary that positive and orderly housing and urban development be undertaken from the beginning.

In constructing the metropolitan loop highway connecting the growth centers such as Cabo, Jaboatao, and Paulista, proposed earlier, it will be necessary to build part of it as a by-pass for PE–60, because factories are located at the intersection of BR–101 and PE–60. Fig. 4-9 indicates an example of how to proceed with the development.

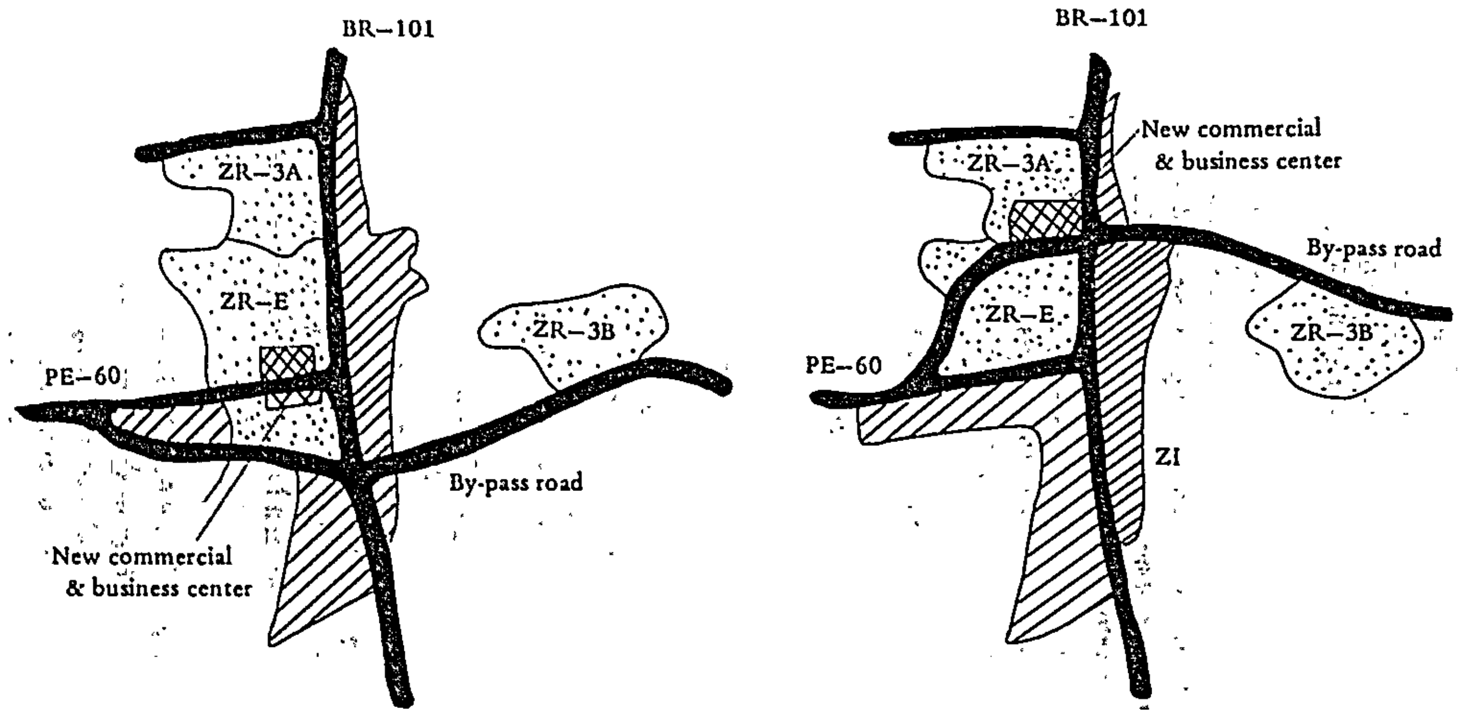
(4) Development of Santo Agostinho and Gaibu

In Brazilian cities, most of the littoral areas are used as swimming beaches, as is the case in Recife City. The Suape Development Plan incorporates a large-scale project for tourism development. To develop an industrial estate and a large-scale scenic resort together in an organic way is a recent trend and an effective way of taking advantage of the area's geographical characteristics.

According to the TRANSCON Report, the incorporation of tourism development in the Suape Development Plan was decided in view of the fact that such development would directly contribute to the state's economy since the area has the large potential labor force in spite of insufficient resources and employment opportunities. The development ot multiple projects such as hotels, beaches, marinas, horse-riding clubs, and camping sites is planned, like Languedoc-Roussillon in France.

The fact that Cape Santo-Agostinho physically stands as a divide between the

Fig. 4-9 Example of Cabo City By-pass Road Improvement



industrial development area from the tourism development area may be regarded as an advantage for the Suape project. But the tourism development project does not necessarily have to be coordinated with development of the industrial estate. The construction of high-class housing is planned, however, in relation to tourism development, and 183 ha of land for 5,490 persons has been secured for high-class housing construction on the Gaibu-Itapuama beach. In Brazil residential land facing the beach is the favorite choice of people. It is necessary that residential construction in this area be undertaken in an orderly manner from the beginning.

The hill on Cape Santo-Agostinho commands a fine view of the port. It is desirable that part of the hill be developed as a symbol zone for the Suape project. As an approach road to the tourist area, PE–28 may be used for the time being; in the future a coastal route connecting the area with Recife City should be developed and used as a tourist road, independent of industrial use.

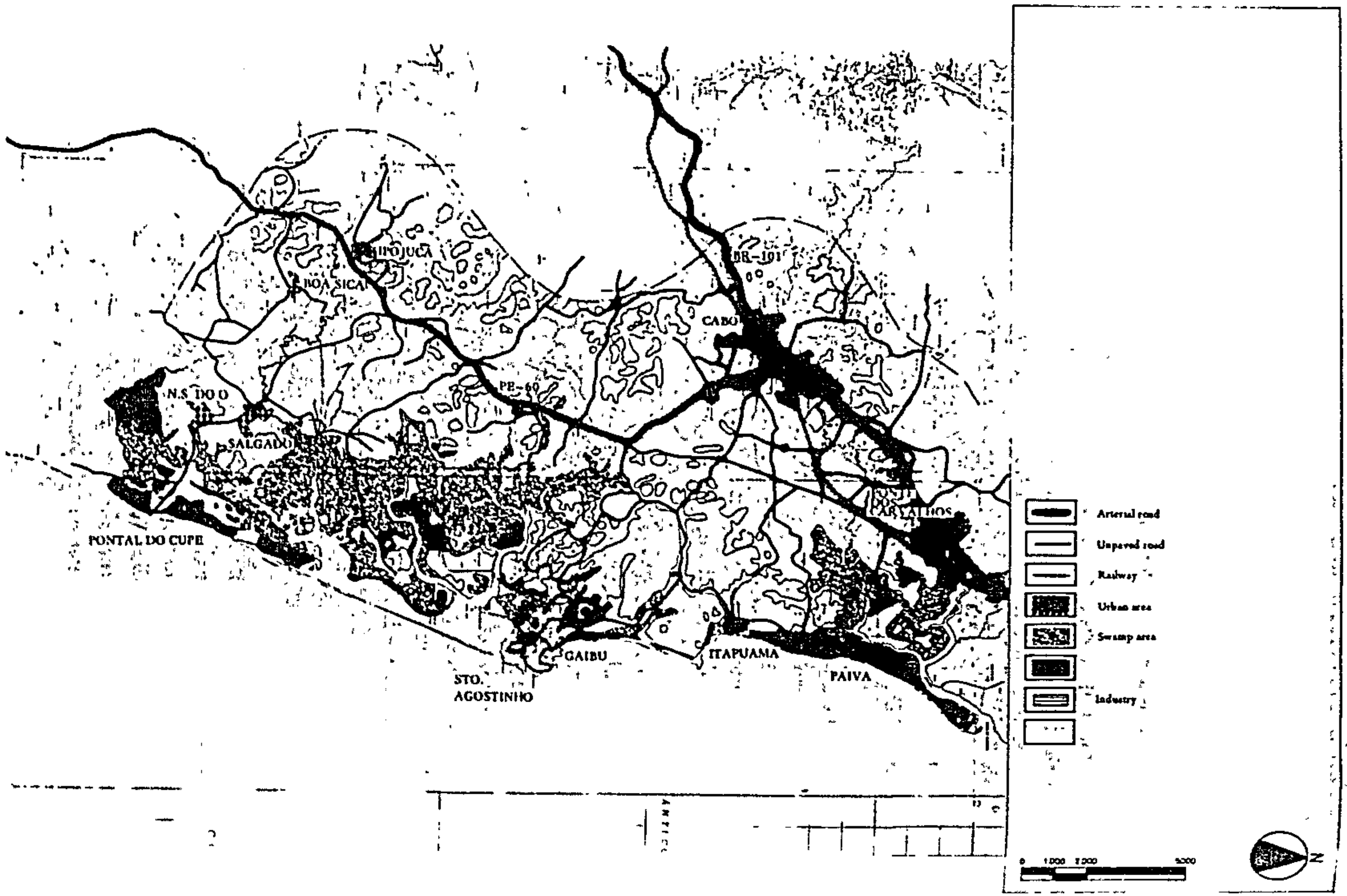
(5) Agricultural Development and Conservation Areas

In the area one to two kilometers from the coastline there are plantations of coconuts. The swamp where a port is to be cut through is left unused, although in some part pasturage is seen (see Fig. 4-10). In the area where drainage is good, sugar cane is grown, favored by the abundant rainfall which amounts to 1,500 mm a year. Forested areas exist on the northern hills of Santo-Agostinho and on the west side of PE–9.

In the TRANSCON report the conservation areas are designated for the following four purposes: (1) cultural conservation, (2) ecological conservation, (3) greenery conservation in urban areas, and (4) forestry and agricultural conservation. The Massangana Sugar Mill, a group of fortresses on the coast, the churches of Garapo, Nazare, and Nossa Senhora do O, vegetation on the Suape Bay, and vegetation on Cape Santo Agostinho have been proposed for designation for cultural conservation. As for ecological conservation, at least 30! of the area, including primeval forests, a forested zone separating the industrial area from Cabo City to provide protection from air pollution, vegetation on Cupe Gamboa, mangroves in the swamp, and riversides, should be conserved. Furthermore, parks will be provided in the built-up area, and the conservation areas mentioned above will be incorporated in forested and agricultural areas. The unique and the most important of these conservation areas is the large-scale forested zone for protection from air pollution (called Zombi Woods). It will be used as a State park.

In the TRANSCON Report there is no detailed examination of environmental pollution problems, but in planning for the large-scale development projects such as Suape adequate measures for protection from pollution should be taken. The need for creating a large green zone to cope with air pollution has been pointed out since a long time ago. Experience in Japan, however, has shown that the density of polluted air on the ground varies considerably, depending on natural and climatic conditions, season, and time of the day, and that the best way to reduce air pollution is to control it at the source. In Japan efforts are being made to reduce the amount of pollutants to the one-tenth of the present level in the next 10 years. In Brazil, too, it will be necessary to take adequate measures for controlling pollutants at the source. Recently in Japan the tendency for establishing pollution-reducing green zones has been

Fig. 4-10 Existing Conditions in the Suape Development District



replaced with the movement for building green zones in the immediate vicinity of factories for visual effects as well as for minimizing damage from possible explosions and designing attractive factories and industrial estates, rather than establishing large-scale green zones at remote distances, combined with the strengthening of measures for controlling pollutants at the source. In the development of Suape the concept of attractive industrial estates and port should always be kept in mind. It is important and meaningful that cultural and historic facilities and rare vegetation be conserved, but it is no less important that efforts be made to create greenery and design landscaping for the creation of attractive industrial estates.

We propose that the construction of a boulevard connecting the green area at the entrance of a port with the administrative center, and the development of green strips along the Collective Port and the ZI–1 loop road and along railway lines be considered.

The goal of conserving 30% of the whole area as green zones, mentioned earlier, is admirable.

The dominant winds in the Suape area are from the south and southeast. Considering the buffer zone from the refinery area, it is likely that the ground density of polluted air will be highest at the distance of 4 - 6 km or of 6 - 8 km from the chimney whose height is 100 to 200 meters. In the light of this fact, the location and width of the buffer green zone are adequate, and the establishment of agricultural land around the green zone is highly evaluated.

2. Required Capacities of Urban Activities and Contents of the Suape Development Plan

(1) Urban Population to be generated by Development of the Suape Complex

The employed population to be generated by the Suape development is estimated at 66,360. Its breakdown is: 63,360 for industry (applying the criterion of 11/ha in the Cubatao industrial estate to the 5,760-ha Suape estate) and 3,000 for port facilities (applying the criterion of 600/km of quay wall in Recife Port to the 5-km-long quay wall of Suape Port). The average size of families is estimated at 5.3 persons. Accordingly, the total population to be generated is estimated at 234,472. It is expected that 71.4% of the total population will live in the area and the remaining 28.6% will live in the existing cities.

In estimating the population generated by industrial and port development, the following three methods are available:

1) Calculating on the basis of the relationship between the total investment and population;

2) Correlation between the input-output table and population; and

3) Calculating from the proportion of population to the area of an industrial estate.

An example of an equation based on the third method is given below:

$$P = A \times Pul(1 - S)(1 + nef) \times (1 + T)$$

P:	Population projection
A:	Area of industrial estate (or area of port or length of quay)
Pul:	Number of workers per unit area (or length)
S:	Rate of local employment/100
Nef:	Number of family members dependent on worker
T:	Rate of increase in tertiary industrial population to increase in secondary industrial population

The number of workers differs considerably, depending on the types of industry and of port. The direct population increase varies depending on the size of the worker's family. Furthermore, a tertiary industrial population is needed to support a secondary industrial population. The population increase is derived as the end product of all these calculations. The development of the infrastructure is planned in anticipation of such a population increase.

As the result of a great deal of research, reasonably accurate figures have been obtained in Japan. It is doubtful, however, whether these figures should be adequately applied to Brazil. In Brazil where the rate of unemployment is high, the development of an industrial estate contributes only toward the increase in the rate of employment, followed by a possibility of reducing the new population increase; when highly technological industries are introduced, it is not clear where required engineers and technicians can be obtained. Another factor unique to Brazil where there is a high rate of unemployment is that the rate of increase in a tertiary industrial population to a secondary industrial population is very high. For the reasons given above, an estimation of the future population increase should draw on the past examples in Brazil. The estimates of 66,360 employed population and of the total population of 234,472 in the target year of the Suape development plan should be regarded as generally reasonable although we have some reservations. The above figures are, however, the populations directly dependent on the development. To them should be added the increase in a tertiary industrial population.

If the figures in the TRANSCON Report are applied to the equation given earlier, the following result will be obtained:

$$P = 66{,}360\,(1 - 0.286)\,(1 + 3.8/1.5) \times (1 + T)$$

$$P = 167{,}400\,(1 + T)$$

The rates of increase in a tertiary industrial population to the increase in a secondary industrial population in recent littoral industrial development in Japan are 0.3 to 0.5, sometimes below these figures, but in some industries the rates exceed 1.0. The data the Japanese Mission obtained at the Aratu Industrial Estate indicates the rate of four to five tertiary industrial population to one secondary industrial worker. It is said, however, that half of the tertiary industrial population are in actuality unemployed and that in fact the rate of increase in a tertiary industrial population to the increase in a secondary industrial population is 2 - 3 to one. It is conceivable in Brazil with the low rate of employment that one member of the family works at an industrial estate while another member of the same family is engaged in a commercial trade. It is probable that the above-mentioned rates are two to one, not four to one. The total population in the Suape Development Area will be 334,800 if T is 1, and 502,200 if T is 2. A detailed examination of these estimates based on analyses of past examples will be needed.

(2) Development of Residential Land

In planning for residential land development, first, potential land for residences and the size of population to be accommodated there, second, the module including the urban infrastructure and service facilities, designed to cope with the population increase by construction in stages, and finally, detailed plans for an image of a residential area, roads and pedestrian walks, community facilities, and parks will be examined.

The Boasica area where a new town is scheduled to be constructed is an ideal site for residential development. If a flood control dam is built, there will be no danger to residential developments in the other areas, either. We are not in a position to weigh the pros and cons of a module approach to residential development, but we believe that in residential development in this area where a self-contained city is expected to be built, the concept of building a city or of urban development in an organic relationship with the existing cities is more important than merely supplying housing. First, the amounts and types of service industries, commercial facilities, and utilities that will support a large population in the target year of the plan should be examined; second, decisions as to whether these facilities should be dispersed or concentrated or whether the facilities in the existing cities should be left to themselves for spontaneous growth should be made; and finally, the facilities should be constructed according to the module. The number of workers and the size of their families were examined, but the resident population in commercial and community facilities were not. It is hoped that they will be examined closely. It is also hoped that in the construction of a new town in the future workplaces, homes, and recreational areas should be developed together in a unified manner so as to create a self-contained communicty.

3. Land Use and Total Plans for Suape's Development

A land use plan is the result of work on condensing, coordinating, and generalizing the contents of all sectoral plans. It is essential that it be coordinated with the plans for areas outside the planning area and that the data in each sectoral plan be uniformly accurate. A reading of the TRANSCON Report, however, does not clarify whether the Recife Metropolitan Plan and the Suape Development Plan have been coordinated with each other. It reveals great differences in depth among the data in sectoral plans. It is necessary that both plans be coordinated.

The key factors in the Suape Plan are the depth and shape of a port to be dug and the layout of an industrial estate. The design of the port and the industrial estate should be given thorough examination. As for the layout of the port, the following points should be kept in mind:

In order to find out whether a reef bar can be cut through or not, it is necessary to collect large amounts of data on boring, drift sand and oceanographic conditions. In the plan the port has a single main course. In view of the fact that the Kashima Industrial Port has become overcongested because of having only a single navigational channel, a recent tendency in Japan is toward establishing a double channel, as in the case of the Higashi Tomakomai Port. In the light of the expected number of ships, the possibility of creating a new entrance into the Suape Port in the future should be considered.

Since it is not necessarily clear what types of industry will need direct access to the water line and how long the required quay will be, a detailed examination of these matters and some modification of the plan for industrial location will be necessary.

The other aspects of the design of the port, except for some minor specific points mentioned in the following, seem generally adequate.

Regarding entrance into the fishing port, at present the mouth of the Massangana River serves as the entrance and exit for fishing boats. Although it is planned in the future that this part will be closed so that fishing boats may use the central channel, it seems advisable that the fishing boats be separated from the other kinds of ships and continue to enter the port from the river mouth as now.

Regarding the Santo-Agostinho area, since the fortress and the church in the area are being repaired and restored by IPHAN, this area has been designated a conservation area. It is thought that it would be good if part of the area is developed. All the administrative offices for the port management will be concentrated in the central zone. This area, a waterfront edge of the Suape Development Area, located at an elevated land, enjoys a highly symbolic position. It is thought that it would be good if part of the area is put to positive use and planned as the symbol zone of the beach.

According to the present plan, a marshalling yard will be located at the junction of the lines to Cabo and Recife, east of Cabo. Several different locations for a marshalling yard will be considered, depending on whether the national government or the DIPER will operate the yard. In case the national government operates it, a large-scale marshalling yard to be constructed in the west of Recife City in the near future may be used. In case it does not, it will be possible to expand the yard to the area now designated as the administrative area. The capacity of the soil to bear the weight of trains should be tested. However, the location of a marshalling yard in the present plan will not cause any difficulty.

Since most of the industrial estate will be built on swamps, it will be necessary that the development of Suape be preceded by construction of a canal. The original plan envisions the establishment of canals preserving the present river-beds as much as possible. Since many canals will be needed, it will be desirable that they be planned as part of some functional area or of a large-scale green-belt in the land use plan.

Some concern is felt over ambiguity in the land use plan concerning the location of plants for treating effluent. Primary treatment of waste water will be undertaken by the individual enterprises, but from the viewpoint of preventing pollution, it will be at once desirable and efficient that all the waste water from all sources should be collected at one place for secondary treatment rather than be discharged directly into the river. As to the location of such a treatment plant, the plan proposed by the Japanese Mission should be referred to (see Fig. 4-11).

The present plan envisions a large green belt between the industrial estate and Cabo and a green-area for conserving some vegetation even within the estate. Since details of the green belt system are omitted in the plan, however, the image of the network of green belts remains unclear.

Since industrial estates usually are designed on a large scale and on a flat plane, there is a strong likelihood that they will become monotonous landscapes. Accordingly, it is important to develop a network of green belts appealing to the eye and to provide plazas and parks which workers can easily use. It is not enough to build parks centralized in and around the administrative center.

4. Study of Construction Program

(1) Development Program as a Whole

The area covered by the Suape Development Plan is huge, totalling about 30,000 ha. The sum of required investment in each of the sectors such as industrial, port, infrastructure, and urban facility development, is enormous, and how to program development is exceedingly important. The TRANSCON Report describes the Stage I plans of each sector. Reading these plans, however, one cannot but entertain a fear that a large number of uncoordinated, haphazard investments will be made in the huge development area. The reasons for such an impression are as follows: (1) the period of the Stage I plan differs from one sector to another, and furthermore there is no orderly pacing of development among them; (2) the sites for the Stage I plan are scattered all over the development area; and (3) almost no mention is made of regional plans supportive of the Suape development.

The first of these problems is primarily due to the difference in the construction schedules, that is, to the fact that factory and urban construction will be undertaken after roads and a port have been built. Perhaps this point may not be worth considering, but we do not believe that it is necessary to complete the construction of railway lines and road by 1985. It is possible that the construction of some of these will be delayed, taking into account the trends in the establishment of industries and that some industrial land will be acquired in stages considering the order of construction. It is ideal but considerably difficult to develop the infrastructure in all the development area at a single time. It is more realistic to divide the development area into several blocks and to divide the construction period for each block into several stages.

The second problem is due to the fact that factories have already been located, or land for factories has been already obtained, in the area along PE–60, under the stimulus of the tax relief measures for enterprises investing in the Cabo district. Fig. 4-12, taken from the

Fig. 4-11 Conceptual Flow for Land Use Planning in the Suape Region, and Problems Related to Land Use

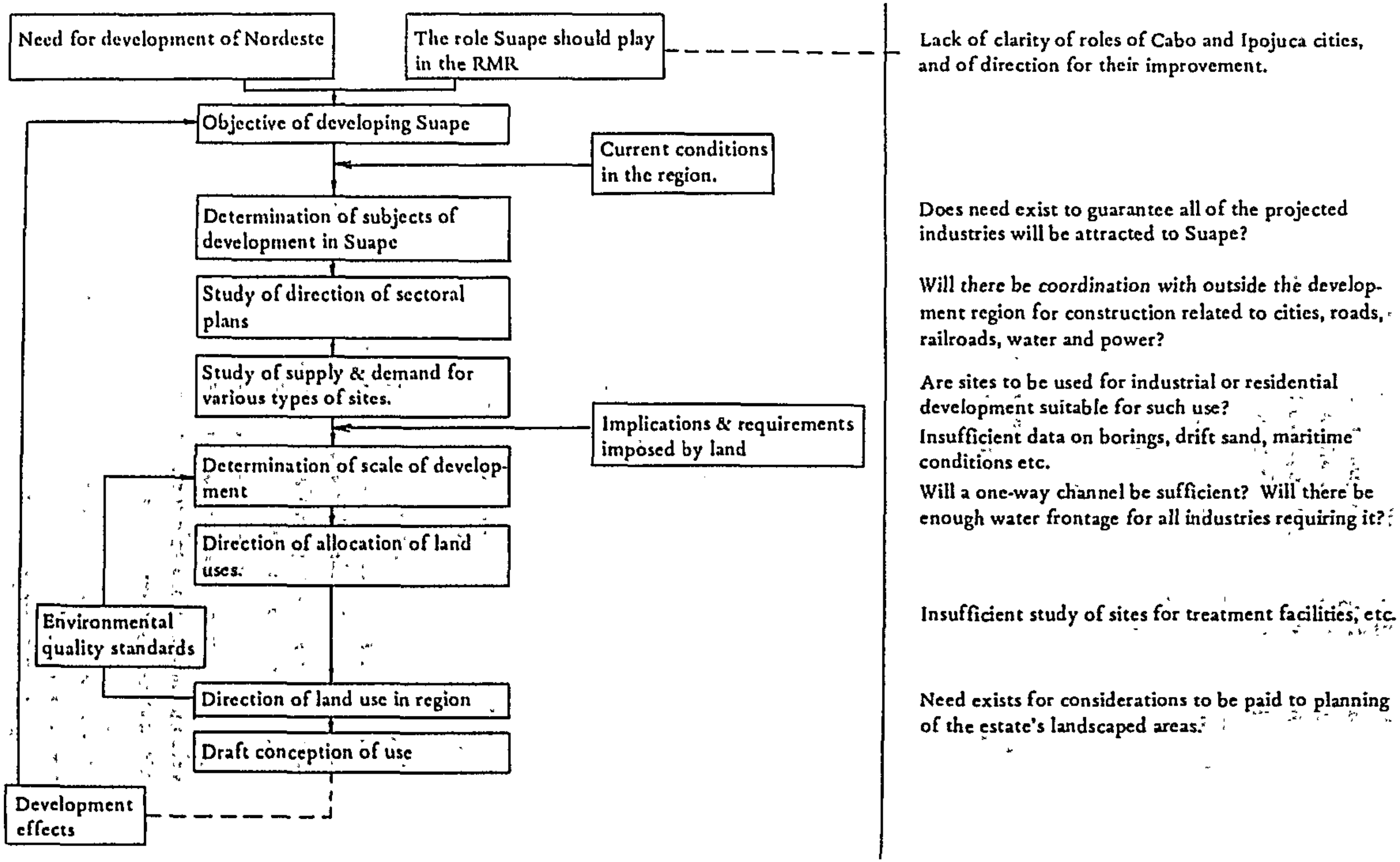
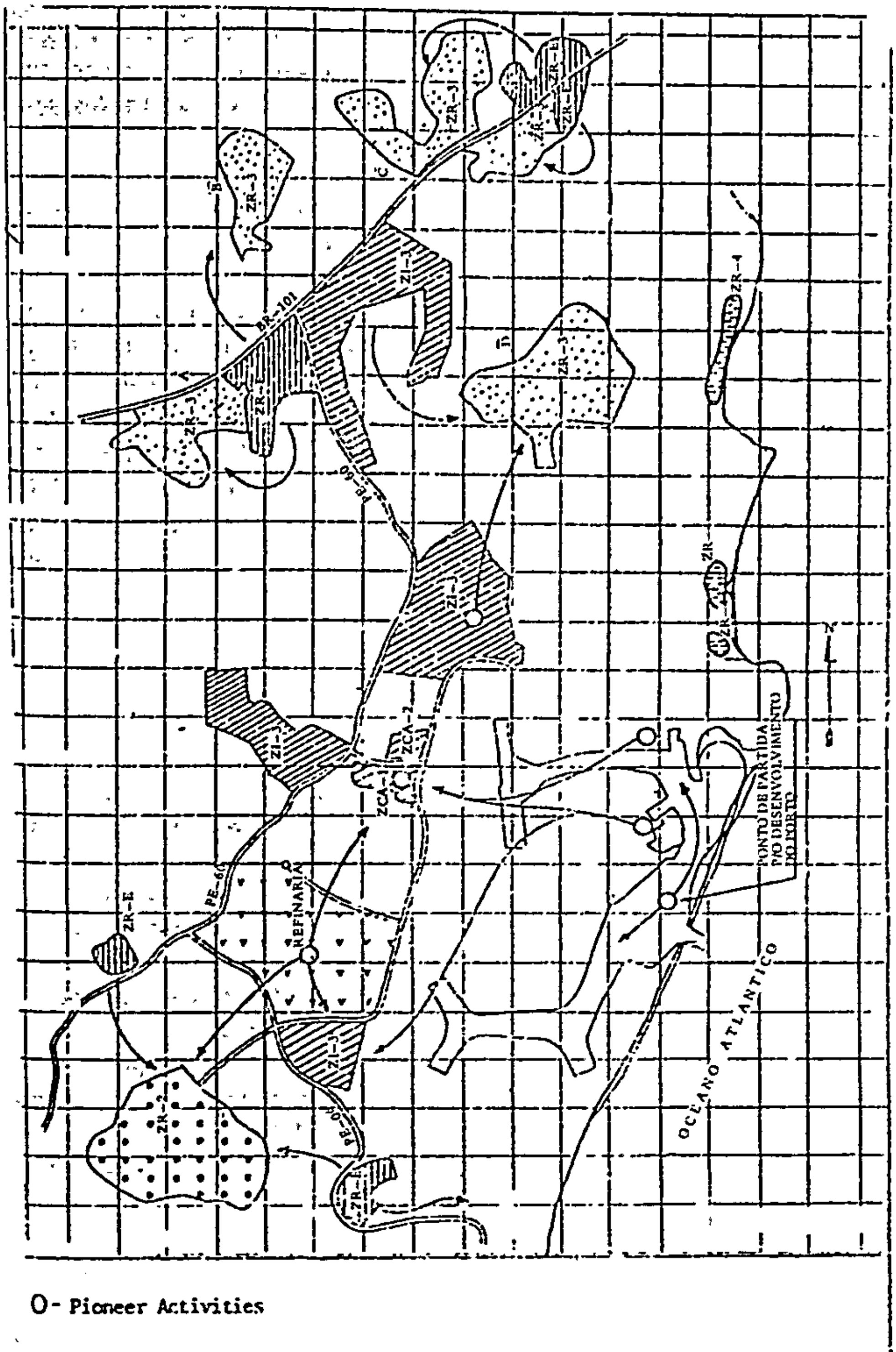


Fig. 4-12 Development Direction of I.C. Areas



O- Pioneer Activities

TRANSCON Report, shows the areas of pioneer activities and the directions of development. They seem to be rather decentralized.

Since the feature of the Suape Development Plan is the construction of a port and the development of basic industries related to it, it is not always necessary to construct at an early date the ZI–3 area dependent on the PE–60; it is desirable to push development in the Cabo industrial estate and in the other satellite cities.

If the status quo is maintained in the area west of the primary distribution road in the industrial area, the pattern of development will be more compact.

The third problem is the vague relationship between the Suape Development Plan and related development plans for the areas outside Suape. It is imperative that the plans for construction of railway lines serving a wide area and of a marshalling yard, and for development of PE–9 serving as a by-pass for BR–101 and of the loop road connecting Cabo with Jaboatao be coordinated as soon as possible and their construction accelerated. In Japan development projects often require residents to be relocated. Although sufficient compensation money is paid to these relocatees, quite a few of them were driven into miserable situations because of the very drastic change in their way of life. It is thought to be desirable to encourage relocatees to establish new firms with their compensation money, secure for them new land for agriculture, provide them with vocational trading and guidance, and help them work in the industrial complex.

(2) Study of Residential Land Development Program

According to the TRANSCON Report, it is estimated that 564 ha of land will be allocated for part of the collective port handling wheat, vegetable oils, and sugar and for the oil refinery, cement terminal, ship maintenance, aluminum, and fertilizer plants, while 846 persons will be employed in the power management district, 5,200 persons in the industrial district, and 15,000 persons in construction work. To accommodate these workers and their families, the ZR–P district, and the ZR–1 and ZR–2 districts will be first developed, then followed by the development of the ZRT district. The ZR–P district, 167 ha in area, is the site for temporary housing for workers who will be engaged in the construction of factories, the port, and the infrastructure including roads, railways, water supply and drainage facilities, and electric power supply facilities. Since some pollution is likely to occur, it is planned for the district to be re-zoned for industrial use in the future. As for permanent housing for workers in industry and port management, the ZR–1 (75 ha for accommodating 10,400 persons) in Nossa Senhora do O with some danger of flooding, and the ZR–2 district (627 ha for accommodating 81,400 persons) in Boasica will be developed primarily for low-income families.

