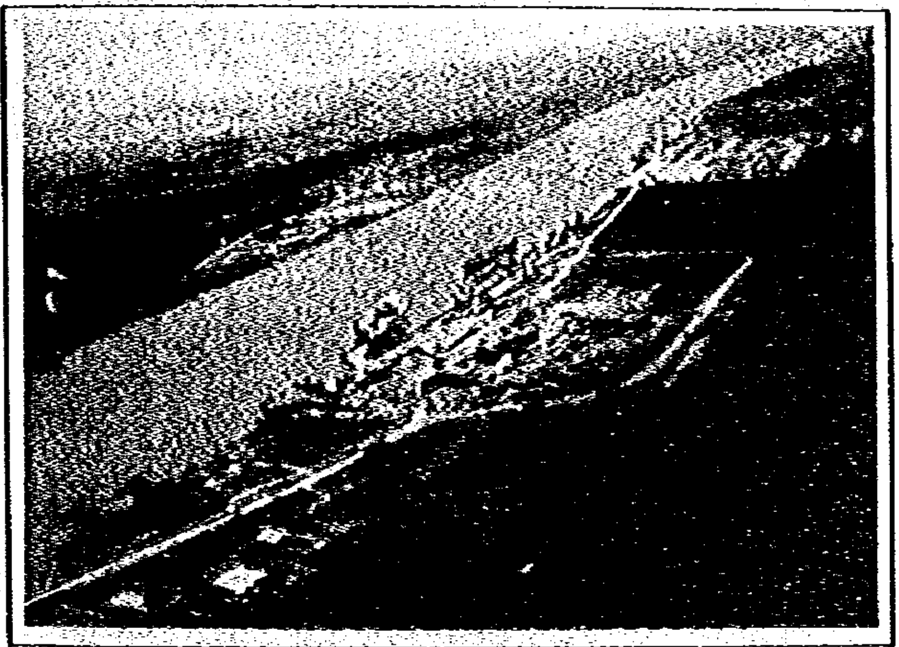
CHAPTER VII MASTER PLAN



Port of Tuxpan

CHAPTER VII. MASTER PLAN

1. Location of Industrial Complex

1-1 Selection of Desirable Site for Industrial Location

In selecting a site from the viewpoint of industrial location, the main requirements are given as follows.

1) The planned located industries require a flat land area of 3,940 ha.
2) The area must be able to provide solid foundations required by such industries as iron and steel, and paper and cardboard, which need heavy plants with high precision.
3) It must be possible to construct a deep sea port in the area, because the iron and steel and oil refining plants necessitate deep wharves for transporting products and raw materials.
4) For large industries such as iron and steel, oil refining and petrochemicals, a certain amount of discharge of pollutants cannot be avoided, even if pollution control is taken. To lessen as much as possible the effect of such burden on the inhabitant, areas where the prevailing wind blows towards the residential area must be avoided.

1-2 Arrangement of Plants

In arranging the plants to be located around the port, the following items must be taken into consideration.

1) Type of industries and facilities requiring nearby locations:

Oil refining	Petrochemicals
Iron and steel	Shipbuilding
	Fabricated metal for ocean use
	Motor vehicles
Silo	Vegitable oil
	Feed stuff
	Wheat flour
Fishery port	Sea food products

2) Types of industries requiring deep water wharves for importing raw materials and exporting products:
   Oil refining, iron and steel, petrochemicals.
3) Types of industries requiring wide water area in front of the plant:
   Shipbuilding
4) Types of industries to be located near the coast because of requirements for abundant seawater input for cooling:
   Oil refining, iron and steel.
5) Types of industries requiring solid ground because of heavy equipment and precise alignment:
   Iron and steel, paper and cardboard.
6) Types of industries to be located far from residential areas because of heavy air pollution:
   Iron and steel, oil refining, petrochemicals, paper and cardboard.

Considering the above points, the following pattern is selected as a model arrangement of plants. (See Fig. VII-1-(1))

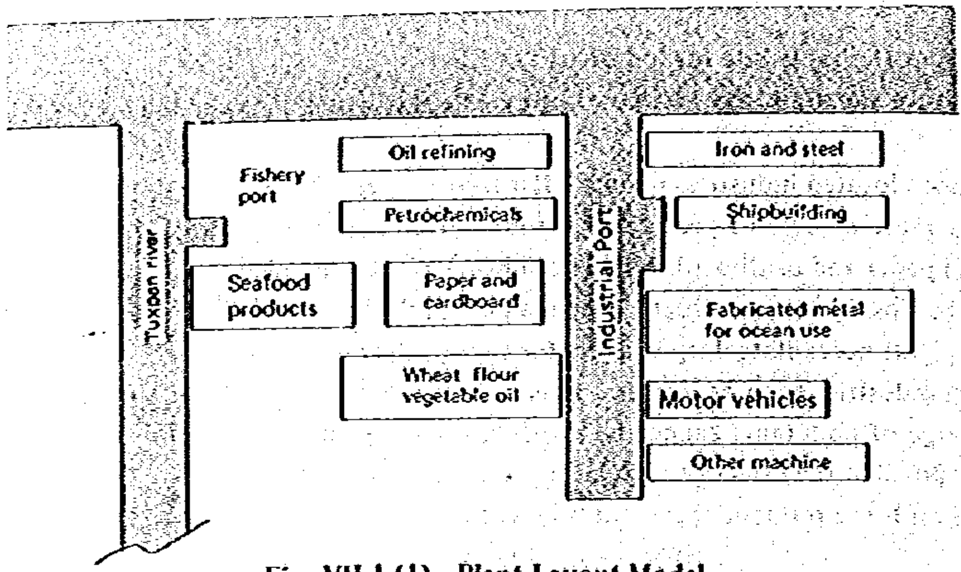


Fig. VII-1-(1) Plant Layout Model

1-3 Site of the Project

For the project, Mexican government had the following 3 site plans as shown in Fig. VII-1-(2).

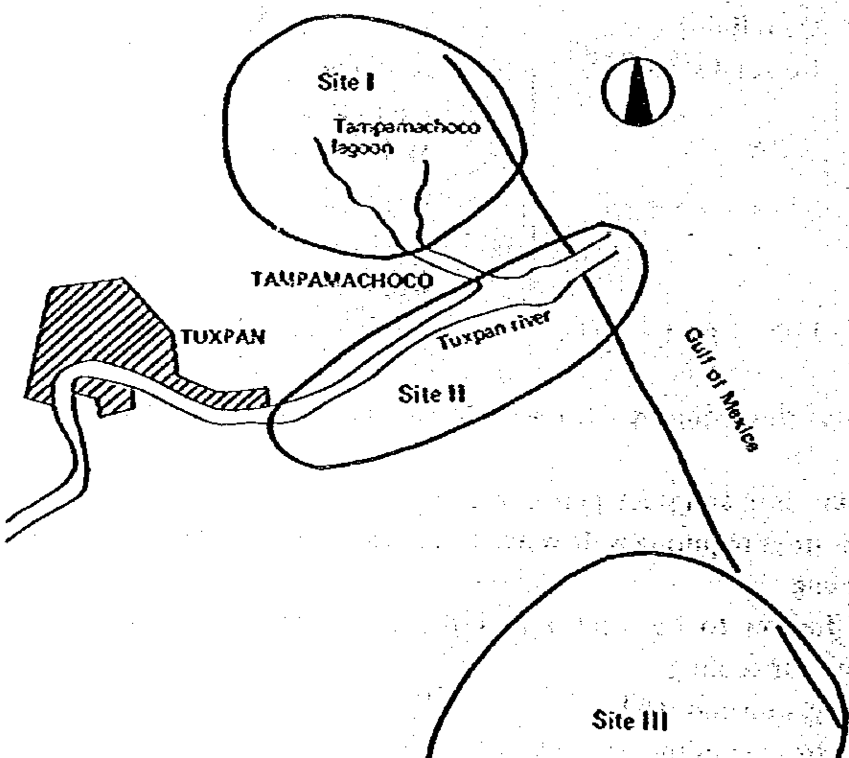


Fig. VII-1-(2) Site Location of the Project

Site I: North of the Tuxpan river around Tampamachoco lagoon

Site II: Tuxpan estuary, excavating southward right bank of the river

Site III: South of the Tuxpan river

As mentioned in Chapter I-2, the Mexican government carried out field surveys at sites II and III, south of the Tuxpan river. In reply to the questions of the Preliminary Survey Team dispatched by the Japanese government that visited the site in May, 1982, SCT personnel concerned gave the following reasons.

1) For the Site I, a survey of natural conditions such as waves, tidal levels, wind, soil, topography and littoral drift was carried out in 1975 – 1976.
2) After that, SCT had an intension to develop the north side of the Tuxpan river as a tourist site or residential area.
3) From the point of view of traffic with Mexico city, construction of a bridge over the Tuxpan river is indispensable, and this means a cost increase.

For the above reason, priority of developing Site I has diminished. On the other hand, Site III has the following advantages.

1) It is low land and easy for dredging
2) It is closer to Mexico city. Cargo traffic does not need to go through the Tuxpan city and across the Tuxpan river.
3) Sand for land filling is easy obtainable from near by hills.
4) It is close to the site of the power plant (Punta de Piedra) and to Poza Rica.

Under such circumstances, the Survey Team decided to reject Site I and the south of the Tuxpan river was selected as the subject area of the survey in consideration of the opinions of the Preliminary Survey Team and the following points.

1) As discribed later, Tampachoco lagoon is rich in fishery resources and is expected as to be a scenic spot.
2) It is not adequate for constructing heavy plant facilities due to the soft ground.
3) Insufficient sand for filling purposes.

From the point of above mentioned desirable site locations for an industrial complex and by the process of site selection, Sites II and III were selected as the locations for the main development site of the Project.

2. Urban Planning of Tuxpan Port City

2-1 Introduction

It is estimated that in the year 2000, the working population in the area around Tuxpan Port will reach 460,000, including 43,000 workers employed in port related industries. Because of the drasticness of this projected population increase, it is expected that a new city will have to be built adjacent to the port at a new site.

Based on principles described in Chapter IV, the basic conception of this new city is discussed in this section.

The basic concepts of city planning to be carried out here are as follows;

1) The new city proposed here, is to create an attractive city with a population of 400,000 and will serve as a regional core for the northern part of Veracruz State. In this sense, this new city is to be regarded as a sort of ideal target.
2) The principle framework of the new city is proposed here as a desirable future goal, based on the past experience gained from various planned cities in Japan.
3) From the standpoint of actual project implementation, we will also make a short study of a more realistic plan.
4) It is necessary to make a F/S on the "new city", taking into consideration the socio-economic conditions of the country and the regional characteristics of Tuxpan, at the time when the work will start.

2-2 Basic Development Policies

(1) To develop a multi-faceted and comprehensive city that is supported by, but not dominated by the simultaneous build-up of large-scale coastal industries.

(2) To develop a city that serves as the core of a regional development area, and in addition, is the main urban center in the northern part of Veracruz State.

(3) To systematically build up social capital at the designated site in order to realize the above goals. This includes the manufacturing and commercial infrastructure (industries, distribution business center and tourist facilities) and the urban infrastructure (housing, schools, water, sewage, electricity, communication facilities, parks and green zones) as well as the regional transport infrastructure (airports, ports, railways, roads).

(4) To organize scientific, cultural and artistic facilities, for the benefit of the entire region while paying special attention to environmental protection and urban disaster prevention.

2-3 Site Selection for the New City

(1) Points for Comparison

(a) Environmental Quality

Minimum air quality and sewage drainage conditions to assure public hygiene.

(b) Transportation Convenience

Convenient to local commuting and regional transport networks.

(c) Safety

Low likelihood of flooding or other disasters.

(d) Regional Impact

Effect on local community, impact on regional development, and measures for environmental protection.

(e) Future Expansion

Possibilities for future city expansion.

(f) Cost Efficiency

Costs for construction of the various urban infrastructures.

(2) Site Requirements

The following factors have been taken into consideration in selecting a site.

1) The site must be close to the Tuxpan Industrial Port.
2) The site must extend over 6,000 ha of broad flat land.
   In order to maximize investment efficiency and centralize urban functions, the city should be built entirely at one site, not scattered in different areas.
3) The site must have a high correspondence to the points for assessment mentioned above.

Based on these requirements as well as on the results of on-site inspection tours, alternative sites have been selected as shown in Fig. VII-2-(1).

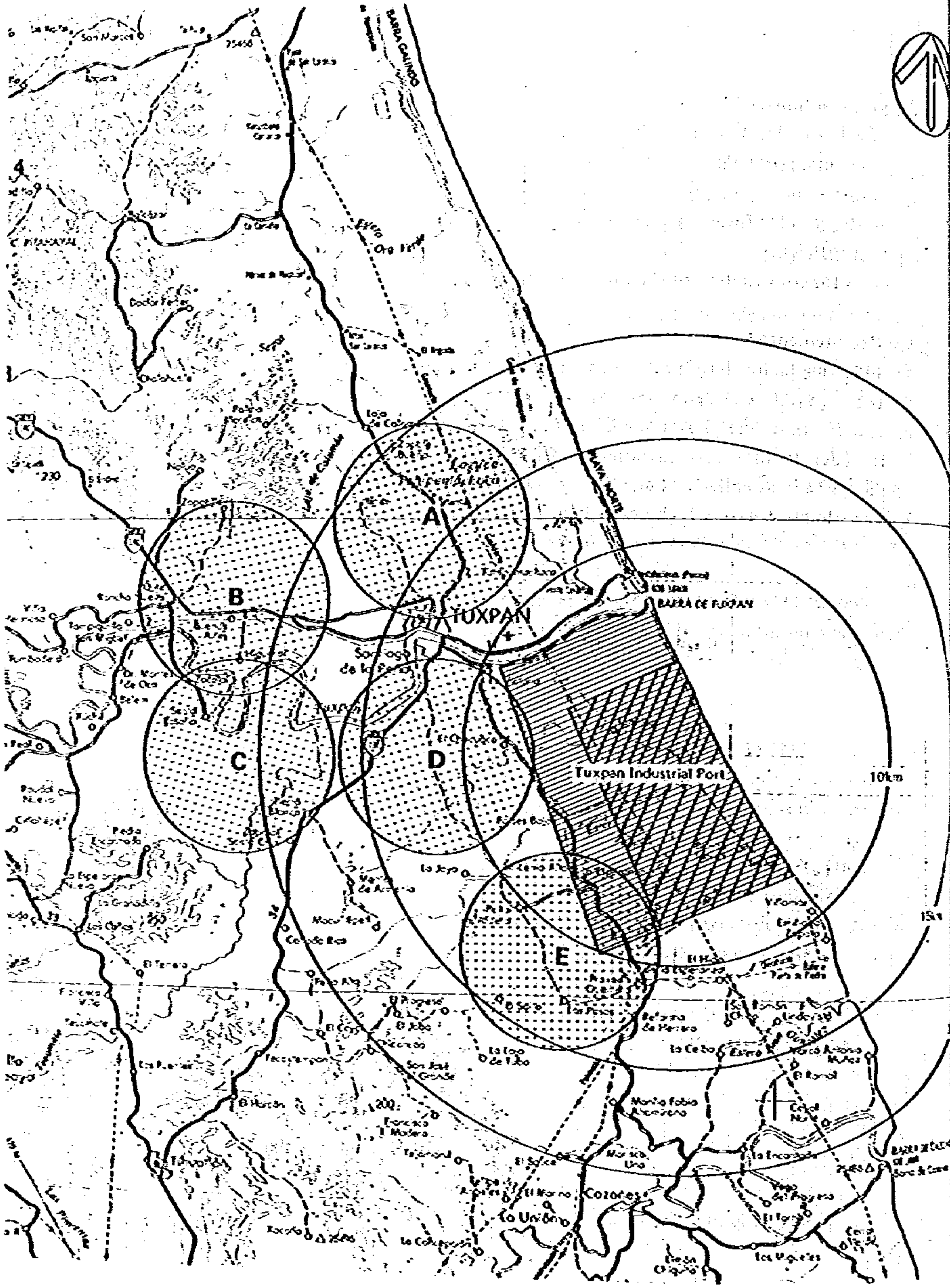


Fig. VII-2-(I) Alternative Sites of New City

(3) Comparison of Sites

Development of a new city with a population of over 400 thousand and the development of an industrial port are both large projects which are bound to have great, and perhaps grave, influence on the natural environment. Careful attention to environmental protection is an important matter that will be treated in the latter Section of this Chapter. At the same time, these projects will also greatly affect the existing community. Although it is difficult to qualitatively measure beforehand, it is still important to roughly assess the degree to which these projects will have an acceptable or unacceptable influence on the community. Effective protective countermeasures must then be drawn up.

If the new city were to be built in scattered areas, then there would of course be little unacceptable influence on the existing community. However, this sort of "break-up" development is not under consideration as it would inevitably hinder the smooth operation of the many city functions necessary to a city of 400,000. In terms of rational and efficient city operations, break-up development is not a profitable investment policy. Accordingly, this study shall compare single, unified sites.

Topographical and soil-foundation conditions for each alternative site are mentioned below. (See Fig. VII-2-(2))

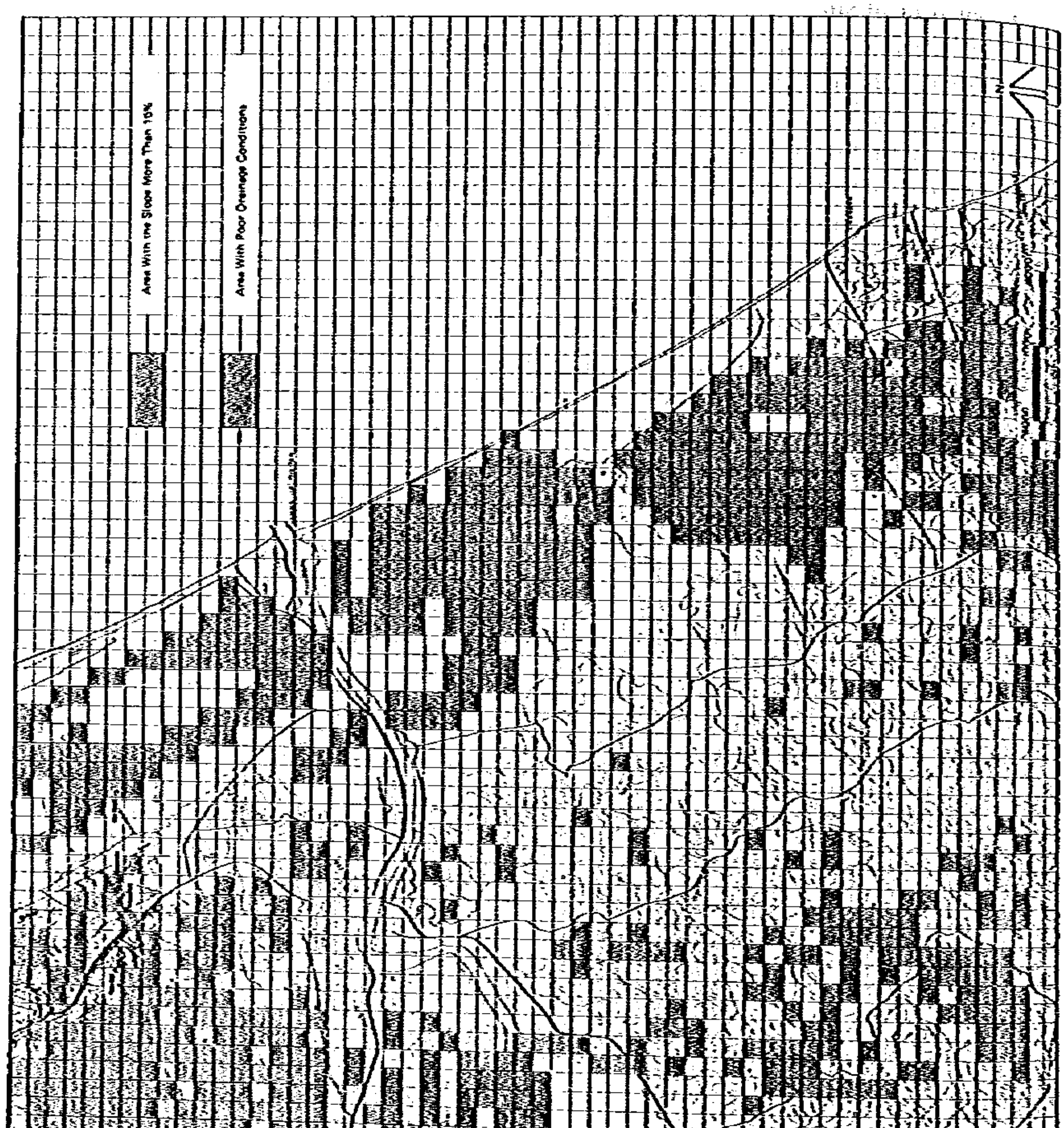
Alternative A: Located in the western part of Tampamachoco, the foundation is relatively weak with fairly poor drainage. The western part of this site has low-lying hills and moderate elevations and depressions. This site is divided in two by the Tuxpan-Tamiahua road.

