CHAPTER VI INLAND TRANSPORT SYSTEM

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VI-1 General

This chapter presents the study on the future transport system in the hinterland. The system, which will support the expected functions of the ports, is studied based on the basic concept of the master plan presented in Chapter IV and the future port demand estimated in Chapter V.
The results of this transport system study will be utilized as an important part of the framework for the study on the separation of functions between the two ports and the master plan layout of the port facilities at the ports of Valparaiso and San Antonio presented in Chapter VII.

The main hinterland in this study is regarded as the area of the 5th, 6th and Metropolitan regions, and the main road and railway networks related to the ports are located in these regions.

VI-2 Regional Structure in the Hinterland

The main factors which have determined the existing transportation system are the local topography and the location of cities and transport axes. These are also the main factors which will determine the future transport system including the modes of transportation and the location of terminals and other facilities. Accordingly, the physical and socioeconomic structure of the hinterland is considered below.

The overall regional land use in and surrounding the hinterland is mainly determined by the topography: the area is mountainous and has large rivers. This is shown in Fig. VI-1-1.

The cities are mainly located along the Los Andes-Calera-Valparaiso, the Santiago-San Antonio and the Santiago-Rancaqua-San Fernand axes as shown in Fig. VI-1-2.

The area around Santiago city has the highest concentration of population. The second most populous area is the area around Valparaiso city and Vina De Mar.

The population of Santiago City is 3,964,025 in 1984, which is 33.4% of the national population and 60.8% of the population of the 5th, 6th and

Metropolitan regions.

Accordingly, the principal transport axes in the region comprise a radial pattern centered on Santiago, avoiding mountain areas. An outline of the principal transport axes is presented in Fig. VI-1-3.

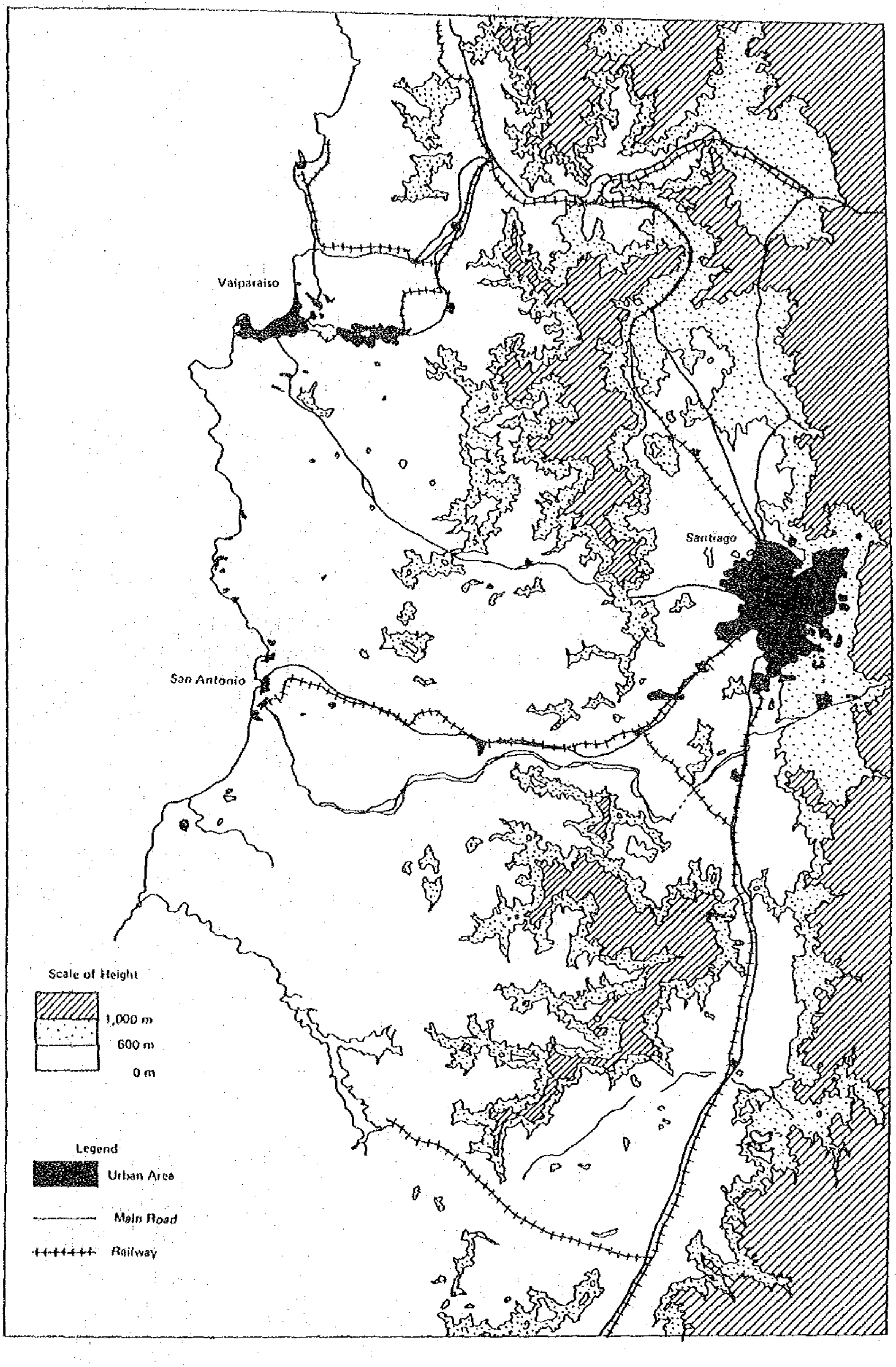


Fig. VI-1-1 Topography of the Hinterland

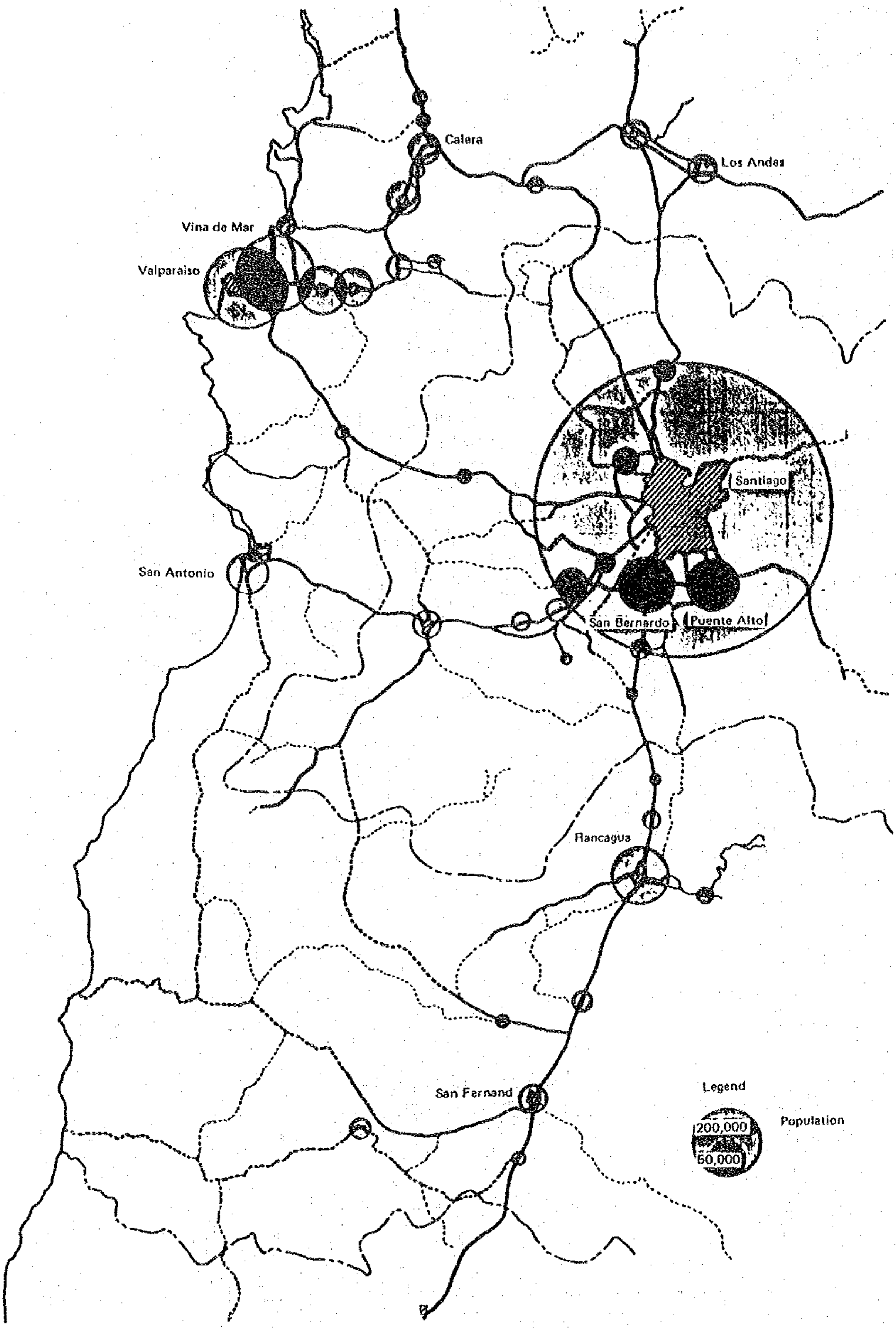


Fig. VI-1-2 Distribution of Population Centers

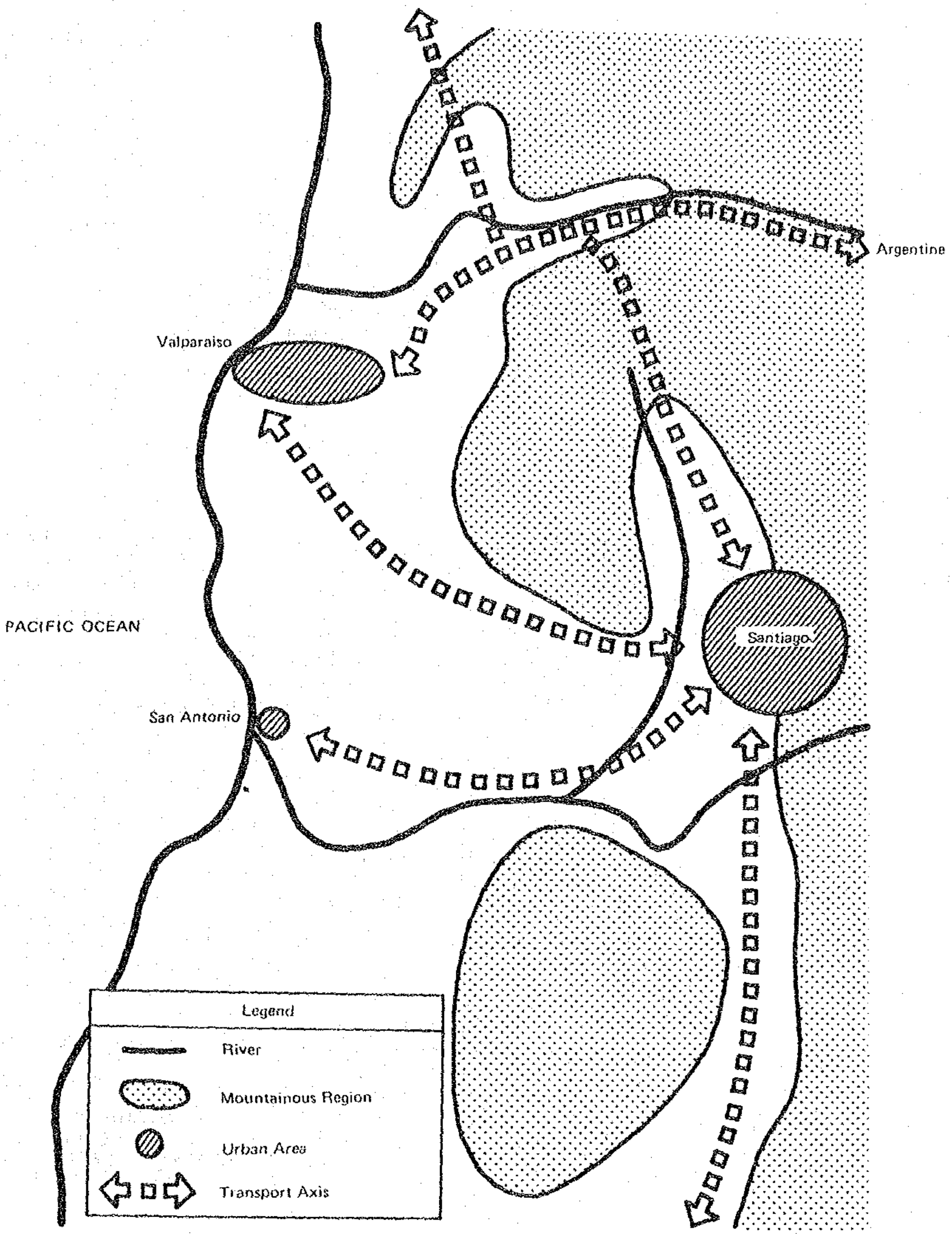


Fig. VI-1-3 Location of the Principle Transport Axes

VI-3 Present Transport System in the Hinterland

(1) Roads

1) Infrastructure

Fig. VI-2-1 shows the principal road network, which includes class A (National), class B (Principal regional) and class C (Secondary regional) roads. The total length of these principal roads in the 5th, Metropolitan and 6th regions is 3,266 Km, with a network density of 0.49 Km/Km^2.

Among these, the most important roads for this study are:

- Route 68 (Santiago - Valparaiso)
- Route 78 (Santiago - San Antonio).

The service levels (traffic capacity) and the traffic volumes on these two roads are shown in Table VI-2-1 and VI-2-2.

Overall, the traffic capacity of Route 68 is sufficient for the annual average daily traffic volume (A.A.D.T.). Even the Zapata tunnel which has the lowest traffic capacity (9,000 vehicles/day) on this route has a sufficient capacity for the average traffic demand of 5,656 vehicles/day. On the other hand, on Route 78, the traffic capacity between Desvio Poniente and Autopista is insufficient to accommodate the A.A.D.T.,

However, since the traffic volume in the summer season increases to 1.5 - 2.0 times the average traffic volume as shown in Fig. VI-2-2, in this season traffic congestion occurs on both routes at sections with 2 lanes, which are the Zapata tunnel and the section between Km 84.7 and the Entrada Reserva Forestal Penuelas on Route 68, and the section between Desvio Poniente and Autopista on Route 78.

In addition, as the ratio of the weekend traffic volume to the peak month average daily traffic volume is 1.6 - 2.1 as shown in Fig. VI-2-4, it is mostly the 2-Lane sections of both routes which have an insufficient traffic capacity for the summer weekend traffic. The traffic congestion increases at the peak hours as shown in Fig. VI-2-5.

The problem sections mentioned above are similar to the ones which were pointed out in the Multi-Modal Corridor Study as shown in Fig. VI-2-6.

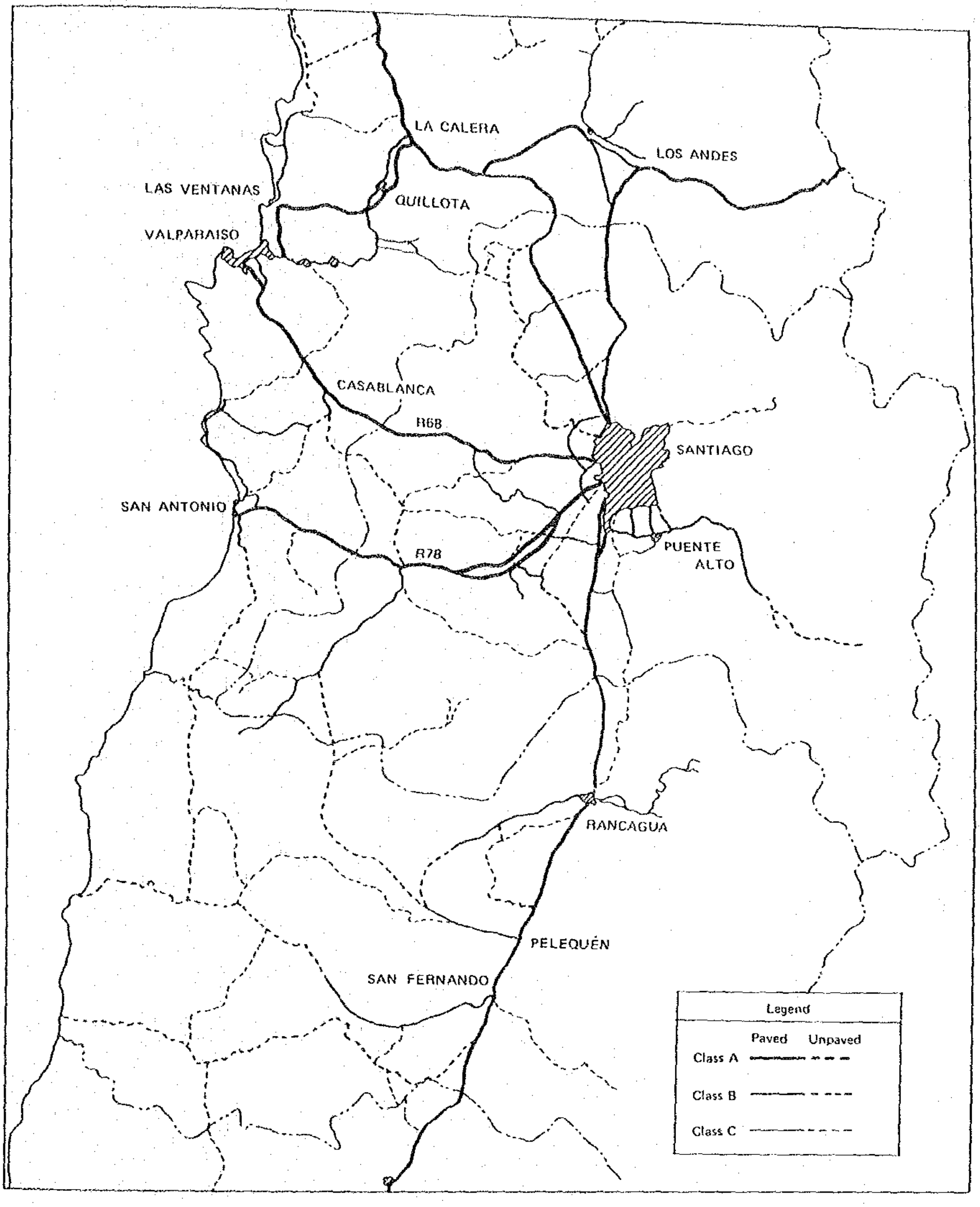


Fig. VI-2-1 Principal Road Network in the Hinterland

Table VI-2-1 Service Level on Route 68

Section	Km to Km	Number of Lanes	Design Speed	Conditions	Capacity (Vehicles/hr)	Capacity (Vehicles/day)	Annual Average Daily Traffic Volume	Average Daily Traffic Volume of Maximum Traffic Volume Month	Average Holiday Traffic Volume of Maximum Traffic Volume Month
	(2)	(2)	(2)	(1) (2)	(2)	(3)	(2)	(4)	(5)
Cruce Pajaritos acceso Aeropuerto Pudahuel Y Maipú.	6.3- 12.6	6	110	P	5,700	72,000			
A Aerop. - desv. Oriente Túnel	12.6- 26.4	4	110	P	3,880	48,000	6,828	11,539	23,886
Desv. Oriente Túnel Lo Prado.	26.4- 27.8	2	96	P	1,900	14,000			
Túnel Lo Prado	27.8- 30.6	2	60	P	1,970	13,000			
Salida Túnel a acceso Cuesta Barriga	30.6- 38.2	4	80	M	3,760	32,000			
A Cta. Barriga-acceso Oriente Curacaví	38.2- 47.9	3	96	P	3,600	21,000	5,160	8,720	18,050
A Oriente Curacaví -Comienzo doble vía	47.9- 55.8	2	96	P	1,900	14,000			
Doble vía	55.8- 57.4	4	110	P	3,960	48,000			
Fin doble vía -desv. Túnel Zapata	57.4- 62.0	3	80	O	3,600	15,000			
Desv. Oriente-T. Zapata	62.0- 62.2	2	80	O	1,900	10,000	5,634	9,521	19,708
Túnel Zapata	62.2- 63.5	2	64	P	1,600	9,000			
T. Zapata-Peaje Zapata	63.5- 66.7	4	80	O	4,000	32,000	5,656	9,559	19,787
De Peaje Zapata-Pte. Rotunda	66.7-80.6	2	96	P	1,900	14,000			
Pte. Rotunda-Km. 84,7	80.6- 84.7	4	80	O	3,760	32,000	5,932	10,025	20,752
Km. 84,7-entrada reserva forestal Penuelas	84.7- 95.0	2	96	O	1,900	10,000			
Entrada reserva forestal Penuelas-Control Penuelas	95.0-102.8	-	-	-	-				
Control Pen. -Cruce Vina	102.8-112.4	4	110	O	3,760	36,000	8,081	13,657	28,270
Cruce Vina-Comienzo Zona Semiurbano	112.4-113.4	4	80	O	3,760	32,000			
Bajada Santos Ossa- -comienzo Av. Argentina	113.4-115.8	4	64	M	3,760	32,000	4,307	7,279	15,068
Average	-	-	87		2,985	26,405	6,332	10,854	22,152