The first necessities for starting the development project are temporary housing for construction workers and places for storing construction materials. The ZR–P district has been planned for such a purpose. Its location seems proper in view of its proximity to the existing PE–60. It is not necessary, however, to concentrate in this district all the prefabricated housing for construction workers. A large number of construction workers, estimated at about 15,000. will be needed for a long period of time. The housing for these workers will need to be relocated at the earliest possible date for fear that workers will be affected by air pollution when an oil refinery starts its operation at the first stage of the project. In Japan, it is proposed that durable and permanent, not temporary, housing be built for construction workers from the outset and be later occupied by resident industrial workers. Housing for single persons may be constructed on a temporary basis in the ZR–P district, but it seems advisable to build permanent housing for married persons from the outset in Cabo and N.S. do O.

The next question is where to start urban construction. The order of construction given in the TRANSCON Report, that is, first the construction of the ZR–1 district in Nossa Senhora do O, then the construction of the ZR–2 district in Boasica, will not cause any problem if PE–9 is constructed and the Ipojuca River diverted to avoid flooding. It is a very good idea to construct high-level urban facilities with a view to building a large-scale new town which combines places of production, recreation, and residence. In the case of building a residential city through industrial and port development as in Suape, the size of the city will be determined largely by the maturity of the industrial complex. Generally speaking, it is likely that such a residential city entirely devoted to workers will face many problems including lack of a balanced population composition and lack of balance of supply and demand of public facilities. The goal should be harmonious, balanced urban development. Such a goal, however, will require increased expenditure for urban construction. It is worth considering the schedule in which the development of the existing cities will precede the construction of a new town, taking into account the progress of the construction of an industrial estate.

The construction of the ZRT district (high-class residential area) is likely to be delayed, for it is detached from the main area of the project. Since the Brazilian people like the seaside, it will be the most-preferred residential area combined with marine recreation. It should be designed from the outset with such a fact in mind. When the ZR–1 district begins to be settled, demand for the construction of the ZRT district will grow.

The above three points concerning residential land development should be closely examined and confirmed.

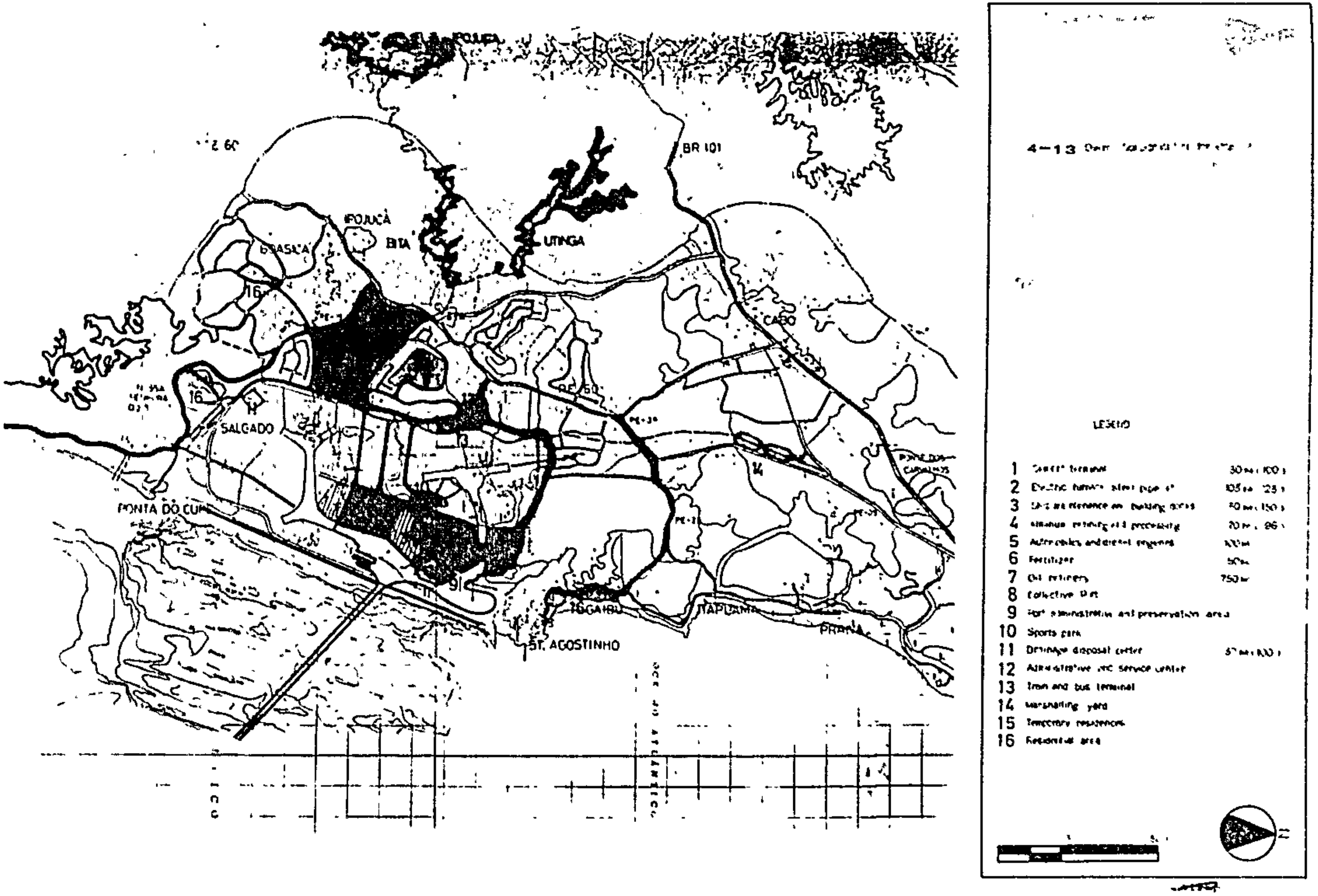
(3) Cost for Residential Construction in the Stage I by the TRANSCON

The total investment for urban construction is estimated at about Cr$ 5,340 million. The breakdown of the investment by district is as follows:

	Residential construction cost (in 10,000 yen)	(Cr$ 1,000)
Administrative district	26,428	8,259
Residential district	94,800	29,625
Nossa Senhora do O	257,766	80,552
Boasica	1,329,699	415,534
Total	1,708,693	533,967

The costs for the main water supply system, trunk roads, and waste water treatment are given elsewhere. It is not clear, however, whether the figures in the above table are the sums of housing construction cost and land development cost or whether they include the costs for rain water drainage, landscaping, power transmission lines, and other work. It is difficult to estimate the actual costs of construction. Estimated on the basis of large-scale residential land development projects in Japan, the total cost of residential land development in Boasica, slightly elevated, excluding the cost for housing, will amount to 100 million yen per hectare. The cost for housing will differ considerably from house-type to house-type. Judging from the size of houses given in the TRANSCON report, the cost for housing construction in the average Japanese new town will be about 200 million yen per hectare. Drawing on the Japanese example, the cost for the Nossa Senhora do O district (75 ha) will be about 23,500 million yen, even if the costs for the main water supply system, roads, and waste water treatment are excluded, much higher than the costs given in the TRANSCON report. It may be said that the costs in the plan are considerably lower than in Japan.

If the costs in the TRANSCON report are justified, the cost of construction required at the outset including only part of the Boasica district, in addition to the Nossa Senhora do O district, will be about 2,200 million CrS. It is obvious, however, that demand for housing will gradually increase when new firms decide to locate in the area after the first stage of construction. If the need for construction up to 1994 is taken into account, at least the cost of construction estimated in the TRANSCON report will be necessary.


4—13
BR 101
UTINGA
IPOJUCA
BITA
SALGADO
PONTA DO CUPE
ST. AGOSTINHO
TAPUAMA
CABO
PRAIA
LEGEND
1
2
3
4
5
6 Fertilizer
7 Oil refinery
8
9
10 Sports park
11 Drainage disposal center
12
13
14 Marshalling yard
15 Temporary residences
16 Residential area

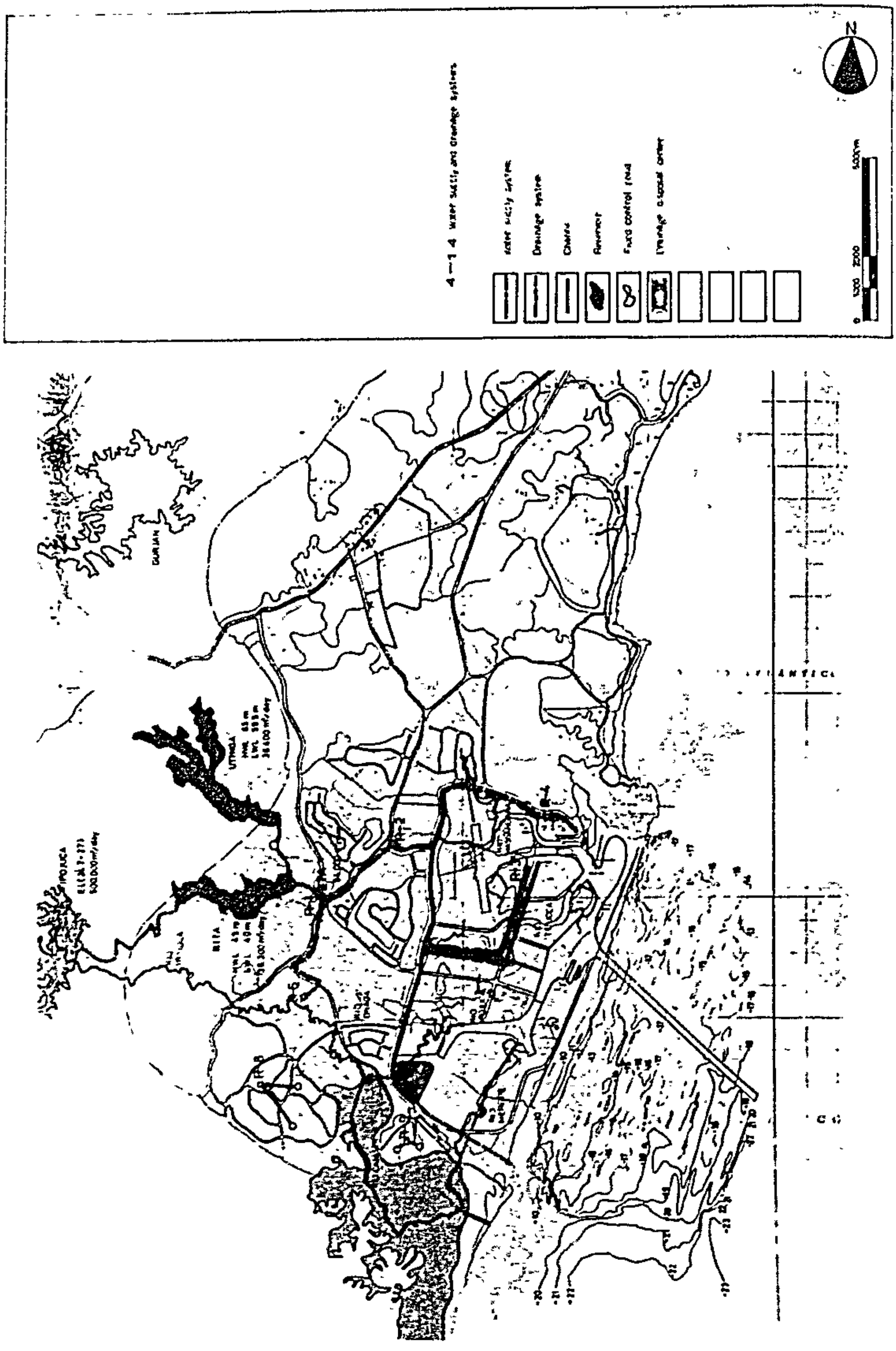

4—1 4 Water supply and drainage systems
Water supply system
Drainage system
Reservoir
N
0

Fig. 4-15 Plan Directeur du Complexe Industriel et Portuaire de Suape Presente por Transcon

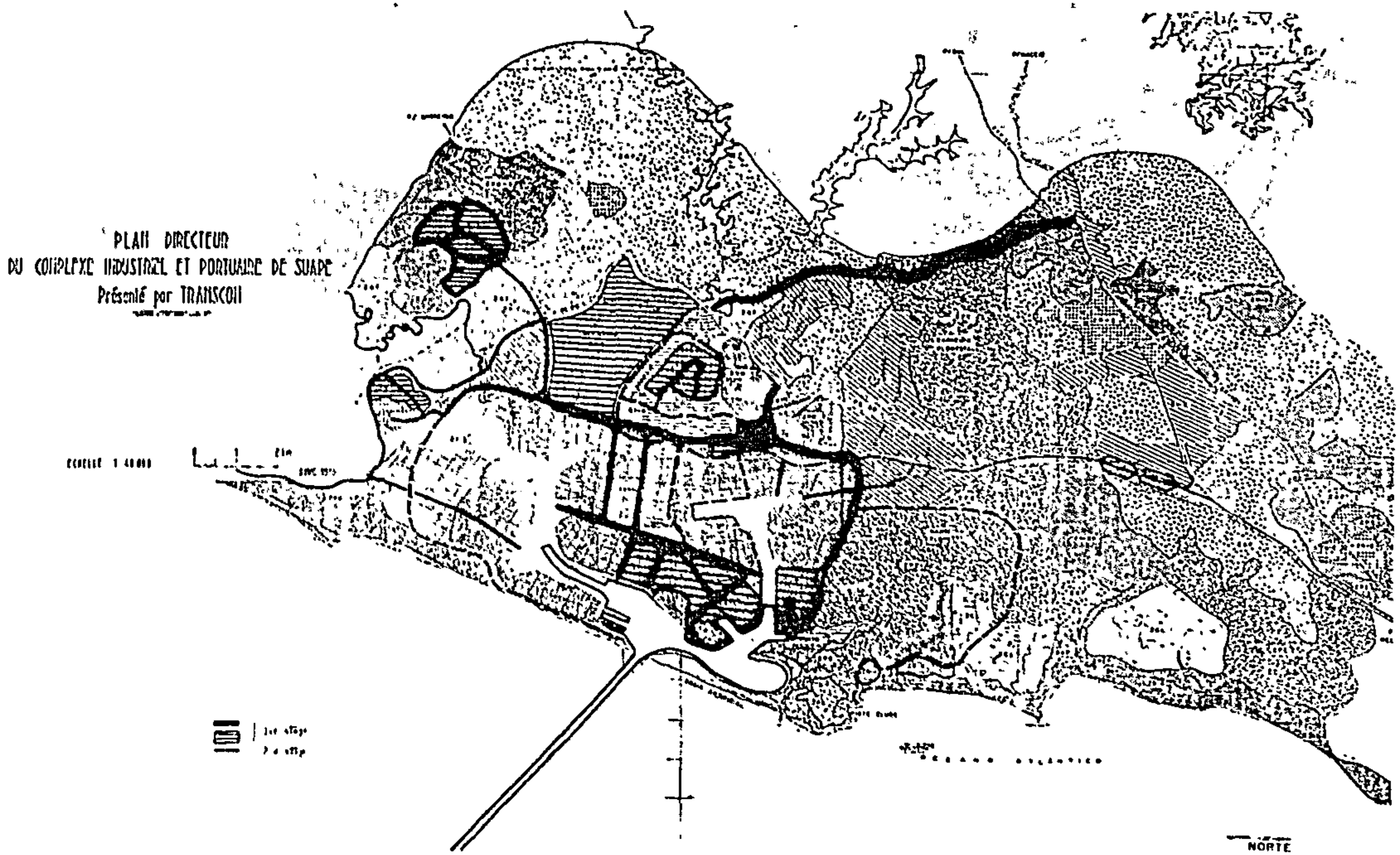
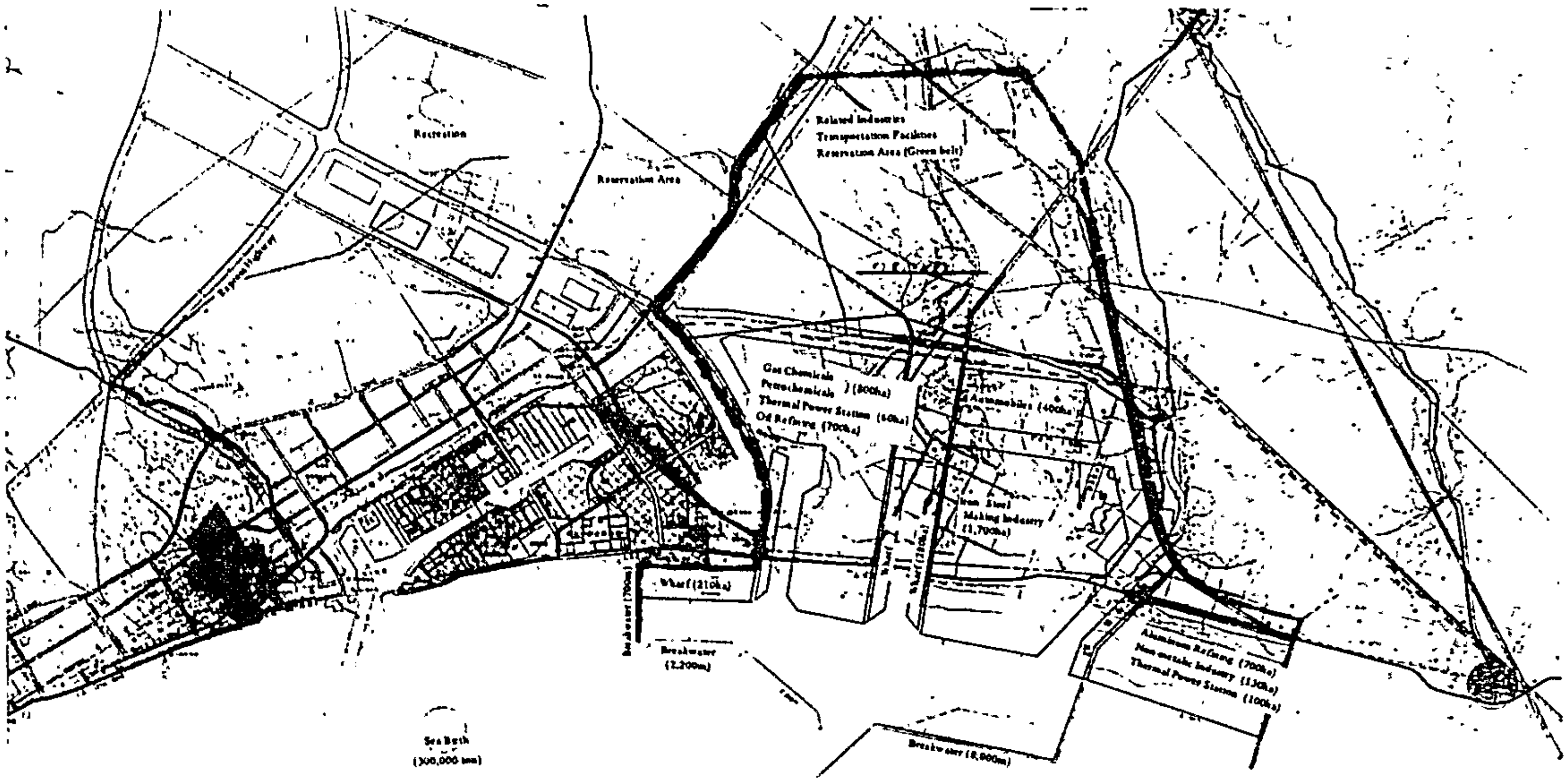


Fig. 4-16 Master Plan for Tomakomai Coastal Industrial Estate



PART II. STAGE I PLANNING FOR THE SUAPE

CHAPTER 1. BASIC THINKING BEHIND THE SURVEY TEAM'S PROPOSALS

Considering the Suape project more realistically, we offer proposals concerning Stage I planning for the Suape, in order to clarify the development possibilities.

Stage I planning considers what kind of industries should be located there, in correspondence with the scale of port and harbor facilities being planned for immediate development; and the infrastructure necessary for this, for example, road, railways, industrial water, domestic water, and housing. Planning also includes flood control measures, which are of prime importance for regional development.

In the TRANSCON report, planning calls for Stage I to begin in 1980, with completion in 2005, and in general this period can be considered appropriate. The scale and categories of industry in Stage I planning are taken up considering the outlook for Stage II, but the land to be used and the wharves are thought to be sufficient for Stage II planning, and the land for future use is not split off.

When this vast amount of land is used during Stage I, from the viewpoint of the final plan of the estate, plants will appear to be scattered around.

However, consideration was directed toward this not occurring, as much as possible.

The industries selected are as follows:

Fertilizer
Aluminum
Ship maintenance dock
Rolled steel
Automobiles
Petroleum
Cement (terminal)

These industrial categories are distributed in the areas for Stage I land and port and harbor development, considering the types of ships, length of wharves, and the necessary area; and are coordinated with planning for roads, railways, etc.

Stage I planning conforms in basic principle to Brazilian intentions.

(1) Character of Stage I

The project comprises the following sections: regional development, industrial development, port and harbor improvement, and infrastructure other than ports and harbors.

Details are discussed in the general outlines for each section.

The overall plan is conceptualized from the standpoint of regional development. Initial concrete planning is studied for each section and provision is made for an organic connection of the sections. The planning itself, as one stage of operations, is generally complete.

The thinking represented in this planning is not what the Brazilians side call a reduction of scale, but includes planning for the principal points which have a high potential for immediate realization in the early stages, which in turn lead to final planning. The planning will be a cardinal point for future development planning.

For that reason, land use in regional planning and improvements in ports and harbors and other infrastructure are in the character of proposed amendments to the planning in the TRANSCON report. In the industrial development planning, the amendments make for much more positive planning than originally.

Also, a promise of planning here is that the Suape regional development is considered within the framework of the Recife Metropolitan Plan, and in this respect is different basically from TRANSCON planning.

(2) Special Characteristics of Stage I Planning

Stated simply, the special characteristics of this planning are as follows:

(A) Regional planning

Planning here gives serious consideration to the Recife Metropolitan Plan. It also works toward the efficient use of ports and harbors in Stage I, the placement of industry, and the roads, water supply, drainage, housing, etc. necessary for that; and in particular toward elimination of the threat of damage caused by flooding. Beyond these concerns, planning works toward the creation of an environmentally superior region.

(B) Industrial development

With the aim of creating a full scale coastal industrial estate that makes the best use of superior conditions for industrial location, planning works toward the introduction of basic industries in the early stages. Regarding industries with a good possibility of locating in the estate, consideration is given to introduction which is coordinated in planning terms with trends in Brazil, and to the development of related industries.

The Survey Team has persistently given consideration to the efficient use of ports and harbors, to good possibilities, and to the important point of introducing industrial categories that will provide an industrial base (for example, oil refinery, aluminum, automobiles, fertilizer. secondary steel products, etc.). Regarding the arrangement of industry in particular, we have investigated the creation of a superior industrial estate in terms of land use, such as waste treatment facilities, and function.

(C) Port and harbor improvement

Taking TRANSCON's thinking as the basis, we investigated commercial use piers in connection with industrial development.

The Survey Team worked toward the concrete investigation of issues such as the volume of cargo to handled, decisions concerning the number and types of ships entering and leaving the ports and harbors, water depth, wharf extension, channels, and berths.

(D) Infrastructure improvement other than ports and harbors

On the basis of TRANSCON's thinking, serious consideration was given flood control measures and water supply in particular. Regarding flood prevention systems in particular, we have stated our opinions on the necessity of new drainage canals and regulating ponds.

CHAPTER 2. REGIONAL PLANNING

1. General Outline

The Stage I planning proposals were prepared recognizing that part of the construction is already beginning. We have confined ourselves to following the original TRANSCON proposals as much as possible, and suggesting partial modifications to the proposal.

The first procedure is to determine the types, scale, and arrangement of the industry and port and harbor features which are the nucleus of the project. In accordance with the discussions of industry and ports and harbors states in the following chapters, estimates of the construction of residential areas and the level of necessary infrastructure were made to formulate the layout.

Planning for the Collective Port generally follows TRANSCON's Stage I planning.

In planning for the industrial estate, industries which do not directly use the port and harbor, or are not directly connected with those industries, should be located in industrial areas such as the satellite cities in the Recife metropolitan area, including the Cabo industrial estate. In Stage I, with the exception of the oil refinery, industries are designed to located in the hinterlands of the port and harbor area. Though it is necessary to coordinate planning with Cabo, housing construction sites are planned following the original proposal to be made in NS.S do O, where urban agglomeration is found, those parts of the Boasica area which are suitable sites for new urban development, and on the ZRT region where demand for quality residence is expected.

Regarding temporary housing areas, because of worries about air pollution when the oil refinery begins operations, they should be removed at an early stage as stated in the original proposal.

In the infrastructure section, flood control and the road system must receive priority in investigation. For flood control, it was decided to call for construction of the Ipojuca dam, which serves also for water supply, and the two dams at Bita and Utinga; and construction of PE-9 (which also serves as a dike) in order to protect the industrial estate and the N.S. do O residential construction area from floods.

The flow of the Ipojuca river, which will be interrupted by this construction, will be led to the outer waters. The waterways within the industrial estate, which will also be used to provide water for purification of the future port and harbor, will use the existing river beds, with the exception of the central waterway, originating from the proposed temporary housing area.

Regarding the road system, the existing PE-60 will be used as an arterial route serving a wide area. Routes connecting the port, industrial, residential, and administrative areas to PE-60, and arterial routes linking the regions have been re-selected.

Considering the transport of only immediate materials, a single track railway to the principal industrial, and port and harbor areas has been indicated.

The placement of industrial waste water treatment facilities should be made in accordance with the result of investigation of the arrangement of industry over the long term. Because a high volume of waste water is forecast, it has been re-established in a position for possible water catchment.

Because tourist areas do not necessarily have to be coordinated with development of the industrial estate, that topic has been excluded from the investigation of Stage I planning.

Regarding agricultural and forest areas to be preserved, within the industrial estate, the periphery of which will be developed in Stage I construction, the present conditions will be maintained, with the exception of two green zones at the port entrance.

2. Advancing Regional Planning in Stage I

(1) Development of Residential Areas, Stage I

The number of employees, calculated from the industrial categories and scales indicated by the Japanese mission for Stage I, and from the planning for ports and harbors, will be 8,276 people.

	Number of Employees
Industry	7,430
Ports and harbors, administration	846
Total	8,276

Based on the TRANSCON report, average family size is 5.3 people per household, and taking 1.5 employees per household, the total number of employees and their families will be 29,241 people.

Within this the ratio of locally-hired workers (in the TRANSCON report this is dependent on the population of the existing urban areas) is 28.6%. Therefore the direct population increase in Stage I is 20,878 people.

Moreover, an increase in the tertiary population, in relation to the secondary population, must be anticipated. Considering the cases of industrial development and urbanization in Japan, the secondary industry population rises suddenly with the development of industrial estates, then there is a temporary halt in population change caused by industry. Following that, and after industrial development has proceeded to a certain extent, the population associated with tertiary industry increases. This pattern of population change is common, and so it does not appear there will be an immediate increase in the population connected with tertiary industry in Suape development.

Assuming that the rate of increase in tertiary industry-related population is estimated at 50% that of the secondary industry-related population, total population increase will be 31,317 people.

Population increase in Stage I will probably be in the 20,000 - 30,000 range.

This early stage population increase will not appear at once, but will develop gradually. Moreover, it is desirable that the first residential areas to be constructed be close to existing urban areas. The N. S. do O region, where the first construction is planned, will be an appropriate site if flood control measures are taken.

In accommodating the greater part of the population inflow into Suape through the construction of new towns, it is safer for planning to call for preparation of residential areas which can handle a large population. In that case, preparations for the N. S. do O to accommodate 10,400 people, and for the remaining 20,917 to be distributed in the ZR-2 and other areas, must be undertaken.

If the TRANSCON proposal is followed, construction will take place in the Boasica area. At the start of construction of the second residential area, it will be necessary to consider the demand for environmentally sound residential areas, and also to start construction in the ZRT area.

There will be no problems with temporary housing areas until the stage of plant construction. However, it is desirable to remove them before full scale operations begin at the oil refinery.

Also included in Stage I planning is the necessity of constructing residential estates for the existing industrial estate at the city of Cabo, because of industries moving in.

(2) Land Use and Allocation within the Industrial Estate

Our position concerning the layout of the estate, in principle, follows the TRANSCON plan.

The locating of industry considers the scale of land operationally possible to use, with some leeway, until such time as the final objectives of the group of plants to be constructed in Stage I are met; and also considers making use along the shore line as compact as possible.

The volume of excavation has increased slightly from the original plan, because of the addition of new industrial categories.

Concerning the zone between the channel and the reef, because the possibility remains for opening a channel from the Ipojuca in the future, it is highly desirable that the selected industrial categories be those that require a low volume of traffic with inland areas and a large volume of cooling water, for example, power generation, petroleum product tanks, or the cement terminal. It has been decided to arrange for a petroleum product tank yard in Stage 1.

Regarding roads, two arterial routes, one connecting the Collective Port and oil refinery, the other linking the Administrative Center area with the littoral section, have been planned. Added to the north-south arterial routes which cross them, each industry has four semi-arterial approaches.

A rail route, to link the Collective Port, the fertilizer plant and oil refinery, is being selected.

Only the central section of the canal will see full-scale construction; in other areas, as much use as possible will be made of the waterways in their present condition.

The green zone being planned within the estate should be safeguarded as much as possible. In order to make practical use of this space within the estate, we propose that the Port Administrative Center's functions be divided and construction take place in the green zone along the shore; and that facilities such as a sports center and pond for employees be placed adjacent to each other in the green zone between the Administrative Center and the shore.

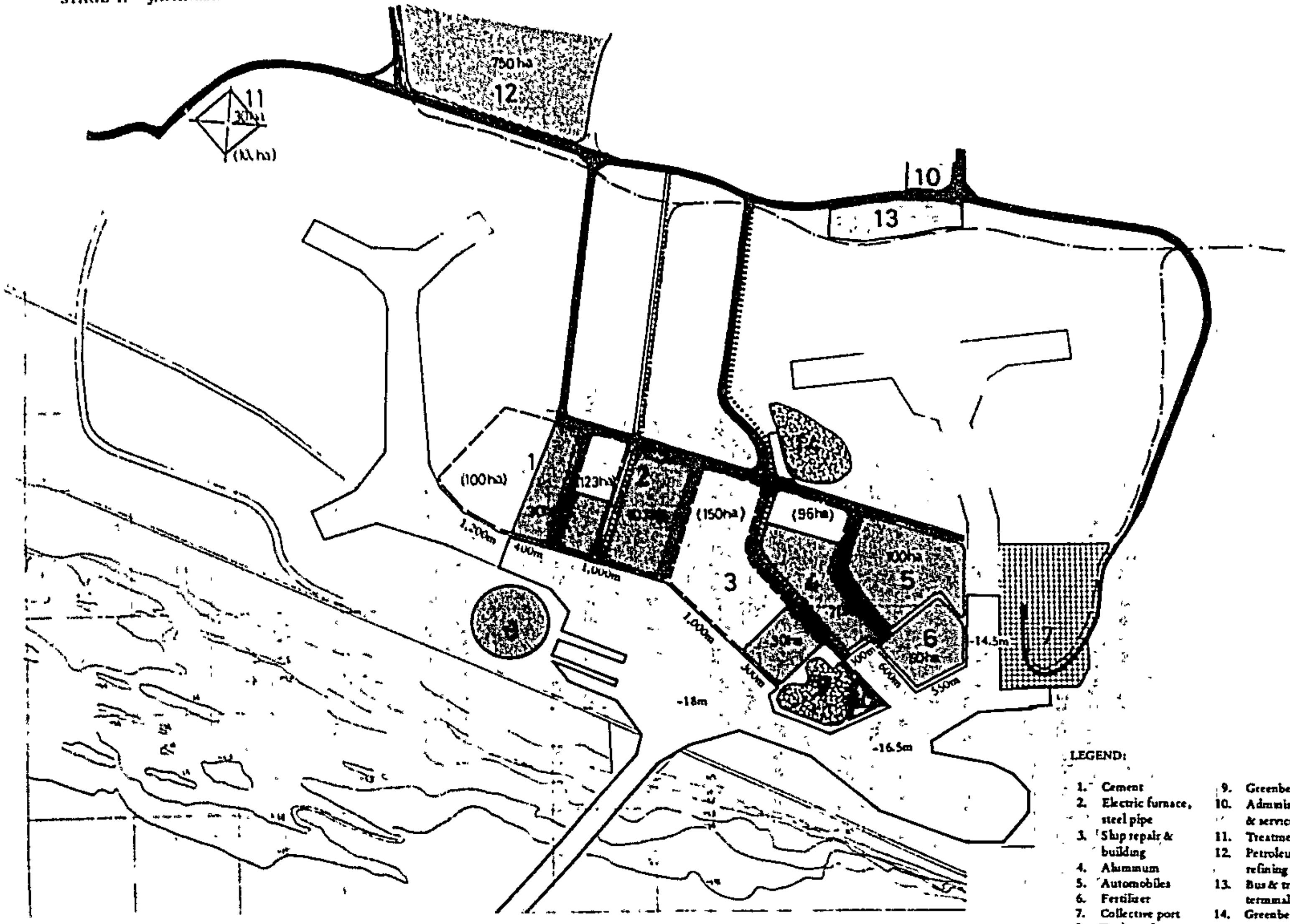
We have also planned for making a boulevard of the road connecting the Administrative Center, sports center, and the preserved area along the shore, to be side by side with a bicycle path.