Alternative B: This site is divided into two areas, with the southern area located in the Tuxpan river flood control zone. Drainage is not excellent, and the site is generally flat.

Alternative C: This site is located in the Tuxpan river flood control zone, and its drainage is poor.

Alternative D: Drainage is good, and this site is generally flat, with undulations in its southwest sector.

Alternative E: Drainage is good, with elevations and depressions in its southern half.


Area With the Slope More Than 10%
Area With Poor Drainage Conditions

The assessment of each site in terms of the preceding points of comparison is as follows:

1. Environmental Quality: At Site E there would probably be a serious air pollution problem due to the industrial complex as well as the Chile Frio thermal power station. From N to E and particularly NE winds predominate. The air pollution at site D would also be fairly great. Drainage conditions at site A, B and C are not good.

2. Transportation Convenience: Sites D and E are most convenient for commuting. Site E would greatly inconvenience regional transportation because of its proximity to National Roads 130 and 180.

3. Safety: Sites B and C, which are located near the Tuxpan River and which have many low-lying areas, are less desirable alternatives from the viewpoint of disaster prevention, and are particularly vulnerable to floods.
In terms of preventing fires from spreading to the existing town, all alternative sites are adequate, with no site as clearly preferable.

4. Regional Impact: Sites C, D, and E would have little negative impact on the existing community, because they are at a distance from it. But for this very reason, these sites are deemed to be inferior alternatives, as they would not lead to centralized and unified urban expansion. On the other hand, site A would allow for this unified type development, but there is the risk that the quiet environment of the currently existing town would be adversely affected if access roads are not carefully planned. Therefore, assuming proper road planning, sites A & B are superior in terms of unified and systematic urban expansion. As for environmental impact, sites B and C would both have a negative impact on the Tuxpan River, regardless of environmental countermeasures.

5. Future Expansion: Each alternative site has room for future expansion.

6. Cost Efficiency: Alternatives B and D are superior because of their topography and soil foundation conditions.

Results of the above comparison are presented in Table VII-2-(1). As can be seen by taking the various factors into account, site D and A are most superior. In making a final decision between these two sites, the different categories of comparison should be given different priorities. We attach most importance to environmental quality, transportation convenience, and economic efficiency. On the other hand, regional impact problems can be dealt with through appropriate planning. Site D has been selected as the site for the new city.

However, if environmental quality is deemed to have prime importance, alternative "A" would be a suitable choice. Moreover, if rationalization of urban operations and investment efficiency are ignored, then a "breakup" development policy could certainly be adopted.

Although the above assessment is a qualitative analysis, it will be necessary before the time of actual project implementation to quantitatively analyze drainage and soil foundation conditions, and construction costs.

Table VII-2-(1) Assessment of Alternative Sites

Item		A	B	C	D	E
Comfortability	Air Pollution	O	O	O	Δ	×
	Drainage Conditions	Δ	Δ	Δ	O	O
Convenience	For Commuting	Δ	Δ	Δ	O	O
	For Regional Transport	O	O	O	O	Δ
Safety		O	Δ	Δ	O	O
Regional Impact	on Existing City	O	O	Δ	Δ	Δ
	on the Natural Environment	O	Δ	Δ	O	O
Future expansion		O	O	O	O	O
Economic Efficiency		Δ	Δ	Δ	O	Δ
Total		O	Δ	Δ	O	Δ

Note: O Good Δ Fair × Poor

2-4 Setting of City Frame

(1) Population

As stated in Chapter IV-1, the populations of the municipio and ciudad in 2000 have been respectively estimated at 514,800 and 463,900. Assuming that the average family size is 4.5 people, then the "ciudad" estimate breaks down as follows:

(a) New city Population: 405,000 Number of households: 90,000

(b) Existing Tuxpan Population: 58,900 Number of households: 13,100

Based upon a consideration of both the industrial port and then new city site, Tuxpan Port City has been zoned as shown in Fig. IV-2-(3). A buffer zone has been set aside between the new city and the industrial port. Land has also been earmarked for future expansion in the southern part of the new city so as to reduce environmental pollution to a minimum. The total land area is approximately 2,500 ha and it is estimated that nearly 100 ~ 120 thousand people will reside there.

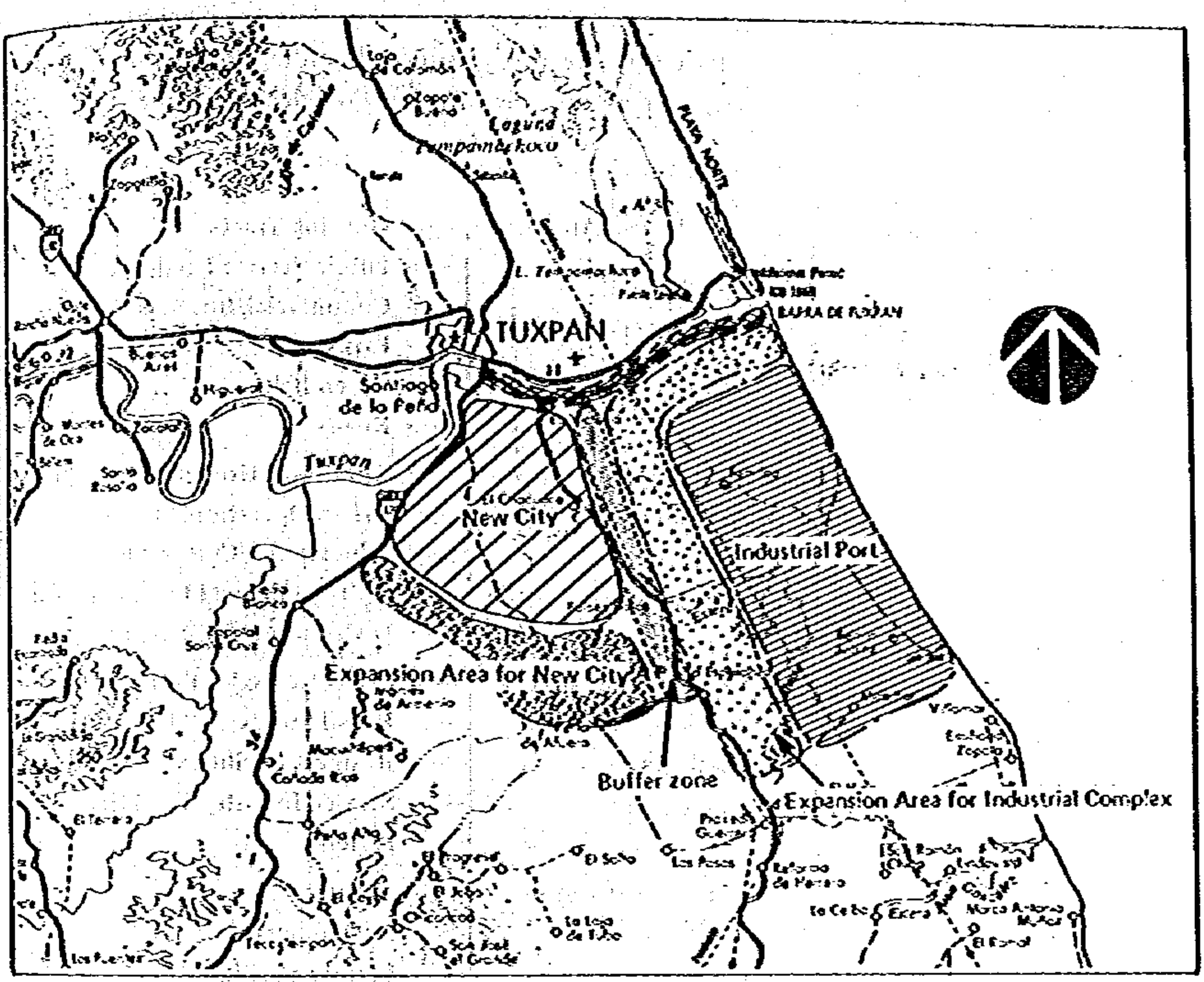


Fig. VII-2-(3) Zoning of Tuxpan Port City

(2) Land use planning

(a) Composition of urban functions

Urban functions in Tuxpan Port City are first classified according to whether they are inside or outside the new city. They are then further divided into the following sub-categories:

- Inside the New City Area
  - Residencial Area
    - Housing Tracts
    - Public Service Facilities
    - Commercial/Business Facilities
    - Parks
    - Green Belts
    - Roads
  - Public Service Facilities
    - Administrative related Facilities
    - Urban Operational Facilities
    - Educational/Cultural Facilities
    - Welfare/Medical Facilities
    - Distribution Business Facilities
  - Central Commerce and Business Facilities
    - Collective Sales Facilities
    - Retail Stores
    - Business Facilities
    - Service Industry Facilities
    - Hotels
  - Amusement and Recreational Facilities
    - Theatres
    - Restaurants
    - Leisure Facilities
    - Community Facilities
    - Sports Facilities
  - Light Industries
  - Parks
  - Green Belts
  - Roads
- Outside the New City Area
  - Public Service Facilities
    - Transport Facilities
    - Research related Facilities
    - Supply/Processing Facilities
  - Recreational Facilities
    - Marina
    - Marine Recreational Garden
    - Leisure Land
  - Green Belts
  - Roads

Urban facilities distributed in Tuxpan Port City are arranged according to the following categories:

- Productive Capital
  - Industrial Complex
  - Distribution Business Center
  - Marine Recreation Base
  - (See Table VII-2-(3), Table VII-2-(7))
- Basic City Services
  - Housing, Schools
  - Water Supply and Sewerage
  - Water Purification Plant
  - Sewage Disposal Plant
  - Garbage Disposal Plant
  - Parks, Green Belts, etc.
  - (See Table VII-2-(2), Table VII-2-(7))
- Transport and Communication Facilities
  - New Port, New Airport
  - Road Network
  - Railroads
  - Railroad Station and Marshalling Yard
  - Bus Terminal
  - Telegraph/Telephone Station
  - Broadcasting Station
  - Post Office, Newspaper Office, etc.
  - (See Table IV-2-(3), Table VII-2-(7))
- Service, Health, and Educational Sectors
  - Educational/Cultural Facilities
    - University, Marine Research Institute
    - Fishery Experiment Station
    - Teacher Training Center
    - Library, Museum, Theater
    - Concert Hall, etc.
    - (See Table VII-2-(3), Table VII-2-(7))
  - Medical Facilities
    - General Hospital
    - Health Center etc.
    - (See Table VII-2-(2), Table VII-2-(3))
  - Commercial/Business Facilities
    - Department Stores, Supermarkets
    - Banks, Hotels, Offices etc.
    - (See Table VII-2-(4))
  - Amusement/Recreational Facilities
    - Movie Theater, Restaurants
    - Golf Link, Sports Garden etc.
    - (See Table VII-2-(4), Table VII-2-(5))

Table VII-2-(2) Required Urban Facilities in the Year of 2000
– Residential Facilities –

Functions and Facilities	Service Unit per Neighborhood Unit (per a building)	No. of Facilities (Unit)	Unit Area	Total Area (ha)
RESIDENCE				
* Detached dwellings (1-2F) (12,000 Households)		12,000	300m²	360
* Terrace dwellings (2F) (38,000 Households)	(5 Houses)	7,600	1,200	912
* Apartment house (4-5F) (30,000 Households)	(30 Houses)	1,000	1,800	180
(14-18F) (10,000 Households)	(95 Houses)	105	1,800	19
Total (90,000 Households)				1,471
PUBLIC SERVICE				
* Kindergarten	2	90	0.15 ha	14
* Primary school	1	45	2	90
* Secondary school	1/2	23	4	92
* High school	1/4	11	5	55
* City office branch	1/4	11	0.1	1
* Day nursery	5	225	0.1	23
* Post office branch	1	45	0.05	2
* Hospital	1/4	11	0.4	5
* Clinic	2	90	0.05	5
* Health center	1/22	2	0.05	} 1
* Police station	2	90	0.01	}
* Fire station	1/4	11	0.36	4
* Church	1	45	0.1	5
* Library branch	1/2	23	0.2	5
* Auditorium or meeting hall	1	45	0.05	2
* Afternoon day care center	1/45	11	0.3	} 5
* Home for young men	1/4	2	0.2	}
* Home for the aged	1/4	11	0.2	}
Total				309
COMMERCED AND BUSINESS				
* Commerce business, amusement and service industry district	1/4	11	4.1 ha	45
* Neibourhood unit center	1	45	2	90
* Daily goods' shops and restaurants	25	1,125	0.01	12
* Parking	1	45	2	90
Total				237
OPEN SPACE				
* District park	1/4	11	10 ha	110
* Neibourhood park	1	45	3	135
* Neibourhood play-ground	4	180	1.5	270
* Play lots	16	720	0.05	36
Parks Sub-Total				551
* Green space				662
Total				1,213
Road				
Total				820
Ground Total				4,050

Table VII-2-(3) Required Urban Facilities in the Year of 2000
– Public Service Facilities –

Functions and Facilities	No. of Facilities (Unit)	Unit Area	Total Area (ha)
ADMINISTRATIVE RELATED FACILITIES			
o Government office branch		0.2 – 1 ha	8
o State-government office branch			
o Court	1		
o Taxation office	1		
o Prison	1		
o City office	1		
o Central fire station	1		
o Police headquarters	1		
o Square	1	4	4
Total			12
URBAN OPERATIONAL FACILITIES			
o Central telegraph/telephone office	1	1 – 2 ha	5
o Broadcasting station	1		
o Central post office	1		
o Bus terminal	1	6	6
o Square	1	4	4
o Transformer substation	1	1	1
o Water purification plant	1	9	9
o Crematory	1		22
o Cemetery	1		
Total			47
CULTURAL AND EDUCATIONAL FACILITIES			
o University	1	100 ha	100
o Teacher training center	1		3
o Business training school	1		
o Research institute	4	0.3 – 1	2
o Central library	1	0.5 – 1	4
o Museum	1		
o Art museum	1		
o Theater	1		
o Concert hall	1		
o Cathedral	1		
Total			109
WELFARE AND MEDICAL FACILITIES			
o General hospital	1		10
o Regional health center	1		
o Home for the aged	2		4
o Rehabilitation center	1		
Total			14
DISTRIBUTION BUSINESS CENTER			
o Warehouses complex			210
o Wholesale complex			
o Truck terminal			
Total			
Ground Total			392

Table VII-2-(4) Required Urban Facilities in the Year of 2000
– Commercial/Business Facilities –

Functions and Facilities	No. of Facilities (Unit)	Unit Area (ha)	Total Area (ha)
COMMERCIAL FACILITIES			
o Department house	2	1	2
o Grocery stores	5	0.2 – 0.5	2
o Retail outlets o Restaurant	10,000	0.02 – 0.05	250
BUSINESS FACILITIES			
o Bank, firm, business, offices, newspaper offices, etc.	1,500	0.3 – 1	74
OTHER SERVICE FACILITIES			
o Service industry	3,000	0.02 – 0.05	74
o Hotel	5	0.5 – 1	3
Ground Total			405

Table VII-2-(5) Required Urban Facilities in the Year of 2000
– Amusement and Recreational Facilities –

Functions and Facilities	No. of Facilities (Unit)	Unit Area (ha)	Total Area (ha)
SHOW BUSINESS FACILITIES	20	0.1 – 0.3	3
AMUSEMENT FACILITIES			
o Restaurants/bars o Game centers o Dance halls o etc.	100	0.05 – 0.2	10
LEISURE FACILITIES			
o Golf links (18 halls)	1	100	100
o Festival plazas	1	5	5
Ground Total			118

Table VII-2-(6) Required Urban Facilities in the Year of 2000
– Industry and Open Space –

Functions and Facilities	Number of Facilities (unit)	Total Area (ha)
LIGHT INDUSTRY (With a population of 37.1 thousand involved in economic activities related to secondary industries, the day time population density is estimated at 150 people/ha)		230
Total		230
OPEN SPACE		
• Central park (park for arts)	1	50
• Recreational sports park	1	70
• Green space as a buffer zone • Green space as a emergency shelter • Green way		485
Total		605
Roads		400

Table VII-2-(7) Required Urban Facilities in the Year of 2000
– Facilities located Outside of the New City –

Functions and Facilities	Number of Facilities (Unit)	Total Area (ha)
TRANSPORTATION FACILITIES		
• Airport	1	200
• Railway marshalling yard	1	100
Total		300
LEISURE FACILITIES		
• Marine recreational park (including swimming pools, an aquarium, camping ground, lodgings, restaurants, clubhouses, hotels, green way and parking lot, etc.)		30
• Amusement park (including amusement facilities for children and adults, restaurants and parking lot etc.)		20
• Marina (including mooring facilities, club house, ramp, boat-houses, parking lot etc.)		10
Total		60
EDUCATIONAL RELATED FACILITIES		
• Marine research institute	1	7
• Fisheries experiment station	1	3
Total		10
SUPPLY AND DISPOSAL FACILITIES		
• Sewage disposal plant • Garbage disposal plant	1 1	25
Total		25
All facilities combined		395

(b) Estimation of the scale of each use

The gross population density of the residential area has been assumed to be 100 persons per hectare based on population densities of other new towns throughout the world as well as figures for the existing Tuxpan city. (75.5 persons per hectare, See Table VII-2-(10)). Therefore, the urban area of the new city is 6,200 ha, including commercial/business area, public service area, amusement/recreational area and light industry etc., excluding urban facilities located outside the new city.

In consideration of the above mentioned estimated population density, the scale of facilities to be located in the new city have been estimated as shown in Tables VII-2-(2) ~ (7). Based on these tables land use in the new city and its residential district can be categorized respectively as shown in Tables VII-2-(8), (9).

Table VII-2-(8) Planned Land Use for the New City in the Year 2000

Land Use	Area (ha)	Percentage (%)
Residential Area	4,050	65.3
Commercial/Business Area	405	6.5
Public Service Area	392	6.3
Amusement/Recreational Area	118	1.9
Light Industry	230	3.7
Road	400	6.5
Open Space	605	9.8
Total	6,200	100

Table VII-2-(9) Division of Residential Land Use

Land Use	Area (ha)	Percentage (%)
Housing Land	1,471	36.3
Land for Commerce/Business Facilities	237	5.9
Land for Public Facilities	309	7.6
Road	820	20.2
Open Space	1,213	30.0
Total	4,050	100

Table VII-2-(10) Land Use of Typical New Town

Name of the New Town	Country	Planned Population (thousand)	Population Density (person/ha)	Site Area (ha)	Land Use Composition (%)					
					Residential Area	Area for Public Facilities	Commercial Area	Parks Green Space	Road	Others
Senri	Japan	150	130	1,150	44	6	4 (including industry)	24	22	
Senboku	Japan	188	120	1,520	44	6	1 (including industry)	22	22	
Kohoku	Japan	350	138	2,530 (2,277)	(67.9)	(8.5)	(4.8)	(7.6)	(20.9)	(0.3)
Tama	Japan	300	100	3,000	47.0	19.6	6.1	11.4	15.9	
Chiba	Japan	340	120	2,900	47.3	9.0	6.6	11.2	20.5	5.4
Cumbernauld	England	70	60	1,690 (1,120)	31	6	4	33	10	16
Redditch	England	90	30	2,880	19.5	6.6	2.1	25.1	8.4	38.5 (including existing town)
Runcorn	England	100	34.5	2,900	29.5*	8.8*	0.9*	30.4*		30.5 (industry area, etc.)
Reston	U.S.A.	75	26	2,800	60*	17* (including industry)		23*		
Columbia	U.S.A.	110	20	5,450	54*	23* (including industry)		23*		

Note: * indicates that the figure includes roads.
( ) indicates the figure for areas that are already developed or urbanized.

(3) Allocation of Urban Functions

The following have been given special consideration in allocating urban facilities.