(Note) 1) P: Plain, M: Mountainous O: Undulation

2) Derived from Multi-Modal Corridor Study

3) Calculated by the Japanese Standard

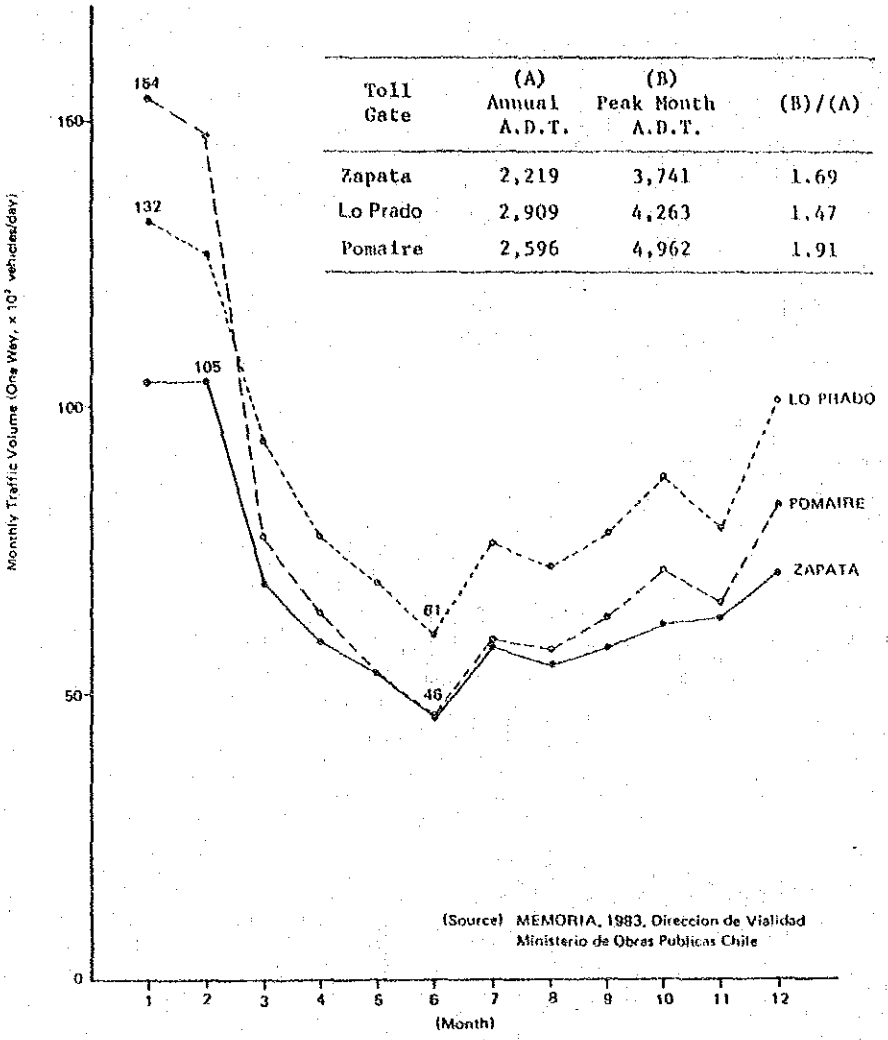
4) Using a ratio of 1.69 at the Zapata Toll Gate (See Fig. VI-2-2)

5) Using a ratio of 2.07 at the Zapata Toll Gate (See Fig. VI-2-4)

Table VI-2-2 Service Level on Route 78

Section	Km to Km	Number of Lanes	Design Speed	Conditions	Capacity (Vehicles/hr)	Capacity (Vehicles/day)	Annual Average Daily Traffic Volume	Average Daily Traffic Volume of Maximum Traffic Volume Month	Average Holiday Traffic Volume of Maximum Traffic Volume Month
	(2)	(2)	(2)	(1)(2)	(2)	(3)	(2)	(4)	(5)
Fin Zona Urb. Cerrillos -Acc. Maipú	8.8~13.9	4	96	P	3,720				
A. Maipú-Padre Hurtado	13.9~21.2	4	96	P	3,880	48,000	14,626	27,919	44,112
P. Hurtado-Autopista	21.2~25.0	4	80	P	3,200	44,000			
Autopista	25.0~50.7	4	110	P	4,000	48,000			
Desvio Poniente-Autop.	50.7~51.2	2	64	P	1,970	13,000	14,150	27,027	42,703
Desvío Poniente -Km. 77.5 (Fin zona parcelas)	51.2~77.5	2	80	P	1,860	14,000	2,937	5,610	8,864
Km. 77.5-Cumbre subida Sepultura	77.5~85.4	2	72	O	1,660	9,000	3,790	7,239	11,438
Cam. sal. Sepult. -Km.94.2	85.4~94.2	2	96	P	1,860	14,000			
Km. 94.2-Cruce Cartagena	94.2~104.0	2	80	O	1,860	10,000	3,988	7,617	12,035
Cam. Cartag. -entrada a San Antonio	104.0~108.2	2	64	M	1,920	9,000	2,618	5,000	7,900
Average	-	-	90	-	2,696	27,171	8,029	15,336	24,231

Note) 1) P: Plain M: Mountainous O: Undulation
2) Derived from Multi-Modal Corridor Study
3) Calculated by the Japanese Standard
4) Using a ratio of 1.91 at the Pomire Toll Gate (See Fig. VI-2-2)
5) Using a ratio of 1.58 at the Pomire Toll Gate (See Fig. VI-2-4)



Toll Gate	(A) Annual A.D.T.	(B) Peak Month A.D.T.	(B)/(A)
Zapata	2,219	3,741	1.69
Lo Prado	2,909	4,263	1.47
Pomaire	2,596	4,962	1.91

Fig. VI-2-2 Traffic Volume by Month at Toll Gates

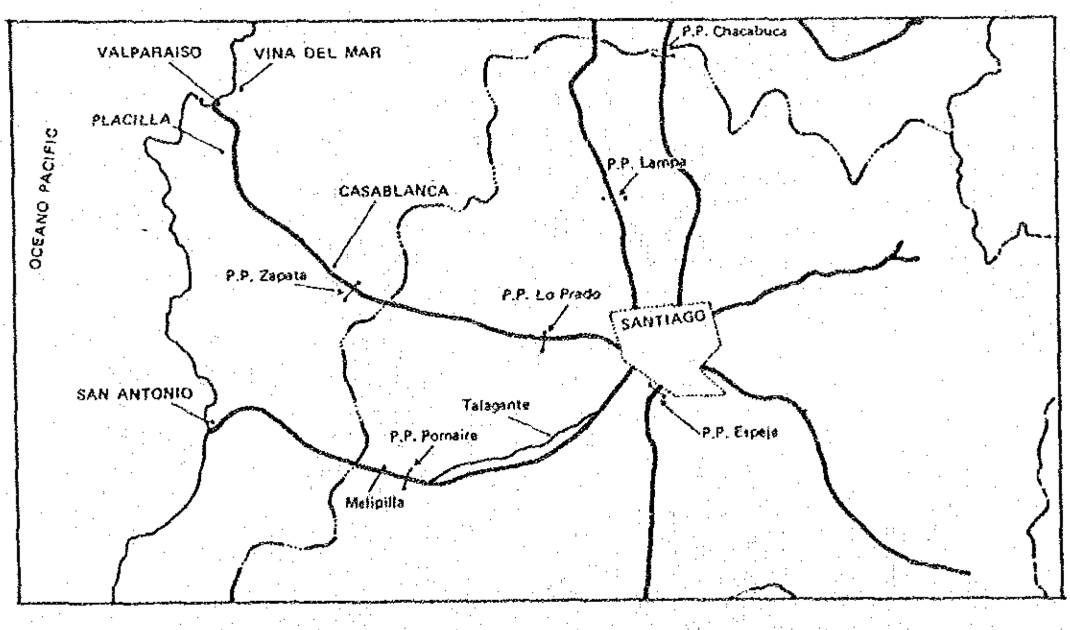
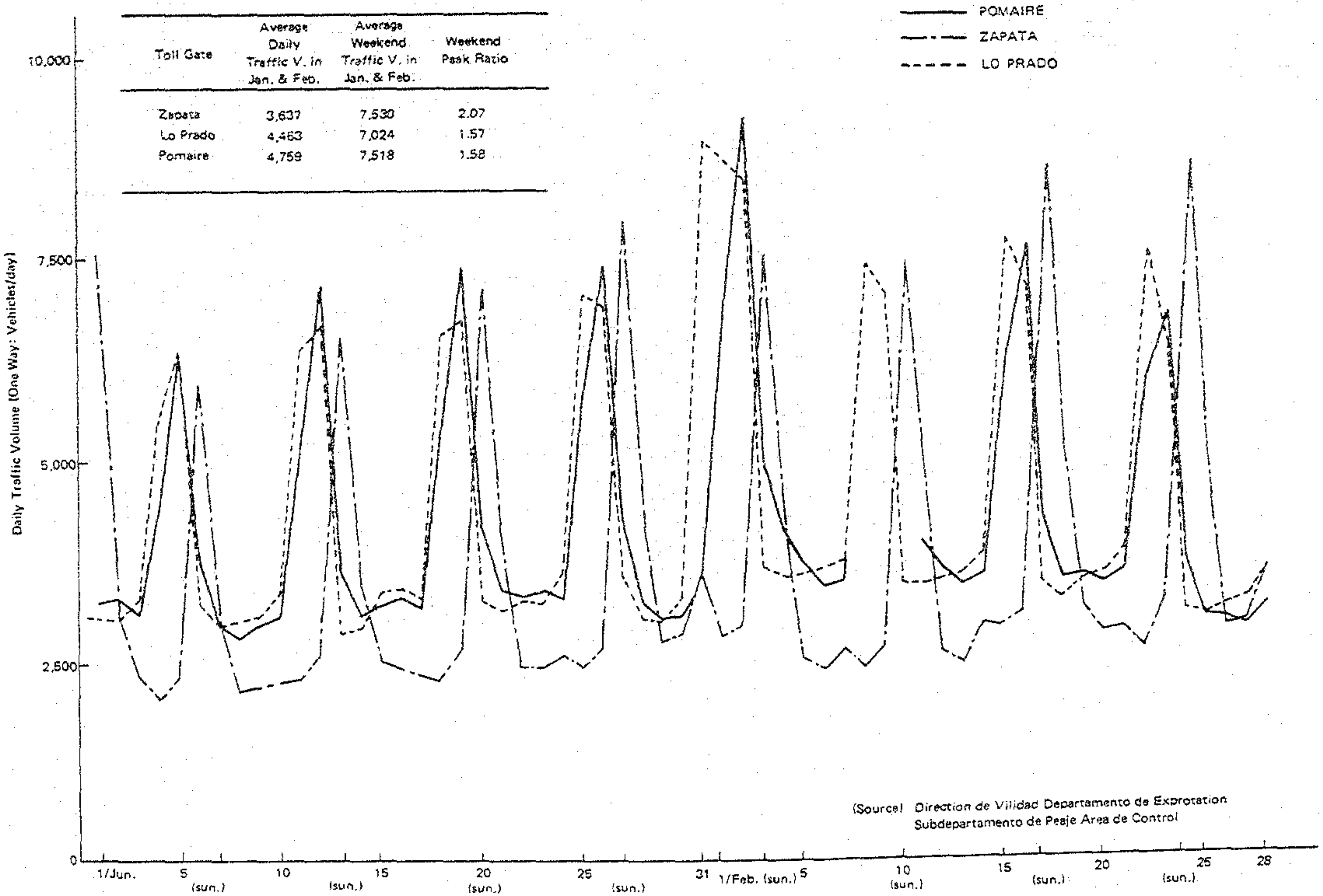


Fig. VI-2-3 Locations of Toll Gates



Toll Gate	Average Daily Traffic V. in Jan. & Feb.	Average Weekend Traffic V. in Jan. & Feb.	Weekend Peak Ratio
Zapata	3,637	7,530	2.07
Lo Prado	4,463	7,024	1.57
Pomaire	4,759	7,518	1.58

Fig. VI-2-4 Daily Traffic Volume in Summer Season (1985)

Toll Gate	Average hourly Traffic V.	Peak hourly Traffic V.	Peak Ratio
Zapata	317	1,314	4.15
Lo Prado	148	311	2.15
Pomaire	387	992	2.57

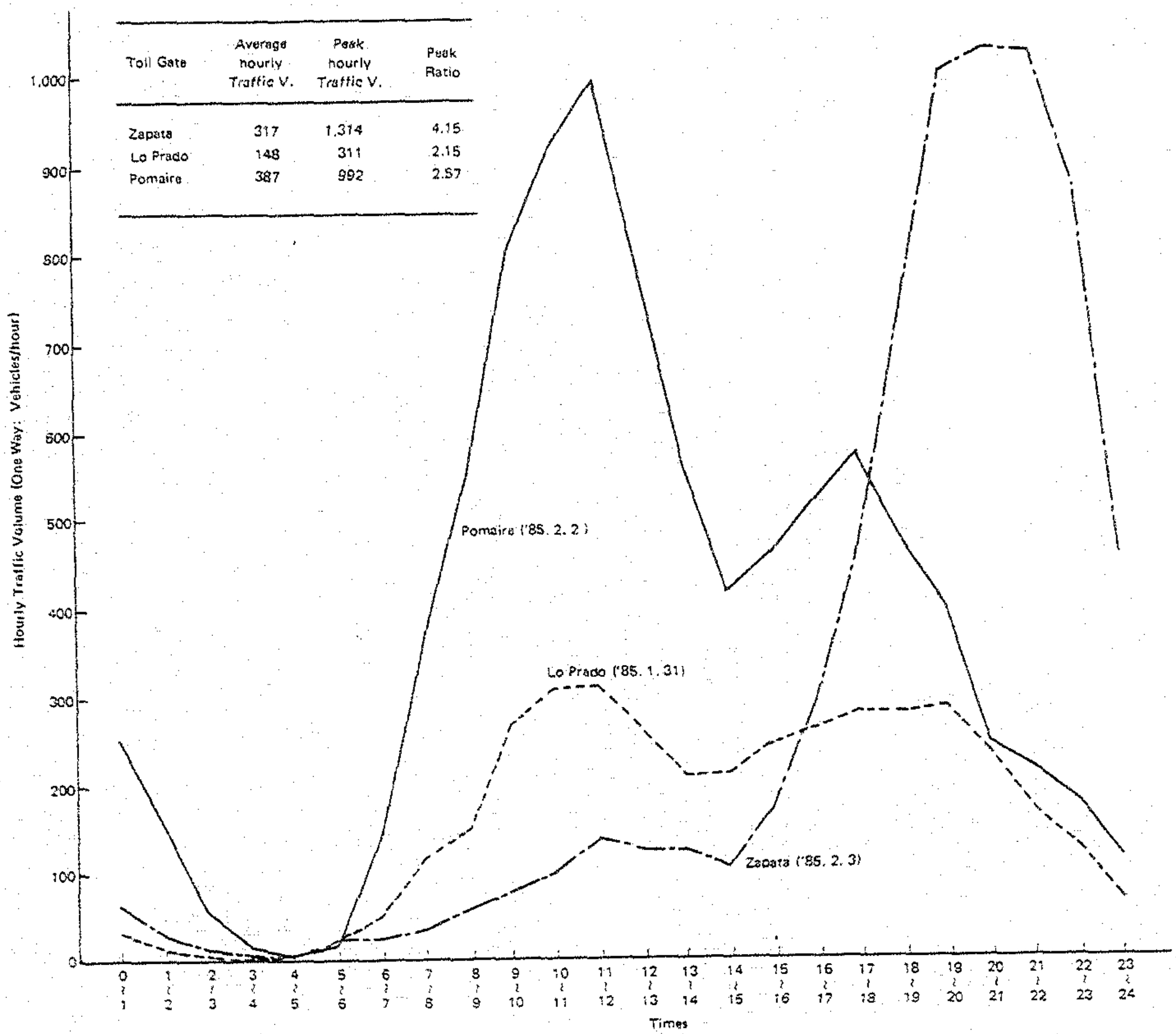


Fig. VI-2-5 Hourly Traffic Volume on Peak Days

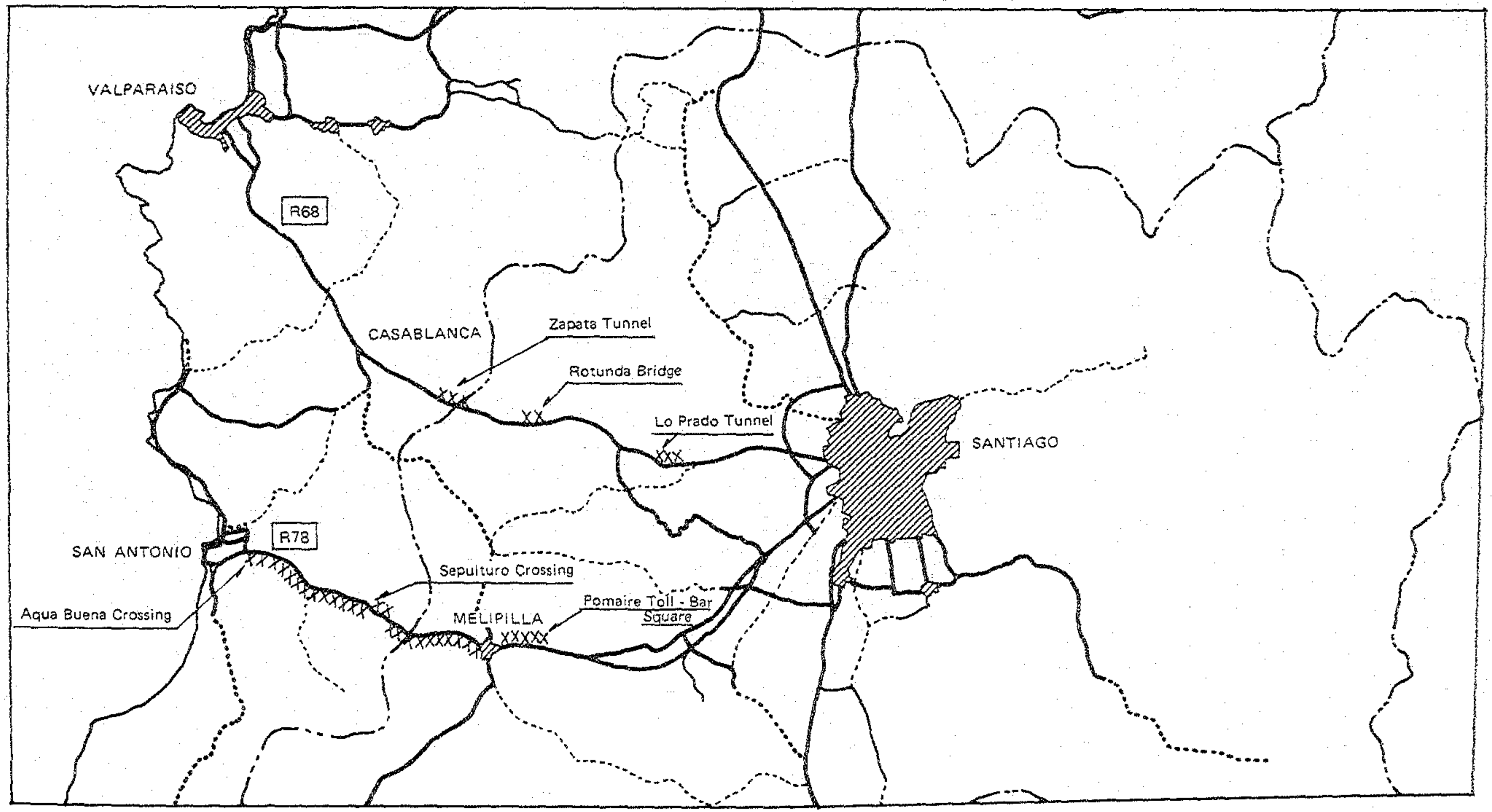


Fig. VI-2-6 Congested Sections of R68 and R78 Noted in the Multi-Modal Corridor Study

2) Trucks

The number of trucks registered in Chile is 79,219 excluding 117,418 small trucks, in 1984. Among these, trailers and semi-trailers, which are suitable as carriers of containers, total 14,347 vehicles. On route 68 and route 78, a total of 500 vehicles with 3 or more axles are estimated as possible carriers of containers, using the ratio of 3 or more axle trucks in Table VI-2-3 and the annual average daily traffic volume on each route shown in Table VI-2-1 and VI-2-2.