Plantings can be made along the central waterway as well. Through this and improving roads for automobile use and other items, we have planned for the creation of a park system within the estate.

(3) Rough Cost Estimates for Development of Residential Areas

There is a wide difference between Brazilian construction costs as indicated in the TRANSCON report, and the costs in cases in Japan. We confine ourselves here to rough estimates which follow the prices indicated in that report.

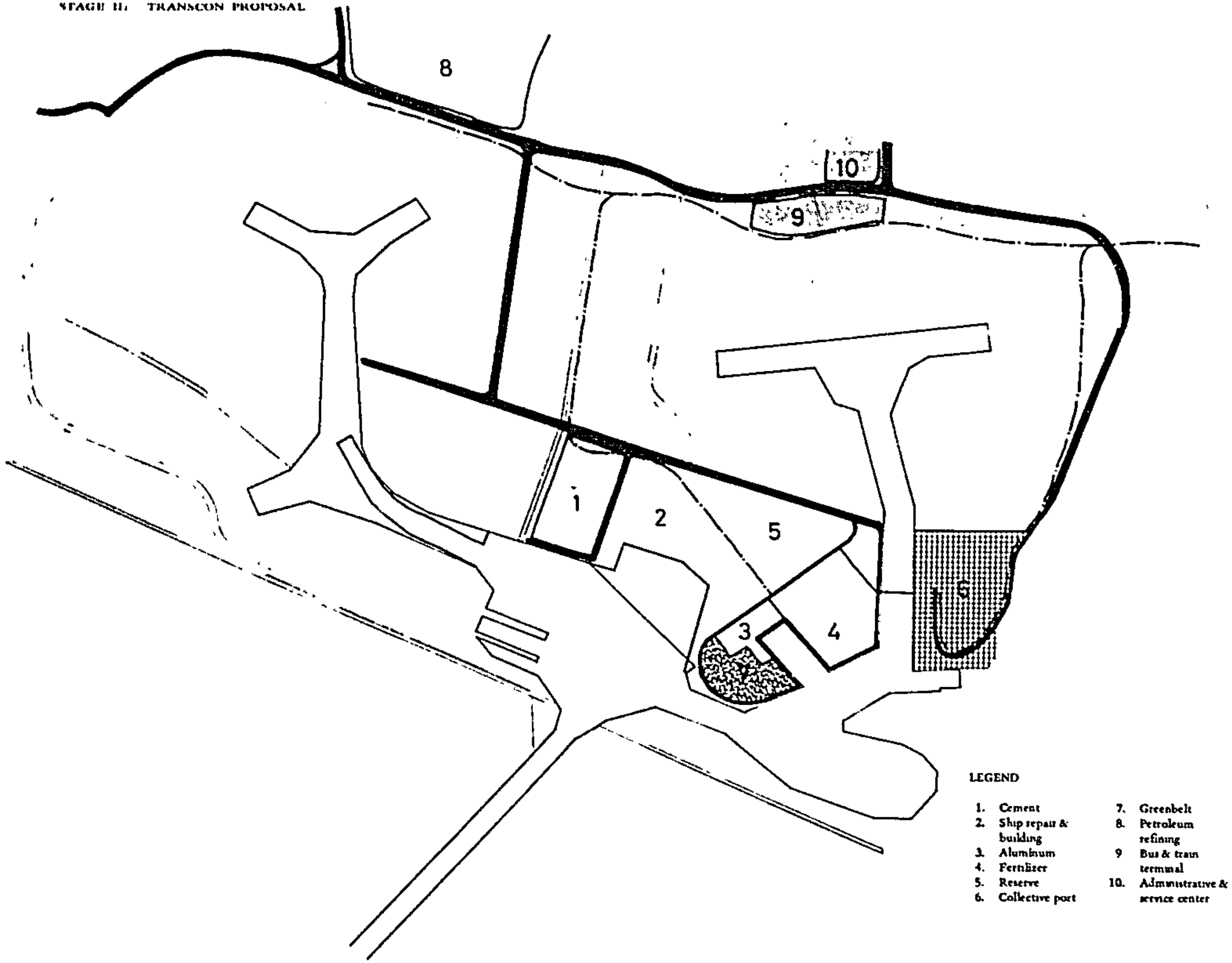
STAGE I: JAPANESE PROPOSAL



LEGEND:

1. Cement
2. Electric furnace, steel pipe
3. Ship repair & building
4. Aluminum
5. Automobiles
6. Fertilizer
7. Collective port
8. Tank yard
9. Greenbelt
10. Administrative & service center
11. Treatment
12. Petroleum refining
13. Bus & train terminal
14. Greenbelt

STAGE II: TRANSCON PROPOSAL



	TRANSCON proposal	Japanese proposal	
Administration area	8,259 Cr$	8,259	100%
Temporary housing area	29,625	29,625	100%
N. S. do O	80,552	80,552	100%
Boasica and other	415,534	103,883	25%
Total	533,967	222,319	

The construction costs indicated in the TRANSCON report for the N. S. do O area (housing for 10,400 people) and for the Boasica area (81,400) are considered total construction costs until 1994, when construction is to be completed, and were calculated from the urban population expected for Stage I.

CHAPTER 3. INDUSTRIAL DEVELOPMENT

1. Introduction

Industrial development during Stage I basically adopts the plans indicated in the TRANSCON and APL reports.

It is thought that the industries to be established will primarily be those for which applications have already been filed and for which discussions are now being held. These include basic industries which will particularly important coastal industrial estate as a whole.

Because basic industries which are suitable to coastal locations are desirable from the viewpoint of use of the port and harbor to be built at the Suape, oil refinery has been recommended as a Stage I industry.

In determinating the parameters for industries to be introduced, Japanese experience has been used to supplement data given in the TRANSCON and APL reports.

Determining the location of industries has been done in view of their relationship with plans for development of the port and harbor and with infrastructure, in addition to which full consideration was given to the special characteristics of the industries themselves.

In particular, care was taken in regard to land use, infrastructure and other factors of importance in relation to plans for the final form of the Suape coastal industrial estate.

The scale of industrial development of the Suape would be large no matter what country might be concerned, and completion of the development plan will require a very long time. It is therefore desirable that the Stage I be strategically executed.

2. Categories of Industries to be introduced to the Suape

The categories of industry to be established in the Suape are given to Part I.

For all of these industries to engage in operations, a considerable period of time will be required, as is to be expected in view of the impact they will have not only on the Nordeste and Brazil economies, but on the world economy as well.

The TRANSCON report anticipates that the fertilizer plant will start production in 1987, and that aluminum refining and oil refinery will begin in 2005, as the final stage of the Suape development plan.

In Japan, creation of industrial land sites for the Mizushima estate were begun in

1953, and today, 23 years later the basic industries in that estate are just one step away from the final stage. In the case of the Kashima estate, land acquisition was begun in 1964 and 12 years later only half of the final stage of basic industries has been completed. Thus, a lengthy period of time is required for implementation of plans for industrial estates such as these.

Therefore, it is by no means unnatural to make the start of operations in the final stage of planning of the Suape basic industries the year 2000.

The Suape will be the industrial center of the Nordeste in the 21st century, but out of the categories indicated for Stage I, to what extent different categories will be operating is an unanswered question.

However, applications have already been filed and discussion begun with SUDENE and Pernambuco State by investors who wish to establish the following industries:

Fertilizer	Seamless steel pipe
Aluminum refining	Regular steel pipe
Automobiles	Casting
Materials transport vehicles	Forging
Steel rolling	Ship maintenance dock

Before work on construction of the industrial estate begins, as in the case of the fertilizer, aluminum refining and automobile industries, confirmation that strategically important industries will be established in the industrial estate will heighten the reality of the project.

In Japan there is no shortage of examples of preparation of a master plan for an industrial estate, implementation of port and harbor improvement works, and preparation of sites, all without determination of what industries are to be in that industrial estate. And at other times over-aggressive sales have resulted in an investor's purchase of a site having features he did not need.

In the case of the Suape, the favorable situation of there being applications and inquiries already submitted at the early planning stage augurs well for future implementation of plans. It would be desirable that this opportunity be grasped and that these industries be included.

However, from the viewpoint of maximizing the effects of investment in port and harbor development, it is thought that the burden placed on the port and harbor by these industries, the cement terminal and the other terminals plan for the Collective Port area is low.

Therefore, it is thought desirable that oil refinery, which would make extensive use of the port and harbor, be included in Stage I industries.

3. Parameters of Industries to be introduced

Parameters of the industries to be introduced are given in Table 3-2.

The figures given by both consultants in their report have been used without change. Designation of materials, and information on quantities, sources, transport modes, plant site areas and number of workers are from two consultants' reports as well as information obtained in discussions held at DIPER and APL, and are used without change.

However, some costs and some transport modes used for products have been assumed on the basis of the precedents provided by similar goods as reported to the Survey Team.

Concerning industrial water (drinking and process water) and electric power, since no data was available from the above sources, calculations were based on Japanese precedents.

As a result, total requirements for Stage I have been found to be as follows:

A.	Industrial sites (ha)	1,103
B.	Industrial water (m^3/d) (drinking and process water)	91,280
C.	Electric power (kw)	307,360
D.	Employees (person)	7,430
E.	Transport	
	Marine transport	
	Raw materials	
	Crude oil (kℓ/y)	7,650,000
	Others (t/y)	3,132,922
	Products	
	Refined oil (kℓ/y)	6,337,760
	Others (t/y)	2,434,200
	Total	
	Crude & refined oil (kℓ/y)	13,987,760
	Others (t/y)	5,567,122
	Overland transport	
	Raw materials	
	Crude oil (kℓ/y)	
	Others (t/y)	87,510
	Products	
	Refined oil (kℓ/y)	700,000
	Others (t/y)	528,660

Total	
Crude & refined oil (kℓ/y)	700,000
Others (t/y)	616,170

Table 3-1. Categories and Products of Industries to be introduced during Stage I

Category	Products
Fertilizer	NPK (15–15–15), NP (8–30–0)
Aluminum refining	
Oil refinery	
Automobiles	Commercial vehicles; diesel engines
Material transport vehicles	Three-wheel vehicles, trailers, tank trailers, wooden truck bodies
Ship maintenance dock	
Rolling of steel sheets	Tinplate, cold rolled bobbin, sheets
Seamless steel pipe (electric steel)	
Plain steel pipe	
Casting & forging	
Cement terminal*	

* The cement terminal is included here because it is within the estate, and even though it is primarily a trade-related enterprise.

Table 3-2. Main Aspects of Industries to be introduced into Suape during Stage I

Category of Industry, & Product	Production Scale	Raw Materials			Means of Transport				Plant Site (ha)	Industrial Water (Fresh Water) m³/d	Power (kw)	Workers (person)
					Material		Products					
		Designation	Quantity	Sources	Maritime	Overland	Maritime	Overland				
• Fertilizer	215,000 t/y	Phosphate rock	37,701	Morocco Florida	190,362 t/y		86,000 t/y	129,000 t/y	50	18,000	4,000	98
NPK (15–15–15)	170,000	Ammonium sulfate	13,021	Florida								
NP (8–30–0)	45,000	Potassium chloride	42,500	Overseas								
		Phosphate ammonia Ammonia Urea	52,580 6,990	Overseas Bia de Aratu								
• Aluminum refining	100,000	Alumina	200,000	Amazonia	309,000 t/y		40,000 t/y	60,000 t/y	70	7,000	190,000	750
		Cokes	70,000	America Europe								
		Coal	4,000	Santa Calina								
		Pitch	30,000	Sao Paulo Minas Gerais								
		Quartz	2,000	America Europe Japan								
		Aluminum florida	3,000	Sao Paulo								
• Petroleum refining	150,000 BPSD (7,037,760 kl/y)	Crude oil	7,650,000 kl/y	Overseas	7,650,000 kl/y		6,337,760 kl/y	700,000 kl/y	750	18,000	38,000	300
Automobiles									60	500	3,000	1,567
Commercial vehicles (CKD)	10,000 v/y		10,000 t/y	Ex region	10,000 t/y		500 t/y	9,500 t/y				
Diesel motor	50,000 v/y		15,000 t/y	Ex region	15,000 t/y		12,000 t/y	3,000 t/y				
Material transport vehicles	4,752 v/y		24,260 t/y	Ex region	24,260 t/y			24,260 t/y	40	200	1,500	1,016
Three wheel vehicles	2,520											
Trailers	669											
Dump truck	648											
Tank trailers	67											
Wooden truck bodies	848											
Repair dock	70,000 – 100,000 DWT dock								30	500	5,000	800
Rolling of sheet steel	300,000	Billets	304,800	Ex region	304,800		90 000	210,000	40	8,800	1,430	945
Tinplate	150,000											
Cold rolled bobbins thin sheets	150,000											
Seamless steel pipe (electric steel)	250,000 t/y	Pellets Scrap steel	240,000 72,500	Tubarao Own factory etc.	240,000 39,500	33,000 t/y	192,500	57,500	50	38,000	56,630	993
Seam steel pipe	24,000 t/y	Cold rolled steel Hot rolled steel	26,600	Suape, etc		26,600	4,800	19,200	5	50	300	331
Casting	12,600 t/y	Pig iron Sand	10,760	Nordeste		10,760		12,600	4	130	6,700	330
Forging	12,000 t/y	Steel sheet	17,150	Suape		17,150	8,400	3,600	4	100	800	300
• Cement terminal	2,000,000 t/y	Clinker Gypsum	2,000,000	Nordeste	2,000,000		2,000,000		100		-	-
Total			3,220,432 t/y 7,650,000 kl/y		3,132,900 t/y 7 650,000 kl/y	87,510	2,434,200 t/y 6,337,760 kl/y	528,660 t/y 700,000 kl/y	1,103	91,280	307,360	7,430

Notes: A second stage will follow Stage I which is recorded in this table. Plant site areas are total site areas.

4. Location of Industries

Discussion of the location of industries in the final stage is described in Part I, Chapter II. Here, consideration is given to location of industries for Stage I. The basic assumptions in this regard are (1) because the industries to be included in the estate at its final stage of development are already determined, to locate them with consideration paid to locations in the final stage and so that their industrial functions may be fully developed and (2) to match as best possible the tempo of construction of port and harbor facilities and industrial site creation.

Determination of locations followed this sequence:

(1) Distinction is made, among those industrial categories to be included in the final stage, between those closely related to the coastline and ocean and those not so related. As a result of this, the following have been identified as belonging to the first of these two groups (asterisk indicates inclusion in Stage I).

Fertilizer*	Oil refinery*
Petrochemicals	Sugar-based chemicals
Rolling of steel sheet*	Seamless pipe (electric)*
Processing of steel materials	Aluminum refining*
Copper refining	Lead refining
Zinc refining	Automobiles*
Ship maintenance dock*	Ship building dock
Thermal power generation	Cement terminal*

(2) These related industries have been located as close to each other as possible.

(3) Of the above, those related to other industries have been located as close to each other as possible.

(4) Industries have been located in accordance with the channel depth to be required by vessels serving those industries.

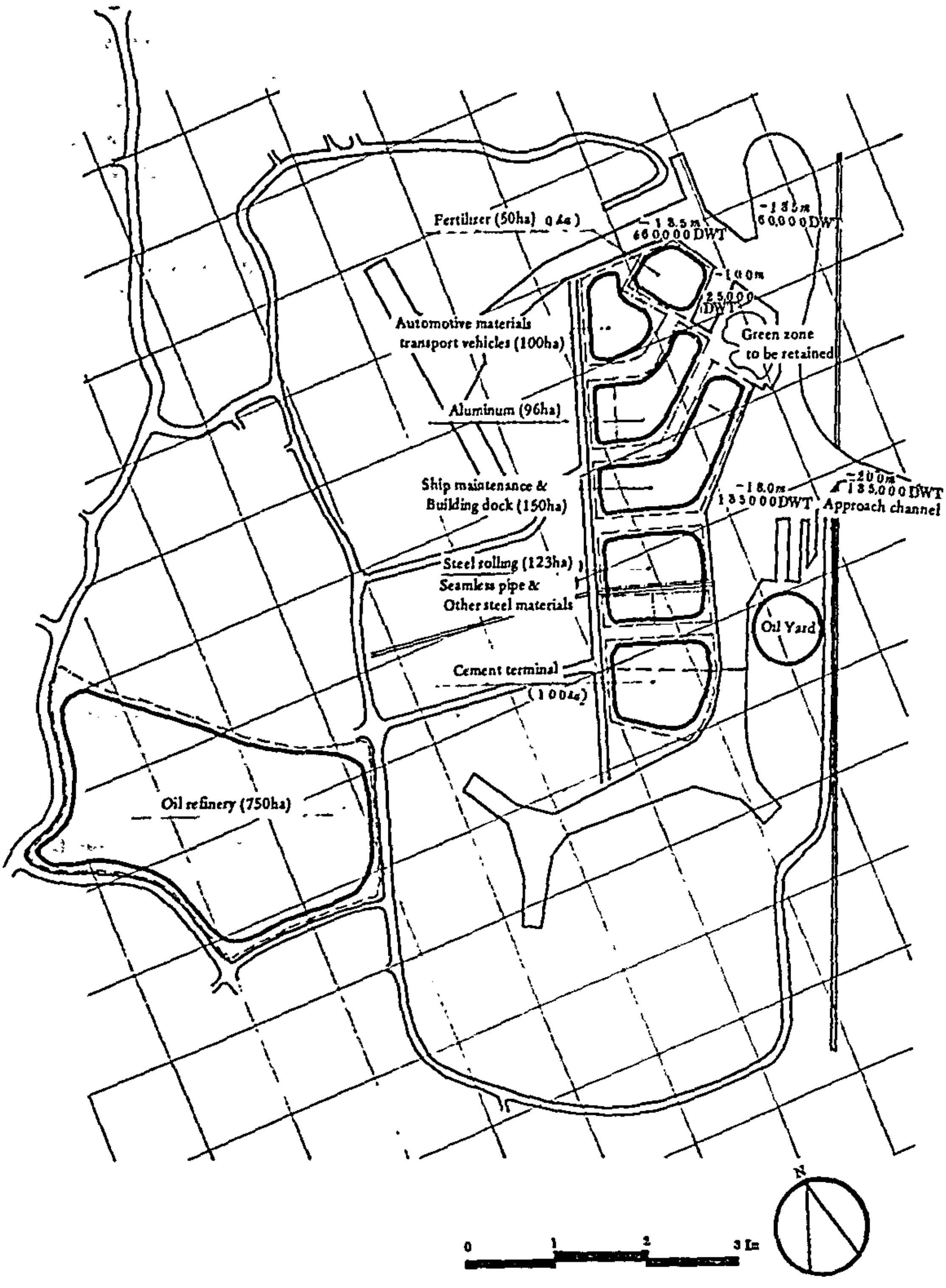
(5) Industries have been located in accordance with water frontage requirements and industrial site water frontage requirements.

(6) By following the above procedure, our image of the ultimate general layout of the estate is obtained. Industries were then located on the assumption that in Stage I. For industries to be established in Stage I, locations were decided on the basis of where port and harbor facilities would be constructed and where industrial sites would be formed during Stage I. The results are shown in Fig. 3-1.

The manners of locating industries was as follows:

(1) Because among the fertilizer, aluminum refining and automobile industries, the

Fig. 3-1. Conceptual Plan of the Location of Industries for Stage I



maximum size vessel which would be used would be 60,000 DWT (–13.5 m), for the fertilizer industry, and the standard vessel would be 20,000 DWT (–10.0 m) for the fertilizer and aluminum refining industries, these are to be in the north channel district.

(2) The ship maintenance dock would service 70,000 to 100,000 DWT vessels, and the ship building dock to be built in the future would, in combination, require considerable water frontage. Also because of need to make entry to and exit from the docks convenient to vessels, the dock is to be in the district directly facing the approach channel. Moreover the ship building dock will be adjacent to the maintenance dock.

(3) Rolling of steel and production of seamless steel pipe (from an electric furnace), including categories to be introduced after Stage I, are expected to use vessels of the maximum class of 20,000 DWT, for which reason they could be located in the north channel district, but since a shipbuilding dock will be constructed, it was deemed better to locate them adjacent to the future dock site, in view of their relationship to shipbuilding. Therefore, wherever possible steel-related industries should be located here.

(4) A site for the oil refinery has already been reserved behind the southern channel. However, because ships servicing the refinery will be of a maximum of 135,000 DWT it will be necessary to build tanks for crude oil and oil products at the south side of the entrance to the anchorage in the approach channel, and the petroleum wharf was located here. Pipelines would link the wharf and the refinery.

(5) The other industrial category to be established during Stage I is materials transport vehicles; if there is sufficient room, it should be located behind the automobile plant site.

(6) It is thought that exports from the cement terminal would be 60,000 DWT or larger, for which reason it is located in the south channel district, where none of the above are located.

CHAPTER 4. PORT AND HARBOR IMPROVEMENT

1. Outline

The Suape port is to have two functions, that of a large-scale industrial port and that of a collective port. It will be essential to stress the development of the industrial port since the amount of cargo and the number of ships handled in the industrial port will be extremely large. However, in the TRANSCON report, there is a rather detailed study of the Collective Port but almost nothing concerning the private terminals. No consideration has been given to the scale of the industry to be established in the estate, the resulting amount of cargo to be handled, the supply sources of the raw materials, and the conditions in the port, etc. with respect to the sizes of the ships to use the port of Suape and the sizes were decided merely on the basis of recent trends in the size of each type of ship.

Therefore, it will be necessary to investigate in detail the setting of the basic conditions and the port plan. The investigation of Stage I of the plan is to be based on the following concepts:

1) The concepts in the Stage I plan in the TRANSCON report will be respected.

2) The scale of the channels and mooring basin will be based on the current plan.

3) The overall berth length of the private terminals will be calculated on the basis of the standard berth handling capacity in Japan.

4) In the industrial layout, the cement terminal was originally considered as being included in the Collective Port but because of such considerations as the processing needs and the large space required, it will be located in the industrial area.

2. Stage I Port and Harbor Planning

(1) Industries

The Suape port has the following two important functions:

(A) Industrial port
An industrial port to handle the in-coming raw materials and out-going products for the industries located in the coastal industrial zone — private terminals.

(B) Collective port
Transshipment base for wheat, sugar, molasses, alcohol, and vegetable oil — special wharves for each commodity.

The Survey Team's selection of industries to be introduced into the industrial port zone is based on the results of interviews with APL. Detailed explanation of the materials to be handled at the collective port is given in the TRANSCON report.

The scales of production for industries that are considered to operate in Stage I planning are given below:

(A) Industrial port

Fertilizer (NPK, NP)	215,000 t/y
Oil refinery	150,000 bpsd
Steel (sheet rolling, pipe, casting, forging)	600,000 t/y
Aluminum refining	100,000 t/y
Automobiles and materials transport vehicles	10,000 v/y and 4,752 v/y
Ship maintenance dock	70,000 – 100,000 DWT
Cement terminal (clinker mill)	2,000,000 t/y

(B) Collective port

Sugar (out)	648,000 t/y
Wheat (in)	612,000 t/y
(out)	300,000 t/y
Molasses (out)	109,000 t/y
Alcohol (out)	115,000 t/y
Vegetable oil (out)	30,000 t/y

(2) Volume of Cargo Handled at Port

The volume of cargo to be handled in connection with these industries will be about 20,000,000 tons. Of this, the private terminals will handle 18,000,000 tons and the collective port 2,000,000 tons. In-coming and out-going volume will be about the same, about 10,000,000 tons each.

The estimate by TRANSCON of about 17,500,000 tons in 1980 is about 2,500,000 tons less than the Survey Team's estimate. The difference is mainly due to the volume of cargo handling for the steel-related industries, recommended by the Survey Team for inclusion in the estate.

Table 4-1 compares the cargo handling volume estimates of the Survey Team and TRANSCON. Table 4-2 gives estimates of the volume of cargo to be handled, by each industry.

Table 4-1. Cargo Handled at Port, Stage I

	Estimate by the Survey Team	Estimate by TRANSCON
Private Terminals	18,156	15,701
Imports	10,018	10,456
Exports	8,138	5,245
Collective Port	1,814	1,814
Imports	612	612
Exports	1,202	1,202
Total	19,970	17,515
Imports	10,630	11,068
Exports	9,340	6,447

Table 4-2. Cargo Handled at Port, Stage I, by Industrial Categories Planned for Introduction

	Production Scale	Site Area (ha)	Volume of Cargo Handled (t)		
			Raw Materials	Products	Total
Fertilizer	215,000 t/y	50	190,362	86,000	276,362
Petroleum refining	150,000 BDSP (7,037,760 kl/y)	750	6,885,000 (7,650,000)	5,703,300 (6,337,000)	12,588,300 (13,987,000)
Steel-related					
Steel rolling	300,000 t/y	40	304,800	90,000	394,800
Seamless steel pipe (electric steel)	250,000	50	279,500	192,500	472,000
Steel pipe	24,000	5	-	4,800	4,800
Casting	12,600	4	-	-	-
Forging	12,000	4	-	8,400	8,400
Total	598,600	103	584,300	295,700	880,000
Aluminium refining	110,000	70	309,000	40,000	349,000
Autos					
Automobiles		60	25,000	12,500	37,500
Materials transport	4,752 y	40	24,620	-	24,620
Total		100	49,620	12,500	62,120
Repair dock	70,000–100,000DWT	30			
Cement		50	2,000,000	2,000,000	4,000,000
Indust. port total		1,153	10,018,282	8,137,500	18,155,782
Collective port					
Sugar				650,000	650,000
Wheat			612,000	300,000	912,000
Molasses				109,000	109,000
Alcohol				113,000	113,000
Veg. oil				30,000	30,000
Total			612,000	1,202,000	1,814,000
Volume of cargo handled at Suape Port			10,630,282	9,339,500	19,969,782

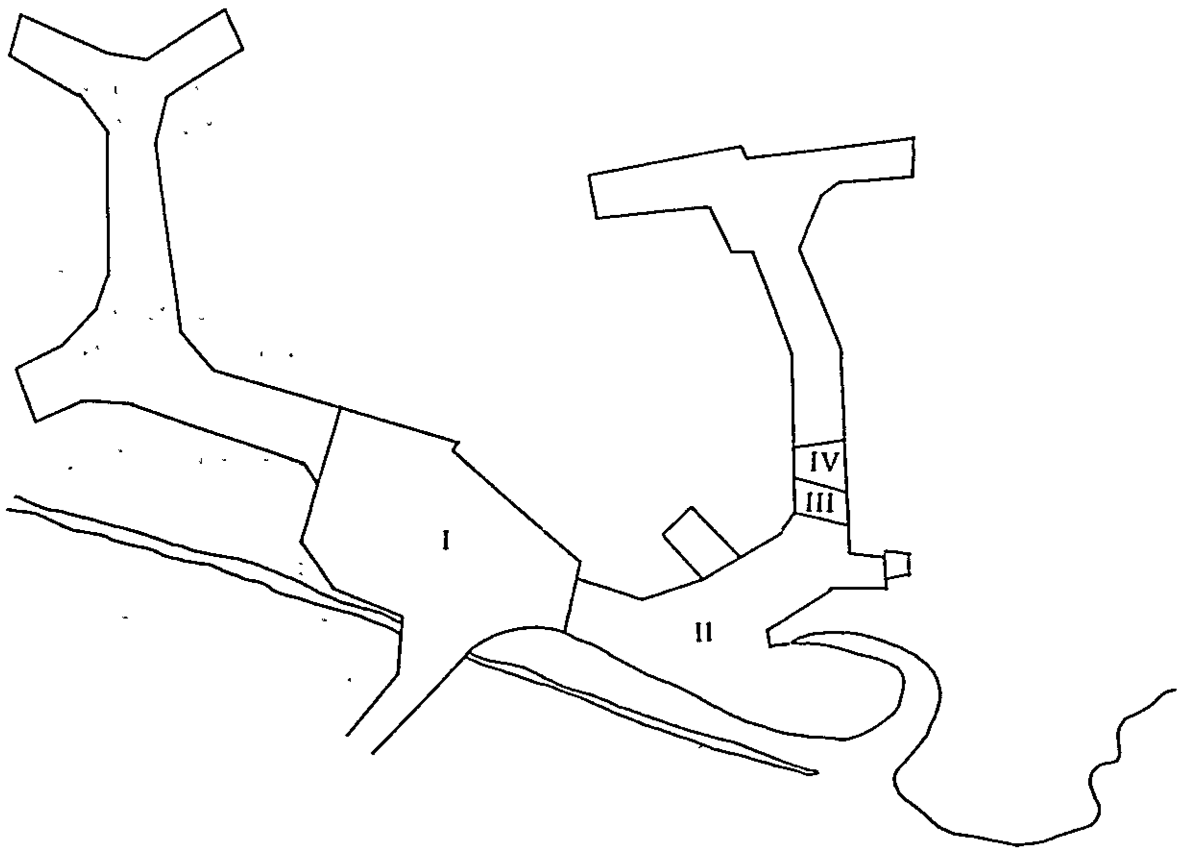
Note: For composition of raw materials, by destination, etc. See Table 3-3.

(3) Layout of Port and Harbor Facilities

(A) Area of Stage I planning

The port areas in Stage I of the Suape industrial port are indicated in Fig. 4-1.

Fig. 4-1. Port Area Objectives, Stage I



(B) Types and sizes of ships to be accommodated

The largest type of ship to be accommodated at each area of the inner port, as indicated in the figure above, and the cargo to be handled, are as follows:

Area	I	Oil, Cement terminal	135,000 DWT
	II	Phosphate rock	60,000 DWT (until 1986)
			125,000 DWT (after 1986)
	III	Wheat (in)	60,000 DWT
	IV	Wheat (out)	25,000 DWT
	V	Fertilizer aluminum	25,000 DWT

(C) Width and depth of channels

Planning for the width and depth of the channels is based on the following considerations.

Width of channels

Access channel:
5 times the width of the largest ship, one-way navigation

Inner channel:
secure the necessary width for one-way navigation when ships are at mooring on both sides of the channel (5.8 B + 50 m)

Depth of channels

The water depth is planned by adding a margin to the draft of ships anticipated to call. The margin for depth considers squatting wave influence, navigation margins, and secondary margins (measurement error, dredging error).