(a) Traffic network

The new city will be surrounded by national route 130, a trunk road running alongside the west end of Tuxpan Industrial Port, and two parallel trunk roads running between route 130 and the Industrial Port. As for the trunk roads (roads H, J, and K – See Fig. VII-2-(11)) connecting the new city with the Industrial Port, intersections will have to be constructed where these roads cross the Industrial Port west end trunk road.

Also, vehicle traffic generated by the industrial complex will have to be strictly regulated so as to not flow into the new city.

For the sake of convenience, the railway will reach the port area via the new city. The site for the railway terminal will be planned so as to provide an easily accessible junction for cars and trucks, and will also be planned in terms of securing lengthy horizontal straight sections for tracks, and allowing suitable space for future expansion. The bus terminal will be located as close as possible to a trunk road, and emphasis will be placed upon easy accessibility to the airport and central commercial and business districts of the city.

(b) Layout of the administrative district and the commercial and business district

These districts form the heart of the new city.

In arranging their layout, emphasis will be placed upon convenience of access from the existing city and connections with the trunk transportation network.

(c) Layout of the residential district

The residential district will be arranged as systematically as possible to avoid population dispersal. Care will be exercised to assure the mainenance of a high quality residential environment by taking into account topographical and drainage conditions.

In addition, space for future expansion will also be a consideration.

(d) Arrangement of educational, welfare and medical facilities

These facilities will be arraanged at nearly equal distances from different residential areas for the convenience of the new city's residents. Furthermore, special attention will be paid to the natural environment in terms of parks and green areas as well as access from the existing city.

(e) Layout of the goods distribution district and the industrial district

Special emphasis will be placed upon linkage with the trunk transporation network. Also, the relationship between this layout and the living environment is viewed as having great importance.

Figure VII-2-(4) shows three alternative layouts for the new city's various urban functions, based upon the above mentioned principle. Points of comparison for these three alternatives are listed below. Alternative III was selected after an assessment of the relative merits of each layout.

<Points of comparison>

A: Equalization of administrative, commercial and business facility services to all new city occupants.

B: Equalization of cultural and medical facility services to all new city occupants.

C: Road patterns.

D: Cohesiveness of residential areas.

E: Efficient utilization of topography.

F: Access to the new city's facilities and services for residents of the existing city.

G: Prospects for future city growth.

Table VII-2-(11) Assessment of Alternative Allocation of the Urban Fanctions

Arrangement Pattern	Evaluation Items							Total
	A	B	C	D	E	F	G	
Alternative I	o	Δ	Δ	Δ	Δ	Δ	Δ	Δ
Alternative II	x	Δ	Δ	o	o	o	Δ	Δ
Alternative III	Δ	o	o	Δ	Δ	Δ	o	o

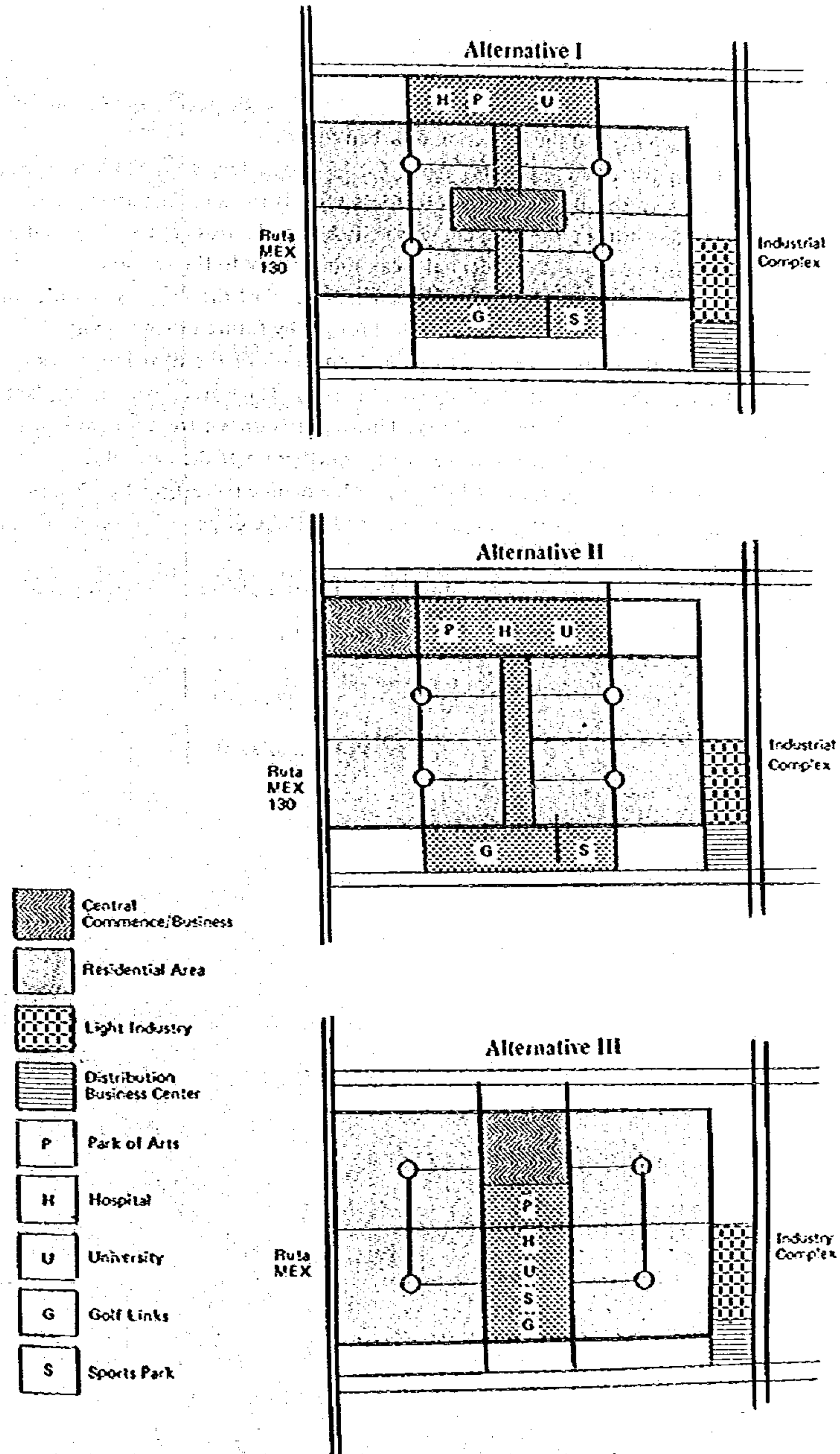


Fig. VII-2-(4) Alternative Allocations for Urban Functions

(4) Land use planning

Land use planning is shown in Fig. VII-2-(5), based on the recommendations of the study as to the scale of each use and the allocation of urban functions.

The New city is located in the area about 7 – 15 kilo-meters westward from the center of the Industrial complex. The public facilities districts such as the administrative district, the central commerce/business district, the hosiptal, university and park areas are to be located in the central linear zone of the new city with residential areas immediately to the east and west.

The light industries district is to be located south-east of the newcity in order to collect the industries in one area which are expected to be brought by future urban activity.

The business distribution center is to be located south of the light industries district taking into consideration the conjunction of roads and reilway. The water purification plant will supply fresh water to each facility in the new city. This water is drawn from a dam constructed in the Tuxpan river. Therefore, the plant is to be located north-west of the new city.

Such facilities as an airport, a marshalling yeard, a marine recreational park, a marine research institute, a fisheries experiment station, sewage and garbage disposal plants etc. are to be located outside of the new city

Details of the above facilities are studied in "District planning", "Transporation planning" and "Public facilities planning".

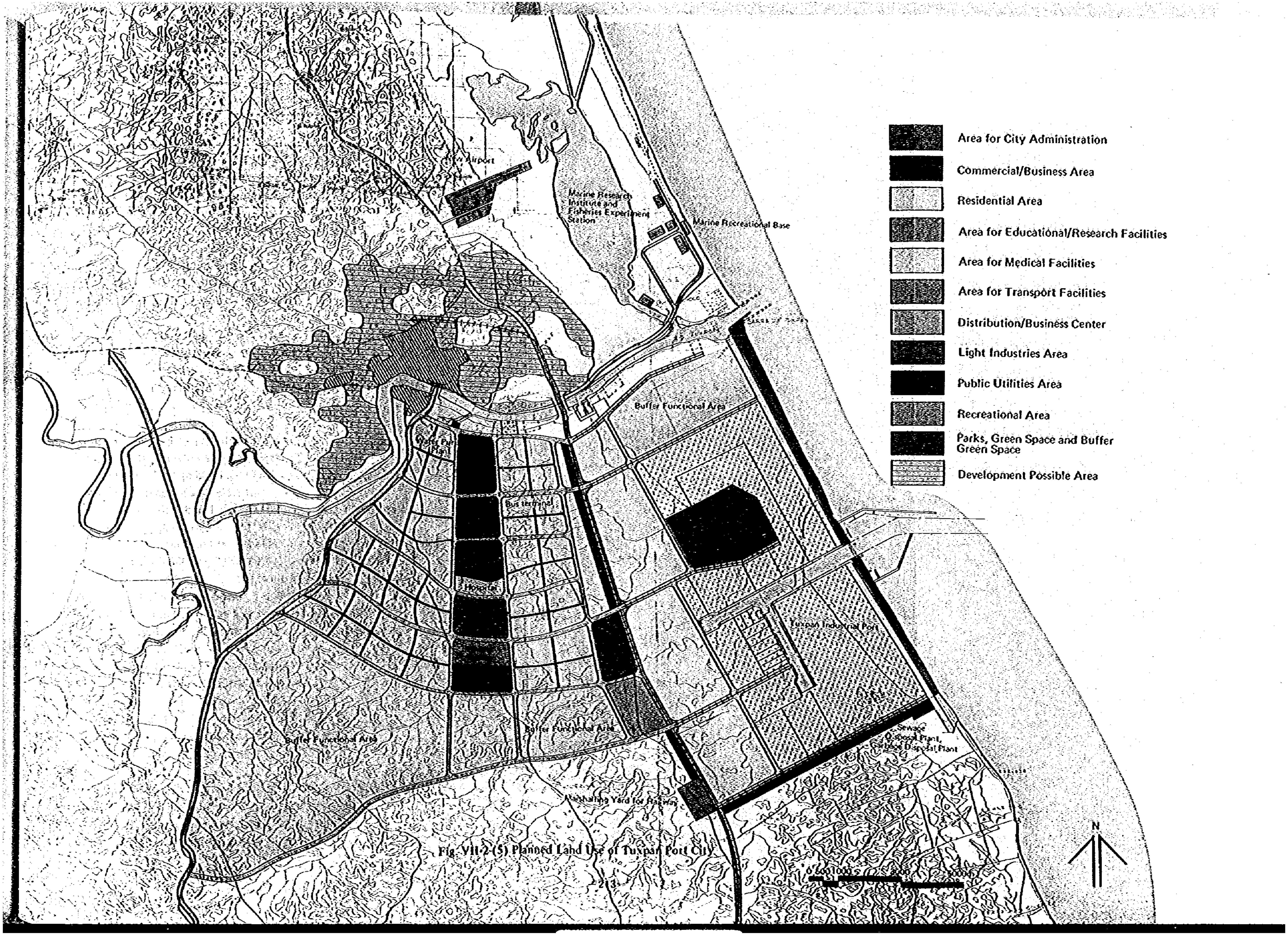


Fig. VII-2-(5) Planned Land Use of Tuxpan Port City

(1) Residential District

(a) Setting of population density

As stated in (b) Estimation of the scale of each use, (2) of 2-4, gross population density of the residential area has been assumed to be 100 persons per hectare. Therefore, the residential district consisting of housing area, public service facilities area, commerce/business area, roads and parks is to be set at 4,050 hectares. The housing area is estimated at 1,471 hectares, all by summing up the site areas of housing types. Since the total population of the new city is 405,000, net population density is 275 persons per hectare. And if the occupancy rate is presumed to be 80%, the prospective floor area per capita is about 29 square meters, and thus the unit floor per house is 130 square meters, assuming a family size of 4.5 persons.

(b) Overview of neighborhood units within the entire residential district

The residential district covers a wide area and forms a large community. The neighborhood unit is assumed to be a fundamental unit within and supporting this larger community. We feel it is important to recognize the fact that neighborhood communities are the primary sphere for daily activities. Plans for the neighborhood units have been formulated as explained below.

Pedestrians are given highest priority in the planning.

Elementary schools, churches and neighborhood centers have been located in the centers of neighborhood units. Basic public facilities have been allocated in each neighborhood unit within easy walking distance of all residents.

The residential district has been divided into 45 neighborhood units, and each neighborhood unit has been sub-divided into 4 neighborhood sub-units. Therefore, the average number of inhabitants, and households, and the average area per neighborhood unit are, respectively, 9,000 inhabitants, 2,000 households and 90 hectares.

Fore each neighborhood unit, the following kind and approximate number of facilities have been allocated: 1 elementary school, 1 neighborhood center, 1 church, 2 kindergardens, 4 neighborhood play-grounds, 16 play lots and 4 retail shopping centers. One towncenter has been planned for every 4 units, to serve a total of about 36 thousand inhabitants. A model plan for a typical neighborhood unit is shown in Fig. VII-2-(6). The unit is surround by four roads and linked to these roads are service roads, which have been designed with cul-de-sacs so as to impede through traffic. A network of green ways has been mapped out for each unit for both pedestrian and bicycle use. These green ways will interlink units with each other so as to assure the safe movement of pedestrians and bicycles without their inconveniencing or being inconvenienced by automobile traffic.

(c) Allocation of housing types

It is both a standard practice, and in this case desirable as well, to classify dwellings as shown in Fig. VII-2-(7) by height and into three types: low, medium and high. High rise dwellings should be zoned in the area facing the central commercial and business district. Medium height dwellings should be zoned in the vicinity of trunk and semi-trunk roads.

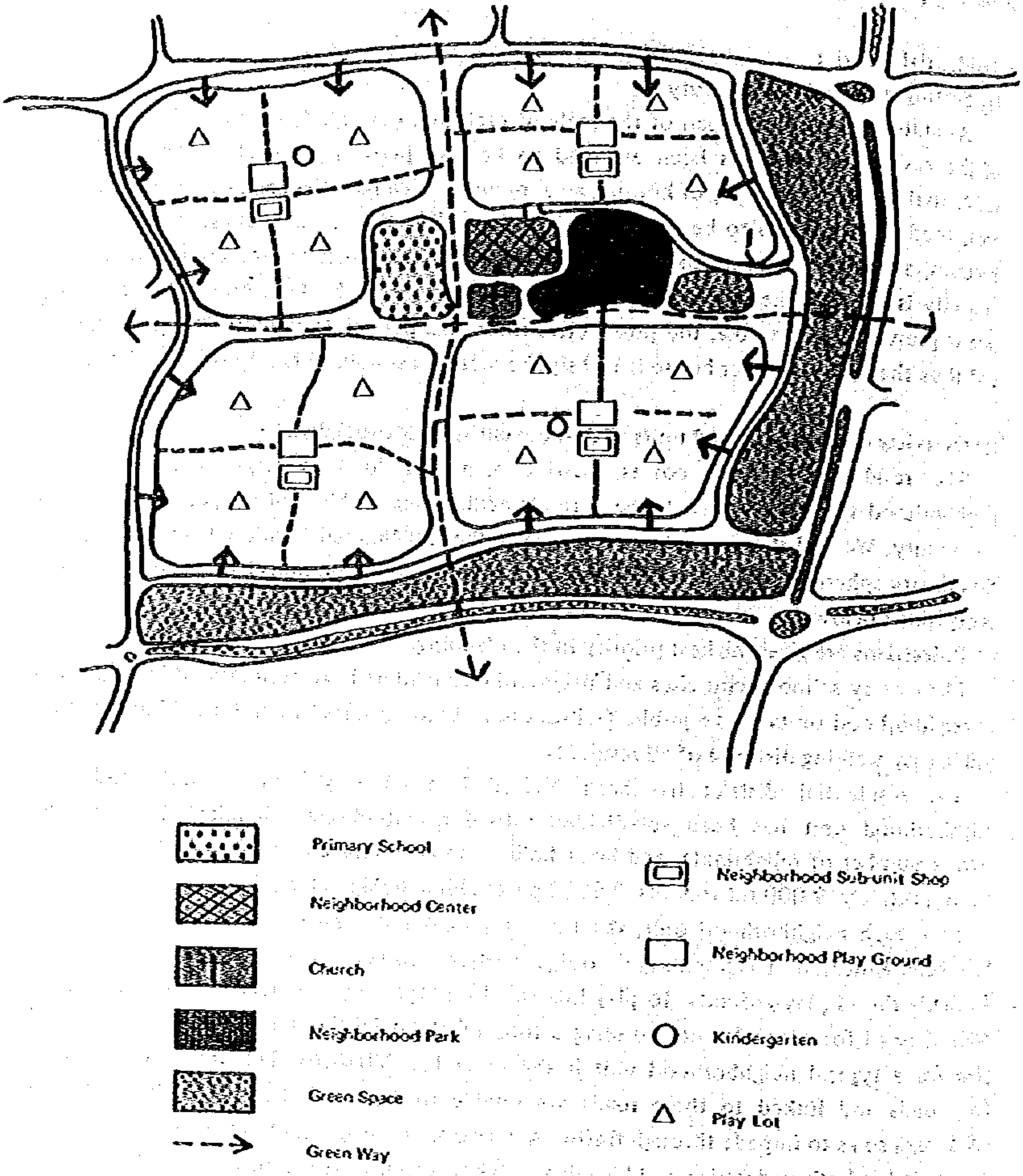


Fig. VII-2-(6) Model Plan of a Neighborhood Unit

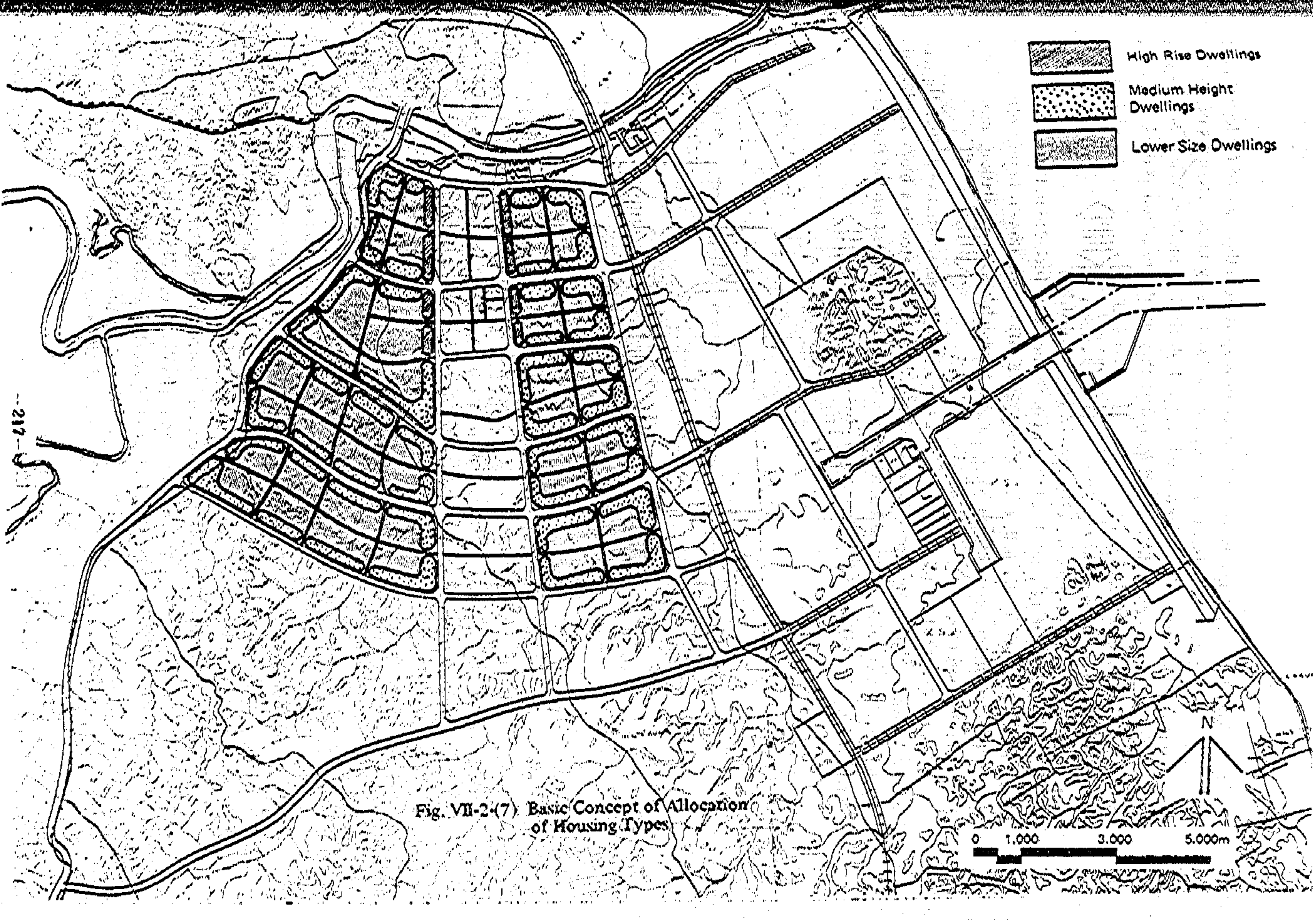


Fig. VII-2-(7) Basic Concept of Allocation of Housing Types

Lower size dwellings should be zoned in other areas apart from those zoned for high rise and medium height dwellings. This method of zoning dwellings by three categories of height is advantageous in terms of fire prevention, as the high rise and medium height buildings are constructed of non-combustible materials, and so they would functioon as fire breaks in the event of a major city fire.