- R 68	6,332 x 0.027 = 171	
- R 78	8,029 x 0.041 = 329	
	Total	500

Table VI-2-3 Composition of Vehicles

Toll Gate	Trucks (2 Axles)	Truck (3 or more axles)	Others	Total
ZAPATA	30,987 (3.8)	21,948 (2.7)	757,054 (93.5)	809,989 (100.0)
POMAIRE	63,253 (6.7)	39,321 (4.1)	847,005 (89.2)	949,579 (100.0)

(SOURCE) MEMORIA, 1983, Dirección de Vialidad Ministerio de Obras Públicas Chile

In Chile, there is no legal requirement to apply for a special licence in order to operate as a truck hauler. A special permit is only necessary for handling international cargoes. Therefore, a great many truck owners, with an average of 1.6 vehicles/owner, have been competing with each other.

However, regulations do exist concerning the vehicles which may be used to haul cargoes. The maximum permitted length and weight have been defined by the Ministry of Public Works as follows.

- Maximum permitted length : 20 m
- Maximum permitted weight : 45 tons

The maximum permitted weight by type is presented in Table VI-2-4.

Table VI-2-4 Maximum Permitted Weight by Type

Axles	Vehicle	Weight in Tons
Simple	Simple	7
Simple	Double	11
Double	Simple	14
Double	Double + Simple	16
Double	Double	18
Triple	Simple	19
Triple	2 double + 1 simple	23
Triple	Double	25

The Inecon report[1/] based on interviews with 300 firms concerned with road transport operations showed that:

- 53% of the total cargo was carried in specialized vehicles, the great majority of which are hopper trucks and road tankers, both of which are unsuitable for carrying 20/40' containers.

Excluding the 53% of specialized vehicles from the figure of 500 estimated above, it seems that less than 250 vehicles are potentially available for carrying containers.

Assuming that each journey requires about 2 days duration, the average capacity for carrying containers to and from the ports of Valparaiso and San Antonio is approx. 1,500 tons/day (250 vehicles x 1/2 x 12 tons/vehicle).

(2) Railways

1) Infrastructure

As shown in Fig. VI-2-8, the corridor is linked by railways running between Santiago and the ports of Valparaiso, San Antonio and Ventanas. The line to Valparaiso (Mapocho STN. - Puerto STN) is electrified throughout, with a distance of 187 Km, and is linked with Alaneda Station via an

1/ Estudio de Mercado de Camiones, Inecon, Sept. 1981 underground line. It has a double track over a short section near Llay-Llay (13.6 Km) and from Limoche to Valparaiso (43 Km).

There is a small marshalling yard at Yunghay and a rather larger one at Valparaiso. Container terminals in Santiago at Yunghay and Renca are served from this line, and rail access is available directly to the container berths at Valparaiso, but is not electrified.

The line to San Antonio (Alameda STN - San Antonio STN), a single line of 118 Km, is electrified as far as Talagante (34 Km). The Port Authority lines are directly connected to the marshalling yard at Barrancas (San Antonio), and rail access is provided to the container quays. In Santiago, the container terminal at Renca is connected to the main line and is served via the Alameda station marshalling yard.

The details of the physical characteristics of both lines are shown in Fig. VI-2-7. 8'6" high ISO containers can be carried on both lines. The Multi-Modal Corridor Study points out that it appears possible that 9'6" high containers can also be carried.

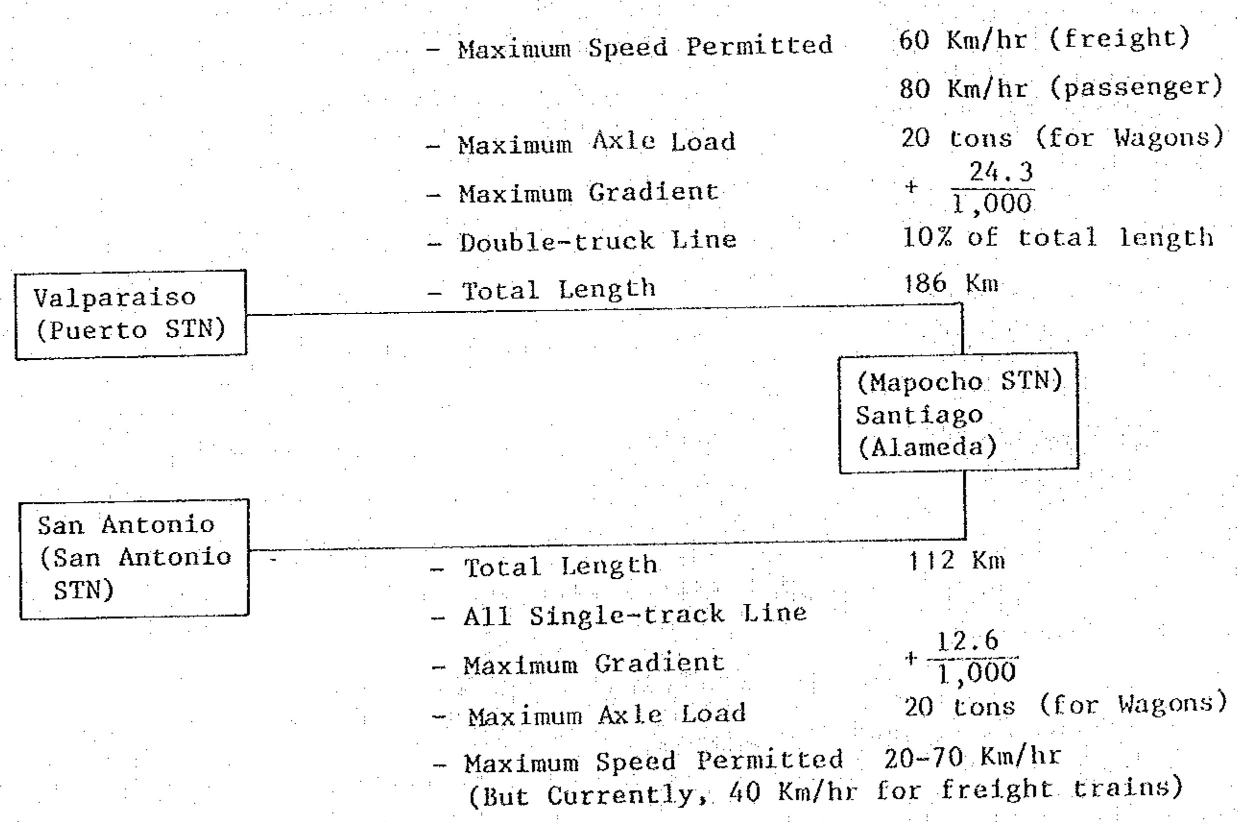


Fig. VI-2-7 Characteristics of the Railway Lines for the Ports

(Source) Multi Modal Corridor Study, 1985, INECON

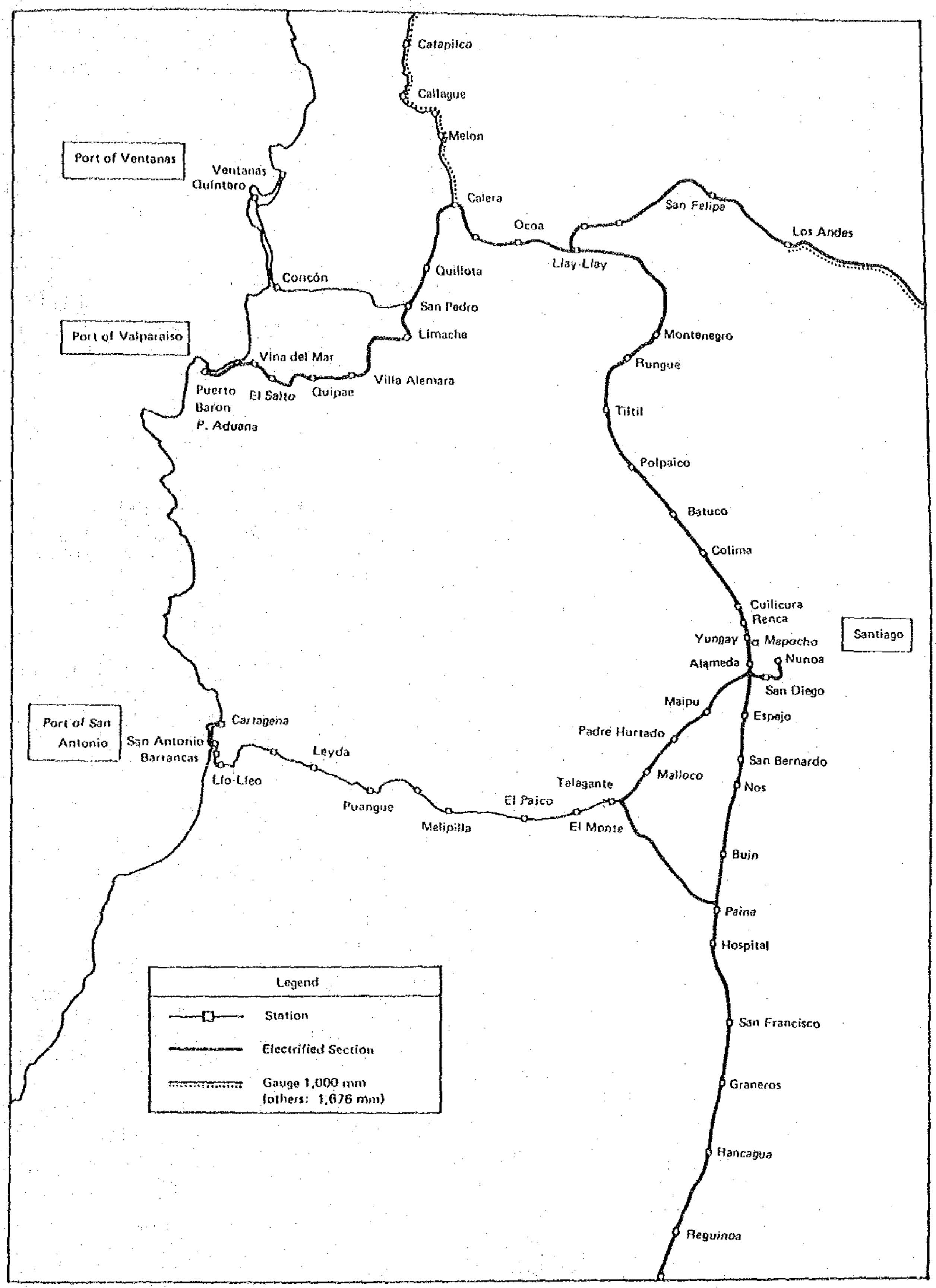


Fig. VI-2-8 Present Railway Network in the Hinterland

2) Train Working Conditions

With respect to the service characteristics, the line to Valparaiso is used for passengers and cargoes. However, during most of the year the line to San Antonio is only used for cargo transport as shown in Table VI-2-5.

Table VI-2-5 Present Standard Running Service

Line	Running trains	
Valparaiso-Santiago	Passenger trains Cargo trains	10 trains/day 2 trains/day
San Antonio-Santiago	Cargo trains Passenger train: Runs only 1/1 - 3/15 as far as Catagena for holiday passengers	12 trains/day (Including special trains)

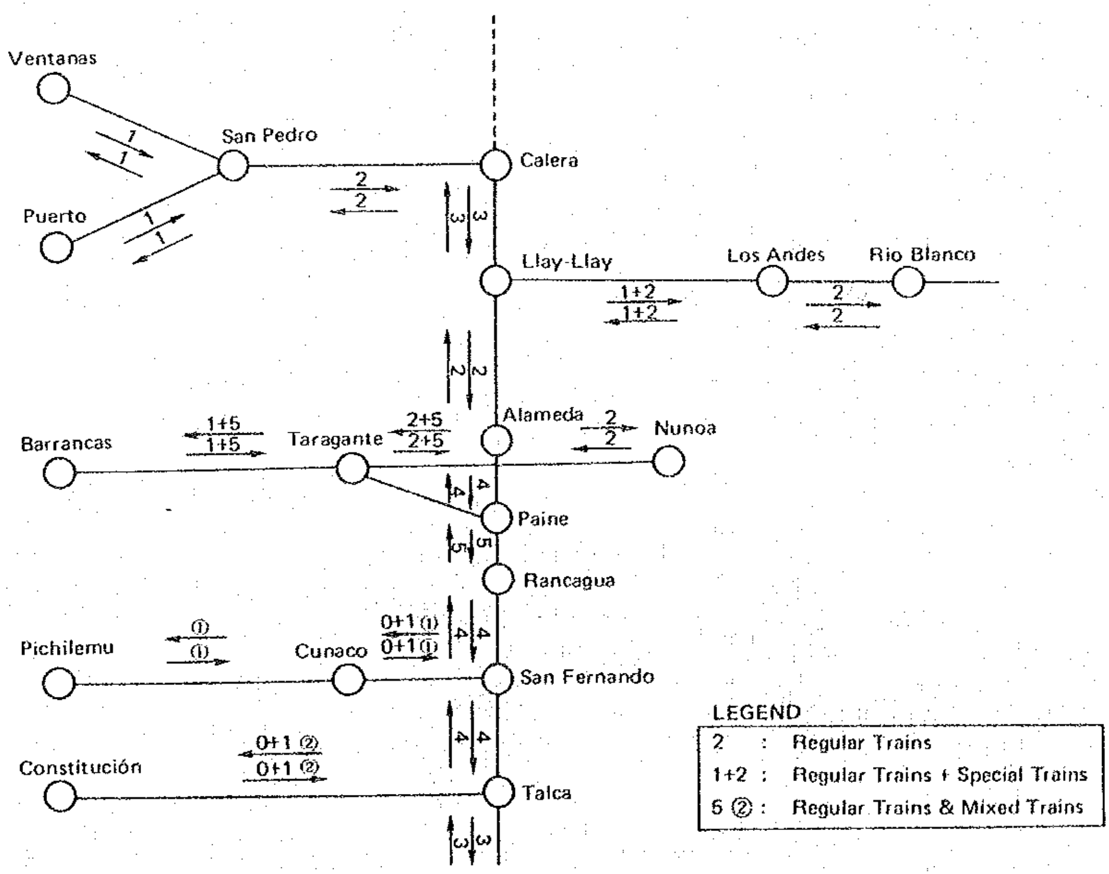


Fig. VI-2-9 Number of Running Cargo Trains

Container wagons are moved to and from the quays at Valparaiso by diesel shunting engine and made up into trains in the yard at SAMM's depot. There are seldom sufficient wagons for complete unit trains. Trains generally attach and detach at La Calera, Llay-Llay and other points including the yard at Yungay. An electric shunting engine places wagons in Yungay terminal. Renca is normally served by an electric engine from Yungay, but wagons can be attached or detached from main line trains at Renca. Container wagons are placed at and removed from the quays at San Antonio by port Authority diesel shunters. Trains are made up and split in Barrancas yard, where a diesel shunter is used. As there are insufficient containers for unit trains at present, the container wagons are moved along with copper, grain and other traffic. 2 diesel locomotives are used on trains to and from Talagante, where they are replaced by electric locomotives for the remaining part of the journey to the Alameda Station yard. Wagons for SITRANS are tripped from Alameda Station to their siding, situated on the main line to the South.

The capacity of the railways depends on the number and type of available locomotives and the capacity of the most restricted sections, which are the steep Llay-Llay ~ Til-Til section on the Valparaiso line and the non-electrified Talagante - San Antonio section on the San Antonio line.

Based on the results of the Multi-Modal Corridor Study and interviews with FFCC, the capacities of the lines between Santiago and the ports are estimated roughly as follows:

Santiago - Valparaiso Line	942 x 10^3 tons/year
Santiago - San Autonio Line	1,139 x 10^3 tons/year

Further, assuming that there are no restrictions as far as the availability of locomotives and the intermediate stations are out of use, the line capacities are estimated by FFCC as follows:

Santiago - Valparaiso Line	5,475 x 10^3 tons/year
Santiago - San Antonio Line	9,636 x 10^3 tons/year

On the other hand, the maximum section traffic at present in estimated as follows.

Santiago - Valparaiso Line	385×10^3 tons/year
Santiago - San Antonio Line	$1,070 \times 10^3$ tons/year

Therefore, the capacity of both lines is sufficient to handle the present demand.

Thus, the existing electrification project of the Talagante - San Antonio section of the San Antonio - Santiago line is not urgent since the electrification of the line would not augment the line capacity.

The main problem on the San Antonio - Santiago line is the need to speed up operations. The time required for shipments on the line is 1 or 2 hours longer than the required time for shipments on the Valparaiso - San Antonio line, despite the shorter distance. This is due to the waiting time at Talagante and Melipulla on route since the line does not have a double line section as shown in Fig. VI-2-10.

Table VI-2-6 Railway Capacity between Santiago and the Ports of Region V

Items	Santiago-Valparaiso Line	Santiago-San Antonio Line		Remarks
Locomotives used	E30	E32 (Santiago-Talagante) 2xD18000 (Talagante-San Antonio)		
Maximum train weight (tons/train)	540 1)	1,300		1) Load for the steep Llay Llay-Til Til section
Net capacity 2) (Cargo tons/train)	430	1,040		2) Assumed empty weight is 20% of maximum train weight
Available locomotives (locomotives)	6	21 (E32) 6 (D18000)		
Available trains (trains/day)	6	3	10 3)	3) Maximum past record
Maximum capacity (A) (cargo tons/day) (cargo tons/year)	2,580 941,700	3,120 1,138,800	10,400 3,796,000	
Maximum section traffic (B) 4) (Cargo tons/year)	385,100	1,070,000	1,070,000	4) Estimated from Fig. VI-2-19
Balance (B/A)	0.41	0.94	0.28	

(Source) Multi Modal Corridor Study, and information obtained from interviews with FFCC.