The dimensions of channels for each area, established on the basis of the above considerations, are indicated in Table 4-3.

Table 4-3. Width and Depth of Channels

District	Ships to be accommodated (DWT)	Width (m)	Depth (m)	Max. size vessel for two way transit
Access channel	135,000	320	20.0	
I	135,000	1,200 turning basin	18.0	
II	60,000	320	13.5	50,000
III	125,000		16.5	
IV	60,000	250	13.5	20,000
IV	25,000	250	10.0	Barge
IX	25,000	180	10.0	Barge

(D) Number of necessary berths

The TRANSCON report does not describe the private terminals for the industries located in the estate; only the number of berths necessary for the collective port is calculated.

Since the type and size for cargo handling facilities and the number of vessels by type entering the Suape industrial port are unclear, the Survey Team calcualted the number of necessary berths (necessary wharf length) of each industry using the standard cargo handling capacity per berth in Japan.

Table 4-4 indicates the necessary wharf length for each industry in Stage I planning. With private terminals requiring about 2,500 m, and the Collective Port 1,100 m, total wharf length of 3,600 m will be necessary.

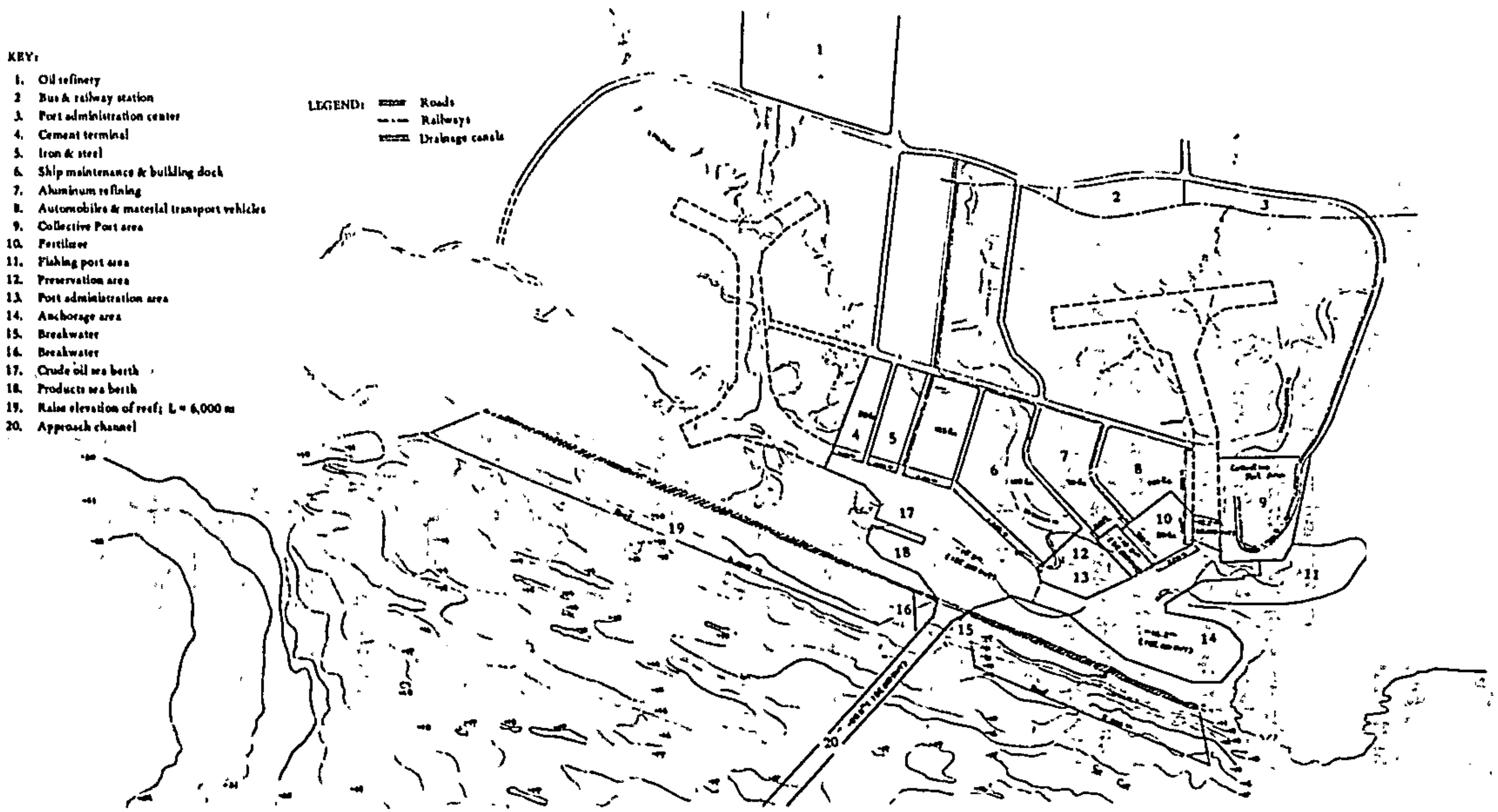
Table 4-4 Necessary Wharf Length, Stage I

(Unit: meter)

Private terminals	
Fertilizer	210
Oil refinery	
Oil	480
Petrochemicals	660
Iron & steel	480
Aluminum refining	310
Cement	
Raw materials	200
Products	200
Subtotal	2,480
Collective port	
Wheat	
Out	260
In	240
Sugar	300
Edible oils	280
Subtotal	1,080
Total	3,560

Note: See Part I, Table 3-18 for details.

Fig. 4-2 Site Location of Industries and Port for Stage I



(4) Layout of Industries and Harbor

The arrangement of industries in Stage I planning is based on the conception of the final planning stage, and when expanded, must be capable of maintaining the functions of the industries.

Therefore, the securing of a total area for the final scale of the each industry was also considered. Based on these considerations, the necessary total area in the coastal section (reclaimed area) for Stage I is as follows:

Fertilizer	50 ha
Aluminum refining	70 ha
Automobiles	100 ha
Shipbuilding	150 ha
Steel	123 ha
Cement	50 ha
Total	543 ha

According to the TRANSCON report, the area of land to be made available in Stage I is about 1,000 ha, which is sufficient to locate the above industries.

Fig. 4-2 shows the distribution of these industries in the Stage I harbor construction area. Concerning the harbor layout, extension of about 750 m is necessary, only at the southern tip (cement terminal section) of the central channel, varying from the plan proposed by TRANSCON.

(5) Dredging of Channels and Mooring Basin and Land Reclamation for Factories

The amount of soil to be dredged in the navigation channels and mooring basin and the amount of soil required for land reclamation in Stage I of the plan have been calculated as shown in Table 4-5.

Table 4-5 Amounts of Soil Involved in Dredging and Reclamation

		Amount of soil to be dredged (10^3 m^3)			
		Sand	Clay	Sandstone	Total
Dredging	Access channels	7,686			7,686
	Inner channels	57,472	12,034	330	69,836
	Total	65,158	12,034	330	77,572

		Reclaimed area	Amount of soil required
Reclamation	Complete reclamation	$9,856 \times 10^3$ m^3	$26,648 \times 10^3$ m^3
	Reclamation up to high tide level	$12,646 \times 10^3$ m^3	$27,916 \times 10^3$ m^3
	Total	$22,502 \times 10^3$ m^3	$54,564 \times 10^3$ m^3

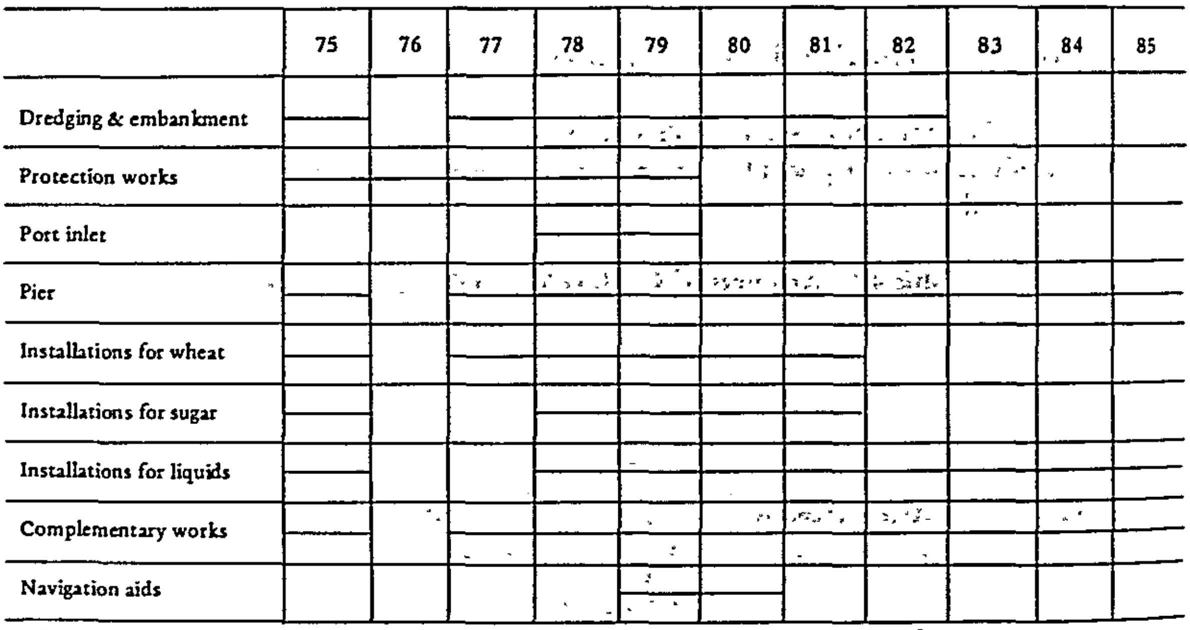
It is evident from the table that 78 million cu.m of soil will be dredged in Stage I but only about 55 million cu.m will be required for reclamation and except for the sand used in reclamation, the clay and sandstone will be discarded in the sea. The area of the completed reclamation will be approximately 1,000 ha and will be sufficient to satisfy the requirements for the coastal area in Stage I (543 ha).

The length of the southern end of the inner channel will have to be about 750 m and the dredging required in this case will be approximately 6 million cu.m Therefore, an increase of about 8% in the amount of soil dredged in Stage I of the plan is foreseen.

(6) Work Schedule and Construction Costs

In the work schedule and investment plan in the TRANSCON report, only the first stage plan has been studied for the port. Fig. 4-3 shows the work schedule for harbor construction. The first stage of the harbor construction has been planned to cover 11 years.

Fig. 4-3 Harbor Construction Schedule



The total harbor construction costs are estimated as Cr$ 1 billion which is 50% of the total investment of approximately Cr$ 2 billion for Stage I. The port budget is as follows:

i.	Dredging and land reclamation Dredging of navigation and inner harbor channels and land reclamation	Cr$462,234,000
ii.	Collective port Terminals and berths for sugar, wheat and edible oils	Cr$378,183,000
iii.	Protective facilities Raising and extending the reef, breakwater and port entrance protection	Cr$86,137,000
iv.	Navigational aids Signals, buoys, VHF, tugboats, etc.	Cr$25,000,000
	Total	Cr$951,554,000

This harbor budget does not include the construction costs for the industrial port (private terminals).

3. Suggestions for the Suape Port Plan and Future Technical Problems

(1) Natural Characteristics Port and Port Construction of the Suape

To determine the possibility of excavated port construction in the Suape, comparisons have been made with natural conditions in Tomakomai, Kashima and Niigata East, typical large scale excavated ports in Japan.

Table 4-6 Natural Conditions in Typical Excavated Ports in Japan

Conditions		Unit	Tomakomai	Kashima	Niigata East
Wind (frequency of winds of at least 10 m/s)		%	6.4	14.4	11.1
Waves ($H_{1/3}$: 99.9% probability of non-exceedence)		m	5.00	4.75	4.55
Topography of the sea floor			1/83	1/118	1/96
Land topography:	Area obtained	ha	2,800	3,900	3,300
	Height above sea level	m	7.7	6.9	8.8

The wind and wave conditions present the biggest problems among the natural conditions in the above table. For the three ports in the table, the frequency of occurrence of winds of more than 10 m/s is 6 to 14% and the significant wave height with a probability of non-exceedance of 99.9% (one time in 1,000) is 4.5 to 5.0 m. However, in the case of Suape port, the wind at Guararapes Airport in Recife over the last 10 years reached a maximum of 15.43 m/s and was an average of 3 – 4.0 m/s. The significant wave height was a maximum of 2.4 m during the period of observation. These conditions are much better than those for the three Japanese ports mentioned previously and the construction of a port is clearly possible. In future plans, the construction of offshore sea berths for crude oil tankers will have to be considered. Table 4-7 shows the results of a questionnaire concerning the limits of the use of sea berths in Japan. In the case of dolphin berths, it appears that berthing is possible up to a wave height of 1.4 m and mooring up to a wave height of 1.8 m.

Wave measurements for Suape port were conducted only for a short period. However, considering the probability of occurrence of significant wave heights of 1.9 m or over is 22.7% and that there are few seasonal changes throughout the year, the berthing and cargo handling required for a sea berth appear possible. Further, the final decision will have to be made on the basis of the results of continued surveys.

Table 4-7 Average Limit Values for the Use of 100,000 – 200,000 DWT Class Sea Berths

		Buoy berths		Dolphin berths		Total	
		No. of replies	Average values	No. of replies	Average values	No. of replies	Average values
Limits to take pilot on board	*Wind velocity (m/s)*	5	13.4	14	13.6	19	13.5
	Wave height (m)	5	1.40	11	1.47	16	1.45
	Tidal current (kt)	3	2.17	9	1.32	12	1.53
Limits for berthing	Wind velocity (m/s)	5	13.4	16	13.9	21	13.8
	Wave height (m)	5	1.34	13	1.34	18	1.34
Limits for cargo handling	Wind velocity (m/s)	5	16.6	16	15.5	21	15.8
	Wave height (m)	5	2.04	12	1.48	17	1.64
Limits for mooring	Wind velocity (m/s)	5	20.0	11	19.6	16	19.7
	Wave height (m)	5	2.70	7	1.79	12	2.17

Source: Crude oil tanker berth survey report (*Ministry of Transport, Japan*)

The plan drawings for the facilities of the three Japanese ports mentioned previously are included here for reference.

Fig. 4-4 General Plan for Facilities, Tomakomai Port

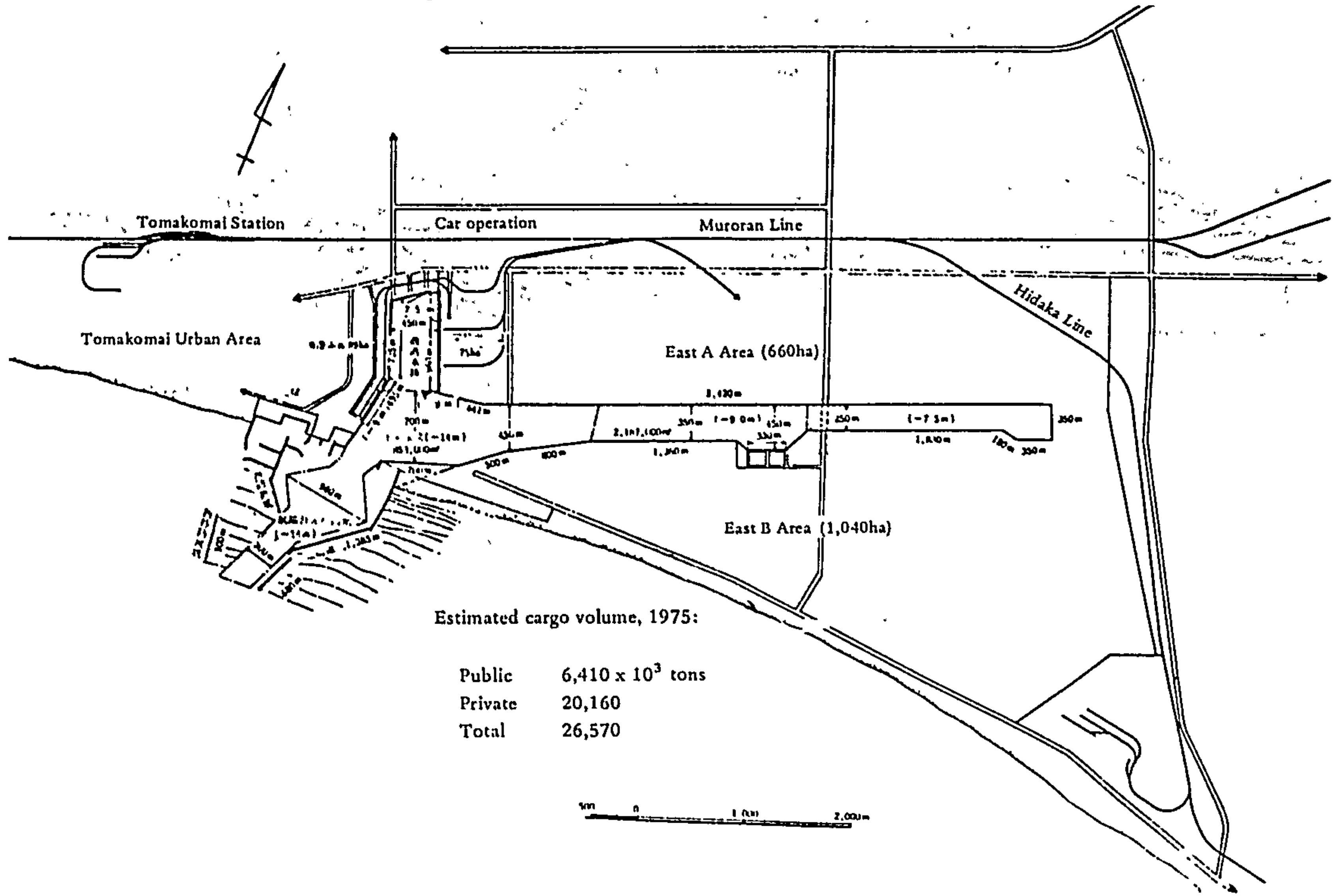


Fig. 4-5 General Plan for Facilities, Kashima Port

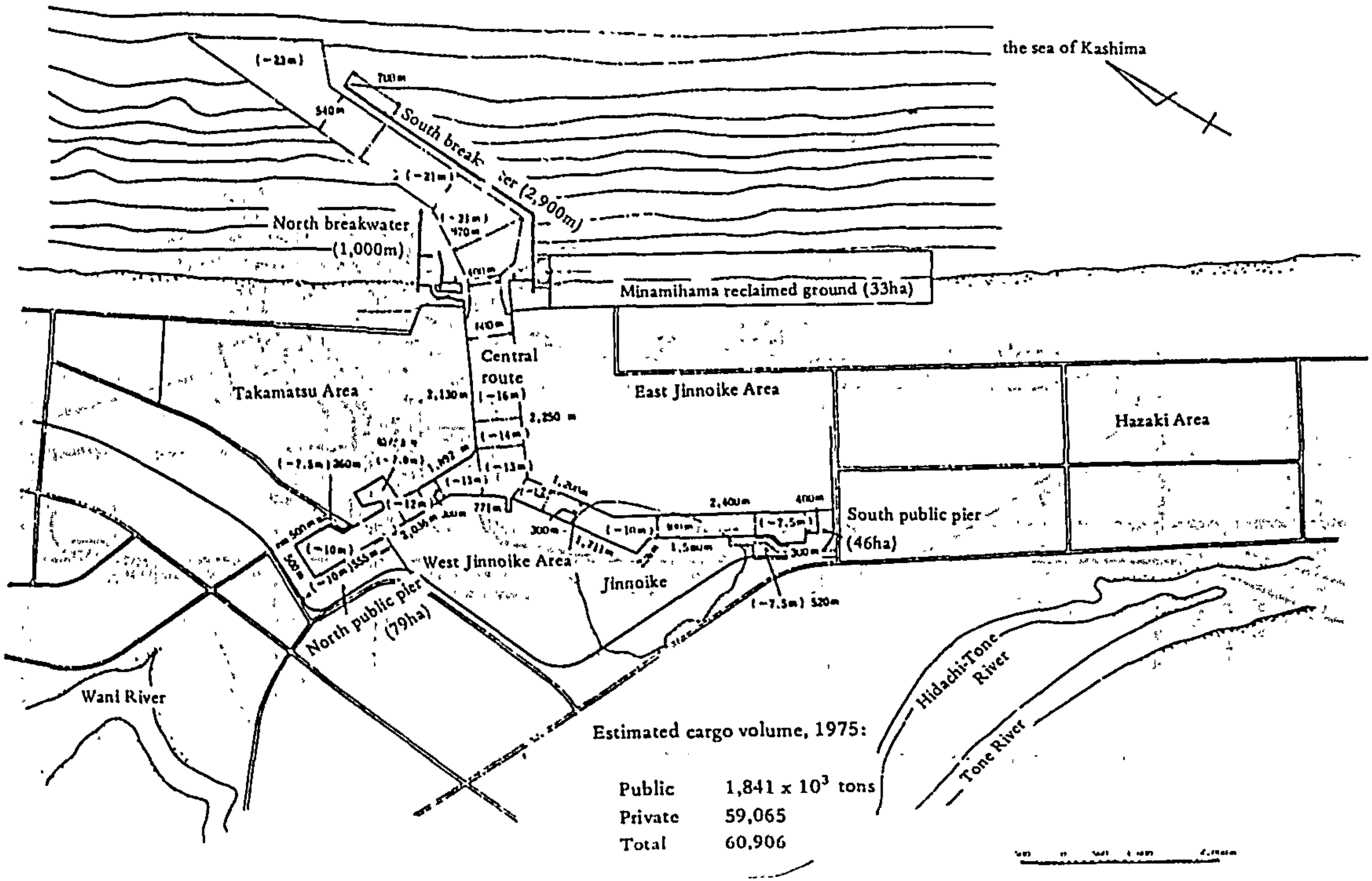
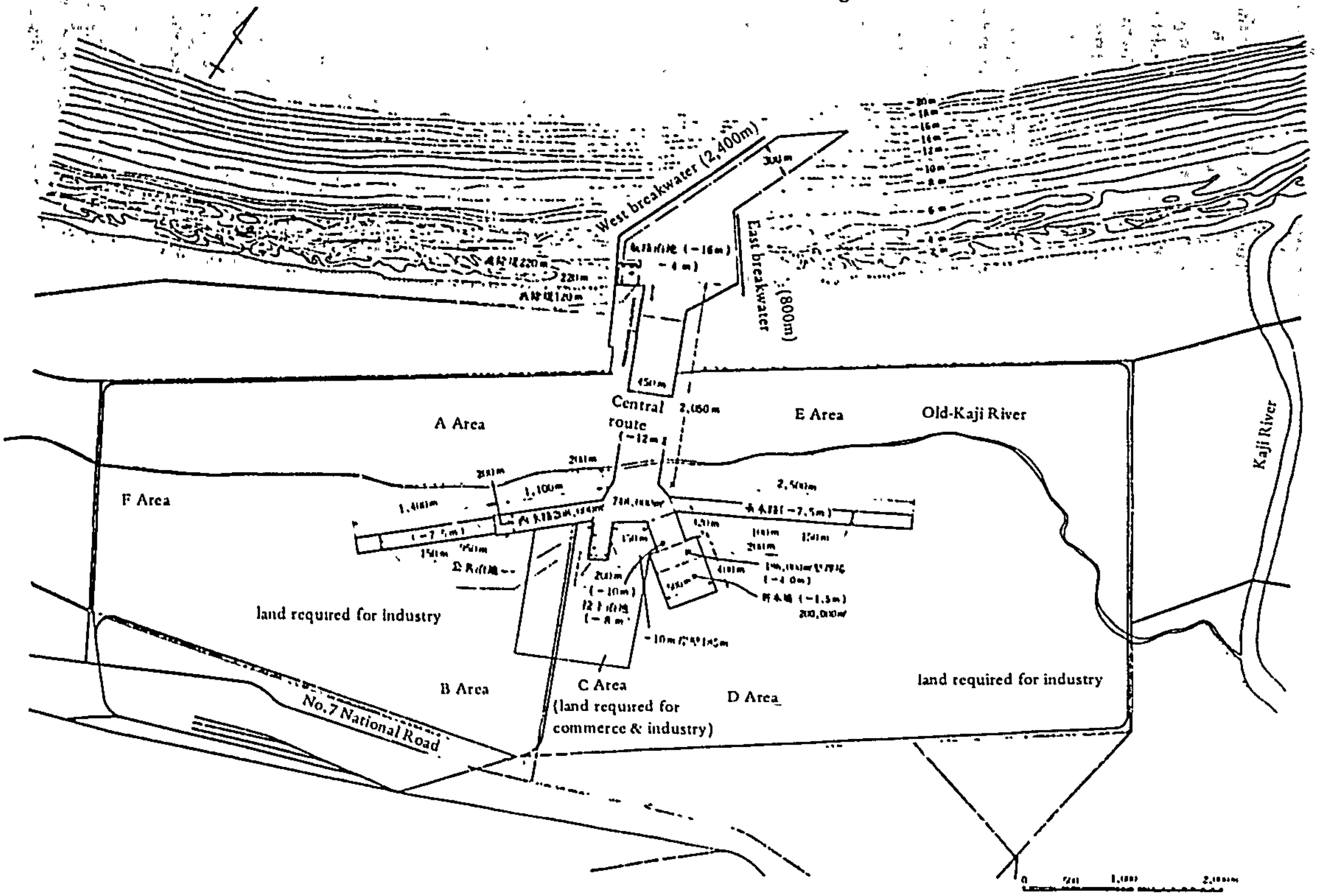


Fig. 4-6 General Plan of Port Facilities at Niigata East



(2) Opening of the Harbor Entrance and Construction Breakwaters

The opening of the harbor entrance presents the main technical problem in the construction of the Suape port. In the current plan, the harbor entrance is to be made by utilizing a place in about the center of the reef where there has been a cave-in. No special techniques would be required since the soil consists of sandstone, sand and clay. However, the opening of the harbor entrance will naturally cause the waves from outside will penetrate the harbor. How to maintain calmness in the mooring basin inside the harbor would belong to the major technical problems among the current port techniques.

The breakwater to maintain this calmness consists of two jetties extending for a total 1 km in the TRANSCON Report. It is intended to assure the safety of ships entering and leaving the port and keep out waves. However, the length and direction of the breakwater must be planned to achieve harmony between the two conflicting aims, i.e. the ease of getting ships in and out of the harbor and the maintenance of calmness within the harbor. In the extreme case, if the harbor entrance is small and the breakwater extends in a direction perpendicular to the incoming waves, it is easy to maintain calmness within the harbor but it is very difficult to navigate ships in and out of the harbor. The reverse is also true.

Investigations of the harbor entrance and breakwater needed to achieve harmony between ease of navigation in and out of the port and maintenance of calmness inside the harbor require the long-term collection of site data concerning the direction and strength of the wind and waves and seasonal variations. Wave data for Suape are still insufficient and such data must be compiled using figures from Recife harbor and other pertinent information as references.

Long breakwaters are effective from the standpoint of navigating ships and improving the degree of calmness inside the harbor but the construction costs are extremely high and the breakwater must be kept to the minimum required length. Fortunately, no hurricanes occur near Suape and during the winter when the weather is at its worst, the maximum wave heights are only about 4 m. Therefore, a breakwater of the same scale as that in the Kashima harbor in Japan might be needed.

Throughout the year, the main wind direction in the Suape region is southeast and the winds are comparatively weak. In the TRANSCON report, the navigation channel to be created by the harbor entrance and the breakwater will be in the southwest direction and waves entering from the breakwater entrance will be dissipated between the reefs which act as breakwaters on both sides outside the harbor entrance. In addition, waves which do enter the harbor entrance will be dissipated by the spending beach in front of the mooring basin. However, the proposed breakwater length of 1 km seems short but it will have to be confirmed by model test. In excavated ports in Japan, the dredged navigation channels are all shielded by breakwaters to prevent silting.

To avoid congestion among ordinary small ships and fishing boats using the fishing facilities and large ships and also to keep the water in the mooring basin and the inner channel clean, it would be worthwhile to investigate the opening of a channel at the point of discontinuity in the reef south of Santo Agostino Point for small boat navigation.

(3) Water Area

The current layout of the inner harbor seems appropriate for the most part. However, considering the current plan was selected from among alternatives, it would be possible to make some appropriate topographical corrections. Therefore, boring and soil test will have to be performed in the future and checks will be necessary concerning the sites for heavy structures and the problems related to berth construction and dredging.

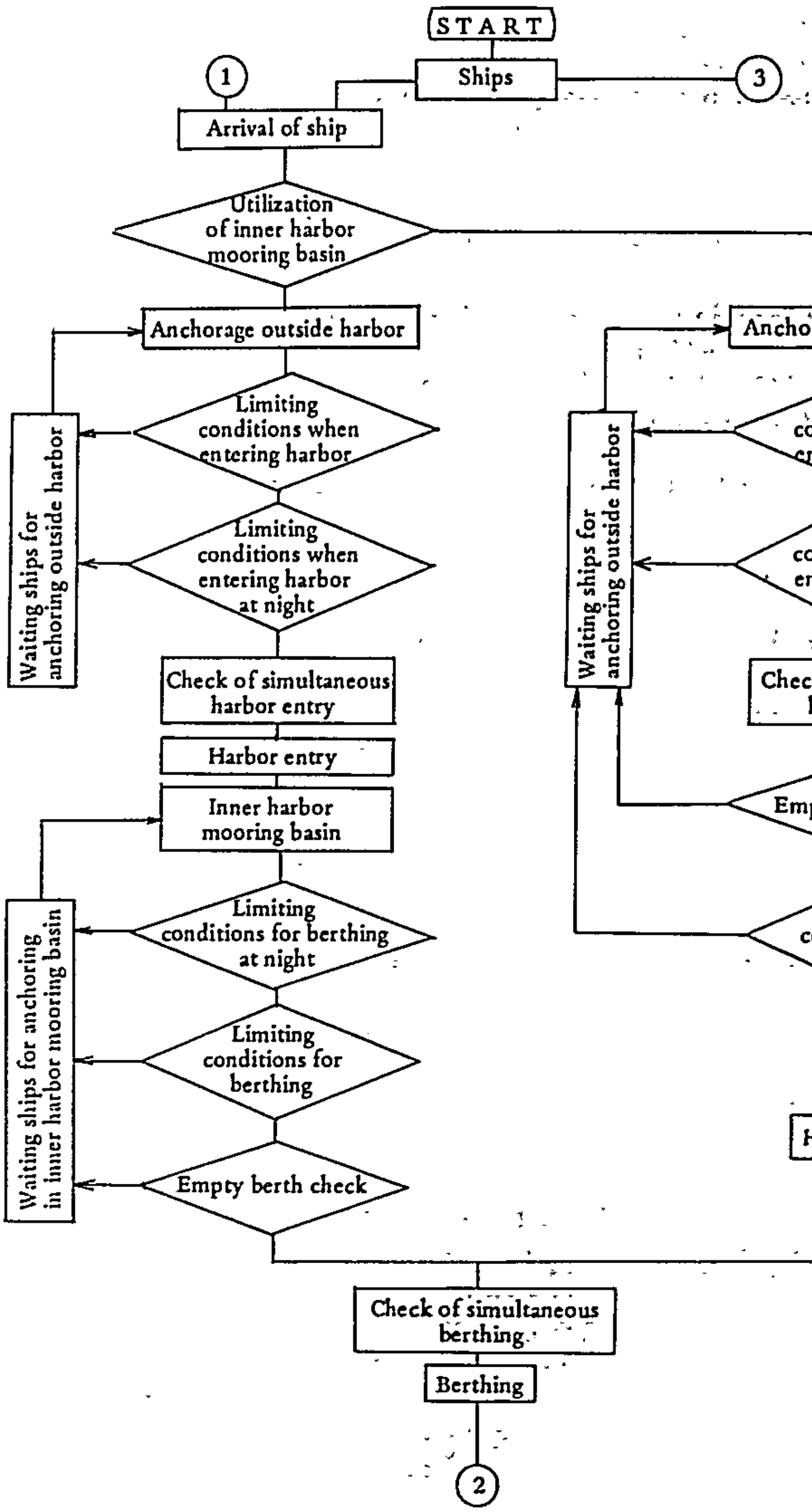
The widths of the navigation channels seem to be almost appropriate but it would be desirable in the future to investigate the capacities of the channels, mooring basin, berths, etc. by simulation study of ship operation. Fig. 4-7 shows a simplified flowchart of the ship operation simulation study currently used in Japan. The inputs and outputs are as follows:

Table 4-8 Items of Simulation Input and Output

	Port	Ships	Others
Input	Amount handled Number of berths Cargo handling time	Size of ships Amount of cargo Number of sailings (number of ships entering the harbor) Period of navigation (time entering the harbor) Period using the berth	Weather and marine conditions
Output	Conditions for ships entering and leaving port Amount of cargo handled Berth utilization conditions Raw material stocking conditions	Waiting conditions Waiting time Number of waiting ships	

With the water depth in the current plan of –20 m for the navigation channels, the total length of dredging of the channels will be approximately 6 km, though the movement of bed materials will be negligible according to the surveys to date, there still is a problem of silting. As was described previously, all of the dredged navigation areas inside excavated harbors in Japan are within breakwaters. But in the case of Suape, it will be very difficult to extend the breakwater to this depth. Therefore, in the future, the concepts of a smaller depth of –18 m, the possibility of the biggest ship not entering the harbor at large wave height and the utilization of tidal variations should be studied on the utilization of the port under such conditions. Off-shore berthing should also be considered for mammoth crude oil tankers.