(2) Administrative district and central commercial/business district

These districts are to be located in the heart of the new city. Included in these districts are a plaza/square, a cathedral, city hall, city administrative offices, government branch offices, and postal/communication facilities such as a central telegraph/telephone station, broadcasting station, central post office etc.

A bus terminal has been planned for the area adjacent to the administrative district. High rise buildings such as department stores, hotels and offices will be located in a block south of the bus terminal. Other commercial and business facilities will be positioned around this central city core (See Fig. VII-2-(8)).

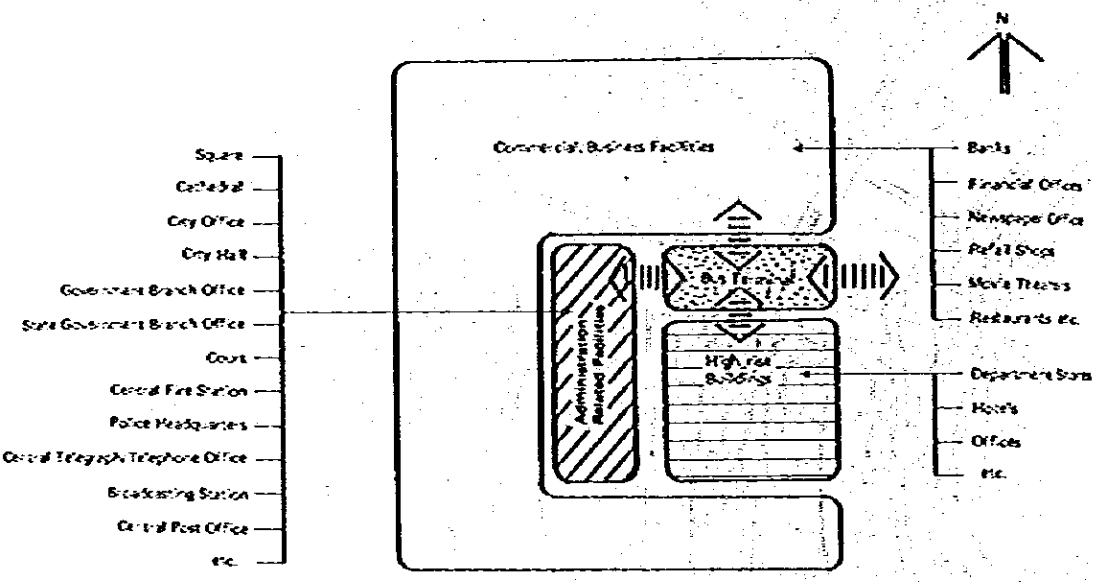


Fig. VII-2-(8) Basic Concept of Administrative District and Central Commercial/Business District

(3) District for cultural, educational, medical and recreational facilities

Cultural, educational, medical and recreational facilities are to be located directly south of the central commercial and business district with residential areas immediately to the east and west. The actual layout of facilities will have a long, narrow rectangular shape, as the facilities will be divided into four separate zones, each zone positioned one next to the other in the form of a chain (See Fig. VII-2-(9)). Abundant green space is planned. In addition, a green way network shall run through the area, linking the opposite residential districts, and making possible access on foot between them.

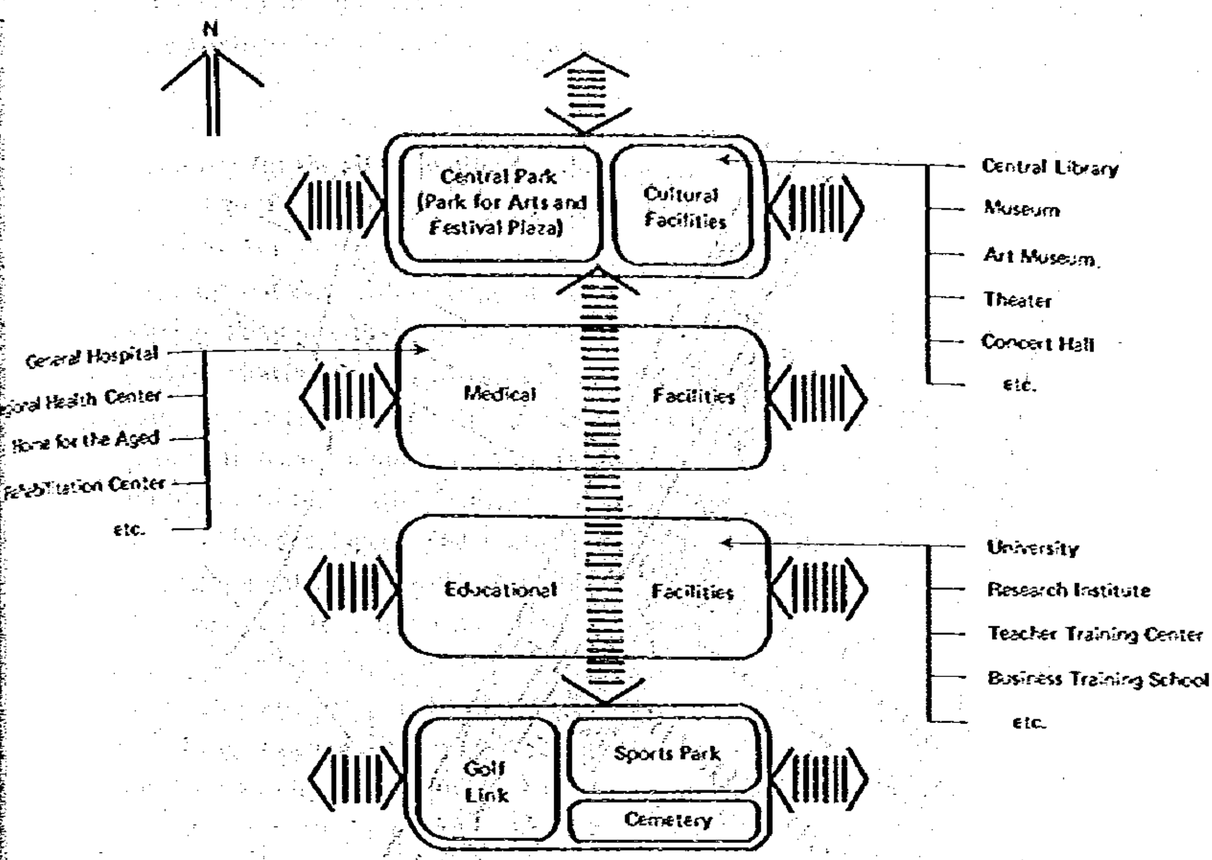


Fig. VII-2-(9) Basic Concept of Cultural/Educational/Medical/ Recreational District

(1) District for marina and ocean front recreational facilities

A marina and ocean front recreational facilities have been planned for the area south of Tampamachoco lake, near the estuary of the Tuxpan river. These facilities will be located at a distance of 1 km ~ 2 km from the Tuxpan river. The marina will be situated just at the lake's inlet, and pleasure boats will be able to sail through to the ocean via the river's estuary.

An access road will be constructed about 300 m inland from the coast line. Along this road, plans call for the construction of hotels, an amusement park, swimming pools, and an quarium, as shown in Fig. VII-2-(10). A camping ground will be located adjacent to the swimming pools and aquarium, on the inland side, and will be linked to these facilities via a green way. The facilities, except for the marina, are as shown below.

As for the marina, details concerning its planning are explained in chapter VII-3-7.

① Amusement Park 20 ha

Rides; restaurants; strolling lanes and promenades; parking lot.

② Swimming Pool/Aquarium 10 ha

fresh water swimming pool; sea water swimming pool; aquarium; club house; promenade; parking lot.

③ Camping Ground/Picnic Area 15 ha

④ Lodging Facilities 5 ha
hotel; shops; a square; parking lot.

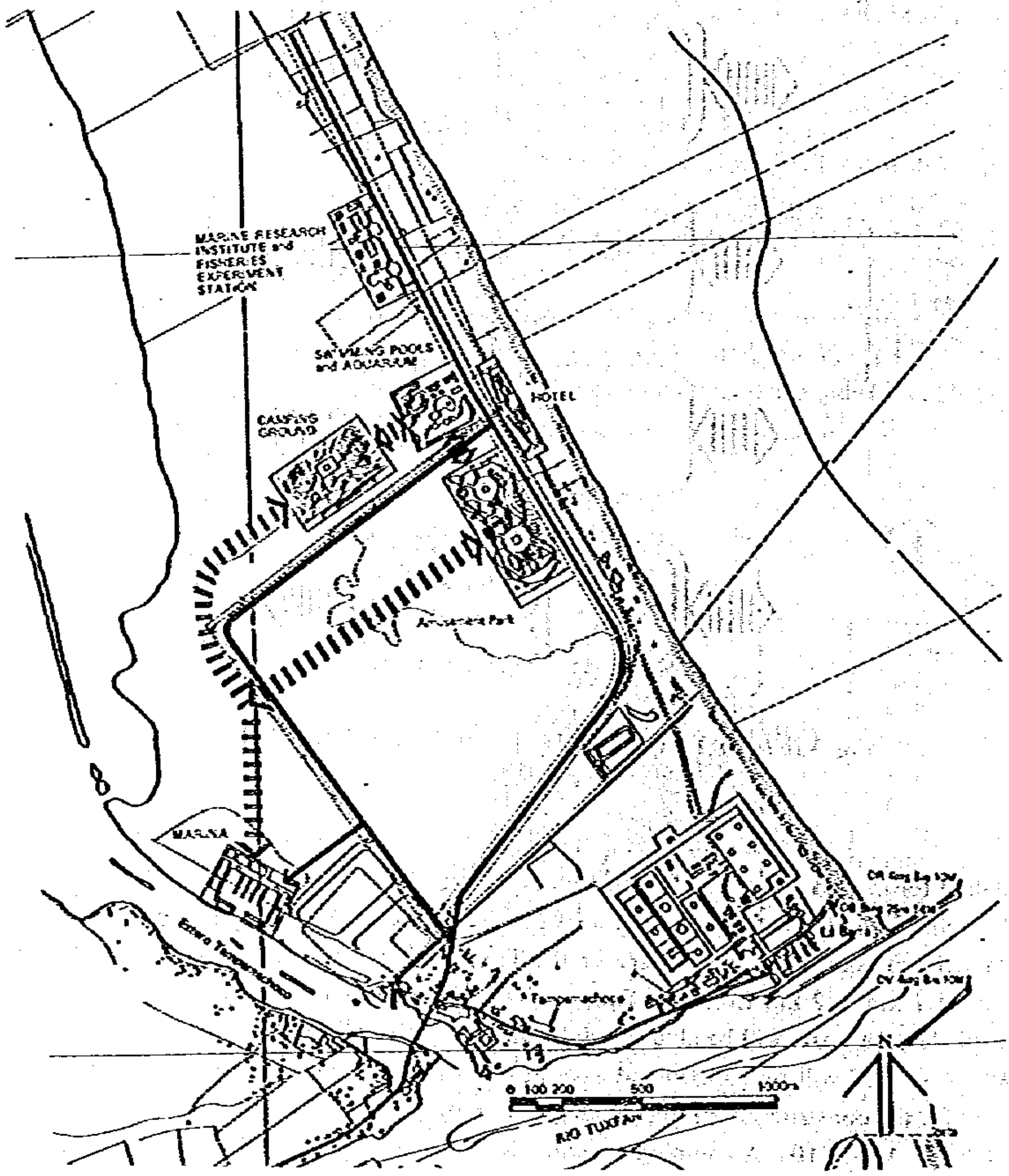


Fig. VII-2-(10) Allocation Plan of Marine Recreational Base

2-6 Urban Development of the Area Surrounding the Existing Tuxpan City

Here, the subjects for urban development of the area surrounding the existing Tuxpan city are discussed.

(1) Considerations for the site selection for the new city

When the site for the new city is selected, the consideration which we attach most importance to are as follows:

(a) Integration of the existing Tuxpan city and the urban development area

Existing Tuxpan city is, as mentioned in chapter III, a small city with a population of about 40,000 having developed centering around Tuxpan port. Such infrastructures as roads, water supply, sewerage and electric power facilities are in poor condition.

Further, transport/communication facilities, educational/cultural facilities, social protection facilities and residential facilities etc. are also insufficient, and thus these urban facilities will have to be developed. The method for intergrafity the existing Tuxpan city and the urban development area is a principal subject when the area surrounding the existing Tuxpan city, is developed. It is important to decide how to allocate such infrastructures as roads, water supply and sewerage as well as other urban facilities. In other words, the question is how to develop and prosper the existing Tuxpan City.

Therefore, when a site available for urban developement is selected surrounding the existing Tuxpan city, the following have to be considered, namely, that the new city has to be in harmoney with the existing city and that sound regional community has to be formed in entire Tuxpan city.

(b) Preservation of natural environment

The area surrounding Tampamachoco Lake seems to be a habitat for various birds and also a fishing ground. Accordingly, it has to be preserved. In the area north of the existing Tuxpan city, many orange groves and other farmlands are distributed, this excellent farm land also has to be preserved.

(c) Construction cost

As for the study of construction cost, following the assessment of topographical and soil foundation conditions an where the costs will be relatively low is to be selected.

The result of assessment of topographical and soil-foundation conditions is shown in Fig. VII-2-(2).

The area with slope more than 15 degrees is to be excluded from the new city development area, because of expensive cost of preparing the ground in terms of disadvantages of road or housing site planning. Areas with weak foundations, or poor drainage are also to be excluded from the new city development area, for the same reason mentioned above.

(2) Development area and population planning

The result of the selection of the sites available for the development based on the above considerations is shown in Fig. VII-2-(5). The site area to be available for development is approximately 2,700 hectares. The existing Tuxpan city is certainly to be the core of the new city, thus, infrastructure and urban facilities need to be developed here. If new urban facilities such as administrative facilities, public facilities, central commerce/business facilities etc. required for the entire new city are presumed to be developed in the existing Tuxpan city, population planning for the new developping area is as follows:

Percentage of housing area	45%
Population density	100 persons per hectare
Population	121.5 thousand

(3) Considerations of new urban development

The main considerations raised by the new urban development in area north of the Tuxpan river are proposed as follows:

(a) Necessity of urban development of existing Tuxpan city as the urban core of the new city.

The population of the new city including the nighttime population of existing Tuxpan city will be over 160 thousand. Accordingly, infrastructure and urban facilities corresponding with the population scale have to be developed by all means. And for this reason, the redevelopment of the existing city must be done.

(b) Necessity of transportation planning for the entire new city

There are many narrow roads in existing Tuxpan city, and the sidewalks of these roads have not been separated from driveways. The network of these roads has not been arranged well, owing to the complexity of the roads.

Therefore, transporation planning for the entire new city is required, including new construction or improvement planning roads and railways in existing Tuxpan city.

(c) The necessity of community planning

Socio-economic dislocation of the inhabitants in existing Tuxpan city is expected to arise, if a large population of over 120 thousand inhabits moves into the area adjacent to the old city which has a population of only about 40 thousand.

Further, there is some fear that the new city will be divided into separate areas, owing to the new construction of railways, located in the northern part of the existing city, trunkroads and topographical conditions.

Accordingly, administrative facilities, educational facilities such as elementary schools and secondary schools, commercial facilities, parks and green ways have to be allocated according to community planning.

2-7 Transporation Planning

(1) Road

(a) Inter-regional highways and main access roads

≪Layout of the port roads≫

The port roads generally lead right up to the wharf. These roads, laid out within the port area, have been built for the purpose of transporting cargo to and from the wharves. In general, port roads are those roads that link wharves with other wharves and wharves with trunk roads outside the port.

In addition, port roads are used not only for transporting port related cargo, but are also used by port workers commuting to their jobs. For all these reasons, it is necessary to construct a network of roads extending up to the wharves, and spread throughout the industrial port area.

In the industrial zone, different industries are situated in different sub-zones, so roads will be laid out to connect these subzones. Parallel roads shall extend westward from each wharf, connecting up with a north-south road on the western edge of the industrial zone. The layout for these roads is shown in Fig. VII-2-(11). As for the north-south road F, it is laid out with an emphasis on using existing roads and with the goal of making it as straight as possible.

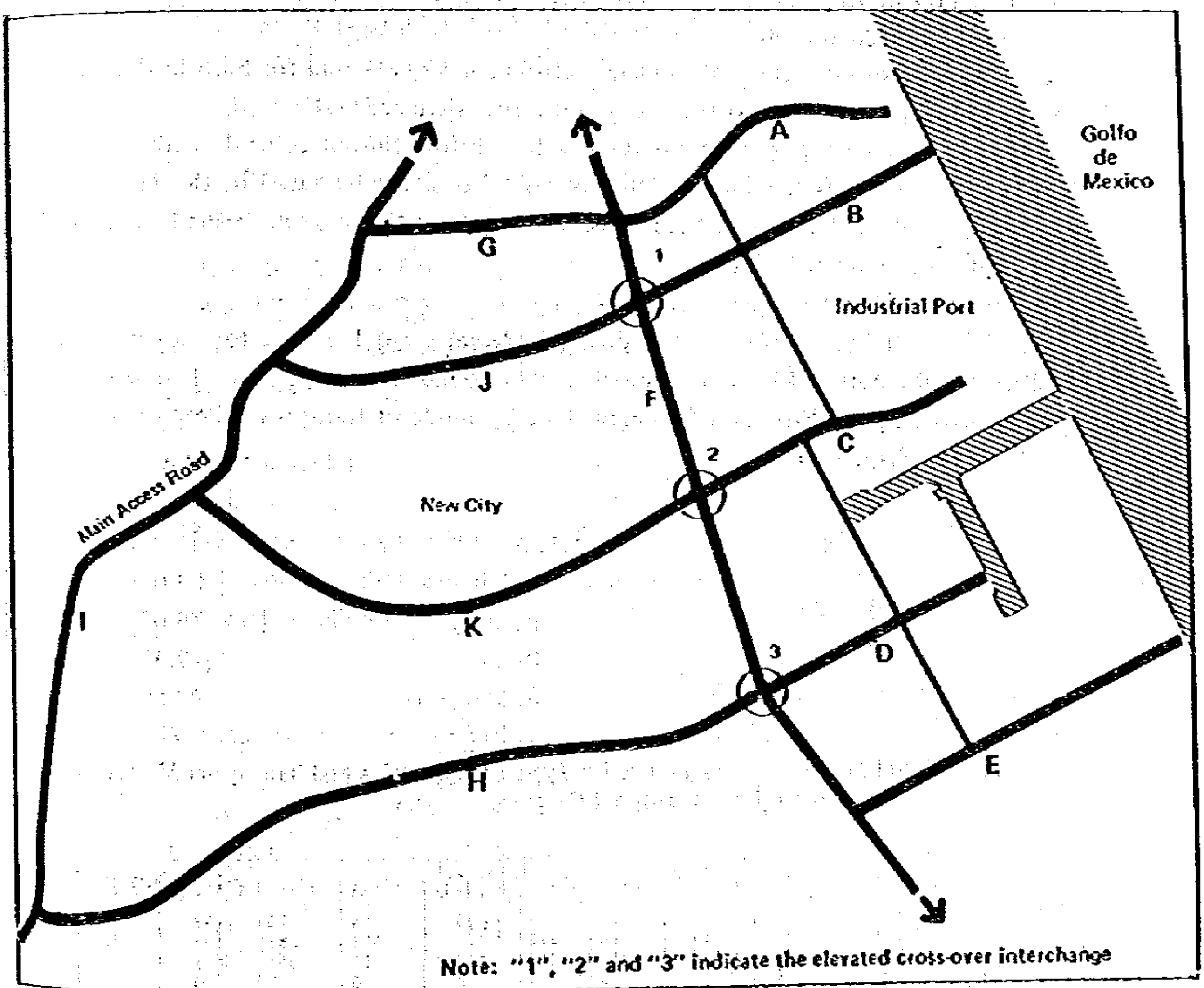


Fig. VII-2-(11) Layout of Trunk Road Network

≪Connection with access roads≫

Access roads that will pass near the new city include national roads 130 and 180, as well as a road connecting Tuxpan with Tamiahua. Roads A,D, and F are major trunk roads within Tuxpan Industrial Port that link-up to outside access roads (See Fig. VII-2-(11)). Trunk roads J and K are laid out so as to connect the new city with the port roads. Trunk roads H, J and K will require overpass/underpass intersections at crossing points with port road F. It is necessary that vehicle traffic generated in the industrial complex be strictly regulated so as to by-pass the new city.