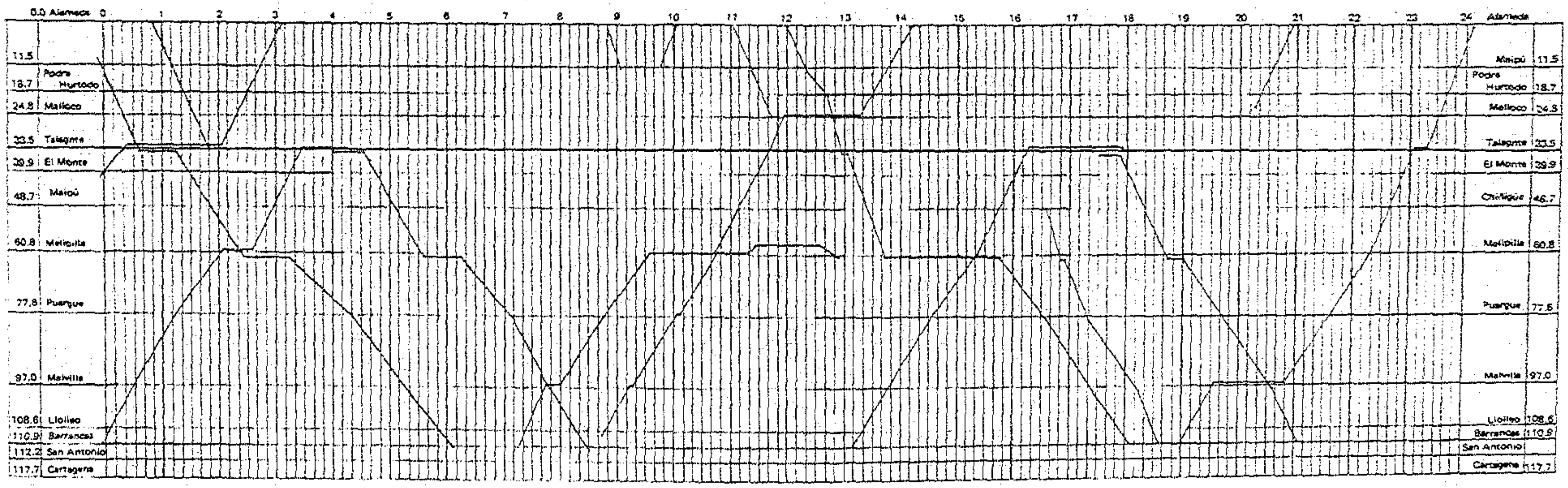


Fig. VI-2-10 Railway Traffic Diagram of the Normal Day (19, Dec., 1985)

(3) Terminals and Accesses

1) Valparaiso

Fig. VI-2-11 shows the land use of Valparaiso city. Valparaiso has a very long and narrow port area, and the urban area is centered along the port area.

There are at present two important accesses to the port of Valparaiso. For the traffic from Ventanas, the Valley of Aconcagua and the north, the entry is via Av. Espana from Vina. For traffic from the MR and the south, which comes by Route 68, access is by Av. Argentina. The latter traffic cannot turn left directly into Av. Errázuriz but has to take Av. Espana and then turn back in order to take Av. Errázuriz which leads to the immediate accesses to the port. The port itself has two principal accesses from Av. Errázuriz:

- Opposite the Muelle Barón, across railway land.
- Opposite the Customs House, beyond the Plaza Sotomayor.

A study of improvement of the accesses to the port is currently being undertaken by MTT. The main solution under study (No.1 in Fig. VI-1-11) is to complete the over-pass Argentina-Espana which would permit direct access to the port over the railway land opposite Muelle Barón. From there, a new improved coastal road would be constructed leading to the Espigon (berths N° 6-8) and across Muelle Prat to berths N° 1-5. The other alternatives (2 and 3 in Fig. VI-2-11) are the construction of the new access roads.

Table VI-2-7 shows the characteristics of the truck operations at the port of Valparaiso. From the table, it is clear that the most important problem is the long waiting time at the port: approximately 8 hours. This is the cause of the low operation ratio of the trucks and of the congestion in the port and its vicinity especially during the peak traffic hours. Thus, the long line of waiting trucks interferes with the regular flow of traffic.

The trucks and drivers should only stay in the port for the time necessary to uncouple one trailer (with an empty or full container) and to couple another. Based on the observations by INECON, the drivers always bring their trailers into the port area and keep them coupled to the

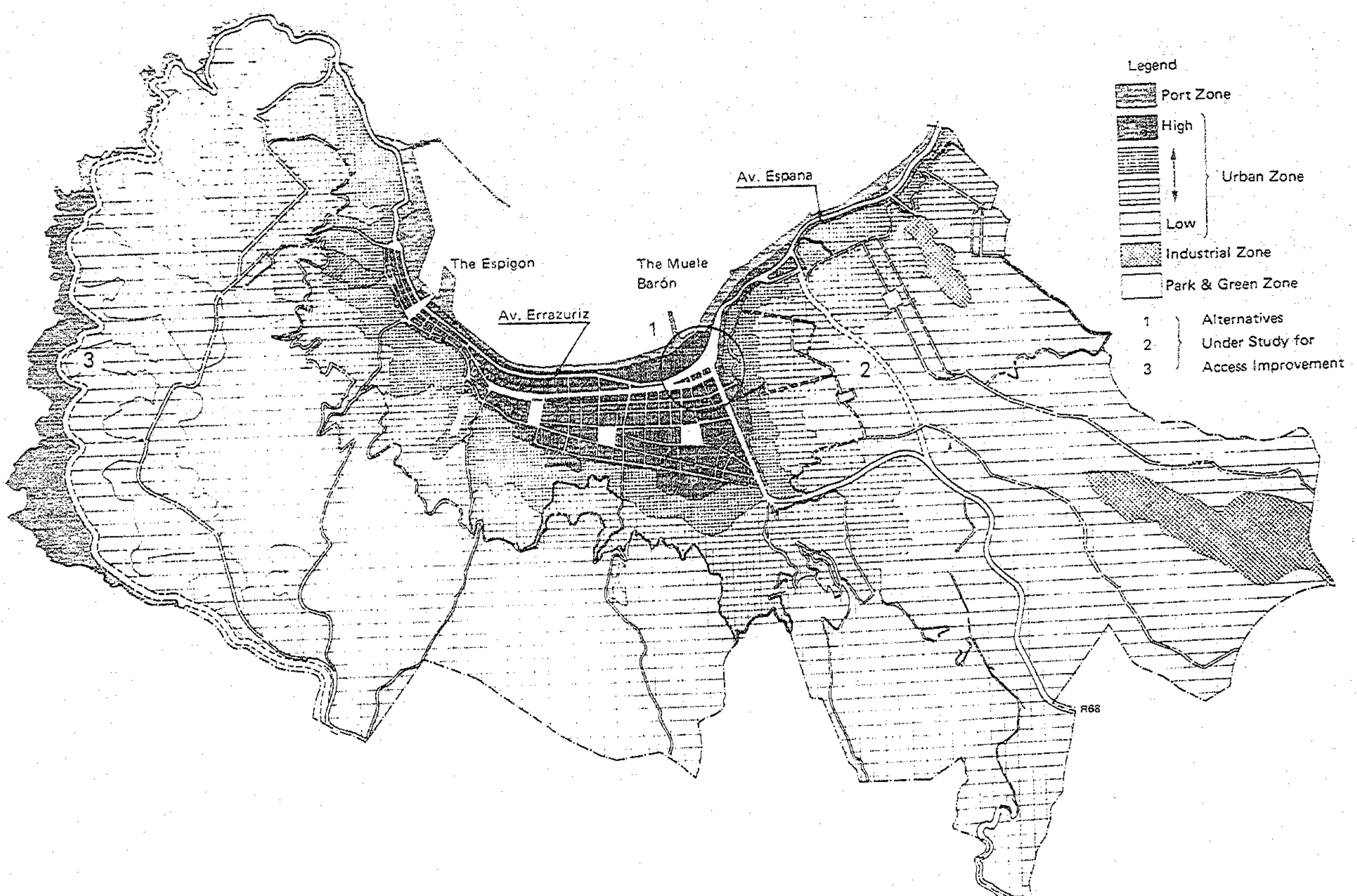


Fig. VI-2-11 Zoning Map in Valparaiso

tractors while they wait for their turn to load a container.

Empty trailers and containers should be left in a pre-determined parking area outside of the main port area next to the container loading area.

The Placilla terminal shown in Fig. VI-2-12 is already being used by various transport operators as a transit area outside the port for empty containers.

However, this terminal is located about 14 Km away from the port. Its location is really too far from the port to serve efficiently as a port terminal.

Table VI-2-7 Characteristics of Truck Operations at the Port of Valparaiso

Item	Small Trucks	Large Trucks
Average Loaded Cargo Volume (tons/vehicle)	5.8	20.5
Average Age of Vehicles (years)	9.3	8.9
Annual Rate of Operation (%)	58.1	60.6
Average Rotation Time (hours)		
Valparaiso - Santiago	22.5	
San Antonio-Santiago	14.1	
Valparaiso - Rancagua	29.8	
Valparaiso - Los Andes	20.0	
Curico - Valparaiso	38.8	
Rancagua - San Antonio	10.7	
Average Waiting Time at the Port (hours)	8.1	
Return Load Factor (%)	20.7	

(Source) Multi-Modal Corridor Study

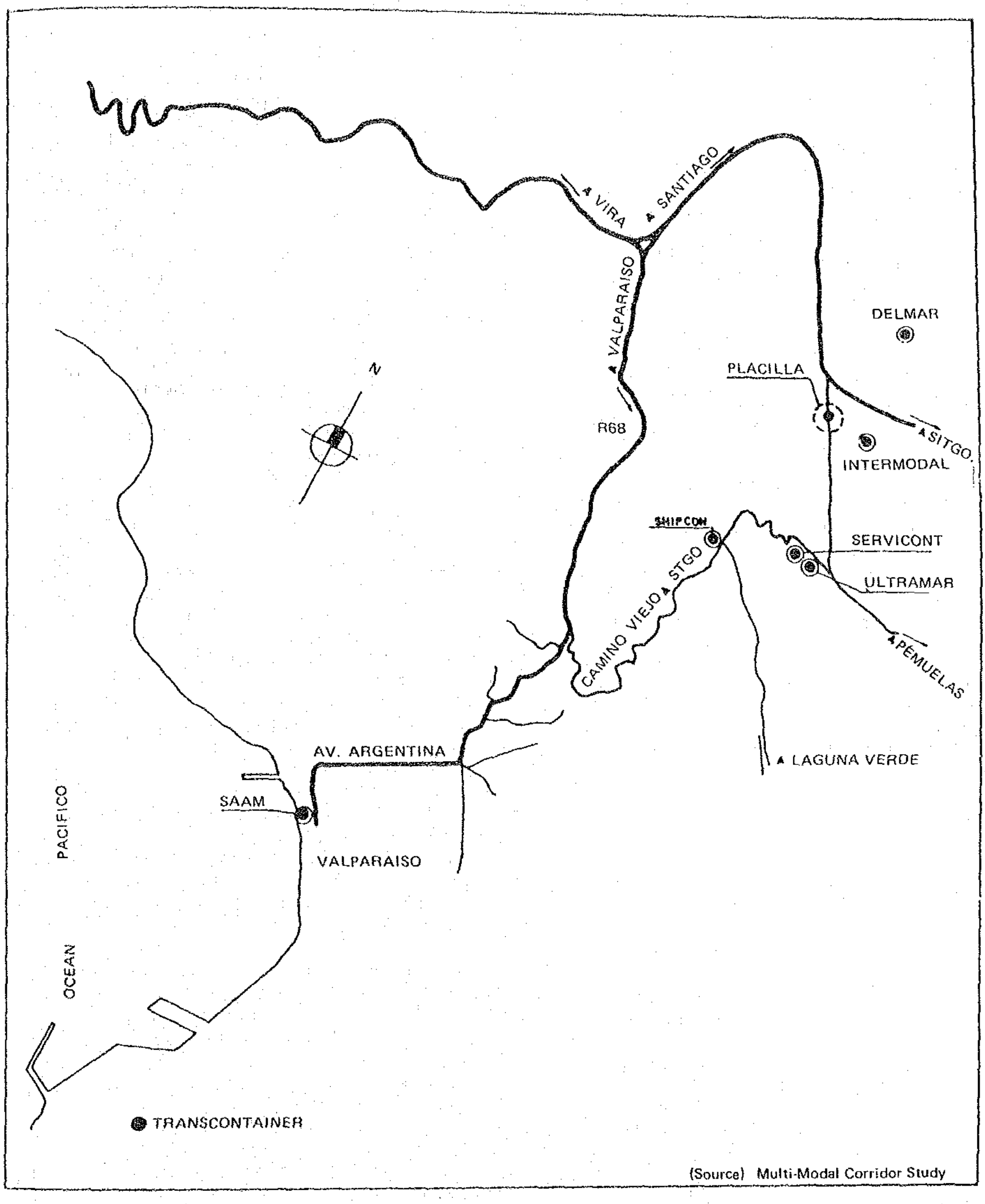


Fig. VI-2-12 Location of Terminals around Valparaiso

2) San Antonio

In San Antonio, as mountains approach the shoreline, the flatland is very narrow. The residential zone is on the hill, and the port, commercial and recreation zones are in the flatland. The topography restricts the development of San Antonio. (See Fig. VI-2-13)

Access to the port of San Antonio is via route 78 at present, but the construction of a new access route is in progress as shown in Fig. VI-2-14. The new route will deviate to the east of the city all the traffic coming to the port as well as the through traffic to Santo Domingo. This diversion which branches off near the exit for route 78 toward Cartagena will include an extension of 8.5 Km up to the port entrance. This is longer than the old access which runs approx. 5 Km to the port. The new road should successfully reduce the interference between the port related traffic and the urban activity related traffic, and the gradient and the curvature of the new road should be superior.

Table VI-2-8 shows the characteristics of truck operations at the port of San Antonio. There is no serious problem with the truck operations at the port.

Table VI-2-8 Characteristics of the Truck Operations at the Port of San Antonio

Items	Small Trucks	Large Trucks
Average Loaded Cargo Volume (tons/vehicle)	9.7	26.0
Average Age of Vehicles (years)	11.7	6.7
Annual Rate of Operation (%)	70.0	65.0
Average Rotation Time (hours)		
Valparaiso - Santiago	22.5	
San Antonio - Santiago	14.1	
Valparaiso - Rancagua	29.8	
Valparaiso - Los Andes	20.0	
Curico - Valparaiso	38.8	
Raneagua - San Antonio	10.7	
Waiting Time at the Port (hours)	2.3	
Return Load Factor (%)	10.9	

(Source) Multi-Modal Corridor Study

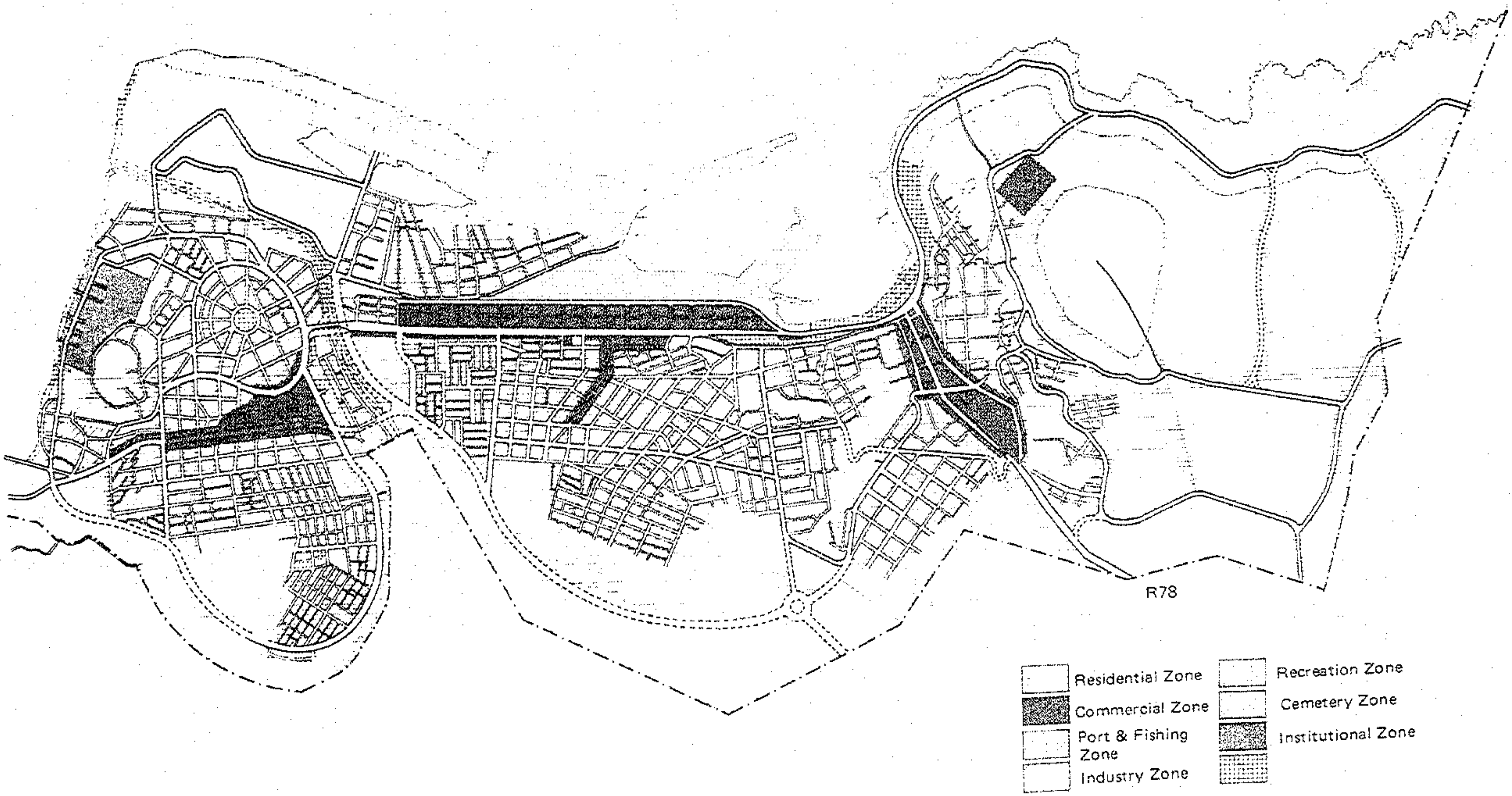


Fig. VI-2-13 Zoning Map of San Antonio

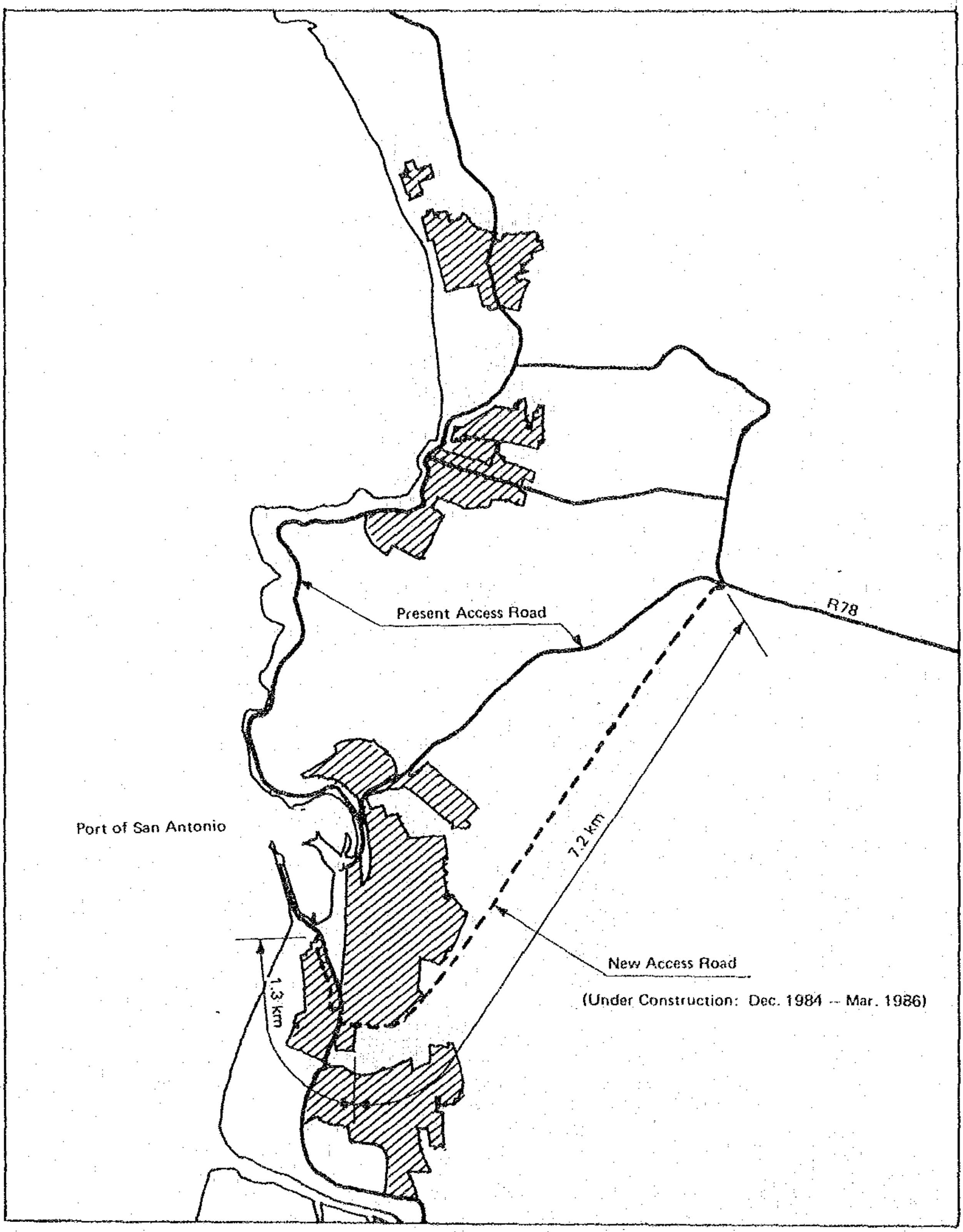


Fig. VI-2-14 Access to the Port of San Antonio

3) Santiago

Fig. VI-2-15 shows the zoning structure and the locations of the three container terminals in Santiago. The industrial zone is located around the central zone, which is the business and commercial area.