Fig. 4-7 Simulation Flowsheet



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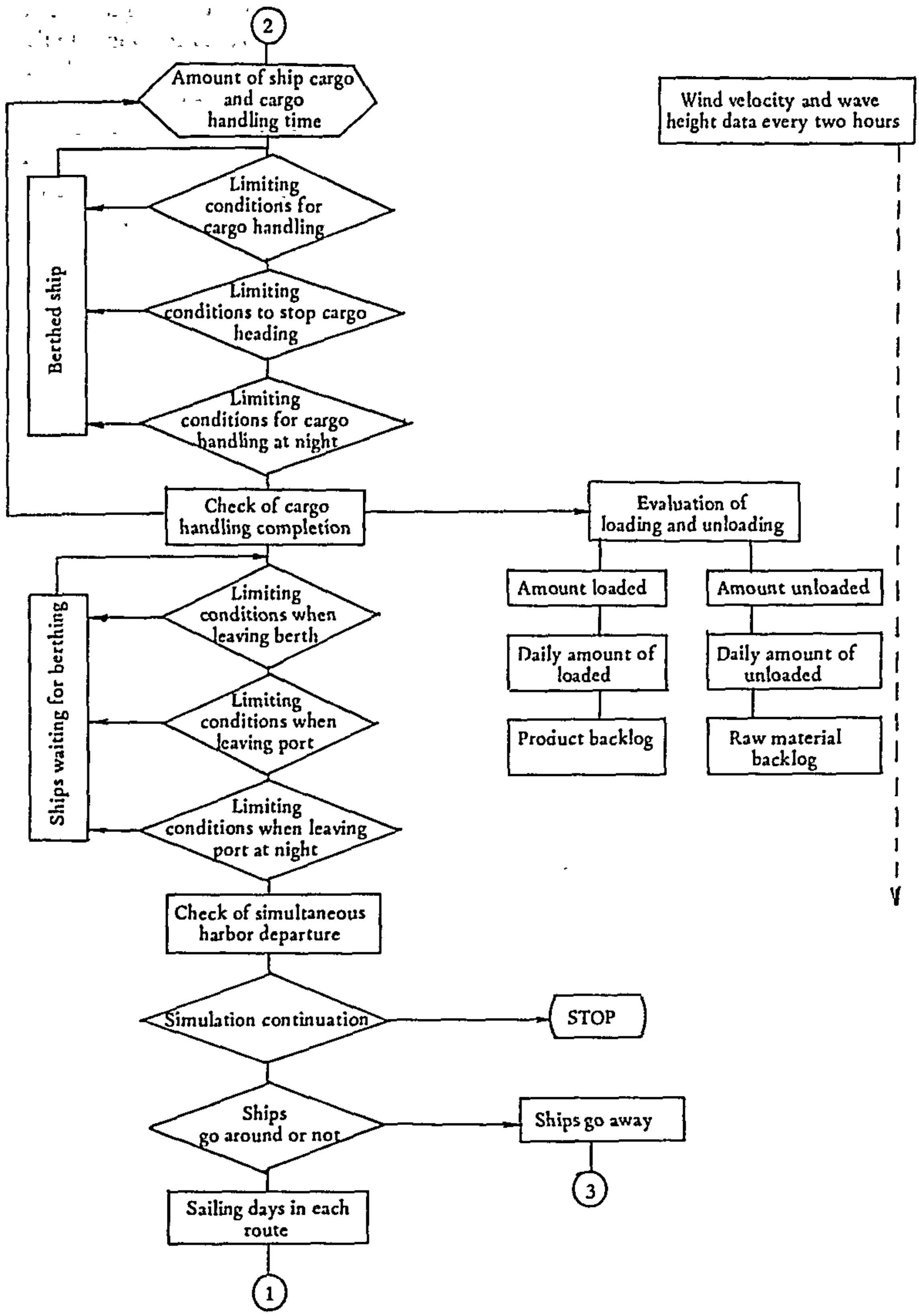

2
Amount of ship cargo and cargo handling time
Limiting conditions for cargo handling
Limiting conditions to stop cargo heading
Limiting conditions for cargo handling at night
Berthed ship
Check of cargo handling completion
Limiting conditions when leaving berth
Limiting conditions when leaving port
Limiting conditions when leaving port at night
Ships waiting for berthing
Check of simultaneous harbor departure
Simulation continuation
STOP
Ships go around or not
Ships go away
3
Sailing days in each route
1
Wind velocity and wave height data every two hours
Evaluation of loading and unloading
Amount loaded
Amount unloaded
Daily amount of loaded
Daily amount of unloaded
Product backlog
Raw material backlog

In deciding the distance of the mooring basin from the harbor entrance to the opposite shore, consideration must be given to the stopping distances of the ships. In the TRANSCON report, a value of 2L where L is the length of the ship is given. Generally, when a ship enters a harbor, the speed is kept within 4 to 6 knots and to prevent the deviation of the ship to the port or starboard, it is necessary to stop the ship by slow astern. The required stopping distance is 4 - 5L. For example, Fig. 4-8 shows the results of an experiment concerning the stopping distance of a 210,000 DWT tanker by engine astern. These results indicate that only 2L is required when the ship enters the harbor under is own power. It will be necessary to reinvestigate by taking into consideration the speed at which the ships can enter the harbor during rough weather, the possibilities of using tugboats to assist in navigation, etc.

(4) Sizes of Ships

In the TRANSCON report, there are detailed investigations concerning conventional cargo ships, bulk carriers, oil tankers, combination ships such as the OBO and special ships such as container ships, LASH and RO/RO ships and the research level is extremely high. Concerning the sizes of the ships, there are difficult problems among specialists in marine transport and it is especially difficult to predict the size of ships for the new, long-term Suape project.

From the standpoint of the port, the criteria for the prediction of the size of the ships include the port depth and the scale of the berths but special ships differ greatly with respect to tonnage, size and draft and it is difficult to obtain general standards. Since Suape is not so far away from the main ports of shipment and destination in the United States and Europe and there are limits to how big ships can get, Stage I of the plan at least should be based on the size of ships currently in use rather than prediction of larger ships.

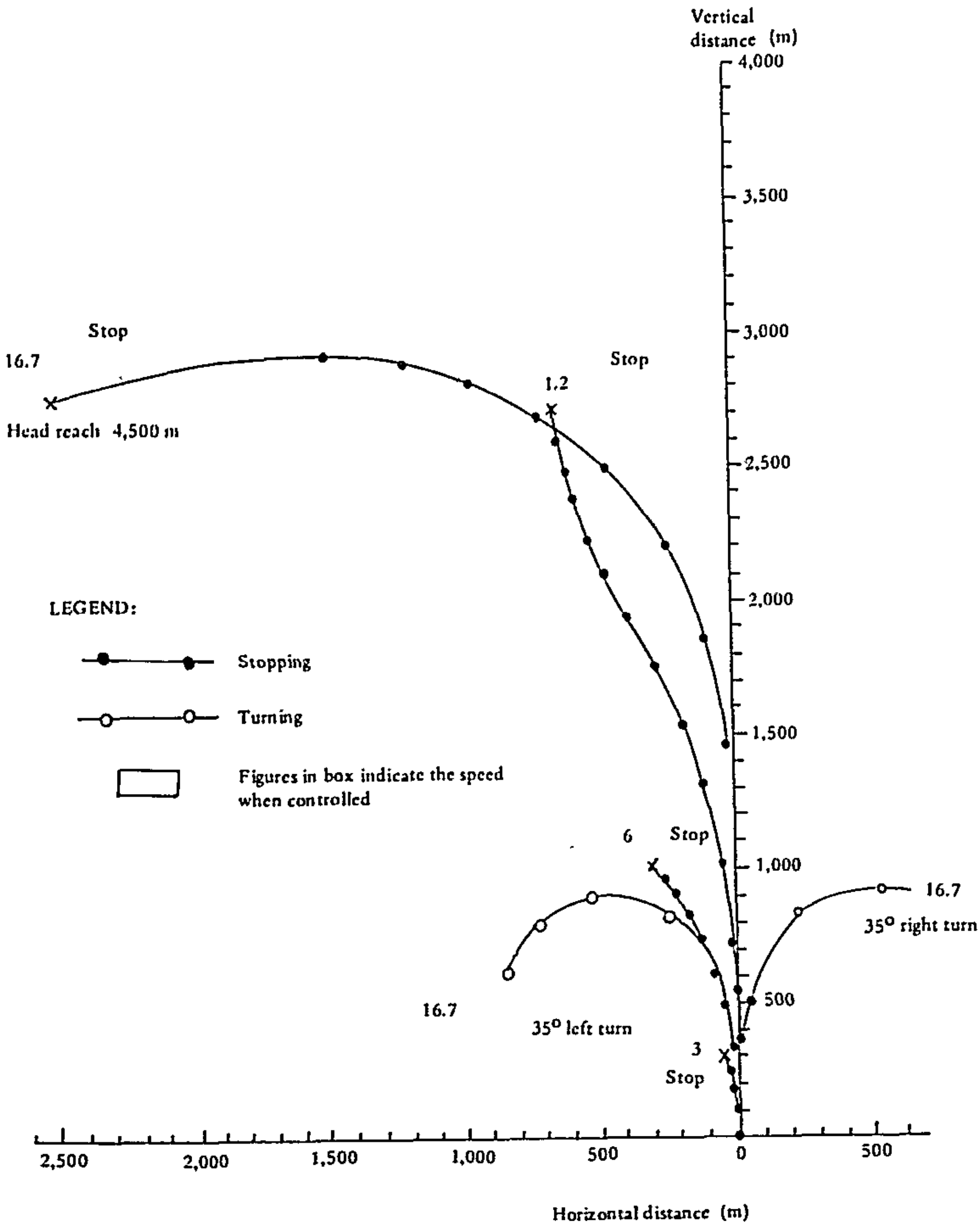
The tonnage and draft of combination ships differ in each case and it would be better to decide on the ships permitted to enter the port on the basis of the water depth. Because of the close connection with the amount of cargo handled, such factors as the number of ships entering the port and berth utilization rate should also be taken into consideration when deciding on the size of the ships.

(5) Suape Port Capacity

In the vicinity of Suape, there is an excellent commercial harbor in Recife, the capital of Pernambuco State. This port has sugar terminals which are well-known throughout the world. However, because of the rapid urbanization occurring around Recife port, the port is being faced with such problems as city traffic jams and urban overcrowding. Because of such conditions, plans are now being formulated for the expansion of Recife port. It appears that the expansion in the amount of cargo handled in Recife port can be increased by 3 to 5 million tons but this is limited and it is estimated that the limit will be reached by 1985. It is also feared that other problems could arise before this date.

Under these conditions, Suape should be stressed as an industrial port with private terminals but because of the population increases, concentration of other industries, etc. entailed

Fig. 4-8 : Stopping Distance of a 210,000 DWT Tanker by Engine Astern



Source: Japanese Society for Prevention of Marine Disasters, 'Research on the Prevention of Damage by Mammoth Tankers' in the development of a large-scale port, it will be necessary to maintain the role of the commercial port, Therefore, the currently planned collective port and public wharves to handle general cargo will have to be investigated.

(6) Miscellaneous

1) It will be necessary to consider the handling of small ships such as fishing boats, tugboats, plying boats and barges which will increase as the port develops, along with their anchorages and mooring basins.

2) It will be essential to determine the possible work schedule with respect to the work plan.

CHAPTER 5. PLANS FOR INFRASTRUCTURE OTHER THAN THE PORT AND HARBOR

1. Outline

Improvement of infrastructure must be coordinated with a series of development programs including the industrial estate, port and harbor and housing. Thus, when the contents of these programs are changed, the infrastructure program must be modified accordingly.

In planning the infrastructure for Stage I, the TRANSCON report was used as a guide.

With respect to water supply systems, capacity and construction cost were calculated on the basis of the system and method of water intake as proposed in the TRANSCON report and with due consideration to scheduled industrial and regional development plans.

Sewer system plans are based on the idea of disposing of sewage after primary and/or secondary treatment.

Flood control is the highest priority project among infrastructure improvement and must be started as soon as possible. The system proposed by TRANSCON is considered appropriate. With respect to the Ipojuca system, however, the Survey Team proposes to excavate a water-way from Amortization Lake to the open sea in order to accelerate the flow and enhance overall system reliability.

For road system, the construction cost was calculated on the basis of the alignment and road width determined in consideration of anticipated traffic density and locations under Stage I.

Regarding the railway system, the Survey Team proposes to adopt the proposal in the above report and start construction from the time of Stage I.

Construction of electric power and communication facilities shall be adjusted to the progress of work and target date of operation for each project. The systems are as proposed in the above report.

2. Progress of Infrastructure Improvement under Stage I

This section outlines the size of construction work and estimated cost based on the requirements for infrastructure and proposed systems under Stage I.

(1) Water Supply System

The requirements for water supply under Stage I is anticipated to be 99,000 m^3/day as shown below:

Industrial District	91,280 m³/day
Administrative District	1,520 m³/day
Residential District	5,675 m³/day
Total	98,475 m³/day

For Nossa Senhora do O, 2,230 m^3/day will be supplied from well water pumped on the spot.

The timing for water intake in the Boasica district is likely to be after the completion of Stage I under which the basic requirements for industry are provided, and when this district becomes a residential area.

Since there is also a possibility that well water may be utilized, the requirements for surface water intake will be about 94,000 m^3/day after subtracting 2,765 m^3/day for the Boasica district and 2,230 m^3/day for Nossa Senhora do O.

In the Massangana-Ipojuca system, Bita and Utinga de Baixo reservoirs are assumed to be capable of supplying 36,300 m^3/day and 34,600 m^3/day respectively, and the balance will be pumped up from the Ipojuca reservoir. The rate of water supply from said reservoir shall be as follows: (94,000 – 36,300 – 34,600 = 23,100 m^3/day). This volume reflects changes in the type of industry to be induced, and is far greater than the TRANSCON's planned figure. Accordingly, waterways and pumping stations required will be larger than those proposed in the above report. The overall system, however, remains the same as in the TRANSCON plan.

The quantity of work and estimated construction cost for Stage I will conform to the TRANSCON figures when their computation standards are employed, except for Ipojuca pumping station and Ipojuca-Bita water supply line which will cost as follows:

Ipojuca Pumping Station:

Item	Quantity	Unit Cost (Cr$)	Amount (Cr$)
Pump & Motor			400,000
Pipeline	600 m	1,200/m	720,000
Civil Work	80 m	6,000/m	480,000
Total			1,600,000

Ipojuca-Bita Water Supply Line:

Item	Quantity	Unit Cost (Cr$)	Amount (Cr$)
Waterway	6,000 m	400/m	2,400,000

Underground water intake: Assuming underground water is available in the Boasica district, Cr$ 3,104,828 as per the above is used as estimated cost for the work.

Treated water: The filtration plant capacity shall be 94,000 m³/day to match the increase in water supply with corresponding increase in construction cost.

Item	Quantity	Amount (Cr$)
Filtration Plant	Capacity 94,000 m^3/d	7,678,000

Note: A filtration plant (Eta) and Bita-Eta water supply line combined.

Service reservoir and main pipeline for distribution: Certain modifications are made in pipe diameter and reservoir capacity to meet changes in the water supply capacity, although the planned locations remain the same as proposed in the TRANSCON report. The estimated construction cost is as follows:

Service Pipe (main pipeline):

Interval	Item	Quantity	Amount (Cr$)
ETA—R-2	Main Pipeline	4,000 mϕ 700 mm	4,800,000
ETA—R-6	Main Pipeline	4,500 mϕ 600 mm	4,500,000
R-2—R-3	Main Pipeline	9,000 mϕ 600 mm	9,000,000
R-2—R-4	Main Pipeline	7,500 mϕ 450 mm	4,950,000
Subtotal			23,250,000

Reservoir:

Reservoir	Item	Quantity (Capacity)	Amount (Cr$)
R-2	Service Reservoir	2 x 5,000 m^3	4,650,000
R-3	Service Reservoir	2 x 4,000 m^3	4,090,000
R-4	Service Reservoir	2,000 m^3	1,160,000
Subtotal		20,000 m^3	9,900,000

Service pipe network: Since the layout of the service pipe network is contingent upon the location of each plant, the TRANSCON plan is adopted here. Also, the installation of the service pipe network in the Boasica district is provisionally assumed since there is a possibility that development may be deferred until a later stage depending on the outlook for housing demand at the time of Stage I.

The construction cost is estimated as follows:

District	Item	Quantity (m)	Unit Cost (Cr$)	Amount (Cr$)
Residential & Administrative districts	Service Network	7,500	162	1,215,000
N.S. do 0		12,000	162	1,944,000
(Boasica)		(2,000 x 17)	130	(4,420,000)
Offsite	Main Conduit	6,500	270	1,657,000
	Branches	1,000	162	
Subtotal, excl. Boasica				4,816,000
(Subtotal, incl. Boasica)				(9,236,000)

The construction costs related to the waterworks are recapitulated below:

Construction Item		Cost of Work (CrS)
Bita reservoir		1,966,987
Utinga de Baixo reservoir		1,669,423
Utinga de Baixo – Bita water supply line		338,000
Ipojuca pumping station		1,600,000
Ipojuca – Bita water supply line		2,400,000
Surface water intake	Total	7,947,410
Underground water intake	Total	(3,104,828)
Filtration plant	Total	7,678,000
Main service pipeline		23,250,000
Reservoirs		9,900,000
Service reservoirs & main pipeline	Total	33,150,000
Service pipe network	Total	4,816,000
(including Boasica when developed)		(9,236,000)
Waterworks construction costs	Grand Total	53,618,410
		(61,143,238)

(2) Sewage System Works

With respect to the sewage system, the approximate location of the gathering network can be identified from the sewerage system diagram, but details such as the computation standards for construction cost still remain unknown.

The Survey Team proposes to relocate the treatment station to the south of the industrial estate where it would be close to the major users of industrial water and where topological conditions are favorable.

Regarding the construction cost, TRANSCON's Estimate was revised upward assuming an increase in the cost of facilities to reflect increased sewage volume as summarized below:

Area of Construction	Construction Cost (CrS)
N.S. do 0	1,605,000
Boasica	1,661,000
Residential & Admin. Districts	1,076,000
Grailw	1,273,000
Gathering (Concentrated Pipe) Network	15,703,000
Common Treatment Station	39,675,000
Sea Water Drainage	32,222,000
Total	93,215,000

(3) Flood Control and Canal

TRANSCON's proposal is to be adopted for this system as it is deemed satisfactory from cost and reliability standpoints.

No problem is anticipated if by the utilization existing rivers and channels are utilized without constructing the Merepe canal during Phase I. This is based on the belief that flood waters can be contained, without causing damage to the industrial estate, with the existing surface flow pattern, provided certain measures are taken whereby overflooded portion is temporarily pooled into the lagoon dug outside of the industrial estate while the influx into the industrial estate is regulated by gates on the dike road.

Also, to prepare for the time when the whole industrial estate is fully developed, it is considered more desirable to build a flood control outlet from the lagoon to the sea, outside the industrial estate, so that the lagoon can be quickly drained in case of a flood.

In the proposed system, the problem of sedimentation by river flow in the harbor also seems to be low as the discharge through the Merepe canal is not high. This problem needs further detailed review including comparison of costs of construction of alternative measures.

On the Massangana River, the existing channels will be utilized based on the same reasoning as for the Ipojuca River. However, both rivers need to be extended by canals for some distance to the junction with the harbor. The construction cost in the TRANSCON report was revised as follows, based on the above standpoint.

Flood Control and Canal	Cr$40,798,000

(4) Road System

Anticipating an increase in the work force to be employed within the industrial estate under Stage I, Port Road–2 has been newly added to eliminate traffic congestion at peak hours and to ensure smooth access to each plant.

Also, for the convenience of residents in the Gaibú district, part of PE–9 and PE–28 are to be extended to give them access from Boasica to Cabo, as well as town-site access roads. On the other hand, Road–2 and Road–5 in ZR–2 and a portion of Road–1 and also Road–3 have been eliminated from Stage I.

The following shows the total extension of road under Phase I program:

*	Main Access	1.60 km
*	Main Distribution Trunk	5.60
	Port Road–1	5.30
*	Port Road–2	2.80
*	Port Road–3	2.57
*	Port Road–4 (Part)	4.07
	Port Road–5 (Part)	2.60
	Town–site Access I	3.75
	Town–site Access II (Part)	2.90
	Town–site Circuit	3.70
	Secondary Access to the Refinery	1.70
	N.S. do 0 Access (ZR–1)	1.15
	Access to the Cement Plant	1.20
	Access to the Metal Plant	1.20
	Access to the Fertilizer Plant	1.60
	Road–1 (ZR–2)	1.30
	Road–3 (ZR–2)	1.50
	Road–4 (ZR–2)	0.70
**	PE–9 (Part)	2.30
**	PE–28 (Part)	6.70
	Total	54.24 km

* Includes bicycle lane

** Unpaved road

The following are estimated construction costs for the above roads using the geometric design standards and cost calculation standards according to the TRANSCON report:

Drainage Facilities	Cr$	7,314,978
Bridges		4,799,070
Earthwork		27,466,276
Pavement		36,744,790
Total	Cr$	76,325,114

(5) Railway System

TRANSCON's proposal for the railway system is acceptable. However, as stated previously, further review and modification of details are required. Furthermore, the length of branch lines is longer by about 1 km compared to the TRANSCON's proposal.

Trunk and Branch Lines	Cr$	32,794,000
Marshalling Yard		32,770,000
Railway Bridges		2,392,000
Total	Cr$	67,956,000

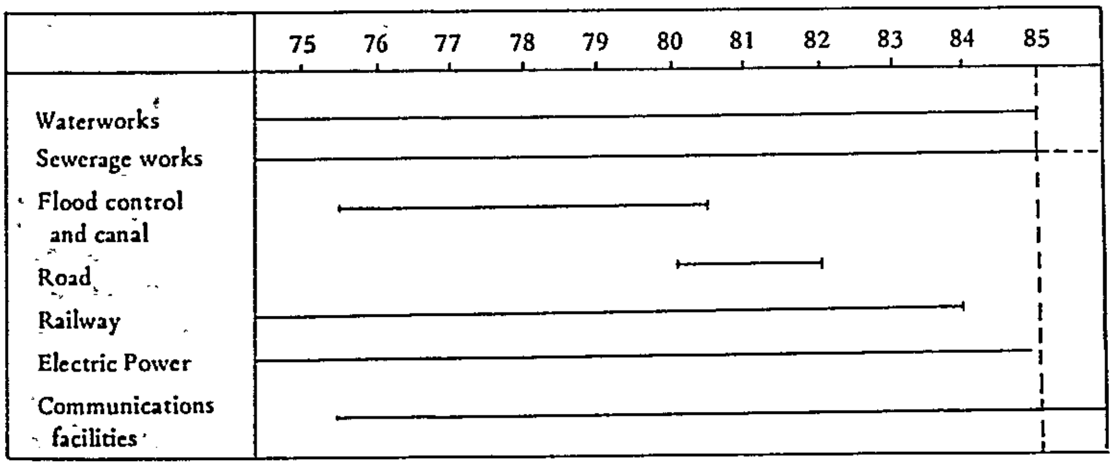
(6) Electric Power and Communication Systems

TRANSCON's proposal for electric power and communication systems is acceptable. The general proposal is as stated previously, and likelihood of any sizable shortage of capacity is considered slim even if TRANSCON's proposal is followed:

Electric Power System	Cr$	107,696,000
Communication System		13,706,000

3. Construction Schedule and Cost

According to the TRANSCON report, the construction schedule is as follows. Pavement and drainage works of roads in the Boasica district will be carried over beyond Stage I.



The following summarizes the construction cost of infrastructure other than the port and harbor. The estimate was made as of October 1974 and is based on the TRANSCON report.

Waterworks	Cr$	61,143,238
Sewerage works		93,215,000
Flood control and canal		40,798,000
Road		76,325,114
Railway		67,956,000
Electric power		107,696,000
Communication facilities		13,706,000
Total	Cr$	460,839,352

CHAPTER 6. FUTURE PLAN IMPLEMENTATION PROBLEMS

The Suape regional development project is of very high strategic importance both to the Federative Republic of Brazil's national development policies, and to the concrete regional promotion policies of the state of Pernambuco.

However, even if the project has a strategically high priority, in the long term proper economic rationality must be recognized regarding the national and regional economies.

The Suape regional development project involves industrial development that is large-scale in worldwide terms.

Viewed from Japan's experience, it is clear that such a large-scale industrial development project will produce great change in the region.

In order to absorb the project and its diverse impacts effectively, the region must prepare sufficiently receptive organizations.

Because regional improvements have not caught up with development of the project, there are examples of many social and economic problems arising in the region, that we know of. These problems are the cause of much concern even for the Suape regional development, and must be solved.

Through the guidance of SUDENE and the Pernambuco state government, DIPER commissioned TRANSCON and APL to prepare plans for the Suape's regional development. The project has now progressed to the stage of the survey team's review and evaluation of those plans.

The detailed results of the survey team's investigations have been stated above. Here we want to take up a number of problems that are indicated in the course of proceeding with the regional development of the Suape, and consider policies for solving these issues in the interest of the project's smooth development.

In order to achieve regional development of the Suape, detailed surveys and research must of course be undertaken. This requires an integrated, coherent idea and program that includes preliminary surveys to gather the necessary basic data; basic concepts that have incorporated regional development policies; a master plan based on those concepts; a basic design derived from the master plan; and detailed planning.

To promote the realization of this project, organizations for this purpose, supported by a unified policy, and heavy fiscal financing must be prepared.

Next, we present the major problems, on the basis of study of the TRANSCON and APL reports, that require solution urgently for future planning implementation.

1. Regional Planning

(1) Coordination of Broad Area Development Planning and the Suape Regional Development Planning

TRANSCON conceives the Suape regional development as an independent project, but this carries the danger that it will become isolated from the region.

Noting that one part of the planning region already overlaps with the Recife Metropolitan Planning Region, this planning region should include the same region.

Moreover, it is necessary for Suape's regional development to be made a premise of the master plan for Cabo and other areas within the planning region.

(2) Construction of an Attractive Industrial Estate, Port and Harbor

In the TRANSCON report it is necessary that sufficient consideration be given to an overall design for land use that can integrate industry, ports and harbors, cities, and other functions

Though the industries and port themselves are investigated, consideration of the daily lives of employees in the estate, and foreign seamen entering the port is lacking.

Sufficient consideration of living conditions, not just functional aspects of the project, is desirable.

As one method for constructing an attractive industrial estate, port and harbor, it appears to be useful to consider such items as agreements regarding building lines and landscaping, planning for the colors of architectural materials, proposals for planning a park system, to establish a good image for the Suape Industrial Estate.

(3) Consideration of the Formation of Urban Area in Conjunction with Industrial Development

Results of the Aratu industrial estate survey showed that with the rise in the population of industrial employees, the number of people employed in tertiary industry, such as in most commercial and service establishments, increased.

However, research by TRANSCON on this point is insufficient. We recommend field study of this issue.

Field studies of other industrial estates, and the recording of change in the formation of urban areas in Suape, should be useful for planning concerned with the formation of urban areas over the long term.

(4) Investigation of Anti-Pollution Planning

In the development of industry on a large scale, planning for the prevention of pollution must be undertaken.

It does not appear that problems of pollution make development in Brazil as difficult as in Japan, but this is still an extremely important problem. We recommend preparation of plans that are complete and thorough in regard to the prevention of pollution.

The issue should not depend only on establishment of a green zone as a buffer; there is also the duty to establish pollution control facilities up to world standards, and the important point of countermeasures against sources of pollution.

Besides standards for air and water quality, integrated studies, in advance, on problems including purification within the newly-created port and harbor, treatment of trash, odors, noise, and vibration; should be conducted and corresponding policies should be established.

2. Port and Harbor Improvement

(1) Wave Observation

Data on waves are basic and most essential in port and harbor design and construction.

In constructing Suape port, it is necessary to raise the elevation of the existing reef and make it a breakwater, to secure calmness of the inner harbor.

Data on waves are also closely related to the length and direction of the breakwater at the entrance of the port, which will extend from the opening of the reef to outer waters.

Generally when a ship enters the port, a stopping distance of 4– 5 L is necessary after reducing its speed to 4 – 6 knots, but at this time the wave height must be below a certain limit.

Accordingly, where waves are rough year-round, it is necessary to have a longer breakwater than where it is calm, so as to enable a ship safely enter the port, and increase the usability of the ports and harbors.

Considering the above points, year-round data on waves are essential, but at the present the only data available are the observations made in June – August, 1974. Year-round observation, using wave recorder (wave-measuring instrument which can send data to shore by cable or wireless transmission) capable of continuous, long-term measurement, is necessary. A depth of –17 m for installing the wave recorder is good for observation. Year-round observation of wave directions should also be conducted.

(2) Soil Mechanical Studies

A rough survey, mainly by jet boring, is being completed, but it is necessary to obtain more data by core boring that can be used in planning, designing, and executing development of the port and harbor and the estate.

It is necessary to study the soil condition of the channels, basins, and areas where dredging is to be done; and it is also necessary to know about the physical and mechanical characteristics of soil of some places in the area where it is planned to locate coastal heavy industry.

Considering the necessity of the elevation of the reef, a detailed survey of the structure of the reef should be conducted, through borings taken along the entire length of the reef, to ascertain its durability as a breakwater. This is very important.

(3) Sounding

It is of basic importance to complete a survey of water depth of whole area of the Suape region and along the outside area of the reef (to a depth of at least -25 m) from Santo Agostihno Pint to Cupe Point.

Surveys of water depth should also be conducted mainly before and after the rough season to understand the movement of the bed materials in the outside area of the reef planned for the entrance channel.

(4) Model Tests

Because it is important to secure the calmness of the inner harbor, for port and harbor planning, model tests to investigate the degree of calmness are recommended. If possible, it is desirable to conduct model tests concerning the situation for outer channel and alongside the berths.