In order to accomodate the extention of port road F, a new bridge will have to be constructed over the Tuxpan river. It is planned that this road will connect the existing Tuxpan City with the new industrial port.

(b) Planned traffic volumes and typical cross sections of main trunk roads

≪Forecast Preconditions≫

In order to estimate peak hourly traffic volumes, volumes for both business traffic (trucks and related vehicles) and commuter traffic have been estimated.

It is assumed that peak hours for business traffic will not coincide with peak hours for commuter traffic, with commuter traffic being concentrated in the morning and evening for durations of one hour. Business traffic in this case is defined as all traffic except for commuter traffic.

≪Forecast of business traffic volumes≫

1) Table VII-2-(12) indicates the planned annual cargo handling tonnage in the year 2000 for the port and industrial complex and also indicates cargo shares handled by road and rail transport. Estimates for cargo share by mode of transport follow the estimates adopted in chapter VI.

Cargo	Transport mode	Share
Input cargo	Road	22.0%
	Railway	78.0%
Output cargo	Road	77.4%
	Railway	22.6%

Table VII-2-(12) Forecasted Traffic by Type of Industries and Transport Modes for Inland Transport Cargoes

(Unit: '000 tons)

Type of Industries	Carry in			Carry out			Total		
	Road	Railway	Total	Road	Railway	Total	Road	Railway	Total
Sea Food Products	11	39	50	65	19	84	76	58	134
Other Food Products	17	59	76	272	79	351	289	138	427
Paper/Cardboard	33	119	152	348	102	450	381	221	602
Petroleum Refining	0	0	0	0	0	0	0	0	0
Petrochemical	14	48	62	898	262	1,160	912	310	1,222
Iron and Steel	180	640	820	1,517	443	1,960	1,697	1,083	2,780
Heavy Electric Machinery	4	14	18	5	2	7	9	16	25
Other Machinery	15	51	65	101	30	131	116	81	197
Motor vehicle	40	140	180	57	17	74	97	157	254
Shipbuilding	5	16	21	16	5	21	21	21	42
Industrial Port Total	319	1,126	1,445	3,279	959	4,238	3,598	2,085	5,683
Commercial Port	213	556	569	0	0	0	213	756	969
Fishery Port	0	0	0	87	25	112	87	25	112
Grand Total	532	1,682	2,414	3,365	985	4,350	3,898	2,866	6,764

Note: Intra-zonal traffic in industrial/commercial port is excluded.

2) Planned traffic volume has been estimated using the following equation. This equation is an empirical formula that is used in drawing up master plans for Japanese port projects.

This formula permits a simple forecast of the traffic volumes generated by a port and industrial complex from a macroscopic viewpoint, so it is especially useful for long-term port plans.

$$\text{Planned traffic volume (vehicles/hour)} = z \times \frac{1}{w} \times \frac{\alpha}{12} \times \frac{\beta}{30} \times \frac{1+\delta}{\epsilon} \times \gamma \quad \ldots \quad \text{(VII-1)}$$

where, z: Annual cargo volume ('000 ton)
- w: Average tonnage/truck
- α: Monthly variation (peak month/ordinary month)
- β: Daily variation (peak day/ordinary day)
- δ: Rate of related vehicles (Related vehicles/all trucks)
- ϵ: Loading rate (loaded trucks/all trucks)
- γ: Hourly variation (generated traffic volume of peak hour/generated traffic volume of peak day)

It is assumed that by the year 2000, values for $W, \alpha, \beta, \delta, \epsilon, \gamma$ will be close to values found in Japan, therefore the following values have been employed.

$w = 15$ $\alpha = 1.0$ $\beta = 1.5$
$\delta = 1.5$ $\epsilon = 0.5$ $\gamma = 0.2$

3) Equivalent passenger car units are assumed as follows:

Passenger car	: 1.0
Bus	: 3.0
2-Axle truck class	: 2.0
Trailer	: 3.0
5-Axle (and above), Combination	: 4.0

4) Traffic volumes that will pass along roads in the port and industrial complex have been forecast as follows.

Port Roads	Transported Cargo Volume ('000 ton)	Total Transported Mixed Traffic (Veh/hr)	Volume per Peak Hour Passenger Car Units (Veh/hr)
A	188	53	89
B	456	127	212
C	1,126	313	526
D	331	92	154
E	1,822	506	850
H	3,735	1,038	1,744
I	3,923	1,090	1,832

According to the above results, port road H has the largest traffic volume, and the total amount of passenger car units per peak hour is approximately 1,700 vehicles.

≪Forecast of commuter traffice volumes≫

1) The commuter population in the port area can be broken down as follows.

Industrial Complex	:	42,000 employees
Commercial Port	:	1,000 employees
Total	:	43,000 employees

The amount of commuters at peak hours on each port road are assumed as shown below. However, it is difficult to estimate the peak hour distribution of commuters on trunk roads G. H. J and K. Therefore, the following estimates for these trunk roads have been based on the assumption that the residences of commuting workers are proportionately distributed per residential district.

Traffic volume

G : H : J : K = 1 : 1 : 2 : 2

Port Roads	Commuters (Employees)
A	1,800 persons
B	1,500
C	8,800
D	13,900
E	17,000
City Roads	**Commuters**
G	7,170
H	7,170
J	14,330
K	14,330

2) Commuter transport modes are assumed as follows.

Percentage per mode		Passenger Car Unit	Occupancy Rate
Private Car	35%	1.0	2.0 person/veh
Motorcycle	5	0.5	1.0
Bus	60	3.0	45.0

3) It is assumed that commuter traffic will be concentrated in one hour in the morning and in the evening.

Calculation results are as shown below.

Trunk Road	Commuter Traffic Mixed Traffic	Peak Hour Volumes Passenger Car Units	No. of Lanes per side
A	429	432	1
B	358	360	1
C	2,098	2,112	2
D	3,313	3,336	3
E	4,052	4,080	4
G	1,710	1,723	2
H	1,710	1,723	2
J	3,418	3,444	3
K	3,418	3,444	3

≪Design traffic volumes for trunk roads≫

A comparison of results from the traffic volume forecast reveals that commuter traffic volume is much greater than business traffic volume. Therefore, these peak-hour, one-way commuter traffic volumes have been used in setting design traffic volumes for trunk roads in the residential area, for port roads, and for connection roads between the new city and the industrial complex.

≪Typical cross sections of main trunk roads≫

Fig. VII-2-(12) shows the typical cross section of main trunk roads.

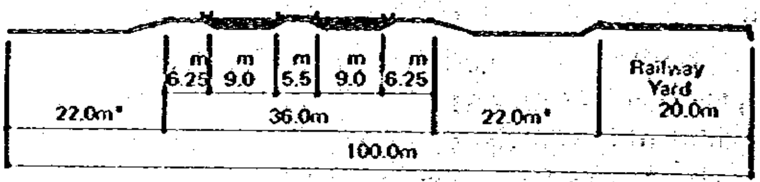
(c) Mass transportation in the new city

The transportation network planned for the Tuxpan Port Area is shown in Fig. VII-2-(13).

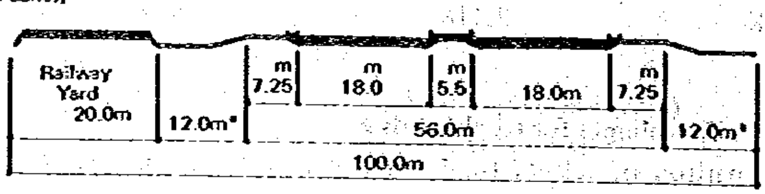
Trunk road intersections are numbered as shown in Fig. VII-2-(11). It is important that traffic flow by carefully regulated along the main access roads, so intersections Nos. 1 – 3 will have to be constructed with underpasses and overpasses.

For public transportation, a rounted bus system with bus stops within 500 m will be adopted.

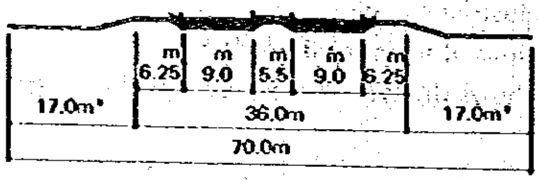
Trunk Road A.B.C.
(Total 4 Lanes)



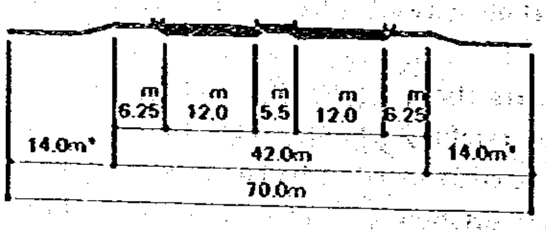
Trunk Road D.E.F.
(Total 8 Lanes)



Trunk Road G.H.I.
(Total 4 Lanes)



Trunk Road J.K.
(Total 6 Lanes)



Note: * for future expansion

Fig. VII-2-(12) Typical Cross Section for Main Trunk Roads

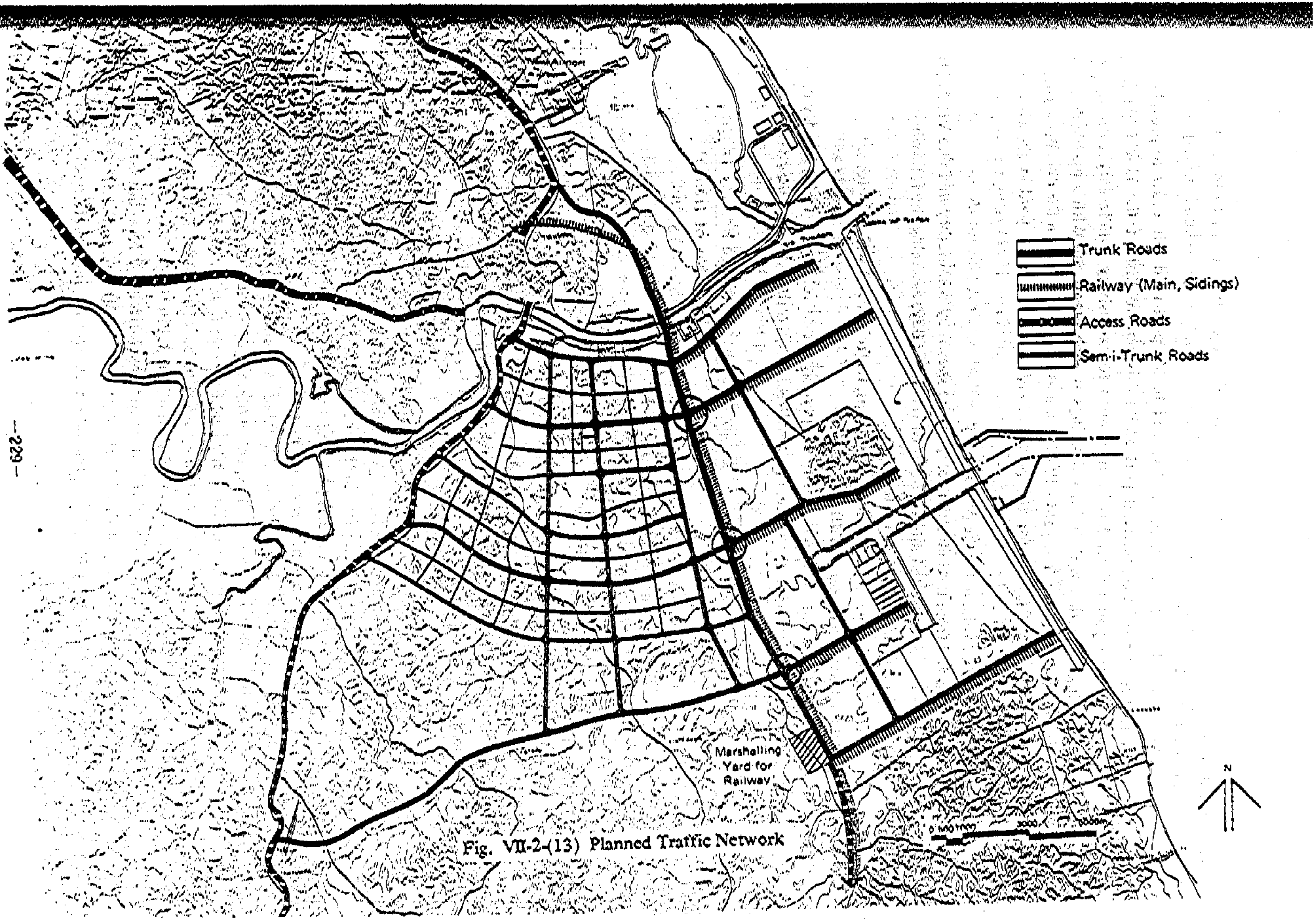


Fig. VII-2-(13) Planned Traffic Network

(2) Railway

(a) Layout of port railway

The port railway has been planned to run beside port road-F in order to provide easy access to the industrial/commercial port and so as not to disrupt the new city's living environment. The port railway has been planned to exclusively handle cargoes relating to manufacturing industries, with industrial sidings at each plant, and with a marshalling yard provided on the main line. The yard will function as the freight station for the entire Tuxpan Port Area. The basic layout for the port railway and marshalling yard is shown in Fig. VII-2-(13).

(b) Planned traffic volume for the port railway

Cargoes to and from the industrial complex are shown by commodity in Table VII-2-(12). These values can be converted into numbers of trains per day, assuming the following:

1) A locomotive can pull 2,000 tons.

2) If a loaded wagon weighs a total of 50 tons, its freight will weigh 25 tons.

3) One train is composed of 40 wagons.

The results in terms of numbers of trains per day are as follows: 8 trains per day depart from the Tuxpan Port Area, therefore, in both directions, 16 trains operate per day.

	Cargo Volume (ton)	Generated Railway Traffic (No. of Trains)
Industrial Port	2,085	5.7
Commercial Port	725	2.0
Total	2,810	7.7

(3) Airport

(a) Estimate of the required scale

In order to estimate the length and number of required runways, it is necessary to estimate the total number of landings and take-offs per year. This is done using the following equation.

$$F = \frac{T}{S \times U} \quad \text{(VII-2)}$$

where, F: Total number of landings and take-offs per year

T: Transportation demand (No. of trips)

S: Average No. of seats per plane

U: Average rate of seat occupancy

Transportation demand has been estimated according to forecasts concerning the demands of tourism and the size of Tuxpan's working population. As a result, transportation demand has been set at 293.4 thousand trips. The average number of seats per plane and the average rate of seat occupancy have been assumed to be 150 and 60%, respectively. "F" is calculated using these above values, and with a result of 3,260 times.

Since it is assumed that the airport will be used exclusively by local lines, the value "F" can be met by a single runway with a length of 2,000 – 2,500 meters. For this plan, a 2,500 meters runway has been selected in preparation for future introduction of larger sized airplanes. In light of this situation, the airport will require a 200 hectare site for the runway, an apron, terminal-buildings, maintenance facilities, cargo handling facilities and a parking area.

(b) Factors affecting the planning of the airport

≪Safety factors≫

(i) Weather conditions

In terms of weather, wind direction and velocity are the most important weather conditions. Fig. V-1-(5), which shows prevailing wind directional frequency by month for the past 10 years (1971 – 1980), indicates that winds from the N, E and NE have been predominant. Accordingly, the direction of the runway will be NE.

(ii) Required airspace for landing and take-off

The following may possibly obstruct the airspace required for landing and take-off at the new airports;

- o the existing city area
- o the existing private airport
- o the planned industrial complex
- o smokestacks of port zone industries
- o the observation tower at the port park
- o the new city – broadcasting station antennas
- o Chile Frio – power plant smoke stacks

≪Noise pollution prevention≫

Airplanes should not be permitted to fly over the new or existing city area. The airport would best be located downwind from the new or existing city, and located as far as reasonable from the city area.

≪Accessibility≫

Locating the new airport near trunk roads, such as route MEX – 130 or MEX – 180, would be advantageous. However, new access roads could also be constructed.

≪Economic Efficiency≫

Construction of the new airport must be reliably and simply carried out.

≪Acquisition of the site and effect on regional development≫

The site for the new airport must, in addition to meeting the above conditions, be located in the vicinity of the existing city, the new city and Tuxpan Industrial Port. It is expected that the new airport will contribute to the development of the new urban area, and also contribute to the prosperity of the entire region.

(c) Site selection

Six alternative sites have been considered as shown in Fig. VII-2-(14), taking into account the above planning conditions. These sites have been compared in Table VII-2-(13), based on results from the planning condition study and site investigation.

Items for comparison include airspace obstructions, economic efficiency, noise pollution, accessibility, and contribution to the prosperity of the region.

The fact that each item for comparison has different importance makes an overall comparison of the sites difficult. Assuming that noise pollution, accessibility and regional prosperity are the most important factors, then alternative sites A and B are most advantageous. As for alternative site A, it poses little problem in terms of noise pollution because of its distance from the city area. Also, site A can be easily reached from the new city, the existing city, and the industrial port via the trunk road that leads north from the industrial port area. For these reasons, site A has been selected for the new airport.