It is assumed that in the future the main industrial area will be located in the northern part of Santiago through the restriction of new factory location in an effort to minimize the bad influence on the residential zone, that is the polluted air which is carried by the wind which blows from the southwest.

The characteristics of the container terminals located in Santiago are summarized in Table VI-2-9.

Currently, the terminals do not function as custom clearance houses. This will become a serious problem with the progress of containerization.

With reference to access, the terminal at Yungay has the most problems. This terminal should ideally be transferred from the central urban area to the suburbans. The locations of Renca and Valledor in the suburban areas are much more suitable for accommodating truck traffic.

It is also necessary to complete the Avenue Americo Vespucio which will serve the traffic entering and leaving Santiago. The main projects to improve sections of this avenue which are currently underway or being planned are summarized below.

- A new section of the Avenue is being constructed between Recoleta and El Salto, and an engineering study has been completed for another new section between El Salto and La Piramide.

- The section between Quilicura and Pudahuel is currently being resurfaced.

- An engineering study is currently taking place for the widening of the Avenue between Cran Avenida and Ochagavia.

- Another engineering study is currently being made for a new section of the Avenue which will run between Ochagavia and Pedro Aguirre Cerda. This project is of particular importance for decreasing the congestion in the urban area by improving the access to southern Santiago from San Antonio and eventually from Valparaiso as well.

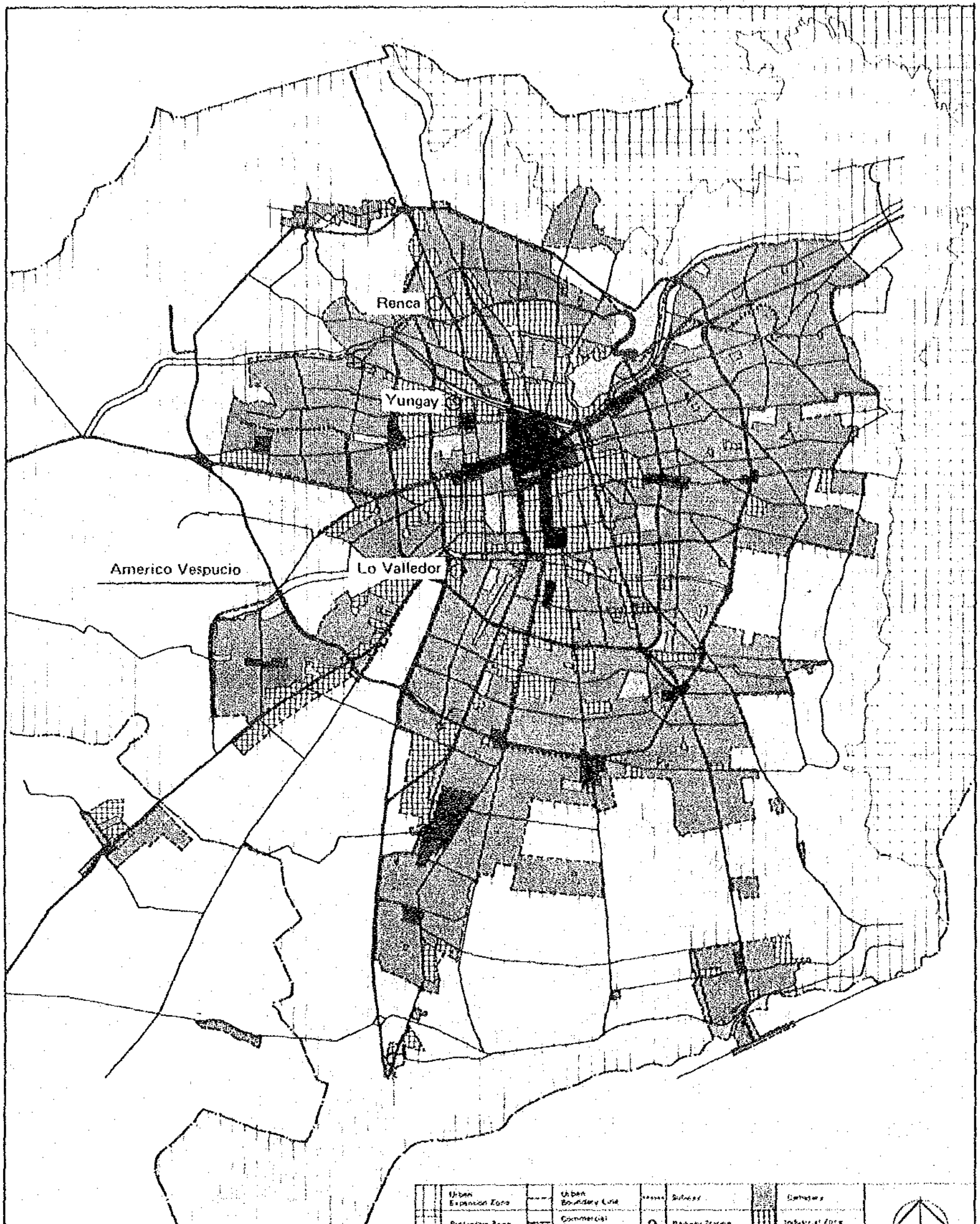


Fig. VI-2-15 Zoning Map of Santiago

Table VI-2-9 Characteristics of the Container Terminals in Santiago

	Renca (CQSAN S.A.)	Lo Valledor (SITRANS LYDA)	Yungay (TRANSCOUNTAINER S.A.)
Facilities & Accesses	- Area: 100,000 m^2 (At present 4 ha is used) - Capacity: 3,000 TEU - Sheds: 2,300 m^2 - Rail access - 250 m route 5	- Area: 64,000 m^2 - Capacity: 5,000 TEU - Sheds: 6,160 m^2 - Rail access - 100 m Route 78 300 m Route 68 1 min Route 5	- Area: 32,650 m^2 - Shed: 1,365 m^2 - Rail access - 900 m Route 5 (North) - 9 Km Route (South)
Available Equipment	- 1 top lifter, 30 ton - 1 light crane, 5 ton - 2 forklift trucks 1.5 ton	- 1 top lifter, spread 20' and 40', 32 ton - 1 top lifter 9 ton - 5 forklift trucks, 2.5 ton - Welding and cleaning equipment	- Forklift truck, 6 ton - Forklift truck, 3 ton - Forklift truck, 3 ton, rented - Top lifter, 40 ton, rented FF. CC. - 2 weighbridge - 1 transpallet - 360 containers, rented for 1 year
Container Movement	- 800 TEU/month - 70% by railway - 80% to/from Valparaiso - Average of 2 days stay in the terminal	- 416 TEU/month (Excluding 330 TEU/month of domestic traffic) - 70% by railway (to S.A.) - 30% by truck (to Val.) -1000 - 1200 TEU in stock - Average of 7 days stay in the terminal	- 100 TEU/month - 64% by railway - 100% to/from Valparaiso - 300 TEU in stock - Average of 3 days stay in the terminal
Remarks	- 2 or 3 trains/day - 30 - 40 wagons/train - 60 tons/wagon - Congested road area: Quliqula - Valparaiso	- 1 train/2 days - 25 wagons/train - 60 tons/wagon	

(Source) The information was obtained from interviews with the terminal companies and from the Multi-Model Carridor Study.
(Note) 1) Details of the Container Movement at the SITRANS Terminal are as follows:

In	Out
- Imp. FCL (By SIT.) 100-150 TEU (Truck: Rail: 50:50	- Exp. FCL (By SIT.) 250 TEU (Truck: Rail: 30:70)
- Empty Containers 100 TEU (Truck: Rail= 10:90)	- Domestic (Rail 100%) 330 TEU
- Domestic 300 TEU (Rail 100%)	- Other Companies 166 TEU (Truck 100%)
- Other Companies (Empty) 216 TEU (Truck 100%)	

(4) Overland Freight Traffic

1) Road (Truck) Cargoes

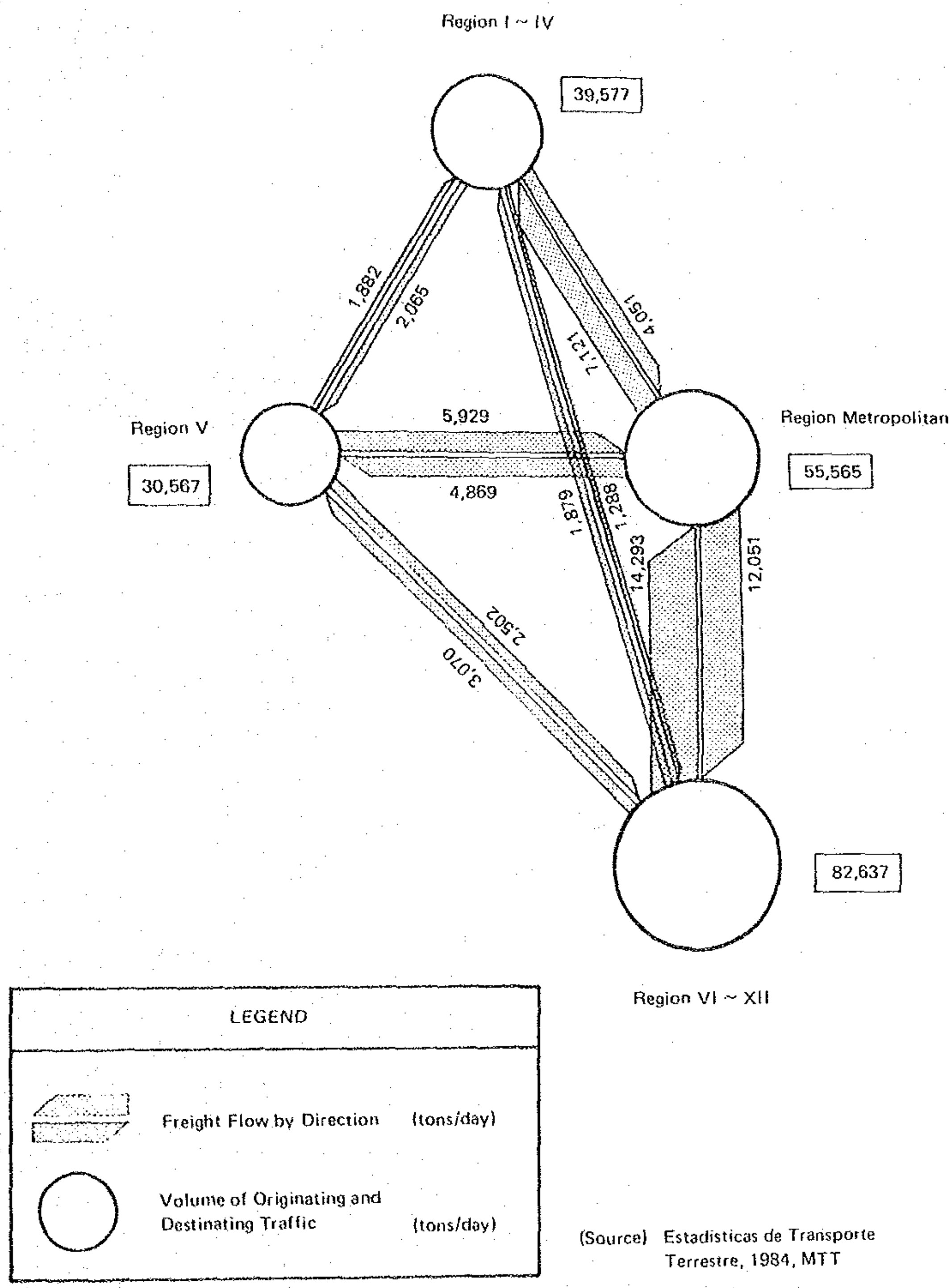
The total volume of the cargoes transported by trucks in Chile in 1983 is 104,173 tons/day. Of this, the volume of the freight traffic in the 5th region and the Metropolitan region including through traffic is 69,766 tons/day, a 67% share of the national total.

With reference to the Metropolitan region, the volume of through traffic, whose OD pairs are generally the 1st ~ 4th region - 6th ~ 12th region and the 5th region - 6th ~ 12th region, is 8,759 tons/day, which is 15.8% of the entire metropolitan region freight traffic volume as shown Fig. VI-2-16.

For the following main OD pairs, the main products transported are agricultural products, livestock, foodstuffs, and mining and construction materials as shown in Table VI-2-10.

- Metropolitan region - 6th ~ 12th region (26,344 tons/day)
- Metropolitan region - 1st ~ 4th region (11,172 tons/day)
- Metropolitan region - 5th region (10,798 tons/day)

Based upon the data of Multi-Modal Corridor Study, the shares of the port related cargoes in the total traffic flow are estimated as shown in Fig. VI-2-17. The highest share is 28.7%, which is the share of port-related cargoes in the overall traffic flow between Region V and Regions VI-XII.



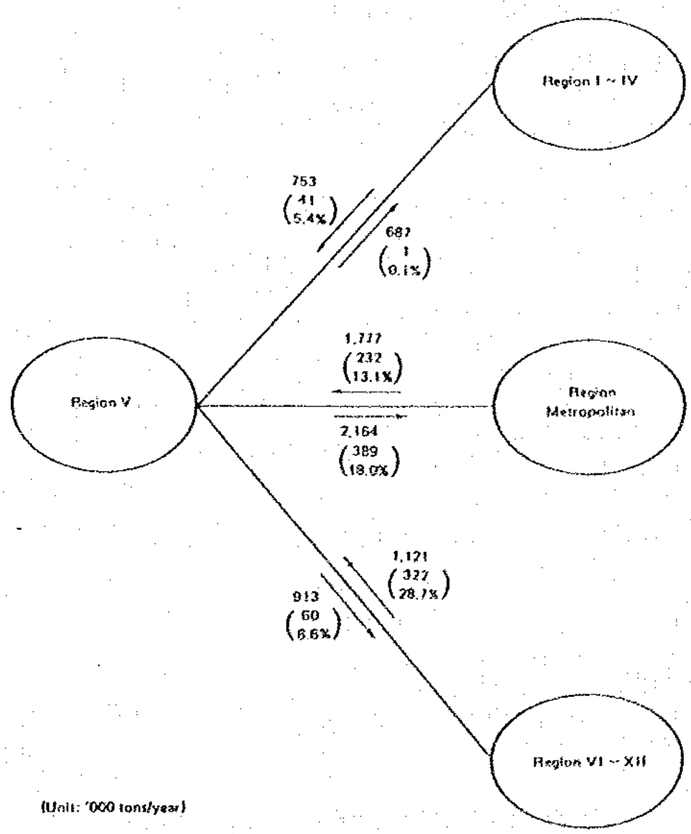
(Source) Estadisticas de Transporte Terrestre, 1984, MTT

Fig. VI-2-16 Inter-regional Overland Freight Flow (1983)

Table VI-2-10 Main Product Flow to and from the Metropolitan Region (1983)

Origin/ Destination	To Metropolitan Region	tons/day	From Metropolitan Region	tons/day
Region I - IV	- Other products	1,177	- Other products	2,128
			- Agricultural products	1,633
Region V	- Other products	1,129	- Other products	1,310
			- Agricultural products	1,147
Region VI - XII	- Livestock products	3,540	- Foodstuffs	3,218
	- Mining products	2,963	- Other products	2,677
	- Other products	1,879	- Agricultural products	2,156
	- Agricultural products	1,708	- Construction materials	1,527
	- Foodstuffs	1,604	- Mining products	1,181

(Source) Estadisticas de Transporte Terrestre, 1984, MTT



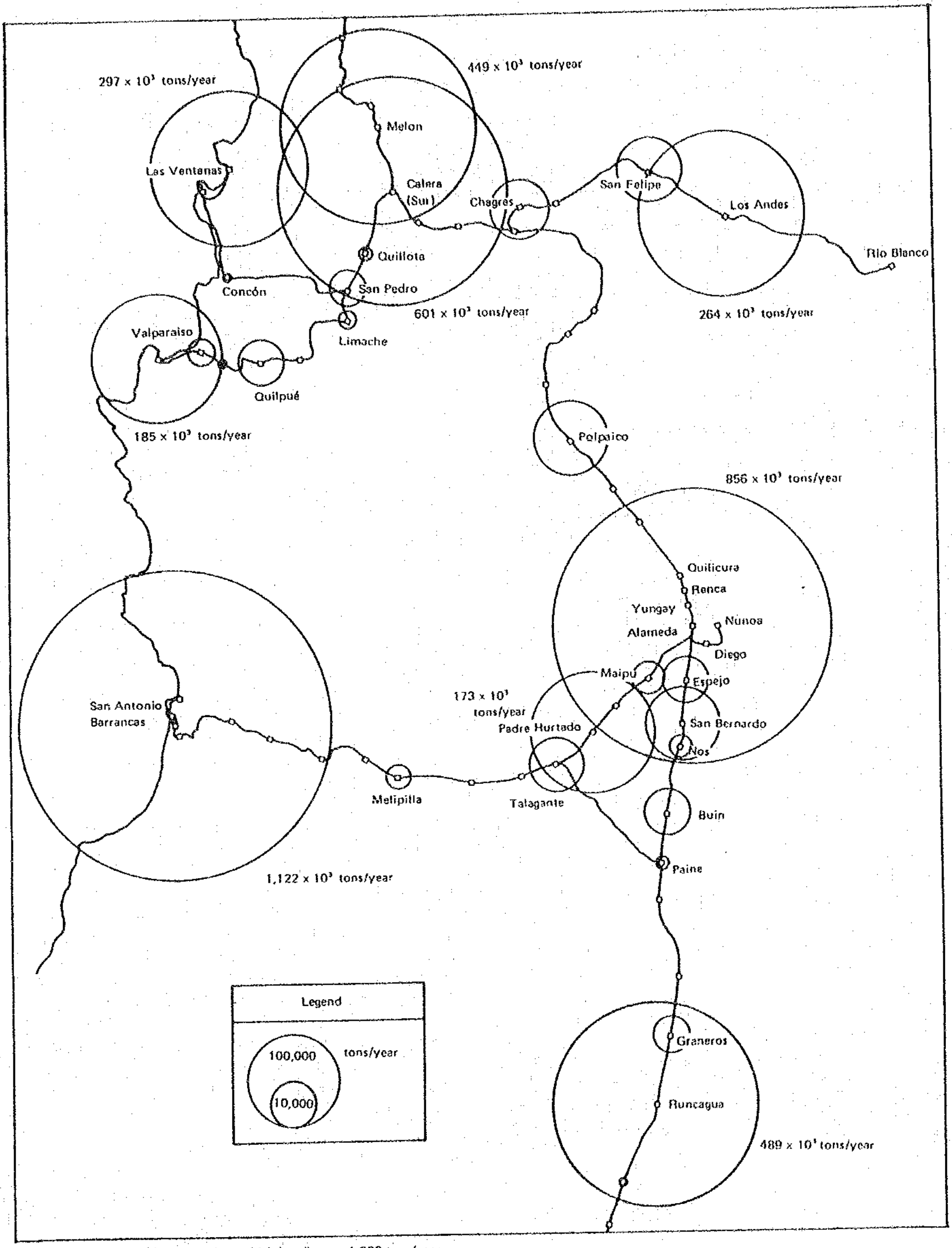
Note: 1) Figures in parentheses are the volume and share of the port related cargoes.
2) Year: the total cargo volume is from 1983 and the port related cargo volume is from 1984.