Model tests covering cases of changing alignment of the breakwater and the direction of the entrance channel should be conducted to find out the best arrangement of facilities within the Basin.

Furthermore, it is desirable to make the model at Suape, so that the people in charge at DIPER can see directly the model tests.

3. Infrastructure Improvement Other than the Port and Harbor

(1) Preparation of Infrastructure Improvement Program

In improving the infrastructure of the Suape, it is necessary to draw up an improvement program that adequately coordinates plans for the industrial estate and for the port and harbor.

Feasibility studies for each aspect of the infrastructure should be undertaken, and based on these studies an order of priority for improvements should be determined.

(2) Improvement of Basic Information

In order to improve the infrastructure, it is necessary to collect at least the following basic information:

(A) Survey of climate, precipitation, river discharge, geological and topographical features.

(B) Surveys on construction materials, raw materials, and construction machinery.

(3) Improvement of Water Supply, Flood Control Measures, and Sewage Treatment Systems

Among the infrastructure improvements in the Suape, establishment of systems for water supply, flood control, and sewage treatment are extremely important, and the following basic surveys must be undertaken:

1) Confirmation of the necessary volume of water.

2) Confirmation of the volume of water to be collected from rivers.

3) Survey of sedimentation in reservoirs and transportation of soils from upstream.

4) Survey of dam foundation and geological features, and confirmation of permeability of materials to be used.

5) Survey of the nature of materials for dams, and sources of stones and filling materials; survey of the quality of material and the volume that can be extracted.

6) Investigation of change in the river bed in conjunction with dam construction.

7) Survey of roads to be used in dam construction.

8) Investigation replacement drainage canals of the Ipojuca and Massangana Rivers in the ports and harbors districts.

9) Survey of tertiary sewage treatment and special effluent treatment for each plant.

(4) Improvement of Railways and Roads

1) Confirmation of the volume of traffic.

2) Determination of appropriate construction method in soft ground.

(5) The Necessity of, and Measures for, Cleansing Water for the Port and Harbor

(6) Power and Communications

Comparative study of independent power generators as a back-up system.

We have noted above items for research and investigation necessary to concretely advance regional planning, improvement of ports and harbors, and improvement of other aspects of infrastructure, in order to achieve the development of the Suape.

4. Future Study Needs

Next, we note below matters that require investigation for the planning stage of the Suape Coastal Industrial Estate planning study, and for the implementation stage. These items include the level of planning, the return on investment, the implementing agency, fiscal financing, and improvement of the training of human resources.

(1) Level of Planning

In the level of planning, inconsistency between fine details and general objectives is regrettably evident. First, it is necessary to strengthen and augment the level of planning. This objective can be attained by re-thinking the research and investigation stages, given above.

Second, the planning phases are not clear. This is because the development potentiality and rank of each project is incorporated into planning without confirming their order of priority.

In the case of preparing the planning stages, besides raising the desired ends of the Suape regional development to the level of development projects, it is necessary that planning be conducted in terms of short-term, intermediate-term, and long-term stages.

Moreover, each planning stage must maintain integration between technical and economic aspects, and must be unified into a total plan.

(2) Implementation

Paralleling the preparation of plans, investigation of implementation must be undertaken, and for that purpose it is necessary to consider at least the following items:

(A) Investigation of the Return on Investment

In industrial development, the main objective of the Suape regional development, comparing the industrial categories currently suggested for introduction with the investment in infrastructure, we are not confident that the investment will have a high rate of the return.

The team proposes rather dynamic industrial categories be introduced, and hopes that there will be a high rate of the return on investment.

In seeking the rational apportionment of investment capital, investigation of federal and state public investment should be coming first, with the aim of reducing the capital risk for desired industrial categories, should be conducted. If, provisionally, federal and state investment accounts for all of the investment, there would seem to be no particular problem with the rate of return, but since it is not absolutely certain that investment will follow that pattern the matter should be throughly investigated.

The most desirable situation is that industries which will become the mainstays of the estate be strategically introduced during Stage I.

(B) The Implementation Agency

Recognizing the long-term economic rationality of the Suape regional development, an implementation agency to lead the project is necessary for concretely moving toward the goal.

The implementation agency should be organized in accordance with Brazilian laws. In most cases, this type of national project is structured through the federal and state levels.

In the Suape case, since a nati onal impetus is necessary, federal organization of a Committee to provide the main leadership (for example, participation by a federal governmental agency like SUDENE, the PE state government, and a public corporation such as DIPER) could be considered.

This Committee, while drawing up plans and securing budgets, could be the entity promoting implementation. In case foreign loans are necessary, this type of Committee can function adequately as the implementation agency for a National Project.

Fortunately Brazil, with experience in large scale National Projects, excels at this type of organization, and a similar implementation agency in the Suape could be easily organized.

(C) Fiscal Financing

Plans call for completion of the Suape regional development by the year 2005, and to that end the necessary measures for fiscal financing must, of course, be undertaken.

However, the worldwide inflationary trends of recent years are quite likely to change the original framework for fiscal financing considerably. It is considered necessary to conduct an integrated investigation of fiscal financing.

For such a large-scale project, a team to investigate fiscal financing should be formed within the Committee.

(D) Human Resources Development

To attain the regional development of Suape, the improvement of training for human resources is necessary.

Since planning for this project maintains extremely high standards, other than personne involved in advancing planning, high-quality human resources will also be required for participating in the planning, and implementation of each aspect of operations.

Moreover, in the Recife, it is necessary to investigate both the raising of the level of education for the training of high-quality human resources in each field, as well as coordinating of this with the development project.

PART III. DEVELOPMENT EFFECTS

CHAPTER 1. UNDERSTANDING OF THE NEED FOR DEVELOPMENT OF THE NORDESTE

The necessity for development of the Suape is explained in the preceding chapters; here, within the scope of that necessity, brief consideration is given to the need to develop the Nordeste, in order to be able to properly understand and evaluate the effects of development of the Suape.

1. Improvement of Economic Conditions

The major source of income in the Nordeste is agriculture. Judging the level of industrialization by the composition of production income, the Nordeste is at half the level of Brazil as a whole. Because of this, the per capita income in the Nordeste was US$223, or less than half the value for the entire nation, US$526 (as of 1970; with the national figure as 100, the index for the Nordeste is 42). While this is in part due to the retarded nature of the region's industrial structure, a major cause is a lag in modernization of industry itself. That is, there is a great gap in labor productivity between industry of the Nordeste and that of Brazil as a whole.

Table 1-1. Comparison of Labor Productivity, Nordeste and Brazil

	Labor Productivity (Cr$/worker)	Difference from Nat'l. Value (Nat'l. value = 100)
Agriculture & fisheries	1,100	60
Manufacturing	5,100	42
Construction	6,800	119
Commerce	6,000	47
Transportation & communication	4,800	67
Services	1,200	61
Government	7,500	57
Average, all sectors	2,700	49

With the exception of the construction industry, labor productivity in all industrial categories in the Nordeste is lower than the national Brazilian averages by 40 to 70%. In particular productivity is low in manufacturing where labor productivity is half the national average.

However, the problem of a labor surplus in the Nordeste takes precedence over problems of industrial structure.

Ordinarily, in growing economies a hidden labor surplus exists in the primary sector, and as progress is made in industrialization, this surplus shifts to the secondary and tertiary sectors. This is the usual pattern of development of industrial structure. However, in the case of the Nordeste, there is an enormous surplus of labor not only in the primary sector but in the tertiary sector as well. This is evident from a comparison of labor productivity by industrial category, in the Nordeste, Brazil, and Japan (see Table 1-2).

In the case of Japan which is thought to have already attained full employment, with the exception of the primary sector, labor productivity is approximately balanced among the sectors of industry, and the labor market, with the exception of farmers who possess low mobility, is said to be in a condition close to perfect competition. In contrast to this, in the Nordeste and Brazil it is typical that at the same time that there are tremendous differentials between industries, the labor productivity in the tertiary sector is extremely low.

Table 1-2. Comparison of Labor Productivity by Industrial Sector, Nordeste, Brazil and Japan

(Unit: Cr$ 1/capita)

	Nordeste	Brazil	Japan
Agriculture & fisheries	1,100	1,800	13,000
Manufacturing	5,100	12,000	47,600
Construction	6,800	5,700	42,500
Commerce	6,000	12,700	35,500
Transportation & communication	4,800	7,100	46,200
Services	1,200	2,000	37,200
Government	7,500	13,000	44,500
Average, all industry	2,700	5,600	38,900

As is evident from the above table, the hidden surplus labor force in the Nordeste has accumulated largely in the primary sector and the services sector.

The labor surplus may be defined as those workers who are unemployed, unpaid workers in agriculture and the service sector, and the workers in the service sector who are not needed for that sector to attain a reasonable level of productivity (i.e., labor productivity equal to that of the rest of the tertiary sector) but are employed there just the same. Using this definition, it may be found that 75% of the work force in the services sector in the Nordeste comprise a surplus labor force. In addition to that, among the female population, the unemployed who may be considered as seeking employment constitute about 10% of the productive population of 14 years of age or older. These are also viewed as part of the surplus labor force.

Calculating the extent of the labor surplus on the basis of the above, it is found that the Nordeste has a surplus labor force of about 5,000,000, and in Pernambuco State the surplus is about 1,000,000. The composition of these figures is as follows:

Table 1-3. Estimates of Hidden Surplus Labor (1973)

(Unit: 10,000 persons)

	Nordeste			Pernambuco		
	Men	Women	Total	Men	Women	Total
Unemployed	13	5	18			
Unpaid workers	125	119	244	31	42	73
Surplus in service	36	87	123			
Hidden surplus among unemployed	-	90	90	-	17	17
Total surplus workforce	174	301	475	31	59	90

More than any other issue, the importance to the economy of the Nordeste of absorbing as much of this surplus as possible, deserves greatest emphasis. Therefore, from the standpoint of economic problems of the Nordeste, solving the problem of the labor surplus is foremost in importance, and is followed by modernization of the industrial structure and of industry itself.

2. Focal Points Regarding Important of the Social Infrastructure

From the viewpoint of improvement of social infrastructure as well as the economic issues mentioned above, the need for development of the Suape is amply evident.

Within the range of social infrastructure are included housing, public services and facilities, medical and health care facilities, transportation and communications facilities, educational facilities and the like. The improvement of social infrastructure has been particularly retarded in the Nordeste. The present conditions there may be summarized as follows:

– Housing: An extremely high percentage of houses have thatch roofs, stucco walls and dirt floors.

– Supply & service facilities: Diffusion rates are as follows:

	Nordeste	Brazil
Electric lights	20%	40%
Water supply	10	30
Modern sewerage	2	14

– Health & medical care facilities

	Nordeste (persons)	Brazil (persons)
Population/hospital bed	500	250
Population/doctor	4,000	2,000

Transportation & communication facilities	No great disparity is evident concerning the level of improvement of railroads and roads, comparing the Nordeste to the over-all situation in Brazil, but the telephone diffusion rate is 3%, which is much lower than the 13% figure for all Brazil.
Educational level	The literacy rate is 40%, whereas the Brasilian over-all rate is 60% (for 1970).

Social infrastructure in the Nordeste is thus extremely retarded in comparison to the over-all situation for Brazil. Although there is some regional disparity within the Nordeste, levels are low throughout.

Thus, the order of priority in developing the Nordeste is (1) improvement of the economic infrastructure and (2) improvement of social infrastructure.

CHAPTER 2. ANALYSIS OF DEVELOPMENT EFFECTS

1. Analysis of Economic Development Effects

(1) Contribution to Economic Growth

The Suape Coastal Industrial Estate project is enormous in scale, and calls for investment of more than US$ 200 million in the infrastructure sector alone. The project would thus have great significance regarding the future growth of the economy of the Nordeste. The project includes development of Suape port and of coastal industry. If the project is implemented as now proposed not only would there be the resultant increase in primary income due to development of the industrial sector but at the same time investment in development of port facilities and industry would increase secondary income. In this chapter the survey team investigates the influence that implementation of Stage I (completion in 1985) would have on the economy of Brazil and the Nordeste.

Primary contributions to economic growth are examined first.

The survey team proposes as components of Stage I the projects listed in Table 2-1.

The TRANSCON report uses prices for each product group which are projections made from a somewhat long-term viewpoint; these prices are as follows:

Prices of fertilizer, aluminum and petroleum products:

Aluminum	US$900/t
Fertilizer	
1975 – 1984 average	US$47.1/t
1985 – 1987 average	US$137.1/t
Petroleum products	US$120/t

Table 2-1. Major Aspects of Stage I Development of the Suape Coastal Industrial Estate Project

Project	Planned Production Volume	Equipment Investment	Annual Value of Production
Fertilizer	215,000 t/y	101,330	70,945
Aluminum refining	100,000 t/y	1,500,000	945,000
Petroleum refining	150,000 BPSD	3,500,000	5,911,920
Motor vehicles	Commercial vehicles	624,687	691,000
	10,000/y		
	Diesel engines		
	50,000/y		
Cargo vehicles	4,752/y	86,250	
Maintenance dock	70,000 – 10,000 DWT dock	1,560,000	
Rolled steel sheet	300,000 t/y	2,257,096	
Seamless steel pipe	250,000 t/y	2,002,846	1,039,935
Steel pipe	24,000 t/y	72,290	123,071
Castings	12,600 t/y	114,669	82,435
Forgings	12,000 t/y	138,953	121,249
Total		11,958,121	8,985,555 + α

Note: Planned production volume and equipment investment are compatible with Phase II figures for industrial development. Conversion of investment in petroleum refining from yen to cruzieros has been US$1 = Cr$7 = 300 yen (TRANSCON report rates). Production values for fertilizer, aluminum and petroleum refining are based on TRANSCON unit prices. For other projects corporate planning data submitted to SUDENE was used.

When industrial production in these sectors is commenced and is later expanded directly contribute to industrial production in Brazil and the Nordeste.

Deduction of intermediate inputs from the value of production of these products will yield the value added of each project. The share of intermediate inputs in the total value of production has been calculated by TRANSCON for the fertilizer, aluminum and petroleum products.

Concerning the other projects, intermediate inputs can be calculated by the use of industrial input-output tables. Table 2-2 gives input coefficients for the 1971 table prepared by Antonio S.C. Leao et al. The categories of industrial projects under consideration here belong to the metal industries (steel-making, casting, forging) and transport machinery industries categories of this table. The amounts of value added formed by the projects may be sought by use of the value of production, while those for projects for which this method cannot be used, can be determined through the use of the amount of equipment investment.

Table 2-2 Input Coefficients of Brazil's Industrial Input–Output Table

			Manufacturing									
		Mining	Non ferrous metals	Metals	Machinery	Electric machinery	Transport equipment	Lumber	Furniture	Paper making	Rubber	Leather
Mining		0.0001	0.1023	0.0006	0.0004	0.0002	0.0000	0.0001	0.0001	0.0010	0.0003	0.0010
Manufacturing	Non ferrous metals	0.0033	0.0720	0.0046	0.0022	0.0111	0.0086	0.0035	0.0092	0.0002	0.0003	0.0022
	Metals	0.0856	0.0208	0.3077	0.1249	0.1373	0.1125	0.0310	0.0861	0.0193	0.0113	0.0232
	Machinery	0.0000	0.0000	0.0000	0.1263	0.0074	0.0827	0.0000	0.0000	0.0000	0.0000	0.0000
	Electric Machinery	0.0310	0.0004	0.0003	0.0184	0.1481	0.0328	0.0000	0.0000	0.0000	0.0000	0.0000
	Transport equipments	0.0000	0.0000	0.0072	0.0309	0.0050	0.1575	0.0000	0.0000	0.0000	0.0000	0.0000
	Lumber	0.0020	0.0023	0.0033	0.0053	0.0024	0.0009	0.3326	0.0986	0.0078	0.0005	0.0034
	Furniture	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0001	0.0000	0.0000	0.0000
	Paper making	0.0051	0.0181	0.0039	0.0023	0.0064	0.0028	0.0202	0.0130	0.2019	0.0023	0.0095
	Rubber	0.0014	0.0008	0.0016	0.0090	0.0021	0.0193	0.0006	0.0016	0.0005	0.0950	0.0038
	Leather	0.0018	0.0001	0.0002	0.0003	0.0001	0.0001	0.0006	0.0055	0.0001	0.0005	0.2383
	Chemicals	0.0784	0.0382	0.0170	0.0092	0.0291	0.0154	0.0340	0.0853	0.0697	0.1716	1.1054
	Pharmaceuticals	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0001	0.0001	0.0001	0.0000	0.0001
	Perfumes	0.0000	0.0003	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0001	0.0004	0.0002
	Plastics	0.0035	0.0018	0.0027	0.0024	0.0033	0.0022	0.0021	0.0061	0.0017	0.0010	0.0044
	Textiles	0.0087	0.0013	0.0017	0.0007	0.0026	0.0063	0.0040	0.0545	0.0030	0.0204	0.0492
	Apparel	0.0115	0.0005	0.0006	0.0005	0.0003	0.0006	0.0007	0.0075	0.0017	0.0050	0.0148
	Foodstuffs	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Beverages	0.0000	0.0001	0.0001	0.0000	0.0000	0.0000	0.0001	0.0003	0.0007	0.0001	0.0004
	Tobacco	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Publishing & Printing	0.0001	0.0007	0.0001	0.0003	0.0002	0.0002	0.0002	0.0002	0.0009	0.0001	0.0002
	Others	0.0013	0.0005	0.0021	0.0045	0.0023	0.0064	0.0028	0.0004	0.0002	0.0005	0.0059
Construction		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Agriculture		0.0004	0.0006	0.0003	0.0001	0.0001	0.0001	0.0032	0.0083	0.0005	0.1469	0.0039
Not classifiable		0.0841	0.0575	0.1084	0.0539	0.0927	0.0246	0.1145	0.0722	0.1279	0.0403	0.0973
Inter. input total		0.3182	0.3185	0.4624	0.3916	0.4512	0.4730	0.5505	0.4498	0.4372	0.4966	0.5632
Imports		0.0541	0.0259	0.0650	0.0911	0.0975	0.0434	0.0130	0.0055	0.0378	0.0384	0.0155
Value added	Worker income	0.4334	0.1456	0.2064	0.2534	0.1290	0.1595	0.1898	0.3397	0.1546	0.1771	0.1432
	Company income	0.0452	0.4004	0.1582	0.2219	0.2369	0.2136	0.1673	0.1125	0.2379	0.2120	0.2250
	Direct taxes	0.0489	0.0669	0.0345	0.0246	0.0693	0.0763	0.0470	0.0560	0.0717	0.0755	0.0528
	Amortization	0.0002	0.0527	0.0729	0.0175	0.0161	0.0341	0.0324	0.0075	0.0407	0.0005	0.0007
	Value added total	0.6277	0.6556	0.4720	0.5174	0.4513	0.4836	0.4365	0.5447	0.5250	0.4650	0.4213
Grand Total		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

		Manufacturing												
		Chemicals	Pharmaceuticals	Perfumes	Plastics	Textiles	Apparel	Foodstuffs	Beverages	Tobacco	Printing & Publishing	Others	Construction	Agriculture	Not classifiable
Mining		0.0047	0.0002	0.0025	0.0001	0.0000	0.0001	0.0003	0.0001	0.0000	0.0000	0.0033	0.0230	0.0001	0.0003
Manufacturing	Non ferrous metals	0.0023	0.0193	0.0177	0.0052	0.0002	0.0001	0.0024	0.0245	0.0000	0.0013	0.0094	0.0019	0.0020	0.0024
	Metals	0.0135	0.0115	0.0190	0.0147	0.0013	0.0069	0.0257	0.0179	0.0061	0.0052	0.0409	0.3442	0.0281	0.0000
	Machinery	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0029
	Electric Machinery	0.0001	0.0000	0.0002	0.0003	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0047	0.0000	0.0027	0.0036
	Transport equipments	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0049
	Lumber	0.0011	0.0002	0.0002	0.0015	0.0006	0.0009	0.0007	0.0019	0.0000	0.0008	0.0071	0.0020	0.0177	0.0004
	Furniture	0.0000	0.0000	0.0000	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0009
	Paper making	0.0120	0.0263	0.0456	0.0256	0.0061	0.0138	0.0214	0.0118	0.0195	0.2336	0.0420	0.0024	0.0009	0.0000
	Rubber	0.0012	0.0033	0.0001	0.0015	0.0004	0.0083	0.0003	0.0001	0.0001	0.0006	0.0019	0.0001	0.0048	0.0010
	Leather	0.0001	0.0002	0.0008	0.0015	0.0003	0.0499	0.0001	0.0001	0.0000	0.0008	0.0048	0.0001	0.0025	0.0000
	Chemicals	0.2076	0.0349	0.1051	0.2286	0.1707	9.0893	0.1175	0.0100	0.0127	0.0326	0.0390	0.0405	0.0216	0.0000
	Pharmaceuticals	0.0059	0.1275	0.0036	0.0009	0.0001	0.0001	0.0004	0.0007	0.0000	0.0002	0.0030	0.0000	0.0002	0.0018
	Perfumes	0.0143	0.0027	0.0803	0.0001	0.0002	0.0001	0.0061	0.0015	0.0004	0.0001	0.0002	0.0000	0.0006	0.0008
	Plastics	0.0046	0.0090	0.0353	0.0306	0.0018	0.0039	0.0052	0.0038	0.0034	0.0025	0.0060	0.0003	0.0032	0.0012
	Textiles	0.0014	0.0036	0.0030	0.0284	0.2076	0.3784	0.0005	0.0002	0.0010	0.0031	0.0162	0.0005	0.0423	0.0024
	Apparel	0.0011	0.0015	0.0003	0.0049	0.0108	0.1034	0.0023	0.0019	0.0002	0.0003	0.0027	0.0007	0.0154	0.0027
	Foodstuffs	0.0027	0.0125	0.0297	0.0000	0.0000	0.0000	0.2085	0.0337	0.0000	0.0000	0.0000	0.0000	0.0001	0.0070
	Beverages	0.0077	0.0010	0.0026	0.0011	0.0001	0.0000	0.0123	0.1284	0.0001	0.0004	0.0215	0.0002	0.0003	0.0009
	Tobacco	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0382	0.0000	0.0000	0.0000	0.0000	0.0006
	Publishing & Printing	0.0008	0.0010	0.0009	0.0006	0.0002	0.0003	0.0002	0.0005	0.0000	0.0138	0.0015	0.0003	0.0005	0.0019
	Others	0.0018	0.0029	0.0034	0.0051	0.0014	0.0063	0.0001	0.0001	0.0000	0.0013	0.0675	0.0010	0.0116	0.1004
Construction		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Agriculture		0.0197	0.0021	0.0003	0.0002	0.0374	0.0027	0.0939	0.0186	0.0000	0.0004	0.0051	0.0000	0.0510	0.0412
Not classifiable		0.1000	0.0867	0.0882	0.0247	0.0777	0.0953	0.0548	0.0802	0.0072	0.1418	0.0692	0.0418	0.1052	0.4880
Inter. input total		0.4028	0.3464	0.4391	0.3756	0.5173	0.7598	0.5528	0.3361	0.0889	0.4389	0.3463	0.4591	0.3111	0.5653
Imports		0.1344	0.1197	0.0408	0.0821	0.0336	0.0090	0.0186	0.0303	0.0000	0.0321	0.1038	0.0000	0.0050	0.0328
Value added	Worker income	0.0826	0.2930	0.1021	0.1926	0.2185	0.1697	0.0538	0.1979	0.0252	0.2186	0.3225	0.2550	0.2560	0.1597
	Company income	0.2854	0.1861	0.2393	0.2712	0.1409	0.0024	0.3377	0.2341	0.1287	0.3337	0.1274	0.2565	0.3158	0.1359
	Direct taxes	0.0355	0.0348	0.1694	0.0692	0.0447	0.0356	0.0182	0.1822	0.7532	0.0666	0.0640	0.0265	0.0276	0.0970
	Amortization	0.0593	0.0201	0.0094	0.0092	0.0451	0.0235	0.0187	0.0194	0.0040	0.0001	0.0361	0.0029	0.0850	0.0093
	Value added total	0.4627	0.5340	0.5201	0.5423	0.4491	0.2312	0.4285	0.6336	0.9111	0.6290	0.5499	0.5109	0.6837	0.4018
Grand Total		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Although the data are limited, corporate planning data previously submitted to SUDENE can be used to calculate the production function (Cobb-Douglas Function) and the independent variables for the amount of industrial value added are capital (K), 0.95, and labor (L), 0.05, which are almost completely determined by the amount of equipment investment. Because of this, the value added created through productive activities may be sought by using the amount of equipment investment per unit calculated using the amounts of value added already determined for certain industrial categories from the input coefficient list of the industrial input-output table. For those categories of industry for which the value of production has not been calculated the amounts of value added may be sought by using the amounts of equipment investment.

The values added are as follows:

Amount of value added, by industrial sector, in Cr$ 1,000,000:

Fertilizer	31
Aluminum	368
Oil refinery	1,951
Metals & machinery	2,268
Total	4,618

Secondary contributions to economic growth are studied next.

Rather than being the value added created by productive activities in this project, these secondary contributions are equipment investment made for commencement or expansion of productive activities, repercussion effects on the national or regional economy, or both economies, value added from the production of raw materials, and value added from the process of port and harbor construction. If these projects are started in 1975, initial economic activities would comprise port and harbor construction, construction of railways and roads, and development of infrastructure such as power generation, telecommunications, water supply and sewage, cities, and the like. If investment is made in infrastructure development in this fashion, employment opportunities will be created in the region, and construction activities will enable private corporations to earn profits. Further, steel, cement, lumber and other construction materials will be required, generating increased demand. The purchasing of these materials will further increase the value added which is created in the region, and hence in the country. Further, when plant construction is begun, the equipment investment will generate value added, just as will construction of the port and harbor, and production of materials to be used for plant construction will also form value added, as noted above. Procurement of material inputs for these proudctive activities will be necessary and such demand will increase over time, resulting in increased generation of value added in the industries supplying those inputs. This process is represented in Fig. 2-1.

Also, the actual value of the value added which is expected to be formed by the Suape project has been calculated and results are shown in Fig. 2-1 (II to IV).

In Fig. 2-1 (II) are shown the contributions which construction of the various facilities required for functioning of the estate and construction of the port and harbor will have on the economic growth of the region. Of these contributions, in (II)-1, the contributions directly resulting from construction will be the workers' earnings and profits of the enterprises concerned, which have been calculated (see Table 2-4-1).

The greatest economic effect will be that resulting from construction of Suape port. In years of peak construction activity, 1978 and 1979, the value added which will be formed will be Cr$ 160.5 million (US$ 2.2 million) and Cr$ 194.36 million (US$ 2.8 million). This will be followed by the effects of urban development. Before the start of the 1980s, investment in construction of the port and harbor will pass its peak and will then decline gradually, but investment in urban development will show the opposite trend, and after the start of the 1980s investment will be at the level of Cr$ 20 million each year, so that the life cycle of the economic effects of this project will be long. (See Table 2-3.)

The improvement of the port and harbor, and related work, will impart stimuli to the national economy and the regional economy of the Nordeste through the economic effects of construction activities as well as through the procurement of materials. The extent of this may be measured by multiplying the amount spent for procurement of materials by the ratio of value added. For this ratio, figures from the 25-sector industrial input-output table for 1971, prepared by Antonio S.C. Leao and others is used. The results are shown in Table 2-4-2. The results are the value of the value added acquired by Brazil as they represent value added derived from the demand for raw materials, with the exception of imports. The value of value added acquired in the Nordeste is necessarily lower than the value acquired in the nation, and can be estimated by use of self-sufficiency ratios for raw materials for the Nordeste. These figures have been estimated and used to calculate the value added obtained by the Nordeste (see Table 2-4-3). For the region's self-sufficiency ratio, use was made of the average ratio for procurement of intermediate inputs within the region, as given in the TRANSCON Report for four industrial projects.

(III) represents the value added from equipment investment in the industrial sector. In this case also distinction is made between the value added from equipment investment, and the value added from procurement of materials in accordance with that investment. The former is evaluated as about 40% of the value of investment in industrial equipment, and the latter is evaluated at about 25%.

These ratios can be applied to the value of equipment investment anticipated for Stage I, in order to obtain the amount of the value added for (III). In this event, however, the amount of the value added thereby obtained is for the entire period of equipment investment,

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Antonio Sergio Carneiro Leao, Carlos Ribeiro da Silva, Elcio Giestas e Jose Nobrega, *Metriz de insumo-produto do Brasil*, Revista Brasiliera de Economia, vol. 27, No. 3, 1973.