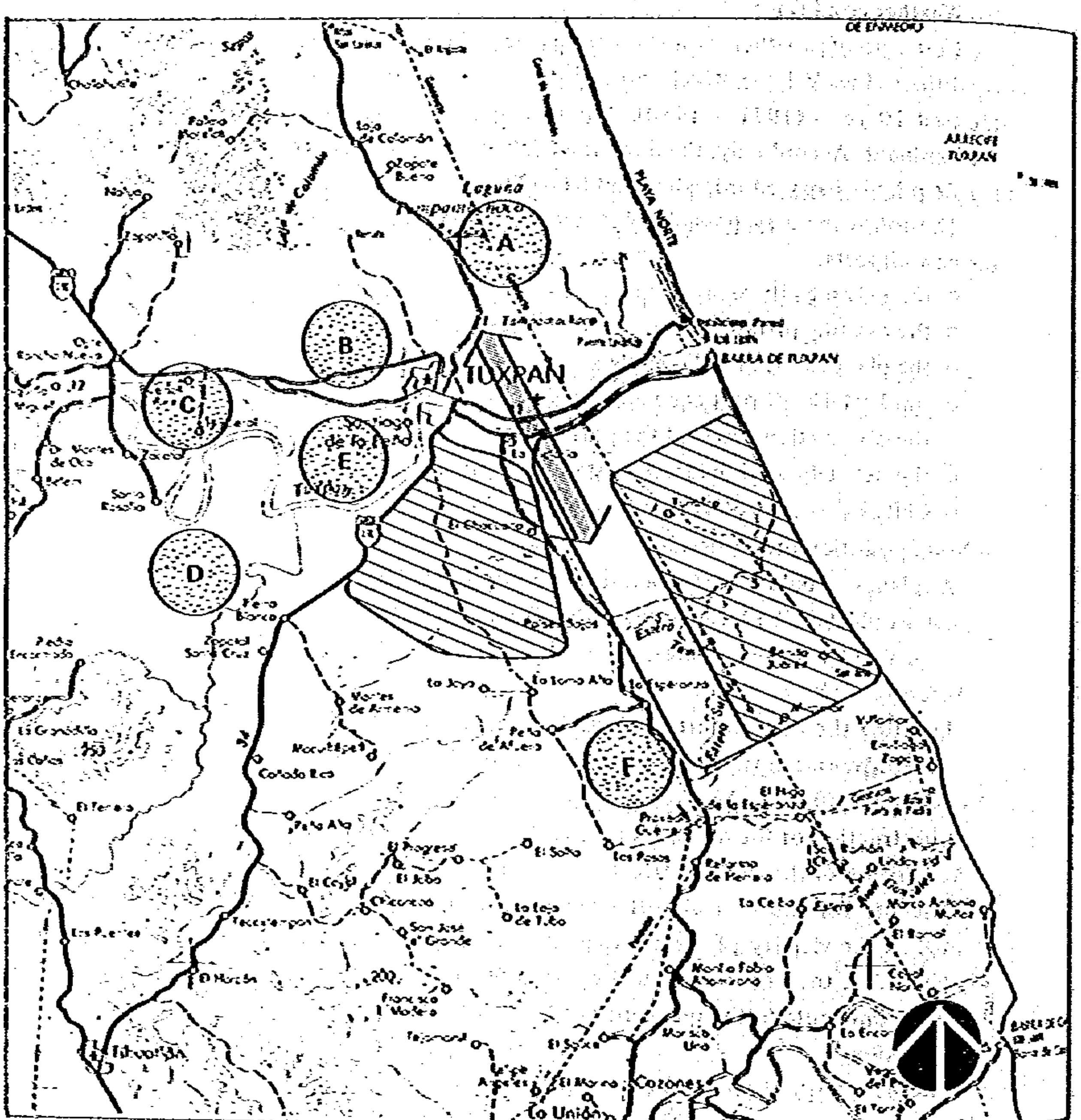


Fig. VII-2-(14) Alternative Sites of New Airport

Table VII-2-(13) Assessment of Alternative Sites of New Airport

Alternative Site	Assessment Items					Total
	Existence of Obstruction	Economical Efficiency	Degree of the Noise	Accessibility	Contribution to the Prosperity of the Region	
A	o	Δ	Δ	o	o	o
B	o	Δ	Δ	o	o	o
C	o	Δ	Δ	o	Δ	Δ
D	Δ	Δ	x	Δ	Δ	x
E	Δ	Δ	x	o	o	x
F	Δ	Δ	o	Δ	Δ	Δ

Note: o Good Δ Relatively bad x Bad

(d) Allocation of the facilities

Major airport facilities include the following (with layout as shown in Fig. VII-2-(15)):

① Landing/Take-off Facilities
runway, conducting way

② Maintenance and Berthing Facilities
apron, handstand

③ Administrative and Refueling Facilities
control tower, administrative office, hanger, repair shop, fuel storage facilities, etc.

④ Service Facilities
terminal building, cargo handling facilities, parking lot, greeen space, etc.

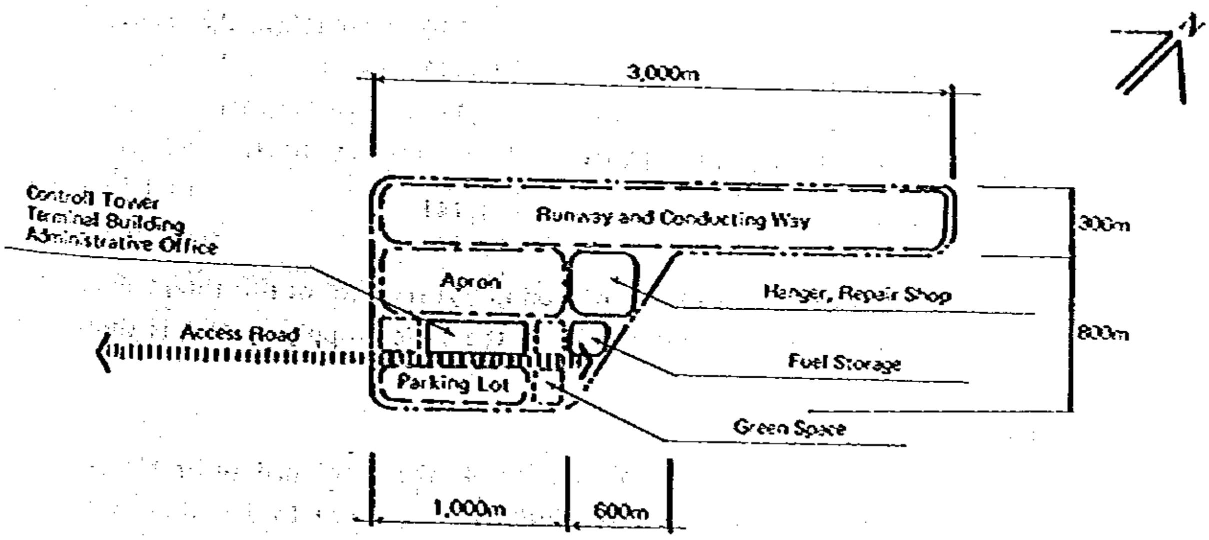


Fig. VII-2-(15) Basic Concept of Allocation of Major Airport Facilities

2-8 Public Facilities

(1) Water supply

(a) Potable water supply

The demand for potable water can be estimated based on the per capita per day method, as follows;

$$\left.\begin{aligned} MPW &= MW \times P \\ APW &= MPW \times \alpha \\ mpw &= MPW \times \beta/24 \\ apw &= APW \times \beta/24 \end{aligned}\right\} \quad \cdots\cdots\cdots\cdots\cdots \quad \text{(VII-3)}$$

where, MPE: Maximum demand per day (ℓ/day)

MW : Maximum demand per capita per day (350 ℓ/capita/day)

p : Population supplied potable water (463.9 thousand)

APW: Average demand per day (ℓ/day)

α : Average demand factor (0.8)

mpw: Peak demand per hour (ℓ/hr)

: Peak demand factor (1.3)

apw : Average demand per hour

The following figures result from using the above equations:

MPW = 162.4/day (Unit: thousand m^3)

APW = 129.9/day

mpw = 8.8/hr

apw = 7.0/hr

(b) Water supply available for fighting fires

It is estimated that it is necessary to have available 40 – 50 cubic meters of water per minute for firefighting purposes, assuming a population of 450,000. This is approximately equivalent to 72.0 thousand cubic meters per day, or 3.0 thousand cubic meters per hour.

(c) Total fresh water required for the project in the year 2000

Potable water (average demand)	130	(Unit: thousand m^3/day)
Water for firefighting	72	
Water for industrial use (as estimated in chapters VI and VII)	1,239	
Total	1,441	

This total figure is equivalent to 526 million m^3/years. 86% of this total will be directed for industrial use. The routing of main links in the water supply system is shown in Fig. VII-2-(16).

(d) Water procurement

As already explained in chapter V, section 4, the combined utilizable fresh water resources of the Tuxpan, Cazones and Tecolutla rivers amount to 3 billion m^3/year. The Tuxpan river alone is capable of providing 860 million/m^3 per year. Therefore, the Tuxpan river could, in theory, provide all the water necessary for the Project. However, due to upcoming irrigation projects in the Tuxpan river region, alternative water sources shouod also be employed. The following steps for water procurement are thus recommended.

First, fresh water can be collected from underground, especially water for industrial use, which accounts for 86% of the water needs. In Japan, this method of tapping underground water for industrial use has proven highly useful. To carry out such a program, it is necessary to estimate to what extent underground water is more economical than river water. Secondly, river water should be diverted, as needed, for the project's water supply. As for the river water, co-ordination will be necessary with other development projects, such as the agricultural development plan, Chicontepec Project, etc. This overall situation will have to be further studied.

(2) Sewage

Sewage shall be drained from dwellings and other buildings into underground sewage mains equipped with manholes and a lift station to pump the sewage into the new city's sewage system. Sewage capacity shall be estimated based on the per capita per day method, as follows:

$$\left.\begin{aligned} qd &= qs \times P + qi + qu \\ qh &= \frac{\alpha \times qs \times P}{24} + (pi + qu)/24 \\ qa &= \beta \times qs \times P + qi + qu \end{aligned}\right\} \quad \text{(VII-4)}$$

where,
- qd: Maximum flow per day (m^3/day)
- qs: Maximum flow per capita per day
  250ℓ – 350ℓ/capita/day
  Here, 350 is adopted, considering the service population.
- P: Service population
- qi: Industrial sewage (15,000 m^3/day)
- qu: Under ground water
  qs x (10% – 20%) Here, 20% is adopted (32,000 m^3/day)
- qh: Peak flow per hour (m^3/hr)
- α: Peak flow factor (1.5)
- qa: Average flow per day
- β: Average flow factor (0.7)

The following results have been obtained from the above equation and conditions:

qd = 210/day (Unit: Thousand m^3)
qh = 12.1/hr
qa = 160.7/day

Main sewage routes are shown in Fig. VII-2-(26).

(3) Drainage

Run-off rain water will flow into drainage mains with manholes. Half of the drainage will be discharged into the Tuxpan river and the other half into the new city drainage system. Estimates of the maximum amount of rum-off rain water are calculated using the following equation.

$$Q = \frac{1}{360} C \cdot I \cdot A \qquad \text{(VII-5)}$$

wherein .... Q: Maximum flow in cubic meters per second

C: Coefficiency of flow

Water Surface	Roofs	Roads	Parks
1.0	0.9	0.85	0.15

I: Average reinfall intensity (mm/hr)

A: Catchment area in hectares

Over the past five years (1977 – 81), 733.5 mm was the greatest amount of monthly rainfall, occurring in September 1981. This figure is equal to 24.5 mm per day, which in turn is equivalent to maximum hourly precipitation of about 24.5 mm per hour. Therefore, the per hour value for I is estimated at 39.2 mm. Employing this value in the foregoing formula, run-off rain water flow is calculated at about 364 cubic meter per second.

(4) Electric Power

Per capita electric power demand is estimated at 0.2 – 0.3 kw. Thus, for a population of 450 thousand, total electric power demand is estimated at about 100,000 kw.
With electric power demand at the industrial complex amounting to 750 – 950 thousand kw, total demand should reach 850 – 1,050 thousand kw hour.

Table IVV-2-(14) shows future electric power supply as planned by the COMMISION FEDERAL DE ELECTRICIDAD. Although an output of 700 thousand kw has been planned for the second stage of the industrial port development, this will not meet predicted demand. Therefore, an extra 350 thousand kw will have to be supplied in the project's third stage.

Table VII-2-(14) CFE Plans for Future Supplies of Electric Power

Stage	Volume of Supply (1,000 Kw)	No. of Dynamos	Station Location	Year of Completion	Source	Intended Use
1st	700	2 x (350)	Chile Frio	1985.11 (350) 1986.6 (350)	Steam Power	Send to Mexico D.F.
2nd	700	2 x (350)	Chile Frio	1989.4 (350) 1989.10 (350)	Steam Power	Send to Tuxpan
3rd	700	2 x (350)	Chile Frio	undecided	Steam Power	Undecided

The route of the main electric power cable supplied from the Chile Frio power station and the routes from the transformer substation are shown in Fig. VII-2-(16). The transformer substation for the new city will be situated south of the distribution business center.

(5) Common Ducts

As for underground public services such as water supply, sewage, drainage, electric cables and telephone lines, it is preferable that these functions be brought together in one location in the form of a shared underground duct. This method has the following advantages:

1) Frequent digging up of the road will not be necessary, so obstruction to traffic can be prevented.
2) Costs involved in resurfacing the road can be minimized.
3) Road durability will be increased.
4) By transferring public services underground, the functional value of the road for transportation is increased.
5) By concentrating public service functions in common ducts, the area occupied by these functions can be lessened.
6) Although initial construction costs will be rather high, it is assumed that subsequent costs will be much less.
7) Administration of common ducts is both easy and accurate.
8) In the case of common ducts, maintenance costs are more economical.
9) Through such improvements to the city streets, the city as a whole can be made more beautiful.

Routes for the common ducts are shown in Fig. VII-2-(16).

The common ducts shall contain main pipes and lines for the water supply, sewage, electric power, telegraph and telephone.

Common ducts shall run along the new city's east-end trunk road and along east to west trunk roads, as shown in Fig. VII-2-(16). When the new city is expanded in the future, the common duct passing from north to south shall also be extended.

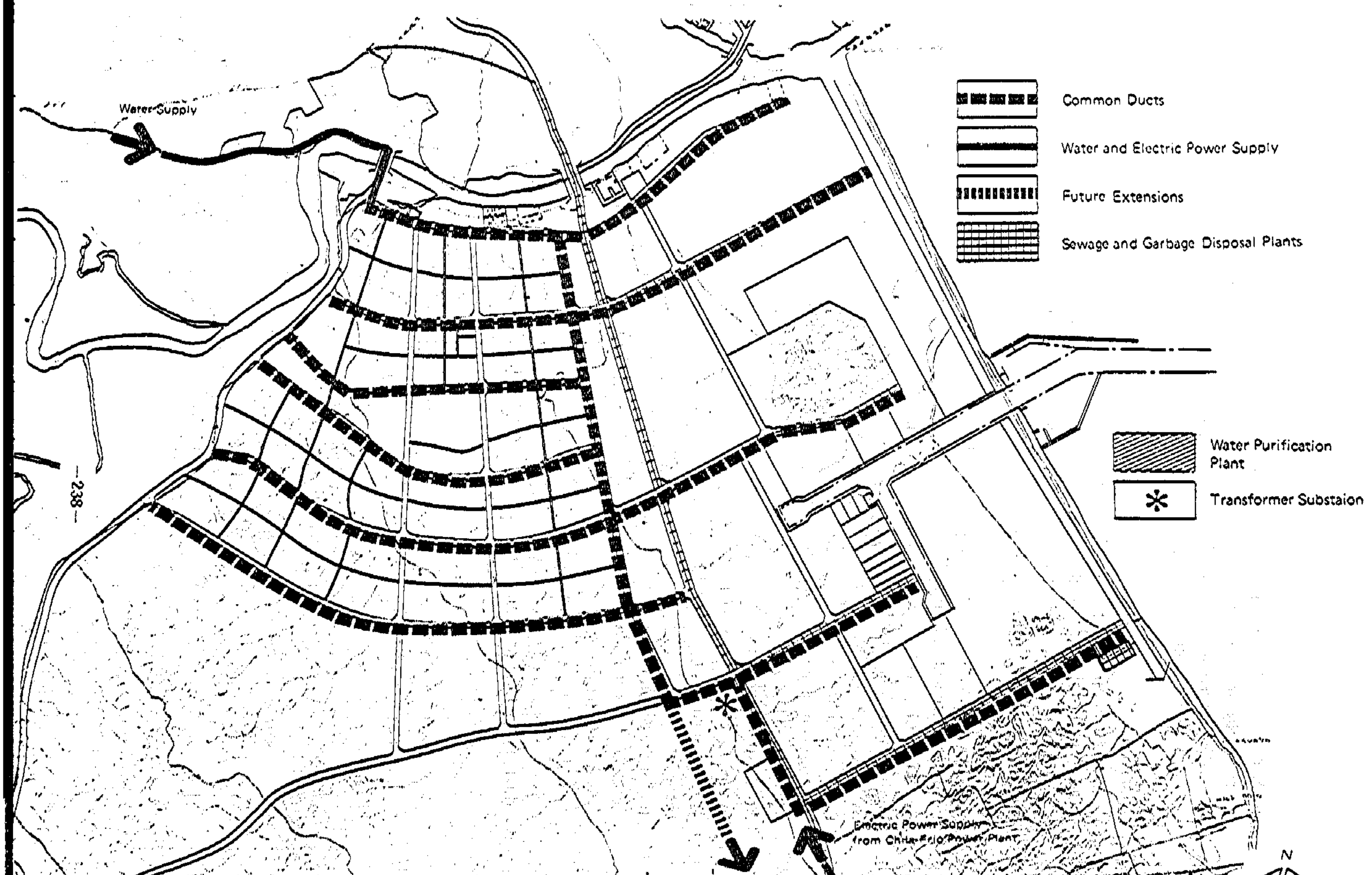


Fig. VII-2-(16) Allocation Plan of Common Duct
(Water Supply · Sewerage · Electric Power · Communication Cable)

3. Port Planning

3-1 Basic Concept of Planning

Port planning targeted at the year 2000 is formulated, in order to realize the basic policies mentioned in Chapter II. In formulating the plan, attention must be payed to meeting fully the requirements mentioned below, especially when it means balancing opposing conditions.

(1) Site of the port

The site chosen for the plan is relatively flat coastal plain about 15 km long and 8 km wide extending from Tampamchoco lagoon to Punta de Piedra.

Tampamachoco lagoon with good natural scenery is abundant in fishery resources such as oysters, shrimps, and so on. It is important to maintain the present condition as much as possible. Tampamachoco lagoon is connected not only with the estuary of the Tuxpan river but also to the outer ocean about 15 km to the north of the Tuxpan estuary (at Galindo). This outlet is also taken into consideration for the plan.

The existing port facilities of the Tuxpan river are important for the future and especially the ones on the right bank of the river must be improved and expanded.

The PEMEX oil base on the left bank of the river mouth has to be maintained at the present scale, in order to maintain present conditionss around Tampamachoco lagoon, so any further expansion should be planned in the newly developed industrial port.

The new city will be developed behind the new port as explained in Chapter VII while maintaining good communication with and easy transportation to the existing city. The new port, new city and the existing city must be developed harmoniously.

While this plan targets the year 2000, space should be allowed for further development and short term small investment use is also contemplated.

(2) Port functions

The port will have 4 functions i.e.: commercial port, industrial port, fishing port and pleasure port (marina).

The industrial port is to possess adequate capacity in relation to the located industries and planned to secure the water line and water depth required by the located industries in the future. Located industries shall be rationally arranged in consideration of the required area and use of the port.

The port is planned to accomodate up to 250,000 and 150,000 DWT ships for crude oil export and iron ore import respectively.

For maintaining good environment, spacious greenbelts are provided. For this, Tumilco hills are kept as a safety green area in which the port welfare facilities will be included.

For the commercial port, TUM are planned in the industrial port as in the preceding five ports such as Lazaro Cardenas and Altamira. But for early utilization of the commercial port facilities, the use of the right bank of the Tuxpan river is considered. (In this study, TUM in the new industrial port are mainly dealed with and the improvement of existing Tuxpan port are not studied.)

The fishery port is planned to meet the requirements of coastal and as well as offshore fishery. The existing coastal fishing facilities in Tampamachoco lagoon and Tuxpan river will continue to be used in the future. The scattered fishing boats now based at various places will be collected in the new fishery port. Besides such basic facilities as channels, basin and wharves, fishery related facilities such as cold storage, freezing facilities, ice-making plants and processing factories are planned.

A marina is planned around Tampamachoco lagoon, i.e. outside the new industrial port to avoid congestion of pleasure boats and other larger ships. Pleasure cruising should be limited to the sea north of the Tuxpan river month.

(3) The shape of the port

The port should be constructed by excavating into the present shoreline, since a great deal of land-fill sand is required for the industrial locations and a long water line is needed for wharves.

The shape of the port is decided so as to balance as much as possible the volume of earth for the land-fill with the dredging volume.

Traffic facilities will be planned to accommodate future increase of traffic volume, while achieving efficient connections with the roads, railways and pipelines already planned.

The space for a 200 m wide inland navigation canal from Matamoros to Cazones will be reserved parallel to the coastline.

Since the site is frequently hit by hurricanes as already mentioned in Chapter V-1, calm water area will be secured for safety.

Also in spite of the drainage change due to waterway excavation and land reclamation, attention must be payed to provide good drainage.

3-2 Location and Scale of the Port

Based on the basic concept of port planning described above, the location of the port is studied as follows.

Three location sites are considered.

A) North part, near the estuary of the Tuxpan river

B) Central part, near the mouth of Tumilco drainage

C) South part, between Tumilco drainage and Punta de Piedra

Plan A) has the merit of developing together with the existing port facilities, B) has the merit of economizing the excavation cost by placing the waterway on the soft ground along Tumilco drainage and C) is the case of the southmost port location where located industries can be rationally arranged.

As already mentioned in Chapter VI-1, 3940 ha of industrial area will be arranged around the port.

For economy and safety, the ships for crude oil export up to 250,000 DWT will be accommodated only in the outer port (along breakwaters) not in the inner port (excavated waterway). So the excavated waterway is planned to accommodate up to 150,000 DWT iron ore carriers.