Fig. VI-2-17 Share of the Port Related Cargoes in Total Road Traffic Volume

2) Railway Cargoes

The cargo volumes handled by station in the hinterland are illustrated in Fig. VI-2-18. Within the hinterland, San Antonio STN. (including Barrancas STN.) handled the largest cargo volume, 1,122 x 10^3 tons/year. Santiago STN. (including Alameda, San Diego, Nunoa, Mapocho, Yungay, Renca and Quilicura STN.s) handled the second largest volume of 856 x 10^3 tons/year. The handling cargo volume of Valparaiso STN. (including Puerto, Baron and P.1 Aduana STN. s) is 185 x 10^3 tons/year.

About 70% of the cargoes at the stations in the hinterland are handled under contract for approximately 50 users, most of which are related to port activities. Fig. VI-2-19 shows the freight flow by railway for the ports of Valparaiso, San Antonio and Ventanas. Railways are used intensively for the export of copper, especially from Runcagua to San Antonio, and for the import of wheat, particularly from San Antonio to Santiago.



(Note) The stations which handle over 1,000 tons/year
(Source) Estadisticas de Transporte Terrestre, 1984, MTT

Fig. VI-2-18 Cargo Volume Handled by Station in the Hinterland (1983)

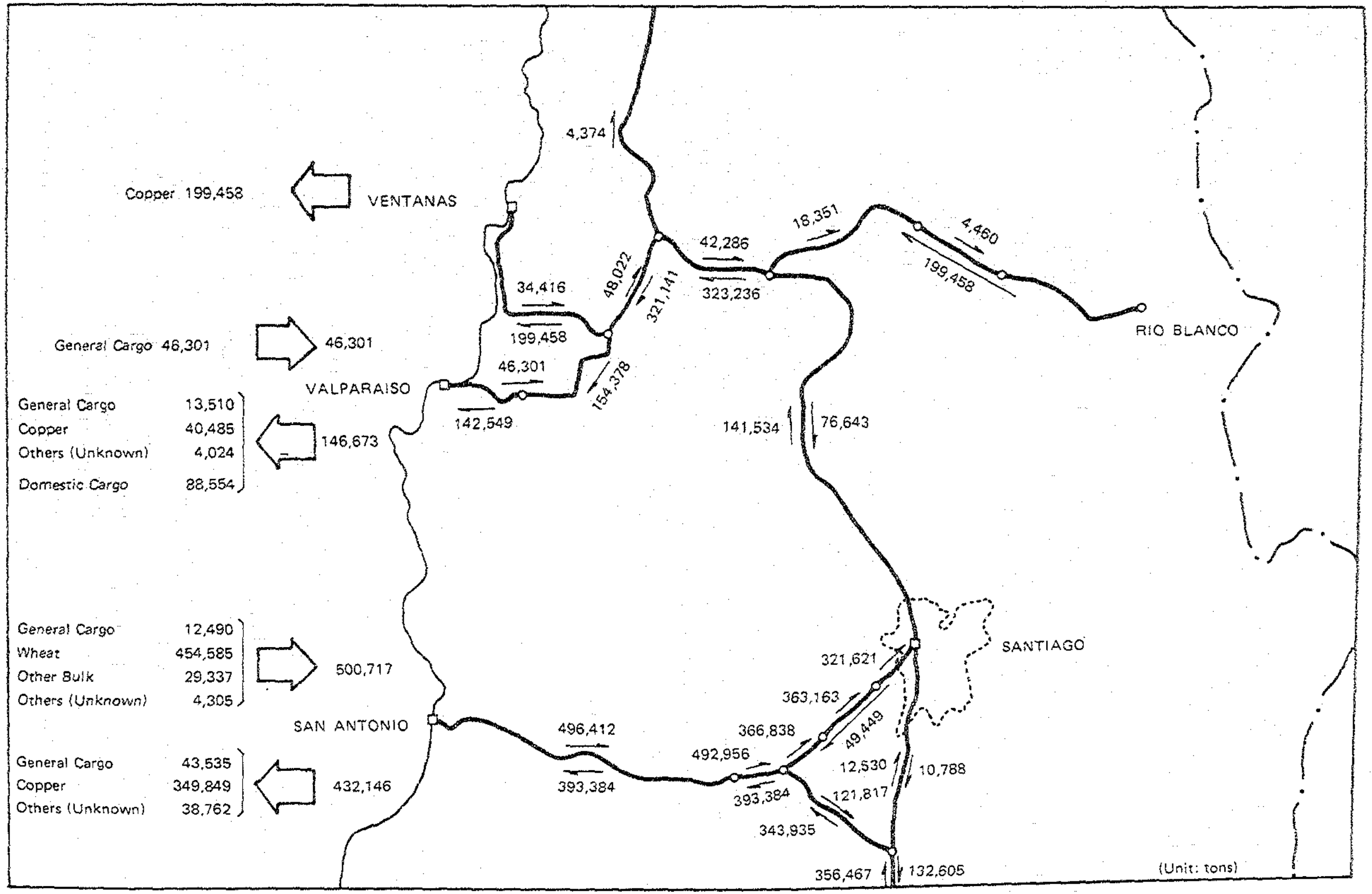


Fig. VI-2-19 Freight Flow by Railway via the Ports of Valparaiso, San Antonio and Ventana (1984)

(Source) Malti -Modal Corridor Study, 1985, INECON

(5) Issues

As a result of the analysis above, the main problems and issues may be summarized as follows:

i) As the mother city of the port of San Antonio, the current accumulation of population, port related traders and other services in the city of San Antonio is not sufficient. It is necessary for the port modernization plan to take a synthetic viewpoint which includes the development of the city itself.

ii) There is currently no direct route between the port of San Antonio and the southern part of the 6th region, so this traffic passes through Santiago. It is necessary to examine the possibility of constructing a direct route not passing through Santiago.

iii) The traffic capacity of most of the 2-lane sections of route 68 is insufficient in the summer season, so it is desirable that the ongoing double highway project of route 68 be completed as soon as possible. The construction program should be accelerated.

iv) Since the traffic capacity between Desvio Poniente and Autopista on route 78 is insufficient for the annual average daily traffic volume, it is necessary to implement the postponed double highway project as least on the sector El Paico - Melipilla including the congested section mentioned above.

v) There is currently no need to apply for a special licence in order to operate as a truck hauler in Chile, so too many small truck owners are competing with each other. This may become an increasingly serious problem in the near future in terms of safety and reliability, especially for container transport.

vi) The current maximum permitted weight of 45 tons/vehicle is somewhat heavy for the roads. In Japan the maximum is 20 tons/vehicle. To protect the pavement and to decrease the maintenance costs of most roads, the routes where heavy trucks and long trucks are permitted to run should be carefully specified (restricted) at least in urban areas.

vii) The railway line capacities between Valparaiso - Santiago and San Antonio - Santiago are sufficient for the demand. However, with respect to the San Antonio - Santiago line, since this line has no double track sections, 1 or 2 hours of waiting time are necessary at Talagante and Melipulla.

viii) With regard to terminal access roads, to resolve the problem of the road congestion in the urban areas, especially in the summer season, it is absolutely necessary to construct a new access path at Valparaiso and to complete the Avenue Americo Vespucio at Santiago.

ix) At the port terminal in Valparaiso, the long waiting time (average approx. 8 hours) of the port related trucks and the subsequent long line of waiting trucks decrease the operational rate of the trucks, limit the size of the useful port area and generally cause congestion in the port and its vicinity. Therefore, it is necessary to examine the layout of the port area to provide an appropriate area for empty trailers and containers, and to realize a smooth system for the flow of port-related vehicles.

x) The three container terminals are located in Santiago. However, these terminals do not provide the function of custom clearance for container goods.
Considering the rapid progress of containerization in the future and the narrow land areas of the ports, each of these inland container terminals should also function as a customs house.
It is also desirable that the container terminals be concentrated within a limited area to facilitate customs procedures.

xi) 15.8% of the total freight traffic volume in the metropolitan region is transit freight passing through the region. A substantial portion of this transit cargo is comprised of freight moving between the 5th region and the 6th - 12th regions. This transit cargo contributes to the congestion in the metropolitan area.

A direct route between the 5th region and the 6th - 12th region which would by-pass the metropolitan region should be provided.

The paving project for routes H-66-G and G-830 between Pelequen and San Antonio is already being studied by EMPORCHI as a direct route. This project, or a similar project, should be executed.

VI-4 Future Transport System

(1) Basic Concept of Transport Improvement

1) General

The study on the desirable future transport system in the hinterland of the ports of Valparaiso and San Antonio must consider not only appropriate countermeasures for the problems of the present transport system, but also the future demand for each mode and the need to support the future port functions.

Therefore, we emphasize the following aspects in the study:

- Usage considering the characteristics of each mode
- Dissolution of bottlenecks in the existing transport system
- Coping with the modernization of the ports
- Coping with the Dual Back-up System
- The involvement of the private sector

2) Usage Considering the Characteristics of Each Mode

The volume of cargoes transported by trucks is increasing regularly. This is due to the increases of a variety of cargoes which are handled in small volumes, the value of time and the demand for door-to-door transport and just-in-time transport. This trend may continue in the future.

Under this situation, the main role of railways is to transport a few kinds of cargo in large volumes, cargoes from terminal point to terminal point, cargoes which cannot bear a high transportation charge and heavy cargoes.

Accordingly, it is desirable that railways carry cargoes over a long distance by unit train (freight liner). Cargoes suitable for railway transportation in Chile are copper, wheat, bulky cargoes, oil products, chemical products and domestic cargoes.

3) Dissolution of Bottlenecks in the existing Transport System

Based upon the issues pointed out in Chapter VI-3, we recommend the following as the main means to remove the bottlenecks in the existing transport network in the hinterland.

- Improving the 2-lane sections to 4-lane sections
- R68 throughout
- R78 between El Paico and Melipilla
- Improving the new route between San Antonio and Pelequen
- Paving Route H-66-G and Route G-830

The analysis of the future road demand is executed based on the premise that the road networks will be improved according to this plan.

4) Coping with the Modernization of the Ports

From the viewpoint of the inland transport system, a key point of coping with the modernization of the ports is how to accommodate the rapid increase in container traffic.

Containerization is a system based on consistency between marine transport and overland transport by using international standardized containers. The containerized transport system is capital intensive, and is aimed at reducing transport costs.

Containerization has the following positive impacts:

- Increasing the productivity of tractors and drivers,
- Efficient usage of the terminal,
- Reduction of stevedoring,
- Inexpensive, high quality transport service

In addition, with regard to LCL cargoes, bringing into full play the merit of the container transport system, the shipping brokers should be responsible for the packing and unpacking of LCL Cargo in the inland container freight station. This will also bring about the good result of practical use of the port container terminal within a limited area, and smooth port terminal operations.

In Chile, since the origin and destination of container cargoes concentrate on Santiago, we propose to establish the inland container freight station for LCL cargoes and partial FCL cargoes in Santiago.

5) Coping with the Dual Back-up System

One of the basic concepts of the port master plan is the dual back-up system of aseismic berths.

For this system to function properly, the inland routes between the ports and the city of Santiago must also be aseismic. For aseismic routes, the most important points are the bridges. The details for providing aseismic routes, however, should be examined in another study.

On the other hand, from the viewpoint of the transport network, the dual route system as shown in Fig. VI-4-1 should be established. The paving of the route between San Antonio and Pelequen is essential for the smooth functioning of the network.

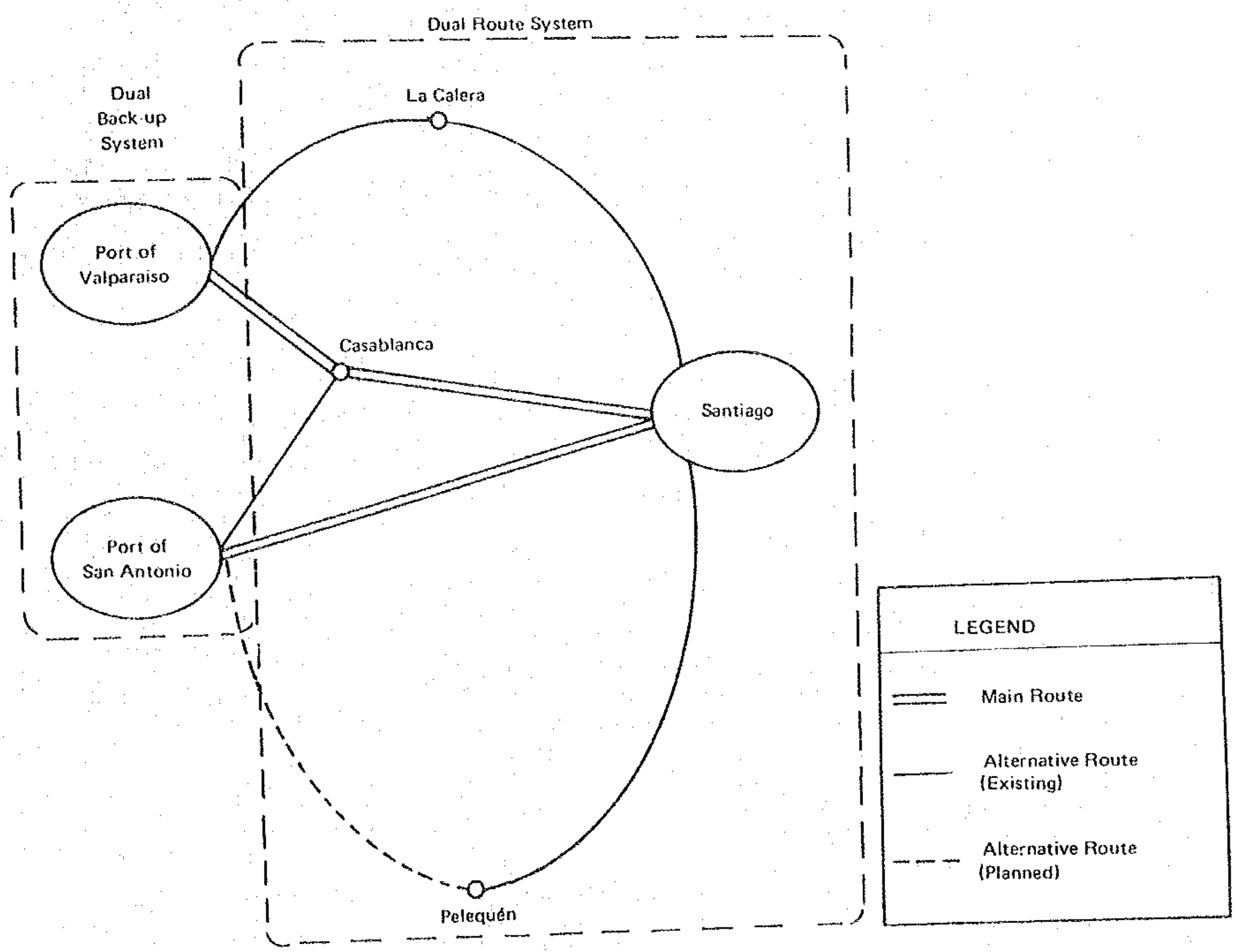


Fig. VI-4-1 Dual Route System

6) The Involvement of the Private Sector

The participation of the private sector in public utility enterprises is generally encouraged to take advantage of the flexibility of the private sector in solving diverse problems. During the recent wave of deregulation in many countries, the intention is to revitalize the economy using private sector capital and initiative.

In Chile, where there is a cumulative national debt of US$18,946 million as of the end of 1984, the public budget is extremely limited and may be insufficient to provide all the necessary infrastructures for social and economic development. Thus, private sector investment is being encouraged to supplement or reduce the amount of investment using public funds.

Furthermore, private sector management tends to be more efficient than management by the public sector. Specifically, the involvement of the private sector in this project may be one way to improve the situation brought about by the worsening management situation of FFCCE.

Thus, in this plan, we propose to positively encourage the participation of the private sector in the development of the inland transport system.

(2) Future OD Traffic Volume

In this section, we forecast the future origin-destination traffic volumes of the main port-related cargoes, based on the present OD patterns and the future port-related cargo volume forecast in Chapter V. The zones of the origin and destination are the following six zones, as the road and railway networks in the north of Region IV and the south of Region VI each concentrate on only one route.

Table VI-4-1 Zones (For OD Table)

1	Port of Valparaiso
2	Port of San Antonio
3	Region I - IV
4	Region V
5	Region Metropolitan
6	Region VI - XII

(i) Fruits and Vegetables (Export)

Table VI-4-2 shows the OD by made for the fruits and vegetables exported in 1984. However, the rate of containerization at the port of San Antonio is unknown.
The future OD volumes are then estimated based on the current patterns and the cargo forecast presented in Chapter V.
The results of the estimation are presented in Table VI-4-3.

Table VI-4-2 Present OD of Export Fruits and Vegetables (1984)

(Unit: tons)

Origin	Trans-portation Mode	Valparaiso					San Antonio
		FCL	LCL	Total containers	Others	Total	Total
Region III	Truck	87	21	108	13,026	13,134	
Region IV	Truck	194	43	237	20,283	20,520	
Region V	Truck	4,231	165	4,396	95,256	99,652	19,292
Region VI	Truck	3,021	82	3,103	121,211	124,314	48,229
Region VII	Truck	1,830	10	1,840	72,525	74,365	28,937
Region VIII	Truck	46		46	3,104	3,150	
Region Metropolitan	Truck	3,081	153	3,234	81,352	34,586	
Total	Truck	12,491	474	12,965	406,757	419,721	56,458

(Source) Multi-Modal Corridor Study

Table VI-4-3 OD of Fruits and Vegetables for Export in 2010

(Unit: '000 tons)

Destination / Origin	Port of Valparaiso		Port of San Antonio		Total
	Container	Non-Container	Container	Non-Container	
Region III, IV	7	61	-	-	68
Region V	84	117	10	31	242
Region Metropolitan	62	111	-	-	173
Region VI - VIII	95	308	41	125	569
Total	248	597	51	156	1,052

(ii) Wheat (Import)

The present OD and the modal split for imported wheat in 1984 is summarized in Table VI-4-4 based on the results of the Multi-Modal Corridor Study.