Table 2-3 Investment in Ports and Harbors, and Related Infrastructure

(Unit: Cr$ million)

Year	Expropriation	Water supply	Telecommunication	Urbanization	Electric power	Flood and channels control	Sewage disposal	Railways	Roads	Harbor	Total
1975	5.0	10.5	-	15.0	0.7	-	2.6	10.6	41.5	21.5	107.4
1976		15.5	2.4	16.0	10.7	0.8	2.0	8.8	22.8	10.0	89.0
1977		8.2	1.1	8.0	10.7	10.0	2.0	8.7	-	99.1	147.8
1978		8.8	1.1	8.0	10.7	10.0	19.0	8.7	-	213.1	279.4
1979		3.5	1.1	8.3	10.7	10.0	19.0	8.3	-	258.1	319.0
1980		2.3	1.1	6.0	10.7	10.0	19.8	4.5	4.0	114.0	172.4
1981		2.3	1.1	7.0	10.7	-	22.8	4.5	4.0	100.3	152.7
1982		1.8	1.1	39.0	10.7	-	1.5	4.5	-	83.8	142.4
1983		1.8	1.1	39.0	10.7	-	1.5	4.5	-	16.4	75.0
1984		3.2	1.1	39.2	10.7	-	1.5	4.9	-	16.4	77.0
1985		3.2	2.6	36.8	10.7	-	1.5	-	4.0	18.9	77.7
Cumulative total	5.0	61.1	13.8	222.3	107.7	40.8	93.2	68.0	76.3	951.6	1,639.8

Note: Value estimations for Plan Phase I, by the JICA Mission

Fig. 2-1 Economic Influence of the Suape Project

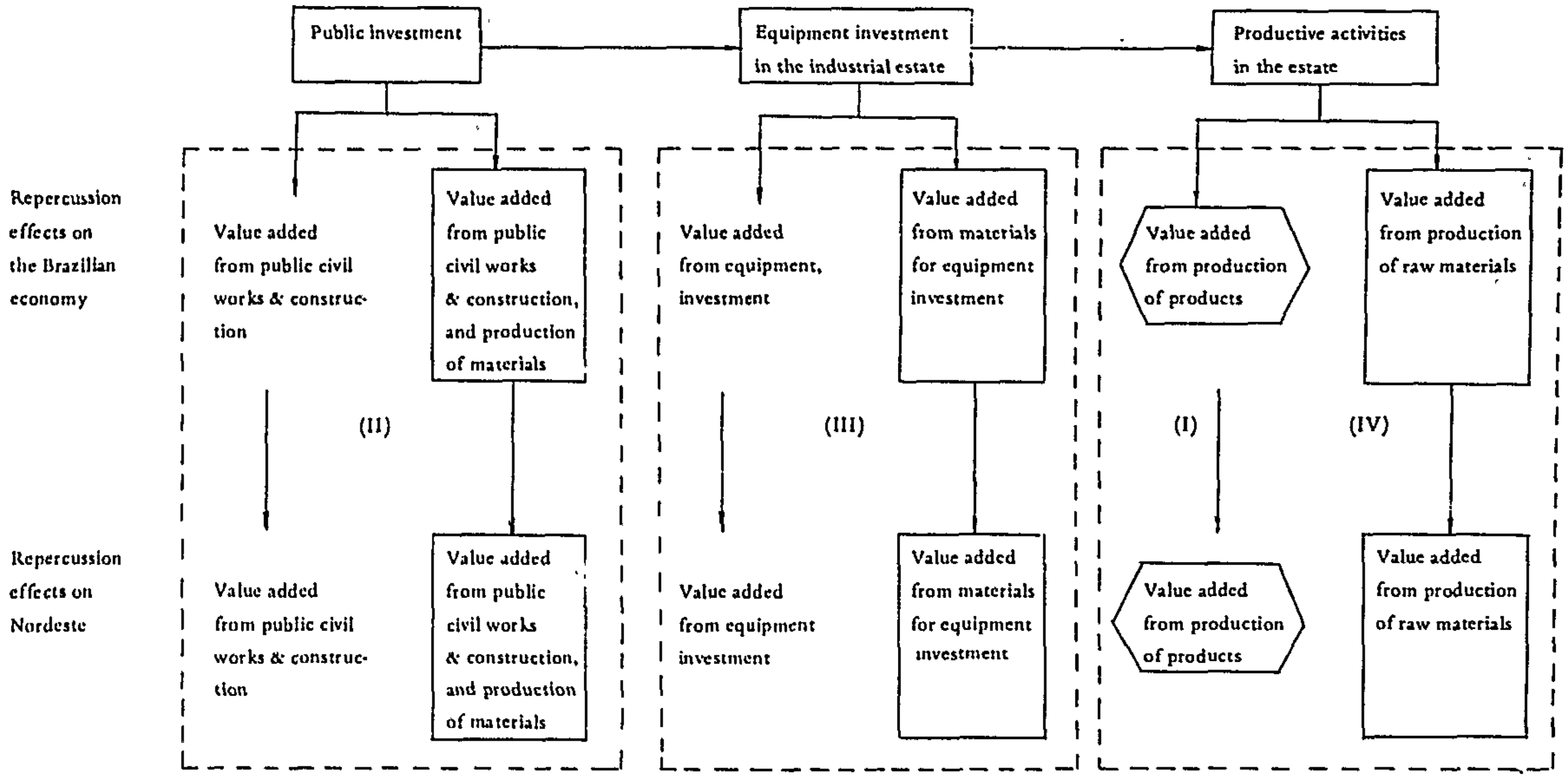

Table 2-4-1 Value Added Created by Investment in Port and Harbor and Infrastructure Development

(Unit: Cr$ 1,000,000)

	A	B	C	D	E	F	G	H	I	Total
1975	0.293	16.154	7.190	31.297	0.0	9.303	6.290	1.950	0.0	72.477
1976	0.293	7.553	6.007	17.139	1.494	10.976	9.331	5.540	0.586	58.919
1977	4.590	74.675	5.920	0.0	0.645	5.482	4.893	5.540	10.100	111.845
1978	4.590	160.495	5.920	0.0	0.645	5.482	5.300	14.062	10.100	206.594
1979	4.590	194.361	5.827	0.0	0.645	5.683	2.135	14.074	10.100	237.415
1980	4.590	85.896	3.037	3.030	0.645	4.117	1.385	14.647	10.100	127.447
1981	4.590	75.548	3.037	3.030	0.645	4.793	1.385	17.188	0.0	110.216
1982	4.590	63.150	3.037	0.0	0.645	26.727	1.098	6.270	0.0	105.517
1983	4.590	12.360	3.037	0.0	0.645	26.727	1.098	6.270	0.0	54.727
1984	4.590	12.360	3.365	0.0	0.645	26.832	1.881	6.270	0.0	55.943
1985	4.590	13.262	0.0	0.0	1.606	25.222	1.881	6.270	0.0	52.831

Note: Ratios of value added according to the TRANSCON report.

Table 2-4-2 Value Added Created by Procurement of Raw Materials in Accordance with Investment in Port & Harbor and Infrastructure Development (Entire Nation)

(Unit: Cr$ 1,000,000)

	A	B	C	D	E	F	G	H	I	Total
1975	0.146	1.942	1.230	3.673	0.0	1.692	1.449	0.247	0.0	10.379
1976	2.217	0.899	1.025	2.011	0.348	1.806	2.148	0.196	0.067	10.717
1977	2.217	8.969	1.015	0.0	0.152	0.902	1.128	0.192	0.835	15.410
1978	2.217	19.286	0.961	0.0	0.152	0.902	1.221	1.997	0.835	27.571
1979	2.217	23.358	1.015	0.0	0.152	0.931	0.493	1.997	0.835	30.998
1980	2.217	10.317	0.521	0.354	0.152	0.878	0.317	1.855	0.835	17.446
1981	2.217	9.077	0.521	0.354	0.152	0.789	0.317	2.134	0.0	15.561
1982	2.217	7.584	0.521	0.0	0.152	4.398	0.248	0.180	0.0	15.300
1983	2.217	1.463	0.521	0.0	0.152	4.398	0.248	0.180	0.0	9.179
1984	2.217	1.463	0.577	0.0	0.152	4.418	0.431	0.180	0.0	9.438
1985	2.217	1.590	0.0	0.0	0.375	4.151	0.431	0.180	0.0	8.944

Table 2-4-3 Value Added Created by Procurement of Raw Materials in Accordance with Investment in Port & Harbor and Infrastructure Development (Nordeste Region)

(Unit: Cr$ 1,000,000)

	A	B	C	D	E	F	G	H	I	Total
1975	0.161	0.815	0.516	1.540	0.0	0.709	0.607	0.104	0.0	4.352
1976	0.929	0.754	0.430	0.844	0.146	0.757	0.901	0.080	0.028	4.869
1977	0.929	3.756	0.426	0.0	0.064	0.378	0.473	0.080	0.350	6.456
1978	0.929	8.077	0.403	0.0	0.064	0.378	0.511	0.747	0.350	11.459
1979	0.929	9.782	0.426	0.0	0.064	0.390	0.207	0.747	0.350	12.895
1980	0.929	4.321	0.218	0.148	0.064	0.284	0.133	0.778	0.350	7.225
1981	0.929	3.801	0.218	0.148	0.064	0.331	0.133	0.894	0.0	6.518
1982	0.929	3.176	0.218	0.0	0.064	1.844	0.104	0.075	0.0	6.410
1983	0.929	0.620	0.218	0.0	0.064	1.844	0.104	0.075	0.0	3.854
1984	0.929	0.620	0.242	0.0	0.064	1.851	0.182	0.075	0.0	3.963
1985	0.929	0.665	0.0	0.0	0.157	1.740	0.182	0.075	0.0	3.748

A: Power
B: Port & harbor
C: Railway
D: Roads
E: Communications
F: Urban development
G: Water supply
H: Sewage system
I: Flood control

and this value would be considerably lower for single years.

Value added from investment in industrial equipment, in Cr$ 1,000,000:

VA formed by equipment investment per se	4,783
VA formed by procurement of materials	2,990
Total	7,773

(Note: Ratios and breakdowns are based on the TRANSCON Report.)

(IV) represents the value added formed by the demand for raw materials generated when plants in the estate start to produce. The TRANSCON Report gives as this value added 1.7% for the fertilizer industry, 17% for aluminum refining, and 3% for the oil refinery.

For other industries, the amounts may be calculated by multiplying the value added ratios by the value of demand for raw materials procured domestically, which is listed among the intermediate inputs in the input/output table. The values obtained are 22 – 23% of original production values. These amounts reflect the special nature of the individual industries; typically the regional demand stimulation effects of the machinery and metals industries are high but because domestic procurement for the oil refinery is low, the effects are weak relative to the value of production.

Value added formed through procurement of raw materials at the operation stage, in Cr$ 1,000,000:

Fertilizer	12
Aluminum	161
Oil refinery	177
Machinery and metals	1,004
Total	1,354

On the basis of the foregoing, the contribution to economic growth made by the Suape estate, by source of contribution, may be determined as summarized in Table 2-5.

Disaggregation into six sources is made, and of these the greatest contribution is that of the value added resulting from production activities in the manufacturing sector. Value added from equipment investment in manufacturing and in infrastructure is quite important at an early stage in the life cycle of the project, but has little meaning during the phase of full operation.

(2) Influence on the International Balance of Payments

Brazil's international balance of payments has continued to show a deficit in the current balance in recent years, which has required supplementing from the capital balance. The *cumulative as of 1973 was US$6,400 million*, and Brazil's international liquidity was further reduced by the oil shock and consequent events. It is therefore necessary to study any project as large in scale as this one from the viewpoint of its likely impact on the international balance of payments.

In the case of this project, final conclusions have yet to be made regarding the amount of funds to be obtained abroad, the amount of direct foreign investment to be permitted in each project in the estate, policy regarding disposition of profits and reinvestment. Because these matters are uncertain at the present time, emphasis here is given to the influence the projects will have on the balance of trade. Attention is given to the influence these projects would have on flows of foreign exchange into and out of the country.

First, demand for imports will be generated by (1) need for raw materials not available domestically, (2) need for equipment in which the industrial sector will invest, and (3) materials for port and harbor development, and infrastructure development, all of which must be acquired abroad.

Table 2-5-1 Economic Effects, by Source, of Phase I, Suape Project (Entire Notion)

(Unit: Cr$ 1 million)

	Mfg. industry activities	Raw material demand of mfg.	Infrastructure construction	Raw material demand for infrastructure construction	Equip. invest. in mfg.	Demand for raw materials equip. invest. in mfg.	Total
1975	-	-	72	10	-	-	82
1980	600	250	127	17	685	420	2,099
1985	4,618	1,354	53	9	1,200	750	7,984

Table 2-5-2 Economic Effects, by Source, of Phase I, Suape Project (Nordeste)

(Unit: Cr$ 1 million

	Mfg. industry activities	Raw material demand of mfg.	Infrastructure construction	Raw material demand for infrastructure construction	Equip. invest. in mfg.	Demand for raw materials equip. invest. in mfg	Total
1975	-	-	72	4	-	-	76
1980	600	100	127	7	685	170	1,689
1985	4,618	540	53	4	1,200	1,300	6,715

Specifically, regarding (1), demand will primarily arise in the oil refinery, aluminum and fertilizer industries. Also, although not classified as an industrial project, a million-ton cement terminal is planned for Stage I. Since inflows of foreign exchange are expected as a result of this terminal, imports of raw materials necessary for production are included in our tabulation of imports.

It is planned to obtain almost all intermediate inputs for the machinery and metals industry projects from domestic sources. Although it is expected that parts for diesel engines to be installed in commercial vehicles will be imported, since they will be exported as integral parts of the assembled vehicles, they are excluded from our tabulation.

Next, (2) is calculated to be 26% of total equipment investment.

Also, (3) is calculated to be 4% of total investment.

Consequently the value of imports at the time of full operation in 1985 is as follows (for Stage I; in CrS 1,000,000):

Value of Stage I imports:

Raw materials for industrial projects				Industrial equipment investment	Port, harbor & infrastructure development
Oil refinery	Aluminum	Fertilizer	Cement		
580	4.2	4.0	3.5	111.1	0.4

(Note: Ratios of imports in investments for materials for industrial projects and infrastructure and based on the TRANSCON Report.)

(Note: Imports of intermediate inputs for the fertilizer, aluminum and cement projects are given in the TRANSCON Report, and are adjusted to match production scales. For the oil refinery, the volume of imports was multiplied by the unit price used in the same report.)

As indicated above, the total value of imports as a share of equipment investment in the industrial transport and infrastructure sectors is not very large. Among imports of raw materials for industrial projects, crude oil is by far the most important item.

Stage I will include production of diesel engines for direct exportation, as a means of earning foreign exchange, but as noted above such gains are offset by the cost of parts which must be imported. Thus it will be exports of cement which will cause an inflow, directly, of foreign exchange. This inflow is estimated as US$40 million.

The balance of international trade will show a clear deficit. However, as may be seen in the following table, almost all industrial projects can be considered to have the function of substituting for imports and the value of their production may be viewed as representing a savings in foreign exchange.

Projects which will save foreign currency equal to the entire value of production are the oil refinery, aluminum and fertilizer projects. All others except ship maintenance produce industrial goods for which there is now a net import surplus. However, depending on the type of project, it is thought that in some instances there will be redundancy in relation to other domestic or imported products (exports of automobiles have already attained a reasonably high level). Further, rolled steel, castings, diesel engines and other semi-finished products become inputs for other industrial projects within the estate, and it is possible that some redundancy occurs here. Because of this, it is not possible to determine the total extent of conservation of foreign exchange.

Brazil's balance of trade in selected industrial commodities during Phase I (1973):

Code	Commodity	Exports	Imports	Balance
332	Petroleum products	592**	2,147	-1,555
561	Fertilizer	6	2,463	-2,457
684	Aluminum	0	63	-63
672	Basic steel products	64	419	-355
672.7	Steel coil	9	136	-127
674	Rolled metal	35	1,004	-969
674.1	Heavy plate	14	316	-302
674.3	Thin plate	11**	444	-433
678.2	Seamless pipe, steel	1	40	-39
678.3	Steel pipe, plain	3	7	-4
69	Metal products	23*	125	-102
711.5	Piston engines	1**	14	-13
732	Automobiles	15	25	-10
735	Ships	18*	16	+2

(Note: Single asterisk signifies units of US$1 million;
double asterisk signifies units of 1,000 tons.)

The maximum savings of foreign exchange was calculated by taking the value of production of the oil refinery, aluminum and fertilizer projects and converting the total to dollars; this was taken to be the minimum savings, and the value of production of the other projects with the exception of the ship maintenance dock was added, also in dollars.

Balance of trade during Stage I (1985) in Cr$ 1,000,000:

Outflow of foreign exchange due to imports	Inflow of foreign exchange due to exports	Foreign exchange savings through import substitution	Balance
-700	+40	+1,000 to 1,500	+340 to 840

Thus the conservation of foreign exchange through import substitution will be a major benefit of the Suape project and may be considered as capable of resulting in a surplus in the balance of trade over the long term. Although there will be a considerable deficit in trade during the period when investment activities are at a high level, that is, 1980 to 1985, the project will begin to yield returns after 1985.

2. Influence on the Life of the Residents of the Region

(1) Creation of Employment Opportunities

In the Nordeste where more than 30% of the labor force may be characterized as being a latent surplus, nothing is more important than the creation of employment opportunities as a means of putting people at ease.

Employment effects of Stage I are calculated to be as follows:

Fertilizer	98 employees
Aluminum refining	750
Oil refinery	300
Automobiles	1,567
Materials transport vehicles	1,016
Ship maintenance dock	800
Sheet steel rolling	945
Seamless steel pipe	993
Plain steel pipe	331
Casting	330
Forging	300
Total	7,430 employees

As noted above, the number of workers required for industrial projects planned for Stage I is about 7,500. In addition, the number of workers to be directly employed in the development of the Suape, at the port and harbor, is given as 3,000 in the TRANSCON Report. At the time of completion of the project, this number will probably be 1,000 to 2,000 for Stage I. If the higher estimate of 2,000 is taken, together with those persons to be employed in industry it is estimated that the direct employment effects of Stage I will be about 9,500 jobs.

In addition to these direct employment effects there will be employment effects in the construction and tertiary or non-basic industries. In the case of the Aratu estate, for there to be an increase of one job in the basic industries, including the employment effects in all non-basic industries, it was necessary to employ four workers. However, this includes maids, serving girls and errand boys, in what the TRANSCON Report calls 'feudalistic tertiary industry'. If use of another method of creating jobs is presumed, for each increase of one unit of income of the basic industries, 1.2 units of income of non-basic industries is induced. Further, if industry is attracted to the same extent as the Brazilian average, the labor productivity of the tertiary industry including hidden surplus labor in the service industry is calculated to be 60% of the average Brazilian productivity. From both of these, it can be calculated that the number of employment opportunities in non-basic industries will be twice the number of direct workers in the basic industries.

That is, for every direct worker, jobs will be created for two workers. If these values are taken to be real employment excluding surplus labor which has accumulated in the service sector, then the precedent of Aratu where four jobs were created for each direct worker may be considered as the maximum value, including surplus labor. It is therefore suitable to assume that the number of jobs created will be three for each direct worker. Therefore the total employment effect will be 9,500 + (9,500 x 3) = 38,000 jobs. The significance this will have on the region's economy is studied in the section on development effects.

(2) Industrialization and the Level of Improvement of Living Standards

To testify as to the contribution regional development will make to the improvement of standards of living, it is useful to observe the relationship between the degree of industrialization of an economy (here, we use the ratio of secondary industry in production earnings) to standards of living (housing, utilities, transport, communications, health and medical care, education), for Brazil's states.

Table 2-6 shows, by state, the extent of economic dependence on secondary industry, as an index of regional industrialization, and the status of standards of living and community services. The states are grouped into highly industrialized, moderately industrialized, and little industrialized classes (respectively, with secondary sector earnings ratios of 20% or more, 10 – 20%, and less than 10%), as shown in Table 2-7.

As may be seen from Table 2-7, with progress in industrialization, the level of improvement of social infrastructure in general also shows progress. In particular, when the earnings ratio of the secondary sector increases from the 10% level to 20%, improvement of the social infrastructure is rapid. Industrialization of course has influences on the social environment which are not favorable, such as the greater rate of occurrence of automobile accidents and the destruction of the natural environment. However, in today's Brazil, which has accumulated a large surplus of labor, in regions where the share of secondary industry is up to 20%, it must be said that industrialization is raising the level of improvement of social infrastructure. In particular, it is thought that gains are especially rapid in improvement of housing and utility supply services, the paving of roads, improvement of communications facilities and elevation of the level of education.

Table 2-6 Relationship of Industrialization and Level of Improvement of Living Standards

State		Housing		Utilities			Transport		Telecommunications	Medical & health care		Education
	Secondary sector earnings ratio	Ratio of houses with thatched roofs	Ratio of houses with earthen floors	Ratio of houses with electric lights	Ratio of houses with water supply facilities	Ratio of houses served by sewage system	Ratio of roads per unit area of state	Ratio of paved roads per unit area of state	Telephone diffusion rate	Population per hospital bed	Population per physician	Illiteracy rate
	%	%	%	%	%	%	km/1,000 km^2	km/1,000 km^2	%	persons	persons	%
Sao Paulo	39.9	1.2	9.1	76.2	59.1	35.6	690	69	25.1	166	1,645	22.4
Rio de Janeiro	34.9	3.0	12.0	64.9	45.5	16.8	596	87	10.1	198	1,616	30.0
Santa Catarina	24.0	1.1	6.8	46.4	28.9	1.6	751	21	5.6	229	3,263	25.5
Guanabara	21.5	0.3	3.0	92.1	80.0	35.5	16	637	0.7	105	510	14.6
Minas Gerais	20.0	6.2	34.5	37.8	30.0	16.6	338	17	9.6	219	2,136	41.0
Amazonas	18.3	63.2	15.8	26.0	20.0	-	2	0	6.1	310	2,675	49.7
Pernambuco	17.1	4.2	41.1	35.3	17.2	3.6	359	27	4.5	345	2,231	56.9
Rio Grande do Sul	16.9	5.6	11.4	48.4	37.3	9.1	572	21	8.8	212	1,799	23.9
Para	16.4	35.7	38.2	28.0	18.9	2.4	17	2	5.4	389	4,016	42.3
Alagoas	13.5	13.6	55.9	24.0	13.6	1.4	443	38	3.0	371	3,876	66.8
Parana	11.3	3.0	22.4	30.2	20.6	4.5	623	23	7.3	343	2,695	37.6
Rio Grande do Norte	10.1	3.7	44.0	21.5	12.4	2.0	474	19	3.0	460	3,835	59.8
Bahia	9.8	9.4	55.6	20.3	10.6	2.4	144	9	3.4	669	4,337	57.9
Ceara	9.7	5.6	50.6	19.7	8.5	0.8	437	20	5.2	505	4,109	62.1
Paraiba	9.1	6.9	48.5	25.0	12.0	2.2	637	16	2.6	412	3,288	61.6
Maranhao	8.7	74.8	84.8	6.8	5.1	1.0	131	5	0.9	1,156	8,027	65.3
Sergipe	8.6	5.0	55.7	29.2	15.3	1.5	387	23	1.3	473	4,756	59.3
Espirato Santo	8.4	3.8	10.0	35.3	31.5	13.5	552	26	7.2	278	2,974	40.2
Mato Grosso	6.8	26.2	51.1	22.2	19.6	2.6	55	2	5.9	420	3,192	43.2
Goias	6.1	24.4	55.5	24.1	15.8	4.9	138	5	5.1	349	4,373	46.2
Piaui	5.5	43.2	71.6	9.3	6.7	-	152	4	1.7	627	7,450	68.1

Table 2-7 Regional Industrialization and Its Relation to Standards of Living and Community Services

Extent of Regional Industrialization	Housing		Utilities			Transport		Tele-communications	Medical & health care		Education
	Ratio of houses with thatched roofs	Ratio of houses with earthen floors	Ratio of houses with electric lights	Ratio of houses with water supply facilities	Ratio of houses served by sewage system	Ratio of roads per unit area of state	Ratio of paved roads per unit area of state	Telephone diffusion rate	Population per hospital bed	Population per physician	Illiteracy rate
	(%)	(%)	(%)	(%)	(%)	(km/1,000 km^2)	(km/1,000 km^2)	(%)	(persons)	(persons)	(%)
Highly	2.4	13.1	63.5	48.7	21.2	678	166	20.2	183	1,834	26.7
Moderately	18.4	32.7	30.5	20.0	3.3	356	19	5.4	347	3,018	48.1
Little	22.1	53.7	21.3	13.9	3.2	293	12	3.7	543	4,723	56.0

3. Review of Economic Evaluation in the TRANSCON Report

This section reviews the methodology, rather than undertake actual economic evaluation, of the Suape estate plan. This is done in order to gain a correct understanding of the methods used for economic evaluation of the Suape project. It should be kept in mind that the framework of the Suape project is based on the economic evaluation given in the TRANSCON Report, which differs from the framework of the Survey Team for Stage I.

(1) The Method of Economic Evaluation

As a result of economic evaluation in the TRANSCON Report, the cost/benefit ratio of 12.3, which exceeds by far ordinarilyfound ratios, is given. This may be explained as a consequence of use of an unconventional manner of evaluation, and also to problems imposed by the basic viewpoint adopted in the report. The method used by TRANSCON does consider the benefits and costs to the region influenced by the Suape estate, but TRANSCON (1) has not examined the project's economics as would be normal procedure in studying an industrial project proposal. or compared the projected investment with the return which may be expected from alternate uses of the same amount of capital. Therefore, it is dangerous to judge the potential of this project solely on the basis of taking the cost/benefit ratio of 12.3 in absolute terms.

This figure is, rather, a relative one obtained by using the TRANSCON method to obtain cost/benefit ratios for other industrial estates and ranking them in terms of their relative potential. Moreover, several defects in this method are evident when attention is given to the performance of economic evaluation primarily based on consideration of the region where it is to be implemented. These crucial points are discussed in concrete terms in the following paragraphs.

TRANSCON used, as benefits, the balance remaining after the intermediate inputs. purchased from outside the region, were deducted from the total value of output of the cement. aluminum, fertilizer, oil refining, sugar and other projects in the new investment portion of industrial projects for the region. As costs, TRANSCON uses only initial and subsequent investment, ignoring production costs.

This method differs from conventional practice in that (1) intermediate goods are deducted from the benefits, and (2) production costs are not included in the costs. This is because the TRANSCON method places emphasis on the residents of the Suape (Nordeste) in efforts to determine benefits. Consequently, in estimating benefits, those intermediate goods acquired from outside the region are deducted from total production value and those acquired within the Nordeste are taken as benefits.

This method is employed to complement the economic evaluation of projects by means of comparison of net benefits and net costs. The TRANSCON Report's viewpoint, however, is strongly oriented toward the advantages and disadvantages the project would have to the Suape, and from this viewpoint, use of the method in the report does have value. Any ratio obtained by that method, however, must be taken as only one indicator of the potential of the project.

The cost/benefit analysis by TRANSCON may be viewed as follows:

Benefits are taken as the balance when intermediate goods are deducted from total production, which is to attribute the value added to the residents of the region and that intermediate inputs from within the region must be distributed as a factor of production within the region.

In connection with this, the validity of such figures as the Cr$6 million for cement in 1980 (given on page 152 of the TRANSCON Report Resume) are open to question.

First, if the cement terminal is built as it is now conceived, there is some question as to whether clinker supplied to the terminal should be included in the intermediate inputs acquired from outside the region. The above figure must be studied in light of all relevant factors.

Second, doubt also exists concerning the method of calculating these values. For example, again in the case of the cement terminal, the relationship between the cost breakdown (Tomo III, I-4-8) and the regional composition (p.152) is not clear.

Further, there is a question concerning the basis for calculation of the economy of scale and of the cost components.

Regarding costs, the TRANSCON Report fails to consider operating costs, and only uses the costs of equipment investment.

The costs which must be borne for the Suape to receive the benefits are the amount of the investment and the factors of production necessary for productive activities. If the project did not exist the cement terminal would have to be treated as a productive activity in another area of production, and is constrained by the implementation of the Suape project. Therefore, operating cost must be included together with investment cost in calculating the cost/benefit ratio.

That is, what must be included in the operating cost is the labor cost expended in relation to acquisitions from outside the region, and the costs required to produce raw materials expenses.

Therefore, despite TRANSCON's intent to undertake economic evaluation of the Suape project primarily from the viewpoint of the Suape, need exists to repeat calculations, taking into account operating cost.

The foregoing shows that the TRANSCON Report's cost items omit (1) that portion of labor costs in the eight categories of industry now planned, which can be obtained within the region, and (2) the cost stream for production of raw materials expenses procured within the region. In order to improve the economic evaluation of the project, modification of the calculations, allowing for (1) and (2), should be done.

(2) Recalculation of the Economic Evaluation

Several variables must be assumed when the economic evaluation is to be repeated with the modifications explained above.

The cost of equipment investment in industrial projects has already been included in the project costs, but the operating costs incurred when that equipment is operated in order to obtain the stream of benefits has been omitted. According to the view adopted for the TRANSCON Report, among the operating costs are to be included not only the costs borne outside the region, and labor outside the region as well as intermediate inputs from outside the region have been excluded. Such intermediate inputs do not enter into the calculation of benefits in the TRANSCON Report, and cancels itself. Presume that labor is completely obtained from outside the region. In such an instance, operating costs would be calculated as follows:

FOPCOi = FOPLAi + REGCOi .... (4.1)

where

FOPCO is the financial value of operating cost, and

FOPLA is the financial value of the labor cost required to operate equipment.

This may be converted to the economic value by use of the following conversion factor.

EOPCOi = 0.6* FOPLAi + REGCOi/1.26 .... (4.2)

where

EOPCO is the economic value of the operating cost.

In this case, assuming that all labor is provided by unskilled miriors, the factor of 0.6 is used for conversion, which is as it is used in the TRANSCON Report.

Of the two variables which comprise the EOPCO factor, the value in the TRANSCON Report for REGCO may be used. Details concerning selection of this figure are not given in the TRANSCON Report, which presents a problem, but this is not germane to the present discussion. Estimates are necessary for sugar, molasses, alcohol and castor bean oil because no value is given for REGCO. Because no data can be obtained from the TRANSCON Report on that portion of the raw material inputs which must be acquired outside the region, these must be estimated by one method or another.

Ordinarily it would be necessary to undertake detailed calculations of the operating costs within the Suape for these categories, but here work will be confined to estimation by means of Brazil's industrial input—output table. Sugar, molasses and the other products under study all are included in the foodstuffs category of the input–output table. If this column is traced from left to right, it is possible to see the relative importance of other industries as sources of inputs for the foodstuff industry, and to see the composition of the value added.

Of the total Brazilian production of the foodstuff industry in 1971, 55% represents intermediate inputs from outside the region, about 2% represents exports, and 43% represents value added. However, intermediate inputs from within the region correspond to the balance of subtracting inputs from outside the region, from the above 55% of intermediate inputs from within the country. Regarding intermediate inputs from outside the region, in the part of the TRANSCON Report concerned with the benefits obtained from production of sugar, almost all are fertilizer and machinery. In actuality, the foodstuff industry within the region need not exclusively rely on fertilizer and machinery from outside the region, nor do its acquisitions from outside the region have to be limited to fertilizer and machinery. Here, however, it is assumed that all fertilizer and machinery are intermediate inputs acquired from outside the region. That portion which corresponds to REGCO is 40.95% and that which corresponds to BRICO is 14.33%.

FOPLA is not discussed in the economic evaluation portion of the TRANSCON Report, and it is necessary to estimate it on the basis of that part of the report which analyzes different industries. For this, Tomo III, Part I, Volume 1 has been used.

Using the above-estimated values, and adding the share of operating costs which must be borne within the region, it is possible to calculate the benefit/cost ratio and net present worth of the project. In this case, the total cost of the project, from (2.4) and (4.2) may be calculated as follows:

$$ECOST = \sum_{i=1}^{8} EINCOi + \sum_{i=1}^{9} EHACOi + \sum_{i=1}^{8} EOPCOi \quad .... \quad (4.3)$$

The results of recalculation, using (1.4) and (4.3) are shown as Table 3-1. Including operating costs in the calculations and using a discount rate of 10% to arrive at the present worth of the project, we obtain Cr$ 39,100 million for the benefits and Cr$ 17,000 million for the costs, so that the net present worth of the project is Cr$22,000 million. The benefit/cost ratio is 2.292.

These figures vary considerably from those in the economic evaluation on the TRANSCON Report. In the report, the net present worth of the project is Cr$44,700 million which is approximately double the figure obtained in the recalculation. Moreover, the benefit/cost ratio is so large, at 12.3, that comparison with the newly-obtained ratio cannot be performed.

Table 3-1 Comparison of TRANSCON Original Values and Recalculated Values

	TRANSCON Case	Recalculated Case
Present value of project benefits	Cr$48,601 million	Cr$39,071 million
Present value of project costs	Cr$ 3,946 million	Cr$17,044 million
Net present worth of project	Cr$44,665 million	Cr$22,027 million
Benefit/cost ratio	12.3	2.29
Internal rate of return	88.3%	64.0%

Note: Asterisk indicates that the IRR was calculated using TRANSCON data and the same manner of thinking, but the benefit and costs streams do not necessarily coincide with those of TRANSCON.

To explain the formidable difference between these figures, with regard to benefits, with reference to intermediate inputs for sugar, molasses, alcohol and castor-bean oil, because the values of the industrial input-output table were used and allowance was made for acquisitions outside the region, the balance of the benefits of the foodstuff industry decrease in value from year to year. Regarding costs, labor costs at the operating level, and costs of intermediate inputs acquired outside the region are included. Because industrial projects to be implemented in the Suape are not highly labor-intensive, the labor costs of the operation of industrial facilities do not have much influence but as the ratio of intermediate inputs for the foodstuffs industry which are obtained outside the region is high, it serves to increase costs.

Recalculation shows that the net present value of the project is half of that which the TRANSCON Report anticipates, but the project still has adequate potential. This is confirmed by the fact that even in the recalculations the internal rate of return is found to be 64%, which is quite high. Using the benefit and cost streams as in the TRANSCON Report, the internal rate of return is found to be 88.3%.

(3) Economic Evaluation by the Conventional Method

(A) Economic evaluation

The Suape plan links the development of the port and harbor and of infrastructure related to the estate, but it may be said that the port and harbor improvement is thought of as being an external economy vis-a-vis the industrial projects, and success of the overall plan is dependent on the potential of the industrial projects. In analysis up to this point, emphasis has been placed on the importance of the plan from the viewpoint of development strategy, rather than on the economics of individual projects, and economic evaluation has proceeded on the basis of the analytic framework used in the TRANSCON Report. Here, however, rather than analyze the plan on the basis of the framework given in the TRANSCON Report, conventional economic evaluation methods are used. Further, some revision of the figures used in the TRANSCON work is made, and the economics of the overall project is investigated.