The commercial port will be located inside the industrial port and is planned to accommodate up to 40,000 DWT cargo vessels. The inner waterways are planned to be 12.0 m deep so as to accomodate 35,000 ~ 40,000 DWT (2000 ~ 2500 TEU) container ships.

The fishery port will be located on the adequate right bank of the Tuxpan river to advoid congestion between cargo vessels and fishing boats.

It will be able to accommodate up to 200 GT fishing boats for offshore use.

Marina will be located as close as possible to the Tuxpan estuary within Tampamachoco lagoon. The reason is as follows. A) pleasure boats entering, leaving marina will use the Tuxpan estuary for traffic navigation to outer ocean, B) They use cruising area on waters in front of the swimming beach to the north of the river C) The relative position of the future expansion site of leisure facilities (on the left bank side of the Tuxpan river and to the north of PEMEX base) and marina.

With regard to bridge across to PEMEX base, a clearance required for pleasure boat traffic must be provided or improvements must be provided such as constructing a swing bridge.

3-3 Breakwaters, Channels and Basin

(1) Layout of breakwaters

Breakwaters are arranged in consideration of the dominent wave direction, which is N-NE. The north breakwater is the main breakwater and the south breakwater is the auxiliary breakwater and the top end of both breakwaters are located to shield the port entrance again North easternly waves.

The distance between the North breakwater and the South breakwater will be 2200 m in consideration of the width of the channel and the future use of the waters.

It would be ideal for the water depth of the main breakwater to exceed that of the channel but the length of the breakwater is decided with reference to the distance of travel of a 250,000 DWT ship from the entrance of the breakwater to the mooring dolfins (stopping distance) and as well as in consideration of the maximum shifting of bottom materials. (see Fig. VII-3-(1)).

Groins are arranged to prevent burying of the channel at the point where the channel crosses the shoreline. The breakwater at the Tuxpan river is made according to the improvement plan as proposed by SCT.

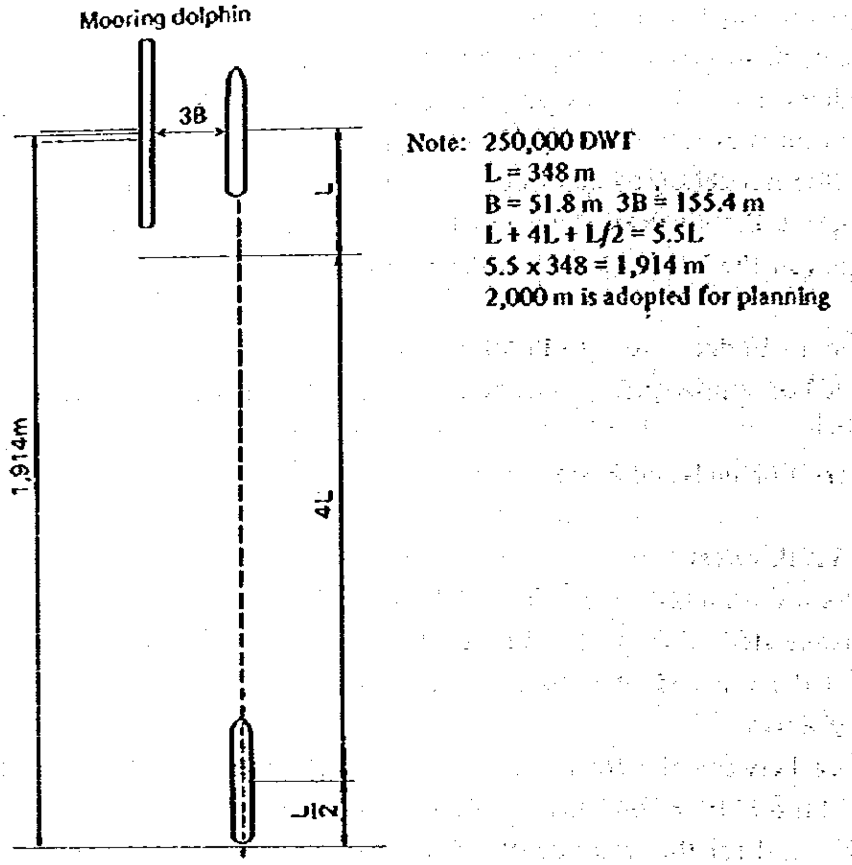


Fig. VII-3-(1) Stopping Distance

(2) Layout of channels and basin

The width of the main channel will be made about 1.5 times the length of the 250,000 DWT ships (L = 348 m) and the 150,000 DWT ore carriers (L = 313 m) and thus for outer port area the width will be 500 m.

The width of excavated channel will be made 500 m and 600 m with 50 m mooring space on both sides allowing the channel width of 500 m even with moored vessels on each side.

This width is used for a relatively long distance channel in which ships pass by each other.

For a channel bend, 30° is proposed as the centerline angle of intersection of the channel so that a ship can pass without the effect of its kick.

As for the turning basin, a circle with 2L as the diameter is adopted assuming the ships are turned by tugboats and 600 m is used for the main channel (about 2L of a 150,000 DWT ore carrier).

Similarly a channel width of 1.5L = 300 m and a turning basin of 2.0L = 450 m are used for the subsidiary channel in expectation of 30,000 DWT – 40,000 DWT ships.

A basin for small ships is provided in both the exterior and interior port zones.

3-4 Industrial Port Plan

In definitely arranging the plants of selected industries discussed in Chapter VI-1, attention was paid to the following:

1) Plants were arranged so as not to leave any problem in arranging their production equipment.
2) It was assumed that the raw materials and products of plants be transported by railway, road or port and that most sea-transported raw materials and products other than those that are in small lots be handled by the private wharves of the plants.
3) As to private wharves, it was assumed that cargoes originating at each plant be handled by the waterline quay adjoining the site of the plant and that the necessary waterline extension including space for future expansion be secured.
4) The steel and oil refining industries were located near the harbor entrance since they require transportation by large ships.
5) Industries manufacturing chemical machines, marine structures, construction equipment, heavy electrical machines, motor vehicle and ships were located as close to the ironworks as possible because they receive steel from it.
6) The petrochemical and oil refining industries were located adjacent to each other because together they form an single industrial complex.
7) The food industry complex was located as close to the main channel as possible because large vessels will be used to import grain and feed stuff.
8) Green belts about 200 m width were planned along the coast and surrounding the industrial plants.

The volumes of cargoes originating at the industrial plants and the number of their private berths are as follows:

Table VII-3-(1) Industrial Cargo and Private Berth

	Production capacity	Area (ha)	Port handled cargoes In. 1000 tons			Necessary number of berths (tentative) Water depth (meter)		
			In. 1000 tons	Out. 1000 tons	Total 1000 tons	Water depth (meter)	Number of berths	Length (meter)
Food industry complex	Flour 116,000 tons/year Vegetable oil 26,000 tons/year Feeds 120,000 tons/year	100	324	0	324	12	1	240
Paper and coardboad	500,000 tons/year	200	760	50	810	12 10 10	1 1 1 (3)	240 185 185 (610)
Petroleum refining	500,000 BSPD	1,000		13,600 4,800 1,700 4,000	24,100	22 19 16 15 13 11	1 1 1 1 1 2 (7)	500 500 450 300 260 420 (2,430)
Petrochemicals	Ethylene 500,000 tons/year	500	248	290	538	12 10	1 1 (2)	240 185 (425)
Iron and steel	5,000,000 tons/year	1,500	7,000 2,240 760 130	2,000	12,130	19 18 14 11 10 7.5	1 1 1 2 3 3 (11)	370 330 270 420 555 330 (2,335)
Machine industries		200	26	83	109	7.5	1	130
Motor vehicles	350,000 Pieces/year	220	90	2,160	2,250	10	5	925
Shipbuilding	250,000 tons x 5 ships/year	200	42		101	(Handled on Public wharf)		
Seafood stuff		20	50	9				
Total					40,362		30	7,035

3-5 Commercial Port Plan

TUM (Terminal Usos Multiples) is proposed for the commercial port of Tuxpan like other industrial ports in Mexico such as Altamira, Ostion, Dos Bocas, Lazaro Cardenas and Salina Cruz. The principle and method of planning are similar to that of these ports. Container, general and bulk cargo berths are proposed in Tuxpan.

The volume of handled cargoes, which has already been discussed in Chapter VI-2., is used and includes domestic trade cargoes.

(1) Number of berths

Container cargo, general cargo and dry bulk cargo berths are proposed.

The number of berths can be calculated by use of the following values of handling cargo volume per year per berth. The results are shown in Table VII-3-(2).

Berth		Thousand ton/year/berth
Container berth	(large ship)	1,000
	(small ship)	500
General berth	(specialized)	300
	(conventional)	150
Bulk berth		300

Table VII-3-(2) Berths Required for Commercial Port

	Volume of cargoes handled (1,000 tons)	Number of berths	Cargo volume per berth (1,000 tons)
Container berths	2,752	4	688
For large ships	1,830	2	915
For small ships	922	2	461
General cargo berths	1,132	6	189
For special ships	729	3	243
For general ships	403	3	134
Bulk cargo berths	976	3	325
Total	4,860	13	374

Note 1: One container berth for small ships and two general cargo berths are planned on the right bank of the Tuxpan River.
2: It is enough to plan two bulk cargo berths according to later detail study.
3: 9 berths will be constructed in the new port area.

Detailed examination concluded that 12 berths were enough because bulk cargo could be handled with 2 berths. Among the 12 berths, 1 container berth for small ships is desired to be located on the right bank of the Tuxpan river for the purpose of early operation, and 2 existing conventional berths are used for general cargo so the other 9 berths will be constructed in the new port area.

(2) Container terminal

(a) Dimension of container berth

The container berths are as follows:

Table VII-3-(3) Dimention of Container Berths

	Ship size	Necessary water depth	Number of berths		Length of berth	Total length	
			Total	New Port		Total	New Port
Container berths			4	3		1,200 m	900 m
For large ships	3,000 TEU (maximum)	−12 m	2	2	300 m	600	600
For small ships	800 TEU (average)	−12 m	2	1	300	600	300

Note: Very few 3,000 TEU container ships can be used in −12.0 m deep.

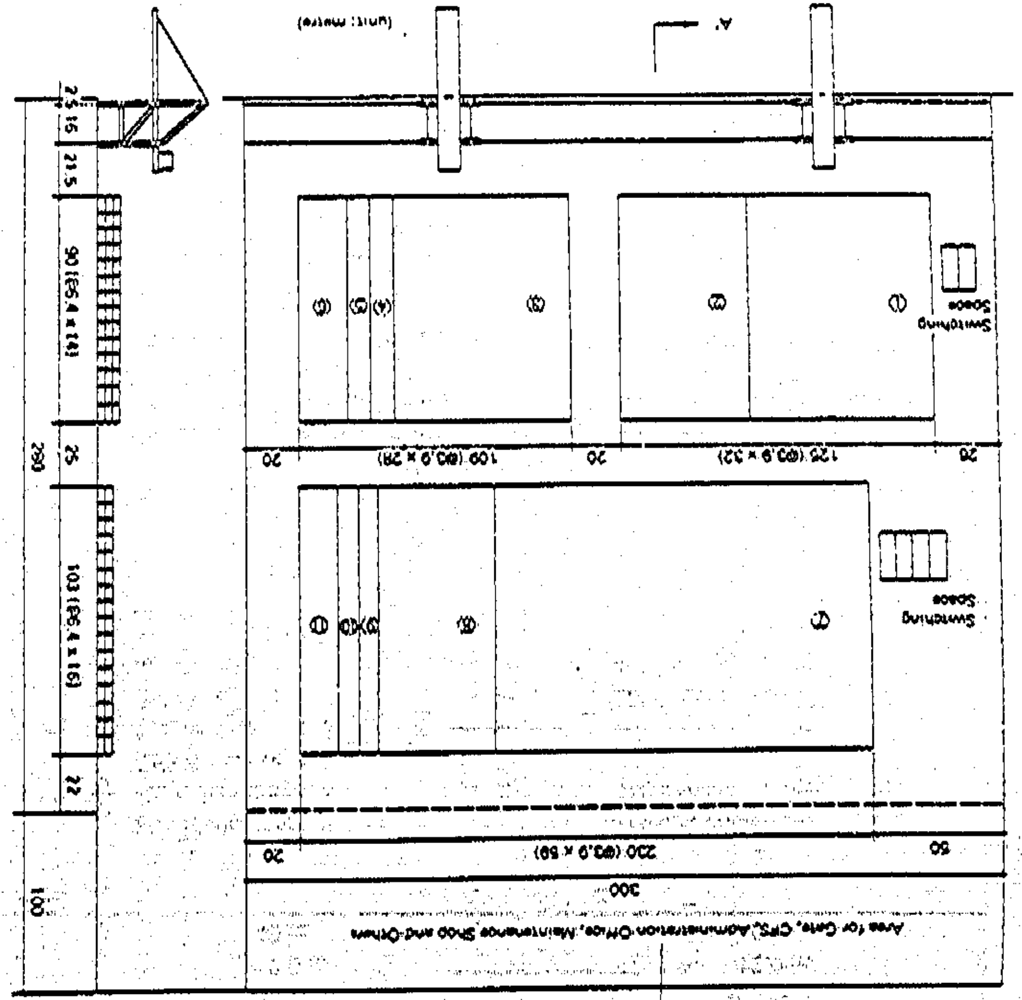
(b) Handling and storage facilities

Container handling and storage facilities are planned after the examples of the Japanese container yards that can handle one million tons per berth in a year. The details are shown in Table VII-3-(4) and Fig. VII-3-(2) − (3). If containers are to be handled by the lift-on lift-off (LO-LO) system, three systems may be adopted, that is, the chassis system, the straddle carrier system and the transfer crane system. Since the chassis system requires a larger yard space than the other systems, the straddle carrier system and the transfer crane system are used in planning the layout. As for the small ship berths, it is sufficient to provide a container crane and cargo handling equipment which is matched with the crane. Their capacity can be increased for larger ships when the cargo volume increases in the future.

Table VII-3-(4) Facilities for Container Wharf

	Specification	Straddle Carrier System	Transfer Crane System
Wharf			
Length		300 m	300 m
Depth		12.0 m	12.0 m
Width of Apron		40 m	40 m
Handling Facilities			
Container crane	Capacity 30.5 t	2	2
Transfering equipment		Straddle carrier: 9 Cargo handling : 8 CFS & reserve : 1 Trailer head : 3 20' Chassis: 5 40' Chassis: 5	Transfer crane: 5 Trailer head : 5 20' Chassis: 10 40' Chassis: 5
Fork lift	Capacity 35 t/2 t 5 t 2.5 t	35 t : 2 5 t : 3 2.5 t : 3	35 t : 2 5 t : 3 2.5 t : 3
Truck scale	Capacity 50 t	2	2
Mobil crane	Capacity 150 t	1	1
Land Facilities			
Container terminal area		114,000 m² (300 m x 380 m)	114,000 m² (300 m x 380 m)
Container yard		65,400 m² (300 m x 218 m) 4,372 TEU	63,300 m² (300 m x 211 m) 4,284 TEU
Container freight station	Annual handling volume 200,000 ton	64,000 m² (40 m x 160 m)	64,000 m² (40 m x 160 m)
Maintenance shop		1,200 m² (30 m x 40 m)	1,200 m² (30 m x 40 m)
Container cleaning yard		900 m² (30 m x 30 m)	900 m² (30 m x 30 m)
Reefer container yard		2,900 m²	2,000 m²
Dangerous Cargoes Storage		1,650 m²	1,800 m²
Administration office		3,000 m² (50 m x 60 m) or 600 m² (30 m x 20 m)	3,000 m² (50 m x 60 m) or 600 m² (30 m x 20 m)
Gate	Exist 3 lanes Entrance 3 lanes	1 set	1 set
Electric facility		1 set	1 set
Water facility		1 set	1 set

Note: 1) CFS is provided with a second story office with the area of 400 m² (40 m x 10 m)



Division No.	No. of Slots (TEU Slots)	Tiers	Capacity (TEU)	Remarks
①	266	3	798	Empty
②	182	3	546	Dry-Outbound
③	252	3	756	Dry-Outbound
④	36	1	36	Over-Dimension
⑤	34	2	68	Dangerous
⑥	60	2	120	Refrigerated
⑦	608	2	1,216	Dry-Inbound
⑧	208	3	624	Empty
⑨	32	1	32	Over-Dimension
⑩	32	2	64	Dangerous
⑪	56	2	112	Refrigerated
Total (Average)	1,766	(2.48)	4,372	

Fig. VII-3-(2) Layout of Straddle Carrier System

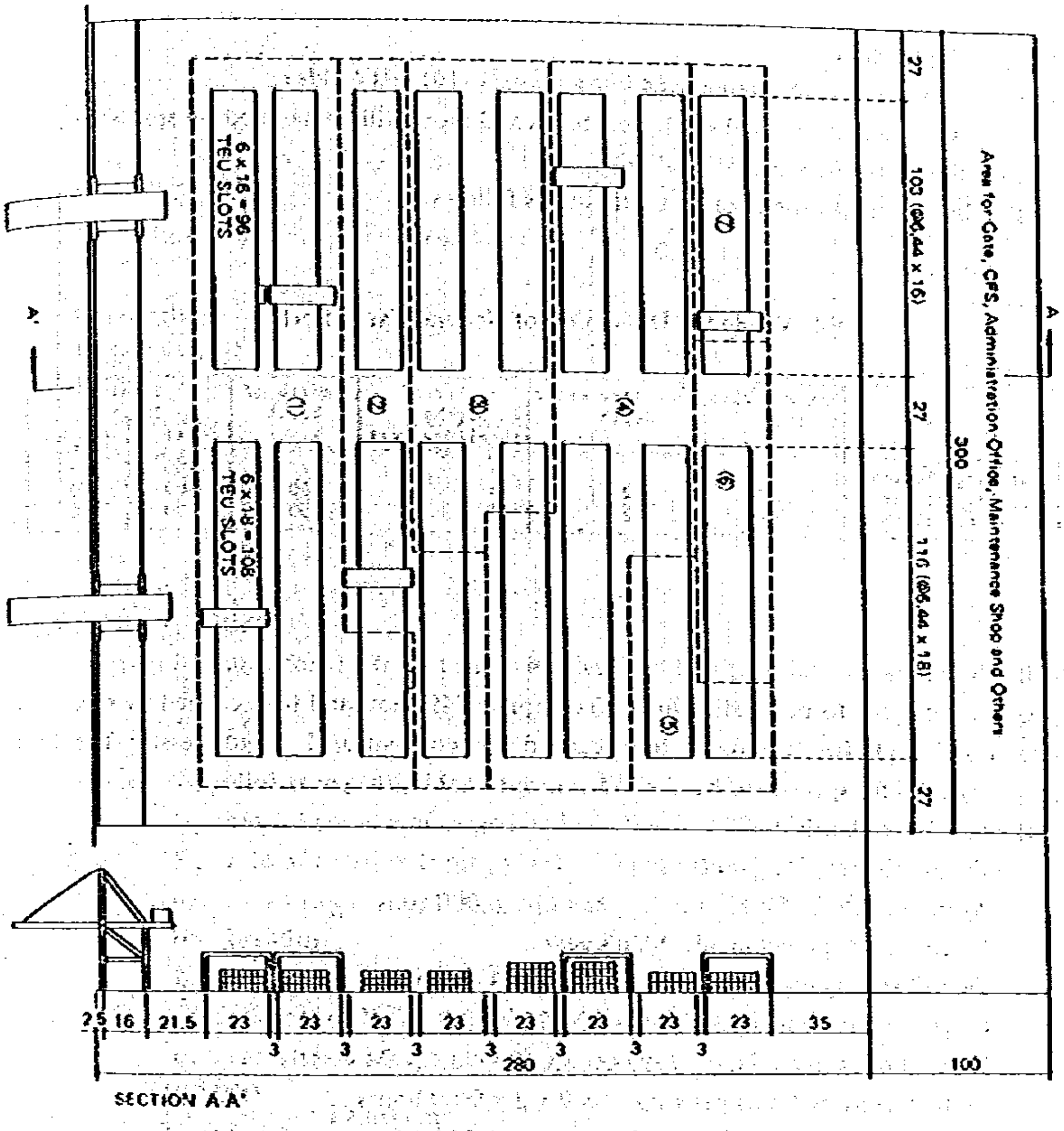


Fig. VII-3-(3) Layout of Transfer Crane System

Division No.	No. of Slots (TEU Slots)	Tiers	Capacity (TEU)	Remarks
①	450	3	1,350	Dry-Outbound
②	228	3	684	Dry-Inbound
③	270	2	540	Dry-Inbound
④	420	3	1,260	Empty
⑤	108	2	216	Refrigerated
⑥	78	1	78	Over-Dimension
⑦	78	2	156	Dangerous
Total (Average)	1,632	(2.63)	4,284	

(3) General cargo terminal

(a) Dimension of general cargo berths

It is assumed that iron and steel, steel tubes and pipes will be handled by specialized ships and the other goods by conventional ships.