The future OD volumes are estimated assuming that the present OD patterns will continue through 2010, except for the marginal volume of direct transport from the port of San Antonio to Region IV which we assume will be discontinued. The projection is presented in Table VI-4-5.

Table VI-4-4 Present OD of Imported Wheat (1984)

(Unit: '000 tons)

Origin / Destination	Port of San Antonio		Modal Split	
			Truck	Railway
Region IV	1	% (10.5)	% 66	% 34
Region V	86			
Region Metropolitan	592	(71.3)	44	56
Region VI, VII, VIII, X	151	(18.2)	40	60
Unknown	18	-	72	8
Total	848	(100.0)	46	54

(Source) Multi-Modal Corridor Study

Table VI-4-5 OD of Imported Wheat in 2010

(Unit: '000 tons)

Origin / Destination	Port of San Antonio	
Region V	73	% (10)
Region Metropolitan	521	(72)
Region VI - X	130	(18)
Total	724	(100)

(iii) Copper (Export)

Table VI-4-6 shows the present OD of export copper based on the data of CODELCO, Minera Disputada, Minera Pudahuel and ENAMI. The OD pattern above is presumed to remain unchanged in the future. However, copper from Pudahuel (Minera Pudahuel) and Los Andes (La Andina) will no longer be shipped after 2000 based on the forecast of the commission Chilena de Cobre. The estimated OD of copper in 2010 is presented in Table VI-4-7.

Table VI-4-6 Present OD of Export Copper (1984)

(Unit: '000 tons)

Origin	Transportation Mode	Destination (Ports)			
		Valparaiso	San Antonio	Ventanas	Total
V (Chagres) La Disputada	Railway	2.4	34.3	-	36.7
V (Ventanas) ENAMI	Truck	130.8	6.9	-	137.7
	Railway	32.7	1.7	-	34.4
V (Los Audes) La Andina	Railway	-	-	199.5	199.5
V (El Soldado) La Disputado	Truck	-	19.1	-	19.1
R.M. (Pudahuel) Minera Pudahuel	Truck	10.7	2.7	-	13.4
R.M. (Los Brances) La Disputado	Truck	-	67.5	-	67.5
VI (Caletones) El Teniente	Railway	5.4	313.8		319.2
Total		182.0	446.0	199.5	827.5

(Source) Multi-Modal Corridor Study

Table VI-4-7 OD of Copper for Export in 2010

(Unit: '000 tons)

Destination / Origin	Port of Valparaiso	Port of San Antonio	Total
V (Chagres) La Disputada	-	44	44
V (Ventanas) ENAMI	210	-	210
V (El Soldado) La Disputada	-	47	47
R.M. (Los Bronces) La Disputada	-	47	47
VI (Caletones) El Teniente		342	342
Total	210	480	690

(iv) General Cargo (Export and Import)

The OD of general cargo in 1984 is summarized in Tables VI-4-8 and VI-4-9 using the data of the Multi-Modal Corridor Study. As for the future OD pattern, the Multi-Modal Corridor Study assumes that the flow of both non-containerized and containerized general cargo will remain the same as at present. However, we expect that the volume and share of containerized cargoes will increase rapidly in the future, and therefore that the futrure OD pattern of general cargo will change from the present one. The projected volumes are presented in Table VI-4-10.

Table VI-4-8 Present OD of Imported General Cargo (1984)

(Unit: '000 tons)

Destination \ Origin		Port of Valparaiso		Port of San Antonio		Total
		Container	Non-Container	Container	Non-Container	
Region I-IV	Truck	9.0	5.6	8.2	1.6	24.4
	Rail	-	3.4	0.01	-	3.4
	Ship	0.3	-	0.4	0.001	0.7
Region V	T.	11.5	7.6	17.6	6.4	43.1
	R.	-	2.4	-	2.1	4.5
	S.	-	-	-	-	-
Region M.	T.	121.2	333.2	102.7	57.2	614.3
	R.	3.8	26.0	4.1	-	33.9
	S.	-	-	-	-	-
Region VI-XII	T.	6.9	36.9	7.8	24.8	76.4
	R.	2.6	8.2	0.7	5.7	17.2
	S.	30.6	7.1	1.6	0.6	39.9
Argentina	T.	-	10.5	-	-	10.5
Peru	T.	2.2	-	-	-	2.2
Total	T.	150.8	393.8	136.3	90.0	770.9
	R.	6.4	40.0	4.8	7.8	59.0
	S.	30.9	7.1	2.0	0.6	40.6
	Total	188.1	440.9	143.1	98.4	870.5

(Source) Multi-Modal Corridor Study

Table VI-4-9 Present OD of Exported General Cargo (1984)

(Unit: '000 tons)

Origin \ Destination		Port of Valparaiso Container	Port of Valparaiso Non-Container	Port of San Antonio Container	Port of San Antonio Non-Container	Total
Region I-IV	Truck	5.0	2.1	0.6	-	7.7
	Rail	-	-	-	-	-
	Ship	-	-	-	-	-
Region V	T.	14.7	10.7	4.6	4.5	34.5
	R.	-	-	0.03	-	0.03
	S.	-	-	-	-	-
Region M.	T.	25.5	7.4	28.1	60.6	121.6
	R.	5.5	0.9	-	13.4	19.8
	S.	-	-	-	-	-
Region VI-XII	T.	12.0	12.0	17.6	5.6	47.2
	R.	3.8	3.3	5.9	24.2	37.2
	S.	2.4	4.3	-	-	6.7
Unknown	(T.)	21.2	14.2	13.6	6.5	55.5
Total	T.	78.4	46.4	64.5	77.2	266.5
	R.	9.3	4.2	5.9	37.6	57.0
	S.	2.4	4.3	-	-	6.7
	Total	90.1	54.9	70.4	114.8	330.2

(Source) Multi-Modal Corridor Study

Table VI-4-10 OD of General Cargo in 2010

[Export]

(Unit: '000 tons)

Origin \ Destination (Ports)	Share (%) Container Val.	Share (%) Container S.A.	Share (%) Non-Container Val.	Share (%) Non-Container S.A.	Volume ('000 tons) Container Val.	Volume ('000 tons) Container S.A.	Volume ('000 tons) Non-Container Val.	Volume ('000 tons) Non-Container S.A.
Region I-IV	7	1	5	0	59	1	12	-
Region V	21	8	26	4	176	12	62	18
Region Metropolitan	46	50	21	68	386	74	51	309
Region VI-XII	26	41	48	28	218	61	115	127
Total	100	100	100	100	839	148	240	454
					987		694	

[Import]

Destination \ Origin (Ports)	Share (%) Container Val.	Share (%) Container S.A.	Share (%) Non-Container Val.	Share (%) Non-Container S.A.	Volume ('000 tons) Container Val.	Volume ('000 tons) Container S.A.	Volume ('000 tons) Non-Container Val.	Volume ('000 tons) Non-Container S.A.
Region I-IV	5	6	2	1	100	21	11	9
Region V	6	12	2	9	120	42	11	79
Region Metropolitan	67	75	82	58	1,338	264	433	512
Region VI-XII	21	7	12	32	419	25	63	282
Other Countries	1	0	2	0	20	0	10	0
Total	100	100	100	100	1,997	352	528	882
					2,349		1,410	

(Note) Fruits and vegetables are excluded.

(v) Domestic Cargo

All of the domestic cargoes handled at the ports of Valparaiso and San Antonio are currently transported to and from the region metropolitan as shown in Table VI-4-11.
We expect that the present OD pattern will remain unchanged in the future, and the estimated OD of domestic cargoes in 2010 is as shown in Table VI-4-12.

Table VI-4-11 Present OD of Domestic Cargo (1984)

(Unit: '000 tons)

COMUNA	Transportation Mode	Punta Arenas	Chacabuco	Puerto Montt	Isla de Pascua	Antofagasta	Arica	Iquique	Total
Santiago	Truck	-	-	-	-	-	-	-	-
	Railway	49.042	3.133	31	-	-	-	-	52.206
	Total	49.042	3.133	31	-	-	-	-	52.206
Renca	Truck	1.749	-	-	-	-	-	-	1.749
	Railway	36.348	-	-	-	-	-	-	36.348
	Total	38.097	-	-	-	-	-	-	38.097
Unknown		-	-	-	11.255	332	6	5	11.598
TOTAL	Truck	1.749	-	-	-	-	-	-	1.749
	Railway	85.390	3.133	31	-	-	-	-	88.554
	TOTAL	87.139	3.133	31	11.255	332	6	5	101.901

(Source) Multi-Modal Corridor Study

Table VI-4-12 Overland Traffic Volume of Domestic Cargo

(Unit: '000 tons)

Port	Region Metropolitan	1984	2010 (Estimation)	Modal Split	
				Truck	Railway
Valparaiso	Out	102 (59.0)	105	2.0%	98.0%
	In	71 (41.0)	73	2.0	98.0
	Total	173 (100.0)	178		
San Antonio	Out	2 (1.8)	1	100.0	0.0
	In	108 (98.2)	65	2.0	98.0
	Total	110 (100.0)	66		

(3) Future Modal Split

1) Concept of the Modal Split Model

Actual modal split under competitive conditions is determined not only by the least social or private cost for the supplier of the transportation service, but also by the user's choice based on maximum utility.

Then, the optional investment plan and policies for the transportation system should be determined considering the least socioeconomic cost which will accommodate actual future demand as well as the user's choice.

Therefore, in this study, we determine the future modal split of the transportation system between the hinterland and the ports of Valparaiso and San Antonio using a modal split model based upon a theory of consumer behavior.

We use the logit modal which was developed by a group at MIT to forecast the modal split.

We assume that the number of the competitive modes is two and that the user's utility Um is composed of two parts, a deterministic part u_m and a randoum part ε, as follows:

$$Um = u_m + \varepsilon = \sum_i W_i S_i^m + \varepsilon \qquad (6.1)$$

where $\{S_i^m\}$ is the vector of service attribgutes of mode m, and $\{W_i\}$ is the vector of weights of $\{S_i^m\}$.

The probability that the user will choose model 1, denoted by P_1, is

$$P_1 = \text{prob } (U_1 > U_2) \qquad (6.2)$$

$$P_2 = \text{Prob } (U_2 > U_1) \qquad (6.3)$$

Assuming that the probability distrubution of is a Wibull distribution, the following results are obtained:

$$P_1 = \frac{EXP(U_1)}{EXP(U_1)+EXP(U_2)} \qquad (6.4)$$

$$P_2 = \frac{EXP(U_2)}{EXP(U_1)+EXP(U_2)} \qquad (6.5)$$

Equations (6.4) and (6.5) define a particular stochastic model, the binomial logit model.

For the two choice case it is instructive to define

$$G = U_1 - U_2 \tag{6.6}$$

So that (6.4) and (6.6) become

$$P_1 = \frac{1}{1+EXP(U_2-U_1)} = \frac{1}{1+EXP(-G)} \tag{6.7}$$

$$P^2 = \frac{1}{1+EXP(U_1-U_2)} = \frac{1}{1+EXP(G)} \tag{6.8}$$

These probabilities are shown as a function of G in Fig. IV-4-2. If $U_1 = U_2$, then G = 0 and the probabilities of both choices are the same, 0.5. If, on the other hand $U_1 = U_2 + A'$, then $G = U_1 - U_2 = A'$ and $P_1 = P_1'$ while $P_2 = 1 - P_1' = P_2'$.

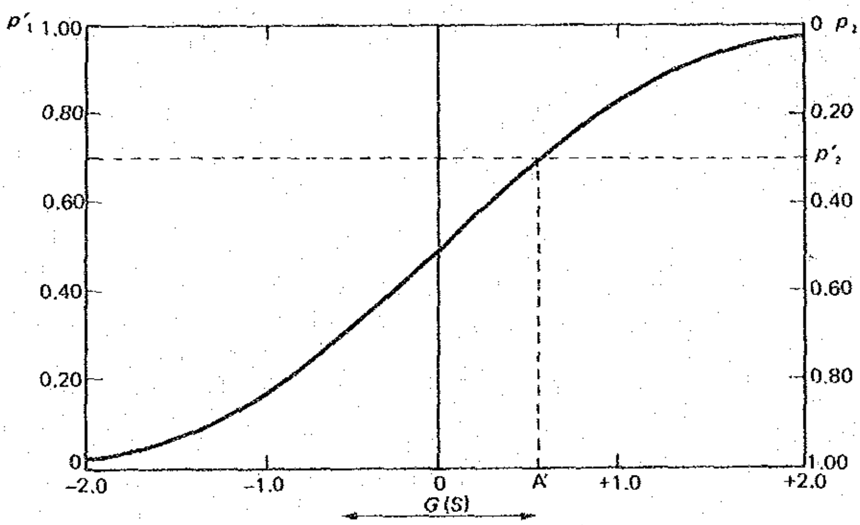


Fig. VI-4-2 Probabilistic Choice

In the previous sections, we forecast the future modal split of fruits and vegetables, copper, and domestic cargoes based on the current modal split.

The future modal split for containers, general cargo and wheat, however, are forecast below using the logit model. The OD pairs are shown in Table VI-4-13.

Table VI-4-13 Summary of the Competitive OD

Product	Origin	Destination	OD Volume in 2010 ('000 tons)	Present Modal Split Truck	Railway	Ship
				%	%	%
Wheat	Port of San Antonio	Region V	73	66	34	-
	"	" Metropolitan	521	44	56	-
	"	" VI-XII	130	40	60	-
General Cargo (Non-Container)	Region Metropolitan	Port of Valparaiso	51	89	11	-
	"	" San Antonio	309	82	18	-
	Region VI-XII	Port of Valparaiso	115	61	17	22
	"	" San Antonio	127	19	81	-
	Port of Valparaiso	Region I-IV	11	62	38	-
	"	" V	11	76	24	-
	"	" Metropolitan	433	93	7	-
	"	" VI-XII	63	71	16	13
	Port of San Antonio	Region V	79	75	25	-
	"	" VI-XII	282	80	18	2
General Cargo (Container)	Region Metropolitan	Port of Valparaiso	386	82	18	-
	Region VI-XII	Port of Valparaiso	218	66	21	13
	"	" San Antonio	61	75	25	-
	Port of Valparaiso	Region I-IV	100	97	3	-
	"	" Metropolitan	1,338	97	3	-
	"	" VI-XII	419	17	6	76
	Port of San Antonio	Region I-IV	21	95	5	-
	"	" Metropolitan	264	96	4	-
	"	" VI-XII	25	77	7	16

2) Determination of Model Structure

We now consider the following freight transportation modal split model.

$$P_T = \frac{EXP(U_T)}{EXP(U_T)+EXP(U_R)} = \frac{1}{1+EXP(U_R-U_T)} \quad (6.9)$$

$$P_R = 1 - P_T \quad (6.10)$$

$$Um = \theta m + \theta_1 Cm + \theta_2 Tm + \theta m' \delta p \quad (6.11)$$

Where P_T = probability of choosing the truck mode

P_R = probability of choosing the railway mode

T_m = trip time by mode m, including inter-city trip time, access or delivery time within the cities and waiting time in the port (hours, one-way)

Cm = trip cost by mode m, including inter-city trip cost and access or feeder in the city and the port (US$, one-way)

δp = dummy variables for the ports,

for the port of Valparaiso, $\delta p = 1$

for the port of San Antonio, $\delta p = 0$

Um = utility of mode m represented as the generalized transport cost

Trip cost is broken down into three general areas as follows:

① Economic cost, for economic analyses such as cost/benefit analysis;
② Financial cost, for financial analyses; and
③ Out-of-Pocket cost, for the modal split analysis.

In the Multi-Modal Corridor Study, economic cost and financial cost are called social cost and private cost, respectively. And, in this paper, we call out-of-pocket cost the user's cost. Table VI-4-14 and VI-4-15 show the comparison of component items of the these costs. Out-of-pocket cost (user's cost) is used as the trip cost Cm in equation (6.11)

Table VI-4-14 Component Items of the Trip Costs (Truck)

Items \ Costs	Economic Cost (Social Cost)	Financial Cost (Private Cost)	Out-of-Pocket Cost (User's Cost)
- Vehicle Operating Cost			
- Interest on Capital	○	○	-
- Depreciation	○	○	-
- Wages and Salaries	○	○	-
- General Expenses	○	○	-
- Fuel	○	○	-
- Lubricants	○	○	-
- Tires	○	○	-
- Vehicle maintenance	○	○	-
- Insurance (Accident Cost)	○	○	-
- Licences	-	○	-
- Toll	-	○	-
- Fare	-	-	○
- Congestion Cost	○	-	-
- Road Maintenance Cost	○	-	-

Table VI-4-15 Component Items of the Trip Costs (Railway)

Items \ Costs	Economic Cost (Social Cost)	Financial Cost (Private Cost)	Out-of-pocket Cost (User's Cost)
- Interest on Capital			
- Land	○	○	-
- Permanent Way	-	-	-
- Buildings	○	○	-
- Equipment	○	○	-
Depreciation			
- Buildings	○	○	-
- Equipment	○	○	-
- Personnel	○	○	-
- Maintenance	○	○	-
- Energy	○	○	-
- General Expenses	○	○	-
- Fare	-	-	○

The parameters θ_1 and θ_2 in equation (6.11) are the same for both modes; θm and $\theta m'$ are specific to each mode. Especially, the parameter θ_2/θ_1 implies the value of time

The values of the these parameters have been determined by multiple linear regression analysis of the following equation using the actual data for $\ln (P_T/P_R)$, $C_T - C_R$, $T_T - T_R$ and δp,

$$\ln (P_T/P_R) = (\theta_T - \theta_R) + \theta_1 (C_T - C_R) + \theta_2 (T_T - T_P) + (Q_T' - \theta_R') \delta p \qquad (6.12)$$

Using the data of the present mode-choice by products as shown Table VI-4-16, the values of the above-mentioned parameters are estimated as shown in Table VI-4-17.