For the framework for economic analysis, rather than take as the benefits the balance remaining when intermediate inputs from outside the region are deducted from the value of production, the value of production itself is taken as the project benefit. Further, regarding costs, because they must be ascribed to individual projects, distinction is made between (1) intermediate inputs source, as being within the region, outside the region, or imported; (2) necessary labor costs for operation of facilities, and (3) equipment investment cost. These are converted from financial value to economic values and inserted into the routine of economic evaluation.

The first modification of TRANSCON figures to be made concerns the amount of investment. Some doubt exists in regard to the value of production and stream of equipment investment in the benefit and cost flows of the aluminum refining project. Equipment investment will be made during the three-year period of 1983 – 1985. Despite the practice in other instances of assuming that the value of production will increase over time, during this three-year period, all that will take place is that investment will be made, and there will be no change in the value of production. The value of production will increase constantly until 1995, during Stage I just half of the total investment will be made, and the value of production will increase by just 50%, which are consistent with one another. It is therefore judged that there is an error in the value of investment, and in the modificed calculation the amount of investment during 1983 – 1987 is placed at zero.

Second, with similar regard to the amount of investment, some doubt is felt concerning the amount of investment in the fertilizer project during 1982 – 1987. During Stage I investment will come to Cr$110 million, and will produce fertilizer worth Cr$70.9 million. However, from 1982 to 1987 the value of production increases by an amazing extent and rises from Cr$494.9 million to Cr$1,029 million, despite a reduction in the amount of investment to a level of one-tenth that at the outset. It is difficult to imagine this actually happening and it is assumed that this must represent a secretarial error which had not been corrected, and the change is made ten times rather than one-tenth.

Third, regarding the conversion factor used for converting financial values to economic values in study of the services sector, in 4.1.4 of the Resume the following equation which omits indirect taxes is, at a glance, obviously incorrect.

$$P = 0.15C + 0.1C + 0.1C + 0.15C + 0.50C + 0.05\,(0.15C) + 1.85C\,(0.1C) + 0.08\,(0.15C) + 0.08\,(0.50) + 0.15C\,(0.08, (0.15C)) + 0.135\,(0.08, (0.500))$$

Here, the right half which includes C raised to the second power cannot yield $P \cong 1.26C$. Further, there is no mention in the text regarding raising to the second power. On the basis of referring to Brazil's taxation system and faithfully following the text of section 4.1.4, the following equation is written; including ICM, ISS and IPI.

$$P = C + 0.15\,(0.15C) + 0.135\,(0.50C) + 0.05\,(0.15C) + 0.185\,(0.1C) + 0.08\,(0.15C) + 0.08\,(0.50C)$$

and

$$P = 1.168C$$

which is the conversion factor -- not 1.26.

The results of evaluation of the industrial projects with the foregoing taken into account are summarized in Table 3-2.

Table 3-2 Economics of the Projects as Revealed by Use of Conventional Methods

	Net present value	B/C ratio	I.R.R.
Cement	3,346	2.247	66.1%
Aluminum refining	1,529	1.712	43.1%
Fertilizer	415	1.149	15.9%
Oil refinery	625	1.060	45.7%
Foodstuffs	6,731	1.397	182.3%

In comparison to the results given in the TRANSCON Report, the net present value of each project, the benefit/cost ratios, and the internal rates of return are lower in all cases. In each project, however, the benefit/cost ratio exceeds unity, and there is no project which should be dropped, so that it may be concluded that according to conventional methods of economic evaluation the Suape project has sufficient potential.

With the exception of the fertilizer project, the internal rates of return are exceedingly high. The reason for this, as noted above, not only are these projects industrial projects, but in addition the long project life of 30 years is postulated and the special case of evaluating them with the inclusion of investment in expansion. Therefore, these figures may not be used in the same manner as customary in project evaluation and need exists to use an evaluation method which examines the benefits and costs of individual projects for more realistic project lives.

(B) Analysis of the Sensitivity of the Project to Environmental Change

The Suape project is viewed as having the long life of 30 years. Over such a long span, there is sample possibility that there will be great changes in real prices and expenses related to external factors. Here, the sensitivity of the project to such changes is examined.

Changes in the sales prices of the products of the industrial projects would impart a great influence on the net present value of the project, but as such changes would influence not only benefits but also costs, the benefit/cost ratios and internal rates of return would not be greatly influenced.

It is evident that the projects are not very sensitive to changes in labor costs (see Table 3-3).

Table 3-3 Changes in Labor Costs and Economics of the Project

Case	Net present value	B/C ratio	I.R.R.
Base case	22,027	2.292	64.0%
Case (2–1): 20% increase in labor cost	20,545	2.109	59.9%
Case (2–2): 30% increase in labor cost	15,258	1.641	45.9%
Case (2–3): 50% increase in labor cost	11,176	1.401	35.6%

The case of this is the capital-intensive nature of the Suape plan.

Further, as in the case of the oil shock of late 1973, external impacts can cause the prices of imported commodities to increase rapidly. What would be the results in such a case? Table 3-4 shows the results of a comparatively strong impact on the project's economics. If it is assumed that there is an uniform 20% increase in the costs of imported materials, while this would have an influence on equipment investment, at the stage of operating the facilities because the prices of raw materials would be higher than that postulated thus far, this project being a coastal industrial estate including industrial projects such as the oil refinery which imports materials and processes them, the net present value of the project would decline to Cr$7,900 million and the benefit/cost ratio would become 1,434.

The internal rate of return would become 19.3%, and in view of the special method of economic evaluation used, this is considered to be exceedingly low.

Table 3-4.

Case	Net present value	B/C ratio	I.R.R.
Base case	22,027	2.292	64.0%
Case (3–1): increase 20% in import material value	19,392	2.124	53.3%
Case (3–2): increase 30% in export material value	14,649		

CHAPTER 3. EVALUATION OF DEVELOPMENT EFFECTS

1. Income Effects on the Project Area

In the previous chapter we analyzed the Suape project's impact upon development and the income effects of Stage I were estimated. In order to understand the magnitude of income effects, this chapter will consider how much the regional income level will be raised by the development project.

TRANSCON's survey of trends in the regional income of the project area (Fig. 3-1 and Table 3-1) shows how the income effects of the Suape project will contribute to economic development within the Nordeste and Upper Nordeste. According to this data, the income effects will peak in 1985 when the plants start full operation. Regional income will increase by about 5% in the Nordeste and by approximately 10% in the Upper Nordeste.

2. Employment Effects on the Area's Surplus Labor Force

It is estimated that, including jobs created indirectly, the first stage of this project will generate 40,000 new employment opportunities. However, the real impact on employment in the project area must be estimated by comparing the figure to the latent demand for employment opportunities in the area. We will examine here the expected trends in population, labor and employment in the Nordeste.

(1) Population

Population projections for the Nordeste are available from TRANSCON and SUDENE (see Fig. 3-2 and Table 3-2). The SUDENE projection utilized birth rates, mortality and population movement from and to the area, and the analysis looks like a trend estimation. The SUDENE figures seem to be slightly high compared with the area's past trend of population growth, because they use a conservative estimate of population out-flow.

TRANSCON's estimate is based only on the past rate of population increase. TRANSCON expects the growth rate in the area to drop gradually in the future, as this pattern is seen in most of industrialized countries. Therefore, their estimation is more or less an expected one.

SUDENE's estimate represents the highest projection while TRANSCON's represents the lowest. The actual future population will be somewhere between these two extremes.

(2) Labor Force

The size of the existing labor force can be determined by multiplying the working

Fig. 3-1 Income Effects in the Nordeste and Upper Nordeste of Development of the Suape

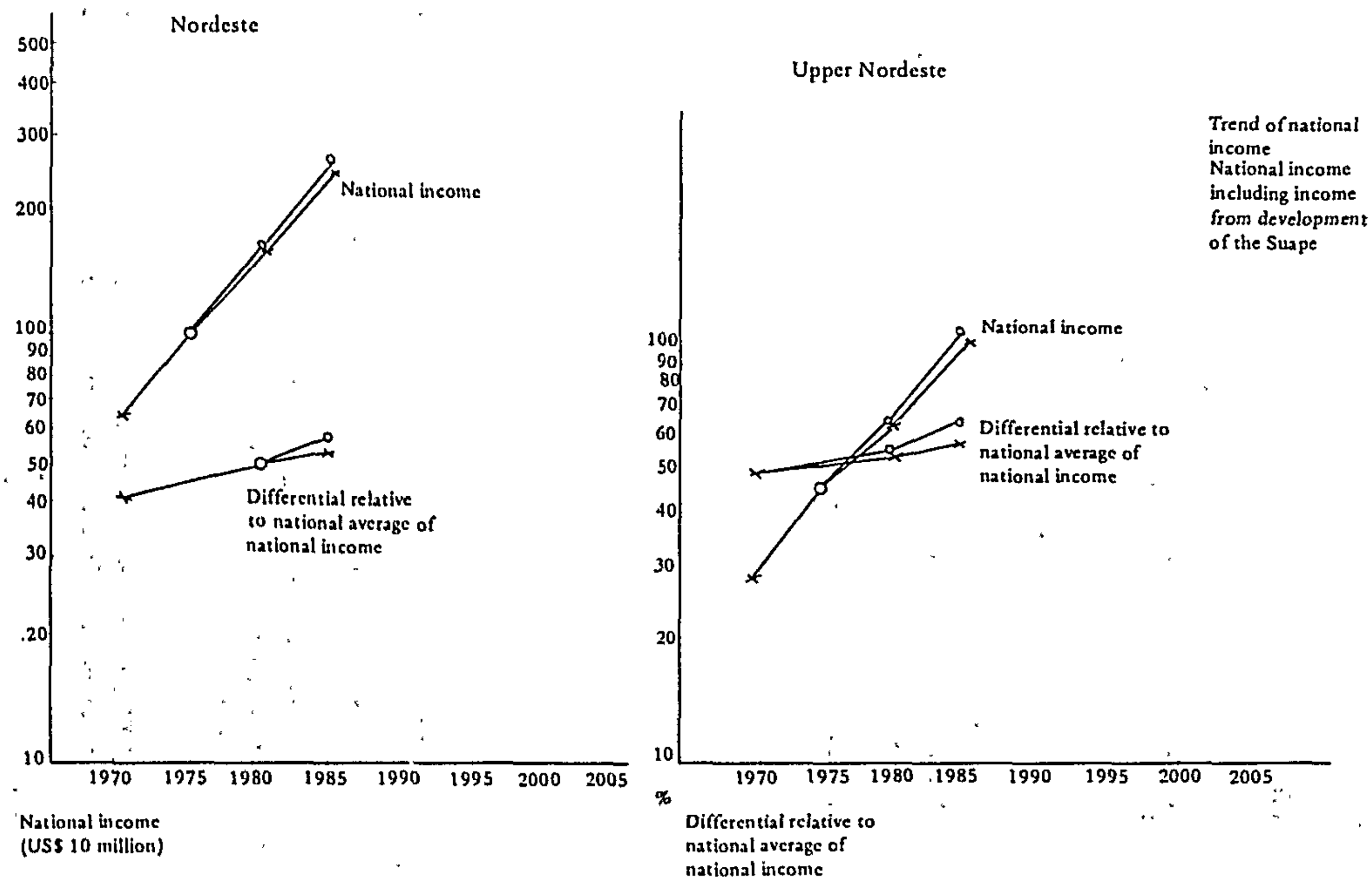

Table 3-1 National Income, and Income Effects of the Development of the Suape

	Income effects, on the income of the Nordeste development of the Suape (US$ million)	Income effects of development of Suape (US$ million)	Total (US$ million)	Population (1,000 persons)	National income per capita (US$)	National income per capita incl. income effects (US$)	Average Brazilian national income per capita (US$)
1970	6,402	-	6,402	28,674	223(42)	223(42)	526(100)
1975	10,326	12	10,338	32,345	320	320	
1980	15,887	300	16,187	36,147	440(50)	448(51)	886(100)
1985	24,445	1,140	25,585	40,082	611(55)	638(57)	1,119(100)

	Income effects on the income of the upper Nordeste of the development of the Suape (44% of Nordeste) (US$ million)	Income effects of development of Suape (US$ million)	Total (US$ million)	Population (1,000 persons)	National income per capita (US$)	National income per capita incl. income effects (US$)	Average Brazilian national income per capita (US$)
1970	2,817	-	2,817	10,916	258(49)	258(49)	526(100)
1975	4,543	11	4,554	12,052	377	378	
1980	6,355	241	6,596	13,241	480(54)	498(56)	886(100)
1985	9,778	960	10,738	14,477	675(60)	742(66)	1,119(100)

Note: Conversion rates used are same as in TRANSCON report:
US$ = Cr$7.

Fig. 3-2 Population Projections of the Nordeste

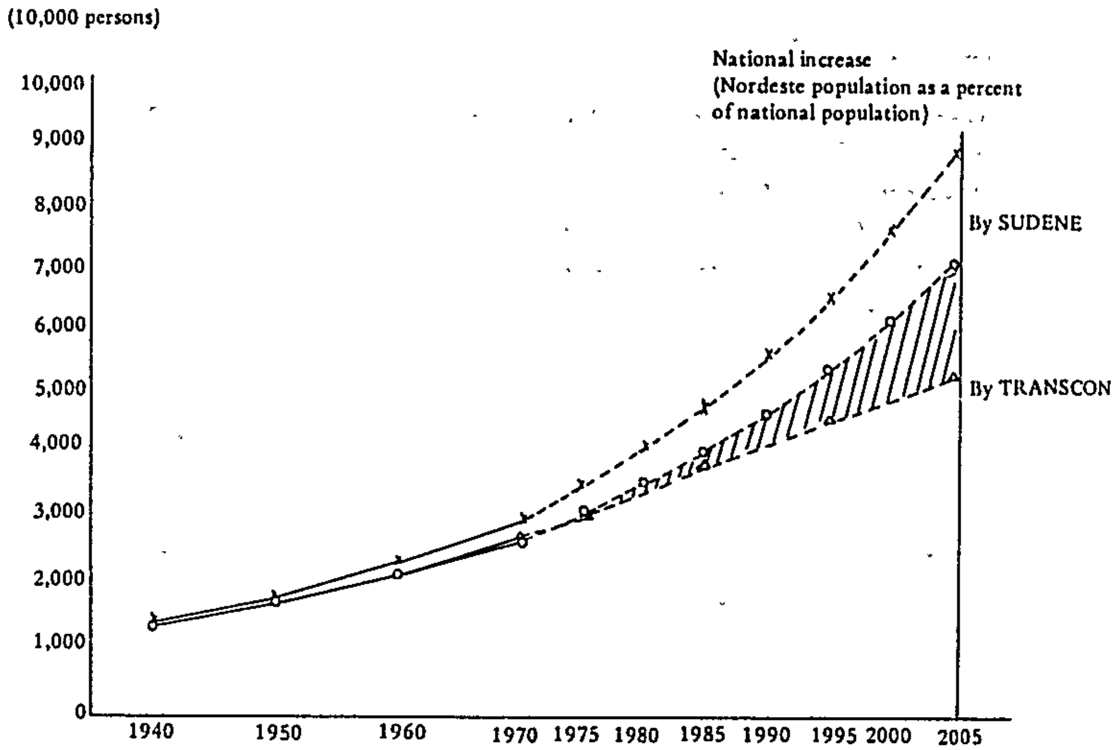

Fig. 3-3 Projections of the Labor Force and Employment

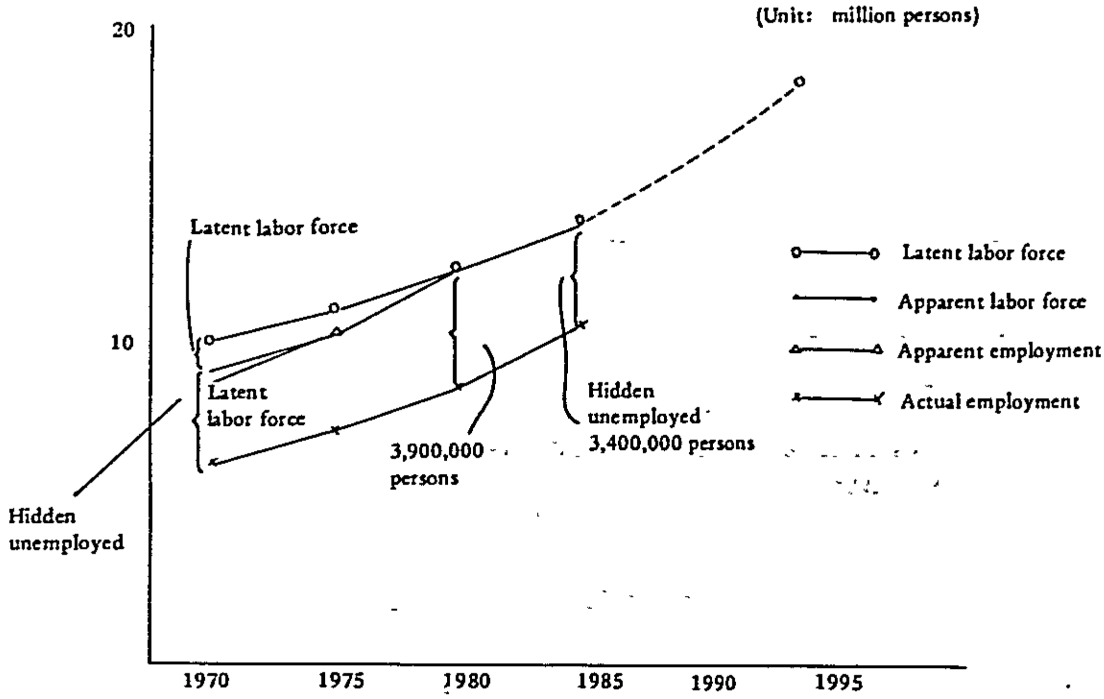

Table 3-2 Population Projections for the Nordeste

	SUDENE projections		TRANSCON projections	SUDENE projections of birth and mortality rates of natural population		SUDENE projection of growth rate of the Nordeste natural population
	Natural pop. of the Nordeste (1,000)	Present pop. of the Nordeste (1,000)	Registered pop. of the Nordeste (1,000)	Birth rate (% p.a.)	Mortality rate (% p.a.)	(% p.a.)
1940	15,048	14,434				
Avr. annual growth	2.3	2.2		4.8	2.5	2.3
1950	18,880	17,974	17,973			
	2.6	2.3		4.7	2.1	2.6
1960	24,473	22,611	22,427			
	2.6	2.2		4.5	1.8	2.6
1970	31,617	28,136	28,674			
	3.3	3.1		4.4	1.5	2.9
1975	37,217	32,822	32,300			
	3.0	2.6		4.3	1.3	3.0
1980	43,067	37,396	36,100			
	3.0	2.7		4.2	1.2	3.0
1985	49,956	42,716	40,000			
	3.0	2.7		4.1	1.1	3.0
1990	57,969	48,841				
	3.0	2.7		4.0	1.0	3.0
1995	67,203	55,825	47,900			
	3.0	2.7		3.9	0.9	3.0
2000	77,908	63,808				
	3.0	2.7		3.8	0.8	3.0
2005	90,319	72,933	54,800			

Note: After 1995, projections are linear extensions of trends to that year.
Natural population includes Nordeste natives residing elsewhere in Brazil.

Source: Projeçoes da populaçao do Nordeste Brasileiro 1975 — 1990, for SUDENE.

age population and labor force participation rate. At present, Nordeste's labor force participation rate for men 14 years or older is 86%, which is higher than Sao Paulo (83%) and Japan (83%). As the urban population increases and educational level goes up, this figure will drop until it approximates those for the industrial areas of Sao Paulo and Japan.

The labor force participation rate for women 14 years or over is only 34%. This figure is 10% lower than that for Tokyo, where a wider variety of employment opportunities are available and women have some choice of occupations. This low rate is caused by the actual shortage of employment opportunities within the area. It is possible that the latent labor force based on a 10% higher participation rate could emerge if the situation is improved. Thus, the labor force estimate obtained by multiplying the female working age population by the current participation rate should be regarded as only the 'apparent labor force'. On the other hand, the labor force estimate which is calculated by using the 10% higher participation rate can be regarded as a 'latent labor force'.

Two series of working population (by age group) estimates were calculated; one was based on the highest population projection while the other was based on the lowest.

(3) Employment

Increase in employments opportunities in the future depends on industrial growth in the area. The 2nd PIN estimates Nordeste's growth rate for each sector of industry as follows (annual growth rates for 1975 – 1979, from Banco do Nordeste information):

Primary sector	6.5%
Secondary sector	15.0%
Tertiary sector	10.0%

The rate of increase in labor productivity is estimated at 7.5% per annum for Brazil in terms of the increase rate in per capita income. However, in order to correct disparities in per capita income compared with the national average, the Nordeste Government contemplates an annual growth rate of 8.0% in labor productivity. The number of 'apparent employees' in the area can be estimated using the trends for industrial growth and increases in labor productivity: this labor force is termed 'apparent', because it includes unpaid workers and latent surplus labor force (about 30%) in the service industry. The actual employment is estimated at only 70% of the original figures.

Based on the above considerations, we have estimated the magnitude of employment opportunities in the future by extending the projected growth rate of the area's industry and of labor productivity for 1975 – 1979 until 1985.

(4) Employment Effects on Surplus Labor Force

Fig. 3-3 illustrates the projected labor force and employment situation until 1985. As the basis for calculation, we have employed median values between the highest and lowest projections.

As these figures indicate, the differences between latent labor force and actual employment represent the latent unemployed population. This latent unemployment, i.e., surplus labor force, will remain at 3 to 4 million for the Nordeste between 1970 and 1985. This figure will be 1.2 to 1.5 million in the case of the Upper Nordeste.

As mentioned in the beginning of this section, the Suape project will generate about 40,000 new employment opportunities in its first stage. These opportunities will account for 1.0 to 1.3% of the surplus labor force in Nordeste and some 2.7 to 3.3% of that in the Upper Nordeste area. Accordingly this impact is rather small compared with the income effect, which as mentioned above, is estimated at approximately 5% for Nordeste and at about 10% for Upper Nordeste.

3. Problems of the Development Effects of the Suape Project

In this last section we review problems identified during our investigation and consider the basic orientation of the Nordeste project. A model methodology for undertaking industrial development is also summarized.

(1) Problems Identified in the Analysis of Development Effects

The first problem was clarified in our analysis of income effects. The project's peak income effect is estimated at about 10% for the Upper Nordeste, while the employment effect is projected at only about 3%. This means that the area's actual income in the form of wages will not be very great in spite of the rather high income effect.

Since the Nordeste has a large latent surplus labor force, it is important to create new employment opportunities and to help local people stabilize their daily life. In order to achieve this objective, the area should use its limited investment resources as effectively as possible in generating new job opportunities.

The second problem relates to the magnitude of newly created employment opportunities.

Number of New Employments Opportunities Generated by Cr$1 Million Investment

Equipment industry		Processing industry		Machinery industry	
Aluminum refining	0.583	Agro-Industry	3.312	Automobiles	2.507
Petrochemicals I	0.175	Steel pipe, plain	4.597	Material transport vehicles	12.700
Petrochemicals II	0.466	Casting	2.870	Ship maintenance dock	3.333
Cement	0.794	Forging	2.158		
Fertilizer	0.866				
Steel sheet & rolling	0.307				
Steel pipe, seamless	0.496				
Weighted average	0.380				

The level of newly created jobs per unit of industrial investment varies widely, depending on the industrial category: in the equipment industry, the figure is on the average 0.4 person per Cr$1 million investment, while in the processing industry it is 3.0 persons and in the machinery industry it is 3.3 persons. Thus, the equipment industry's employment effect is only one-eighth of that of the machinery industry. Also there are differences within an industrial category: in the machinery industry, the labor-intensive electrical machine manufacturers could create new positions for 30.8 persons per Cr$1 million investment. Compared with the average figure for the machinery industry (3.3 person), this is quite large.

It is expected that in the Suape project's first stage, the metal and machinery industries as well as equipment industry will be established. However, all of these are highly capital-intensive, and therefore, the number of newly created job opportunities per unit investment will be very small, e.g., 0.62 person per Cr$1 million.

Despite these difficulties, the Suape project will still be able to make a significant contribution to the economic growth in the area: it will improve the nation's balance-of-payments and it could create an impetus for general growth in the area's economy.

(2) Basic Orientation of the Nordeste Development Project and a Model Methodology for Industrial Development

1) Present Industrial Status of Nordeste

At present, Nordeste's economy still remains at the first stage of development. No economic basis for self-propelled growth has been established. Because the area is still suffering from a shortage of income sources, there is a lack of employment opportunities resulting in immature development of local economic markets. Also, people categorized as "employed" in the statistics include a large number of the latent unemployed; for example, unpaid workers, those with side jobs and domestic servants. The level of education, the key determinant of labor quality, is not very high in general. A more extensive compulsory education is thus necessary to establish a firm economic base. Most of the area's daily necessities are now supplied from other developed areas. This fact illustrates the lack of an established economic market in the area.

2) Requirements for the Development of the Nordeste

The most important factors in establishing an economic basis for self-propelled growth are as follows:

1) Formation of the area's economic markets; and
2) Establishment of an inter-industry structure within the area.

In order to form markets, the following steps should be followed; improvement in the quality of labor force through upgrading the educational level → creation of jobs → increase in income → increase in consumer spending → production of effective demand → formation of area's economic markets.

Another strategy for establishment of a regional market is to create strong multiplier effects. Strong multiplier effects can be achieved by establishing active inter-relationships between industries. The area should promote industries which have large impacts on many industries.

The following steps are critical for the accomplishment of successful industrial development.

1) improvement in the quality of the labor force through upgrading the educational level;

2) Formation of a master plan for creating new employment opportunities, which considers future growth and distribution in the area;

3) Determination of priorities in industrial development projects:

- First priority:
  Those industries whose L/K is large, or whose L is alone large.
  (L = labor force, K = investment)

- Second priority:
  Those industries which grow area's market, or which need large quantities of raw materials.

- Third priority:
  Export-related industries

The above order of priorities can be changed, depending upon the shortage of market potentialities and locational factors such as good harbor conditions. Equipment industries can be an effective means of development which will create an incentive for other industrial development. In such a case, the consideration of inter-industry structure is still important.

3) An Ideal Method of Industrial Development

In planning regional industrial development it is important to promote parallel growth of related industries rather than seek separate growth of industries. In this way an integrated production system including the entire process from raw materials to final products can be formed.

Due to being located far from big markets, a development project in a less industrialized area is liable to depend too much on equipment industries in which marine transport by bulk carriers plays a major role. There are some examples of this case in Japan. They were not successful because later development is delayed by the absence of industries for further processing of the product thus manufactured.

Of course, a high-level process industry is hard to establish in a place lacking urban infrastructure. However, in the area around Recife, infrastructure is highly developed and we feel that the area is suitable for advanced process industries. The table below is a summary of possible impacts of three industrial categories on Nordeste.

4) Improvement in the Productivity of Existing Industries

Compared with other areas in Brazil, the Nordeste has a heavy concentration in *the primary sector: this demonstrates* underdevelopment of modern industries in the area. In addition, there exist wide differences in productivity among industrial sectors.

To reverse this situation, it is necessary not only to pay attention to the development of new industries but to make efforts to improve the productivities of existing industries as well: *That strategy will lead to the establishment of* a good inter-industry structure.

NATURE OF IMPACTS ON THE AREA AND LOCATION OF INDUSTRIES

	Nature of Impacts on the Area				Nature of Location
	Scale (Number of Employees)	Labore Forece	Related Industries	Development Potentials	
Equipment Industries	Raw materials industries: several thousands Final products industries: several hundreds	• The number of newly created employments opportunity per unit investment (refered to as employment coefficient) is very small. Even in a large factory, the total number of employee is very small. • The percentage of white collar is considerably high. • *Main duty is to monitor the operation* of equipment and does not require high-level skill but a good understanding. A greater part of workers graduate from technical high school. • Wage rate is high.	• *Except supply of* raw materials and processing of products, these industries are of self-sufficient nature, and supplymentary work (e.g., subcontracting) is unnecessary in general. • Therefore, around these industries, only a few factories such as repair shops, packing and transport businesses are located.	• Making use of their advantages due to large scale and existence of competitive raw materials, efforts *are made to conquer restrictions concerning raw* materials; but because of the nature of manufacturing means, it is not easy to change product themselves. • Therefore, when the life cycle of one product is ended, transfer to the next product is difficult; regional development greatly restricted.	• Influenced by physical conditions, such as land, water supply, and transportation *means available*. • Most of industries which needs lots of raw materials located area, but in general, their ability to bear transport charges is low; they tend to locate the area which is close to their market and has convenient transportation means.
Mechanical *Industries:*					
Assembly-type	Smaller scale: 100– 300 Medium scale: 300–1,000 *Larger scale:* 1,000–3,000	• Employment coefficient is generally high. • One-product manufacturing industry uses *mainly simple, female labor.* • Several-products semi-mass manufacturing industry requires experienced labor. Workers' age averaged high. • *Wage rate is low in one-product industry.* In other industries, wage rate depends on the scale of factories.	• These industries engender related industries through successive processing, contracting out, and purchasing of parts; they form so-called basic industrial mixes. • In general, one product manufacturers have many subcontractors and have the ability to *create industrial core.* • Many-products small-amount manufacturers, mainly because of *technical reasons, have not* many subcontractors; in a developed area mostly they exist in the form of related technical groups which share the same subcontractors. • Several-products semi-mass manufacturers fall between the above two.	• The development of new products depends highly on the characteristics of demands; in the course of development, more highly efficient, more precise, more solid, or more sophisticated new products being produced. • Therefore, it is very important for a successful regional development to lead those factories into the area, which has good marketing, planning, and *technical development capability.*	• On the contrary to equipment industry, the location of this industry is rarely influenced by physical conditions. Factories usually locate on an area where industrial basis has been established to a certain extent: They spread toward outside from the established industrial core. • One-product mass-producing industry can *most effectively contribute* to a successful regional development.
Parts-type	Complete parts: *Smaller scale;* 100– 300 Medium scale; 300–1,000 Larger scale; thousands (electronics, communications equipment) Subcontracting parts: *less than 300; mostly* less than 100	• Labor-intensive; employment coefficient is high. • In general, using simple labor with low wage rate. The industry producing final goods hires lots of female labor. • The factories which produce subcontracted parts consists the lowest sector of so-called industrial structure: low wage and poor working conditions. • *Wage rate is generally low.*	• Complete parts *manufacturers have related* industries, mostly subcontractors, to secure low-wage women workers (especially house wives). There are a lot of factories which uses family workers. • Parts manufacturers are generally belonging to big manufacturers producing final goods through subcontract. There are considerable interactions among parts manufacturers, which create a group of related industries.	• *Complete parts factories: main purpose is cost* reduction through mass production, and diversified development will be difficult. • Subcontracting part factories: Heavily influenced by parent factories, but in an area where they are concentrated, there is the possibility that medium scale plants emerge.	• *Complete parts manufacturers:* the existence of labor force is the most important locational determinant. • Subcontracting parts manufacturers: their *location is greatly influenced by the location* of their parent manufacturers.
Process Industries	Smaller scale: less than 100 Medium scale: 100– 300 Larger scale: 300–1,000	• Labor-intensive: simple and manual labor is required; mostly male labor. • Wage rate is not low.	• These industries have no related industries around them, but, because of low ability to bear freight charges, they tend to concentrate in areas near big markets and the junctions of traffic means: Industrial accumulation *consisting of same type* of industry is created.	• Like assembly plants in the mechanical industries, new products are created depending on the characteristics of demand. But the types of products are limited by raw materials which can not be changed easily. As a result the case of the mechanical industries cannot be expected.	• Because of low ability to bear freight charges, distributional junctions near big consuming areas are selected.