The dimension of general cargo berths are as follows:

Table VII-3-(5) Dimension of General Cargo Berths

	Maximum ship size	Necessary water depth	Number of berths		Length of berth	Total length	
			Total	New Port		Total	New Port
General cargo berths			6	4		1,200 m	800 m
For special carrier	20,000 DWT	-12 m	3	3	200 m	600	600
For conventional ships	20,000	-12	3	1	200	600	200

(b) Berth occupancy

General cargoes to be handled in 2000 comprise 749 thousand tons carried by specialized cargo vessel and 408 thousand tons carried by conventional cargo vessel. The berth occupancy rates for specialized berths and conventional berths are as follows:

(i) Specialized berth

Cargo volume: 749,000 tons

Average volume of loaded cargo per ship: 8,000 tons

Cargo handling equipment: Ship's gear

Cargo handling capacity: 90 t/h (30 t/h x 3 gang)

Cargo handling hours per ship: 8,000/90 = 88.9 hours

Number of calling vessels: 749,000/8,000 = 93.6 ≑ 94 vessels

Berth occupying hours per ship: 88.9 + 2 = 90.9 hours

Total berth occupying hours: 94 x 90.9 = 8,544,6 hours

Berth occupancy rate per berth

When 3 berths are prepared: 8,544.6/6,000 (300 days x 20 hours/day) x 3 = 0.475

(ii) Conventional berth

Cargo volume: 403,000 tons

Average volume of loaded cargo per ship: 1,000 tons

Cargo handling equipment: ship gear

Cargo handling capacity: 45 t/h (15 t/h x 3 gang)

Cargo handling hours per ship: 1,000/45 = 22.2

Number of calling vessels: 403,000/1,000 = 403 vessels

Berth occupying hours per ship: 22.2 + 2 = 24.2 hours

Total berth occupying hours: 24.2 x 403 = 9,752.6 hours

Berth occupancy rate per berth

When 3 berths are prepared: 9,752.6/6,000 (300 days x 20 hours/day) x 3 = 0.541

Storage methods by cargoes are assumed as follows:

Table VII-3-(6) Handling and Storage Method

(Unit: 1,000 tons) (Total)

Item	Transit shed	Storage facilities	
		Open storage yard	Warehouse
Iron and steel		100% 729	
Tubes and pipes		100% 131	
Salt		50% 43	
Capital goods	50% 43		50% 43
Consumer goods	80% 105		80% 105
Agricultural Products	80% 44		80% 44

(c) Storage facilities

The required area for the transit sheds is calculated by the following formula:

$$W = \frac{N}{nR} = \alpha\omega\ell b \qquad \ell b = \frac{N}{nR\alpha\omega} \quad \cdots\cdots\cdots\cdots \quad \text{(VII-6)}$$

where, W: storage capacity (t)

N: annual volume of cargo handled (t) = 192,000 t

R: rate of rotation (times/year) = 20 times/year

ω: cargo storage capacity per unit area (t/m^2) = 1.5 t/m^2

b: breadth

ℓ: length

n: number of buildings, calculated as a single unit

α: cargo storage capacity = 0.5

$$\ell b = \frac{192{,}000}{1 \times 20 \times 0.5 \times 1.5} = 12{,}800\ m^2$$

150 m x 35 m x 3 houses = 15,750 m^2

150 m x 35 m x 1 house = 5,250 m^2 planned for new port

The area for warehouses is also calculated by equation (VII-6).

In this case, assume R = 10 and α = 0.7,

$$\ell b = \frac{192{,}000}{1 \times 10 \times 0.7 \times 15} = 18{,}280\ m^2$$

150 m x 50 m x 3 houses = 22,500 m^2

150 m x 50 m x 1 house = 7,500 m^2 planned for new port

The area for the open storage yards is calculated:

$$W = \frac{N}{R} = \alpha\omega A \qquad A = \frac{N}{\alpha\omega R} \quad \cdots\cdots\cdots\cdots \quad \text{(VII-7)}$$

where, W: cargo storage capacity (tons)

N: annual volume of cargo handled (tons) = 903,000 t

R: rate of rotations (times/year) = 10 times/year

A: required area of open storage (m^2)

ω: volume of cargo stored per unit area (t/m^2) = 2.0 t/m^2

α: rate of use = 0.7

$$A = \frac{903,000}{0.7 \times 2.0 \times 10} = 64,500 \ m^2$$

150 m x 150 m x 3 places = 67,500 m^2 planned for new port

(d) Cargo handling equipment

Ship's gear is appropriate for handling the cargo so no use of any special wharf crane is considered. The following machines are required for cargo handling (Table VII-3-(7)).

Table VII-3-(7) Cargo Handling Equipment

Machine	Capacity	Number of Machines	
		Total	New Port
Forklift	2.5 t	46	32
"	3.5 t	46	32
"	10.0 t	8	8
Trailer head		10	8
Chassis		20	16
Mobile crane	150 t	1	1
Platform	150 t	1	1

Note: (1) Total 6 berths
(2) New Port 4 berths

(4) Bulk cargo terminal

(a) Dimension of bulk cargo berths

Dry bulk cargoes to be handled in 2000 comprise 300 thousand tons of cement imported in domestic trade, 359 thousand tons of nonferrous metal ores imported in foreign trade and 317 thousand tons of fertilizer imported in foreign and domestic trade.

The berth occupancy rates for the cement, fertilizer and nonferrous metal are as follows

(i) Cement

Cargo volume: 300,000 tons

Average ship size: 6,000 DWT (Maximum: 15,000 DWT)

Cargo handling equipment: Pneumatic loader

Cargo handling capacity: Nominal 230 t/h
Actual 210 t/h

Cargo handling hours per ship: 6,000/210 ≒ 28.6 ≒ 29 hours

Number of calling vessels: 300,000/6,000 = 50 vessels

Berth occupying hours per ship: 29 + 2 = 31 hours

Total berth occupying hours: 1,550 hours

Berth occupancy rate per berth: 1,550/6,000 (300 days x 20 hours/day) = 0.26

(ii) Fertilizer

Cargo volume: 317,000 tons

Average volume of loaded cargo per ship: 10,000 tons

Cargo handling equipment: Unloader

Cargo handling capacity: Nominal 600 t/h

Actual 480 t/h

Cargo handling hours per ship: 10,000/480 ≒ 20.8 ≒ 21 hours

Berth occupying hours per ship: 21 + 2 = 23 hours

Number of calling vessels: 317,000/10,000 ≒ 32 vessels

Total berth occupying hours: 32 x 23 = 736 hours

Berth occupancy rate per berth: 736/6,000 (300 days x 20 hours/day) = 0.12

(iii) Nonferrous metal

Cargo volume: 359,000 tons

Average volume of loaded cargo per ship: 10,000 tons

Cargo handling equipment: Unloader

Cargo handling capacity: Nominal 600 t/h

Actual 480 t/h

Cargo handling hours per ship: 10,000/480 = 20.8 ≒ 21 hours

Berth occupying hours per ship: 21 + 2 = 23 hours

Number of calling vessels: 359,000/10,000 = 36 vessels

Total berth occupying hours: 36 x 23 = 828 hours

Berth occupancy rate per berth: 828/6,000 (300 days x 20 hours/day) = 0.14

The actual average volumes of cargo loaded per ship in 1979 was 5,500 tons/vessel as indicated in Table VII-3-(8), for domestic trade bulk cargoes and they are somewhat smaller than the planned 6,000 tons. And it is desirable to separate berth by kind of cargo. For these reasons in spite of a little low berth occupancy rate, two berths, namely, a cement berth and a berth for fertilizer and nonferrous metal ores are planned as Table VII-3-(9).

Table VII-3-(8) Cargo Handled Tonnage Per Ship

Domestic Trade 1979

Area	General cargoes			Bulk cargoes			Liquid			Others		
	Number of ships	Tonnage	Tonnage per ship	Number of ships	Tonnage	Tonnage per ship	Number of ships	Tonnage	Tonnage per ship	Number of ships	Tonnage	Tonnage per ship
Pacific side	2,252	1,527,651	678	1,064	5,898,058	5,543	1,046	10,829,873	10,353			
Gulf of Mexico side	2,060	224,364	109	160	816,541	5,103	1,620	25,405,849	15,682	629	622,410	989
Tuxpan Port	88	57,851	657	1	800	800	143	2,724,979	19,055			
Total	4,312	1,752,015	406	1,224	6,714,599	5,486	2,666	36,235,722	13,591	629	622,410	989

Foreign Trade 1979

Area	General cargoes			Bulk cargoes			Liquid			Others		
	Number of ships	Tonnage	Tonnage per ship	Number of ships	Tonnage	Tonnage per ship	Number of ships	Tonnage	Tonnage per ship	Number of ships	Tonnage	Tonnage per ship
Pacific side	597	1,022,244	1,712	315	9,958,155	31,613	49	894,807	18,261	12	135,016	11,251
Gulf of Mexico side	1,324	2,719,220	2,054	530	5,628,031	10,618	767	28,403,938	37,032	175	1,949,530	11,140
Tuxpan Port	78	131,495	1,686	45	138,117	3,069	3	127,008	42,336	-	-	-
Total	1,921	3,741,464	1,948	845	15,586,186	18,445	816	29,298,745	35,905	187	2,084,546	11,147

Note 1: Calculated from SCT Estadisticas del Movimento Portuaria Nacional de Carga y Bu Buques 1979

2: Salt is exported from Isla de Cedos Port and San Marcos Port by large ships. The per-ship tonnage of bulk cargoes other than this in foreign trade is 11,957 tons.

3: Gulf of Mexico side Contains Tuxpan Port

Table VII-3-(9) Dimension of Bulk Berths

	Maximum ship size	Necessary water depth	Number of berths	Length of berth
Bulk cargo berths				
Berth for fertilizer and nonferrous metal ores	30,000 DWT	12.0 m	1	250 m
Cement berth	15,000	10.0	1	200

(b) Storage facilities

(i) Open storage area

The required area for open storage for nonferrous metal is determined similarly to the area for the general cargo terminal, by equation (VII-7).

Supposing $\alpha = 0.5$, $R = 12$ times/year and $\omega = 7$ t/m², it is calculated as follows.

$$A = \frac{359{,}000}{0.5 \times 7.0 \times 12.0} = 8{,}547 \text{ m}^2$$

160 m x 60 m = 9,600 m² is planned for new port

(ii) Cement silos

Cement silos for the cement berth are calculated by:

$$V = \frac{N\omega\alpha}{R}$$

where, V: silo capacity (tons)
N: annual volume of cargo handled (tons)
R: rate of rotation (times/year) = 24 times/year
ω: effective factor of silo (1.3)
α: allowance (1.5)

$$V = \frac{300{,}000}{24} \times 1.3 \times 1.5 = 24{,}357 \text{ tons}$$

If 5,000-ton capacity silos (ϕ18 x H19 m) are proposed

24,357/5,000 = 4.8 ÷ 5

5 silos are required. If it is assumed that four times of the silo area is needed for the total area, including parking and office space, it is calculated as follows.

(18 m x 19 m x 5) x 4 = 6,840 (m²)

so 150 m x 50 m = 7,500 m² planned for new port

(iii) Warehouse area

The required area for bulk warehouses for fertilizer is determined using the same equation (VII-7) as for the general cargo terminal.

Substituting $\alpha = 0.7$, $R = 12$ times/year and $\omega = 5$ t/m² into the equation,

$$A = \frac{317{,}000}{0.7 \times 12 \times 5.0} = 7{,}547 \text{ m}^2$$

160 m x 50 m = 8,000 m²

so 160 m x 50 m planned for new port.

(c) Cargo handling equipment

The following equipment are required:

Table VII-3-(10) Handling Equipment

Equipment	Capacity or quantity
Unloader	600 t/h
Belt conveyor	1 set
Stacker	500 t/h
Reclaimer	500 t/h
Truck dump station (for trucks)	
Surge bin (for railway)	
Trimming dozer	6 t x 3 unit
Angledozer	6 t x 2 "
Bulldozer	6 t x 2 "
Pneumatic conveyor	1 set

In accordance with the above studies the layout and dimensions of the commercial port is proposed as Fig. VII-3-(4) and VII-3-(5) for the plan B (recommended plan).

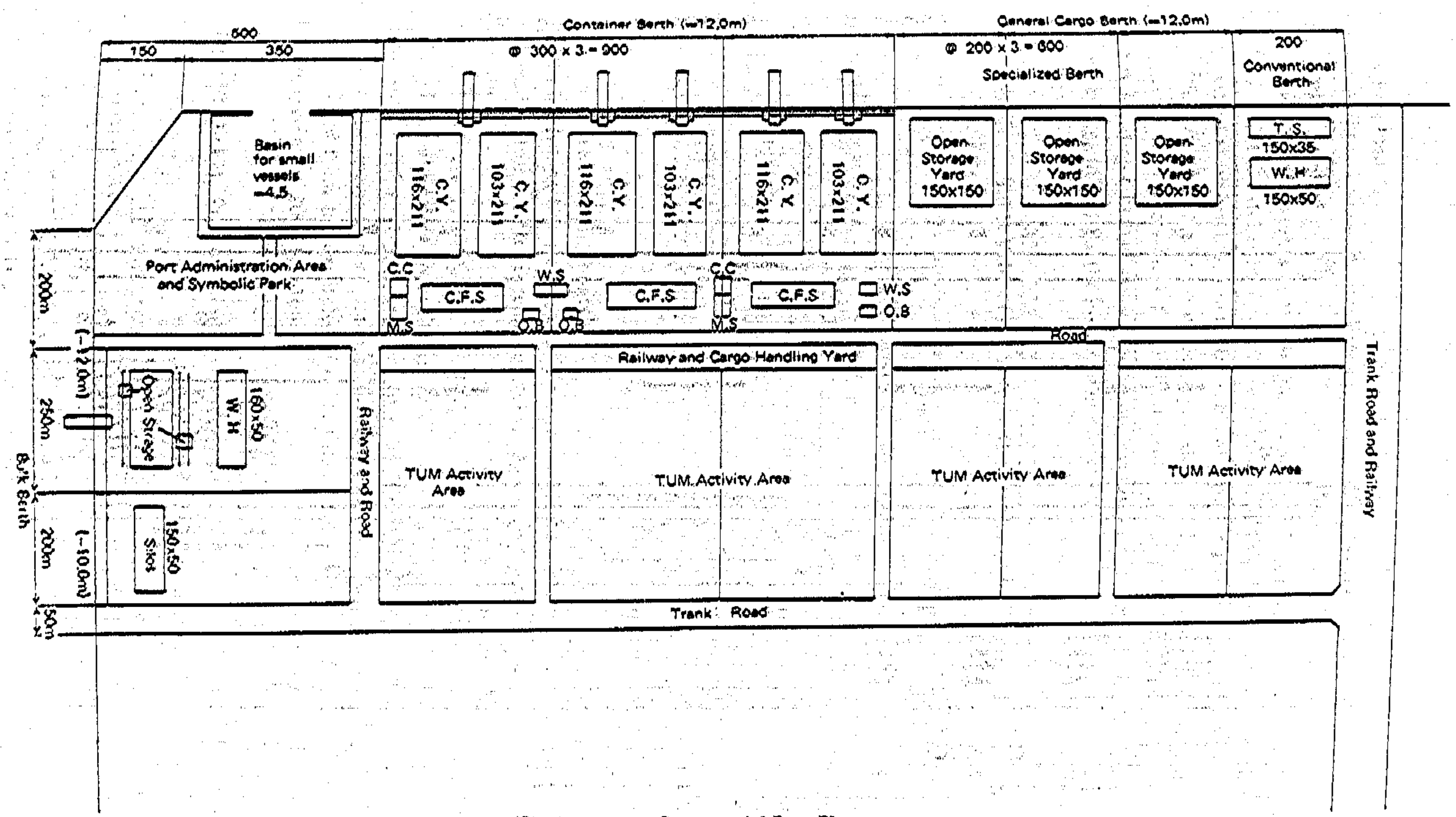


Fig. VII-3-(4) Commercial Port Plan

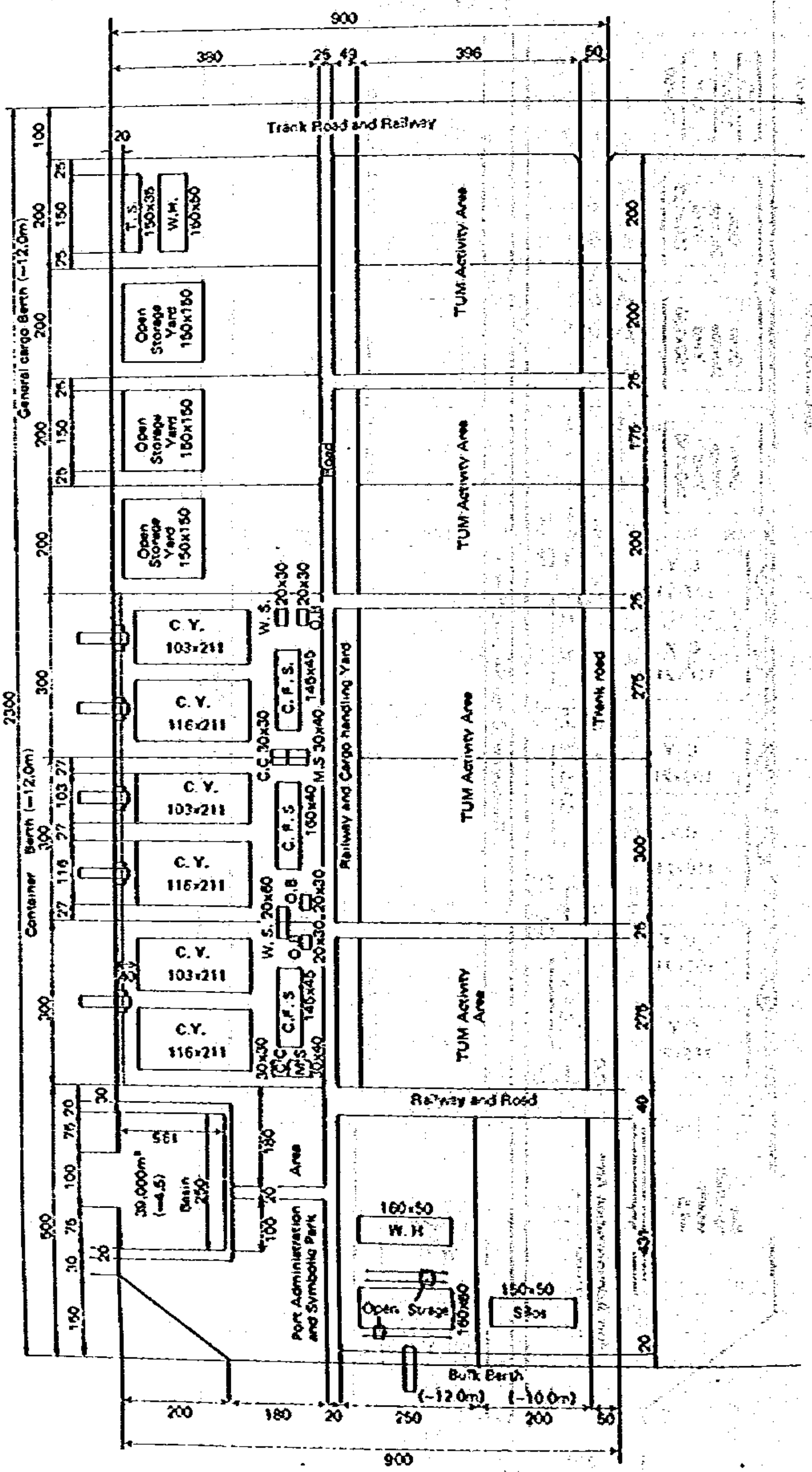


Fig. VII-3-(5) Commercial Port Area (dimension)