Table VI-4-16 Data on Present Mode Choice

Products	Origin	Destination	Mode	Trip Time[1)] (hours)	Trip Cost[1)] (US$/ton)	Modal[2)] Split (%)
Wheat	Port of San Antonio	Region VI (Talagante)	Truck	6.8	16.90	47.0
			Railway	8.5	26.95	53.0
	Port of San Antonio	Region M. (Santiago)	Truck	8.2	17.30	44.0
			Railway	10.8	28.35	56.0
	Port of San Antonio	Region V. (San Felipe)	Truck	9.9	19.70	66.0
			Railway	13.0	31.05	34.0
	Port of San Antonio	Region VI-X (Curico)	Truck	17.4	70.58	40.0
			Railway	31.8	31.59	60.0
General Cargo	Region M. (Santiago)	Port of Valparaiso	Truck	9.4	26.23	89.2
			Railway	9.8	34.07	10.8
	Region M. (Santiago)	Port of San Antonio	Truck	9.2	27.73	81.9
			Railway	11.8	33.17	18.1
	Region VI. (Rarcaqud)	Port of Valparaiso	Truck	11.3	28.73	95.0
			Railway	18.2	38.92	5.0
	Region VII (Concepcion)	Port of Valparaiso	Truck	21.8	36.63	59.0
			Railway	66.8	48.02	41.0
	Port of Valparaiso	Region M (Santiago)	Truck	9.4	26.23	92.8
			Railway	9.8	35.52	7.2
	Port of Valparaiso	Region V. (San Felipe)	Truck	9.6	26.93	88.1
			Railway	9.0	34.62	11.9
Container	Region VI (Rancagua)	Port of Valparaiso	Truck	13.5	15.89	66.2
			Railway	20.4	27.39	33.8
	Region VIII (Concepcion)	Port of Valparaiso	Truck	24.0	21.43	74.0
			Railway	69.0	34.39	26.0
	Region M. (Santiago)	Port of Valparaiso	Truck	11.6	14.32	81.8
			Railway	12.0	25.76	18.2
	Region VI (Rancagua)	Port of San Antonio	Truck	12.4	15.47	14.9
			Railway	19.0	25.12	85.1
	Port of Valparaiso	Region M. (Santiago)	Truck	11.6	14.32	96.6
			Railway	12.0	25.76	3.4
	Port of San Antonio	Region M. (Santiago)	Truck	11.4	14.56	94.2
			Railway	14.0	24.97	5.8

(Note) 1] See Tables VI-4-19 and VI-4-20
2] Using the data of the Multi-Modal Corridor Study and Estudio de la Eficiencia Institucionaly Economica del Sistema Chileno de Transporte Sector Transporte Terrestre de Carga.
(M.T.T. Naciones Unidas, Comsion Economica para America Latino CEPAL)

Table VI-4-17 Results of the Parameter Value Estimation by Product

Parameter \ Product	Container	t-Value	General Cargo	t-Value	Wheat	t-Value
$\theta_T-\theta_R$	-6.66181	-1.63	5.01745	1.75	-4.85925	-0.75
θ_1	-0.69565	-2.10	0.70470	1.31	-0.46948	-0.77
θ_2	0.19354	1.29	-0.26080	-1.00	0.04887	0.86
$\theta_T'-\theta_R'$	2.41931	2.84	2.91275	1.75	-	-
Coeff. of Determination	0.9284		0.4886		0.5164	

Therefore, the probability of choosing the truck mode is

$$P_T = \frac{1}{1+EXP(U_R-U_T)} + S \qquad (6.13)$$

where $U_R-U_T = 6.66181 - 0.69565\ (C_R-C_T) + 0.19354\ (T_R-T_T) - 2.41931\ \delta p$

,for container,

$U_R-U_T = -5.01745 + 0.70470(C_R-C_T) - 0.26080\ (T_R-T_T) + 2.91275\ \delta p$

,for general cargo,

$U_R-U_T = 4.85925 - 0.46948\ (C_R-C_T) + 0.04887\ (T_R-T_T)$

,for wheat,

S = a revised coefficient (actual value - estimated value)

In case of taking of the dummy variables for the ports, the function $U_R - U_T$ is

$$U_R-U_T = (\theta_R-\theta_T) + \theta_1\ (C_R-C_T) + \theta_2\ (T_R-T_T)$$

$$= 0.9712 - 0.34365\ (C_R-C_T) + 0.45415\ (T_R-T_T)$$

(Coeff. of Determination = 0.63)

The above equation implies that this mode choice model can also be used as a route choice model, for example for the problem of route choice, which is equivalent to port choice, between Santiago and the ports of Valparaiso and San Antonio for the containers Transported by truck.

Table VI-4-18 shows the results of the route choice estimation.

Table VI-4-18 Results of the Estimation of Route Choice between Santiago and the Ports (Containers by Truck)

Item / Case	Us-Uv	Port Choice			
		Import		Export	
		Valparaiso	San Antonio	Valparaiso	San Antonio
Using the social cost	0.99086	40%	60%	44%	56%
Using the private cost	1.08364	38	62	42	58
Using the user's cost (Present)	0.79841	54	46	48	52

(Note) The probability of choosing port Valparaiso Pv is

$$Pv = \frac{1}{1+ EXP(Us-Uv)} + S$$

where S = a revised coefficient (Actual value-Estimated value)

In the case of the transport of the exported and imported containers between Santiago and the ports, the handling at the port of San Antonio has a slight advantage compared with the port of Valparaiso. However, it should be noted that this analysis doesn't take into consideration the handling capacities at the ports or the construction costs of the container berths.

Table VI-4-19 Factor of the Transport Cost by Truck

Products Origin-Destination	Distance (km)	Trip Time (hour)				Trip Cost (US$/ton) Social Cost					Trip Cost (US$/ton) Private Cost					User's Cost			
		Inter -Urban	Access in cities	Waiting in Port	Total	Inter -Urban	Access in Cities	Feeder In Cities	Feeder In Port	Total	Inter -Urban	Access in Cities	Feeder In Cities	Feeder In Port	Total	Inter -Urban	Feeder In City	Feeder In Port	Total
	1)	2)	2)	2)		3)	3)	4)	5)		6)	6)	7)	8)		9)	10)	11)	
Contenedores-Importacion																			
Valparaiso-Santiago	119	2.9	1.5	7.2	11.6	7.43	2.27	3.17	0.89	13.76	7.59	1.88	4.17	1.13	14.77	5.21	4.17	4.94	14.32
San Antonio-Santiago	108	2.7	1.5	7.2	11.4	7.41	1.97	3.17	0.89	13.44	7.25	1.63	4.17	1.13	14.18	5.08		5.31	14.56
San Antonio-Concepcion	606	14.7	1.0	7.2	22.9	26.26	1.20	3.17	0.89	31.52	26.45	1.00	4.17	1.13	32.75	18.10	4.17	5.31	21.58
Contenedores-Exportacion																			
Santiago-Valparaiso	119	2.9	1.5	7.2	11.6	8.73	2.27	3.17	0.89	15.06	8.81	1.90	4.17	1.13	16.01	5.21	4.17	4.94	14.32
Santiago-San Antonio	108	2.7	1.5	7.2	11.4	8.71	1.97	3.17	0.89	14.74	8.48	1.63	4.17	1.13	15.41	5.08	4.17	5.31	14.56
Rancaqua-Valparaiso	202	5.3	1.0	7.2	13.5	13.35	1.39	3.17	0.89	18.8	13.60	1.16	4.17	1.13	20.06	6.78	4.17	4.94	15.89
Rancaqua-San Antonio	158	4.2	1.0	7.2	12.4	11.81	1.20	3.17	0.89	17.07	11.81	1.00	4.17	1.13	18.11	5.99	4.17	5.31	15.47
Curico-Valparaiso	312	7.8	1.0	7.2	16.0	18.18	1.39	3.17	0.89	23.63	18.53	1.16	4.17	1.13	24.99	10.65	4.17	4.94	19.76
Concepcion-Valparaiso	650	15.8	1.0	7.2	24.0	29.24	1.39	3.17	0.89	34.69	29.62	1.16	4.17	1.13	36.08	12.32	4.17	4.94	21.43
Concepcion-San Antonio	606	14.7	1.0	7.2	22.9	30.12	1.20	3.17	0.89	35.38	30.11	1.00	4.17	1.13	36.41	12.10	4.17	5.31	21.58
San Felipe-Valparaiso	127	3.2	1.0	7.2	11.4	9.24	1.39	3.17	0.89	14.69	9.19	1.16	4.17	1.13	15.65	5.46	4.17	4.94	14.57
General Fraccionada-Importacion																			
Valparaiso-Santiago	119	2.9	1.5	5.0	9.4	7.31	2.44	7.48	0.48	17.71	7.57	2.03	9.84	0.72	20.16	6.7	9.84	9.69	26.23
San Antonio-Santiago	108	2.7	1.5	5.0	9.2	7.26	2.11	7.48	0.48	17.33	7.15	1.75	9.84	0.72	19.46	6.7	9.84	11.19	27.73
Valparaiso-Los Andes	143	3.6	1.0	5.0	9.6	8.42	1.50	7.48	0.48	17.88	8.55	1.25	9.84	0.72	20.36	7.4	9.84	9.69	26.93
San Antonio-Concepcion	606	14.7	1.0	5.0	20.7	27.41	1.28	7.48	0.48	36.65	27.70	1.07	9.84	0.72	39.33	16.8	9.84	11.19	37.83
General Fraccionada-Exportacion																			
Santiago-Valparaiso	119	2.9	1.5	5.0	9.4	8.52	2.44	7.48	0.48	18.92	8.72	2.03	9.84	0.72	21.31	6.7	9.84	9.69	26.23
Santiago-San Antonio	108	2.7	1.5	5.0	9.2	8.47	2.11	7.48	0.48	18.54	8.31	1.75	9.84	0.72	20.62	6.7	9.84	11.19	27.73
Rancaqua-Valparaiso	202	5.3	1.0	5.0	11.3	13.38	1.50	7.48	0.48	22.84	13.79	1.25	9.84	0.72	25.6	9.2	9.84	9.69	28.73
Rancaqua-San Antonio	158	4.2	1.0	5.0	10.2	11.69	1.28	7.48	0.48	20.93	11.81	1.07	9.84	0.72	23.44	7.3	9.84	11.19	28.33
Curico-Valparaiso	312	7.8	1.0	5.0	13.8	18.57	1.50	7.48	0.48	28.03	19.08	1.25	9.84	0.72	30.89	14.8	9.84	9.69	34.33
Concepcion-Valparaiso	650	15.8	1.0	5.0	21.8	30.60	1.50	7.48	0.48	40.06	31.13	1.25	9.84	0.72	42.94	17.1	9.84	9.69	36.63
Graneles (Importacion)																			
San Antonio-Santiago	108	2.7	1.5	4.0	8.2	6.98	1.24	4.63	0.48	13.33	6.75	1.02	6.08	0.72	14.57	4.4	6.08	6.82	17.3
San Antonio-San Bernardo	101	2.5	1.0	4.0	7.5	6.51	0.76	4.63	0.48	12.38	6.30	0.63	6.08	0.72	13.73	4.5	6.08	6.82	17.4
San Antonio-San Felipe	241	4.9	1.0	4.0	9.9	11.19	0.76	4.63	0.48	17.06	10.99	0.63	6.08	0.72	18.42	6.8	6.08	6.82	19.7
San Antonio-Talagante	68	1.8	1.0	4.0	6.8	5.17	0.76	4.63	0.48	11.04	5.03	0.63	6.08	0.72	12.46	4.0	6.08	6.82	16.9
San Antonio-Melipilla	42	1.1	1.0	4.0	6.1	3.65	0.76	4.63	0.48	9.52	3.41	0.63	6.08	0.72	10.84	3.8	6.08	6.82	16.7
Fruta (Exportacion)																			
Rancaqud-Valparaiso	202	5.3	1.0	9.7	16.0	18.65	0.82	5.67	0.48	25.62	18.13	0.68	7.46	0.72	26.99	9.2	7.46	7.53	24.19
Rancaqud-San Antonio	158	4.2	1.0	9.7	14.9	16.15	0.67	5.67	0.48	22.97	15.52	0.56	7.46	0.72	24.26	7.3	7.46	8.20	22.96
Santiago-Valparaiso	119	2.9	1.5	9.7	14.1	12.97	1.34	5.67	0.48	20.46	12.49	1.11	7.46	0.72	21.78	6.7	7.46	7.53	21.69
Curico-Valparaiso	312	7.8	1.0	9.7	18.5	24.34	0.82	5.67	0.48	31.31	23.74	0.68	7.46	0.72	32.6	14.8	7.46	7.53	29.79
Curico-San Antonio	268	6.7	1.0	9.7	17.4	21.91	0.67	5.67	0.48	28.73	21.19	0.56	7.46	0.72	29.93	12.5	7.46	8.20	28.16
San Felipe-Valparaiso	127	3.2	1.0	9.7	13.9	13.77	0.82	5.67	0.48	20.74	13.15	0.68	7.46	0.72	22.01	7.4	7.46	7.53	22.39
San Felipe-San Antonio	241	4.9	1.0	9.7	15.6	18.06	0.67	5.67	0.48	24.88	17.31	0.56	7.46	0.72	26.05	12.2	7.46	8.20	27.86
Cobre en Barras (Exportacion)																			
Santiago-Valparaiso	119	2.9	1.5	4.0	8.4	3.93	1.38	3.61	0.48	9.4	4.10	1.15	4.75	0.72	10.72	8.2	4.75	5.06	18.01
Santiago-San Antonio	108	2.7	1.5	4.0	8.2	3.90	1.20	3.61	0.48	9.19	3.85	0.99	4.75	0.72	10.31	8.2	4.75	5.48	18.43
Ventanas-Valparaiso	52	0.6	1.0	4.0	5.6	1.19	0.74	3.61	0.48	6.02	1.14	0.68	4.75	0.72	7.29	3.3	4.75	5.06	13.11
Rancaqua-San Antonio																			

(Note) 1) Distance is measured using a road map.

2) Using half the cycle trip time presented in the Multi-Modal Corridor Study (M.M.C.S.).

3)6) Using the data of the M.M.C.S..

4)7)10) Using the data of the M.M.C.S. for containers and estimating by the rate of the tariff in ports for the other products, which means the handling cost at firms.

5)8) Using the data of the M.M.C.S., which includes "Revision Aduana" and Arriendo de contenedor (US$ 5/TEU·day).

9) Using the data of the M.M.C.S. and estimating by tariff function as shown in Fig. VI-4-3.

11) See Table VI-4-21 -VI-4-25.

Table VI-4-20 Factor of the Transport Cost by Railway

Products Origin-Destination	Distance (Km) 1)	Trip Time (hour): Inter-Urban 2)	Delivery in City 3)	Waiting in Port 4)	Total	Trip Cost (US$/ton): Social Cost: Inter-Urban trip 5)	Devlivery in City 6)	Feeder: In City 7)	Feeder: In Port 8)	Total	Private Cost: Inter-Urban trip 9)	Delivery in City 10)	Feeder: In City 11)	Feeder: In Port 12)	Total	User's Cost: Inter-Urban 13)	Feeder: In City 14)	Feeder: In Port 15)	Total
Contenedores-Importacion																			
Valparaiso-Santiago	186	4.0	0.8	7.2	12.0	8.19	2.13	4.93	10.00	25.25	7.16	2.01	5.63	8.75	23.55	4.30	5.63	15.83	25.76
San Antonio-Santiago	112	6.0	0.8	7.2	14.0	5.93	2.13	4.93	6.65	19.64	5.34	2.01	5.63	6.38	19.36	4.10	5.63	15.24	24.97
San Antonio-Concepcion																			
Contenedores-Exportacion																			
Santiago-Valparaiso	186	4.0	0.8	7.2	12.0	7.18	2.13	4.93	10.00	24.24	6.18	2.01	5.63	8.75	22.57	4.30	5.63	15.83	25.76
Santiago-San Antonio	112	6.0	0.8	7.2	14.0	6.01	2.13	4.93	6.65	19.72	5.28	2.01	5.63	6.38	19.3	4.10	5.63	15.24	24.97
Rancaqua-Valparaiso	268	12.7	0.5	7.2	20.4	9.27	1.33	4.93	10.00	25.53	7.98	1.26	5.63	8.75	23.62	5.92	5.63	15.84	27.39
Rancaqua-San Antonio	152	11.3	0.5	7.2	19.0	8.30	1.33	4.93	6.65	21.21	7.24	1.26	5.63	6.38	20.51	4.25	5.63	15.24	25.12
Curico-Valparaiso	371	23.0	0.5	7.2	30.7	10.74	1.33	4.93	10.00	27.00	9.28	1.26	5.63	8.75	24.92	7.40	5.63	15.84	28.87
Concepcion-Valparaiso	754	61.3	0.5	7.2	69.0	15.15	1.33	4.93	10.00	31.41	13.18	1.26	5.63	8.75	28.82	12.92	5.63	15.84	34.39
Concepcion-San Antonio	638	59.9	0.5	7.2	67.6	14.38	1.33	4.93	6.65	27.29	12.67	1.26	5.63	6.38	25.94	11.25	5.63	15.24	32.12
San Felipe-Valparaiso																			
General Fraccionada-Importacion																			
Valparaiso-Santiago	186	4.0	0.8	5.0	9.8	9.97	2.13	11.63	12.83	36.56	8.72	2.01	13.29	10.58	34.6	4.9	13.29	17.33	35.52
San Antonio-Santiago	112	6.0	0.8	5.0	11.8	6.67	2.13	11.63	6.00	26.43	6.01	2.01	13.29	5.29	26.6	4.7	13.29	15.58	33.57
Valparaiso-Los Andes	140	3.5	0.5	5.0	9.0	11.00	1.33	11.63	12.83	36.79	9.72	1.26	13.29	10.58	34.85	4.0	13.29	17.33	34.62
San Antonio-Concepcion																			
General Fraccionada-Exportacion																			
Santiago-Valparaiso	116	4.0	0.8	5.0	9.8	7.54	2.13	11.63	12.83	34.13	6.53	2.01	13.29	10.58	34.41	4.9	13.29	17.33	35.52
Santiago-San Antonio	112	6.0	0.8	5.0	11.8	5.46	2.13	11.63	6.00	25.22	4.84	2.01	13.29	5.29	25.43	4.3	13.29	15.58	33.17
Rancaqua-Valparaiso	268	12.7	0.5	5.0	18.2	15.47	0.33	11.63	12.83	40.26	13.41	1.26	13.29	10.58	38.54	8.3	13.29	17.33	38.92
Rancaqua-San Antonio	152	11.3	0.5	5.0	16.8	14.20	0.33	11.63	6.00	32.16	12.48	1.26	13.29	5.29	32.32	5.8	13.29	15.58	34.67
Curico-Valparaiso	371	23.0	0.5	5.0	28.5	11.16	0.33	11.63	12.83	35.95	9.70	1.26	13.29	10.58	34.83	7.9	13.29	17.33	38.52
Concepcion-Valparaiso	754	61.3	0.5	5.0	66.8	18.25	0.33	11.63	12.83	43.04	15.98	1.26	13.29	10.58	41.11	17.4	13.29	17.33	48.02
Graneles (Importacion)																			
San Antonio-Santiago	112	6.0	0.8	4.0	10.8	6.10	2.13	7.20	4.22	19.65	5.22	2.01	8.22	3.81	19.26	5.6	8.22	14.53	28.35
San Antonio-San Bernardo	127	9.0	0.5	4.0	13.5	7.87	0.33	7.20	4.22	19.62	6.63	1.26	8.22	3.81	19.92	4.4	8.22	14.53	27.15
San Antonio-San Felipe	235	8.5	0.5	4.0	13.0	11.59	0.33	7.20	4.22	23.34	9.99	1.26	8.22	3.81	23.28	8.3	8.22	14.53	31.05
San Antonio-Talagante	79	4.0	0.5	4.0	8.5	5.54	0.33	7.20	4.22	17.29	4.67	1.26	8.22	3.81	17.96	4.2	8.22	14.53	26.95
San Antonio-Melipilla	51	2.5	0.5	4.0	7.0	5.06	0.33	7.20	4.22	16.81	4.19	1.26	8.22	3.81	17.48	3.4	8.22	14.53	26.15
Fruta (Exportacion)																			
Rancaqua-Valparaiso																			
Rancaqua-San Antonio																			
Santiago-Valparaiso																			
Curico-Valparaiso																			
Curico-San Antonio	255	21.6	0.5	9.7	31.8	8.14	0.33	8.82	4.88	22.17	7.51	1.26	10.08	4.35	23.2	7.1	10.08	16.81	33.99
San Felipe-Valparaiso																			
San Felipe-San Antonio																			
Cobre en Barras (Exportacion)																			
Santiago-Valparaiso																			
Santiago-San Antonio																			
Ventanas-Valparaiso																			
Rancaqua-San Antonio	152	11.3	0.5	4.0	15.8	6.67	0.33	5.62	3.59	16.21	5.83	1.26	6.41	3.28	16.78	5.6	6.41	12.31	24.32

(Note)
1) Using the data of FFCCE, such as traffic diagrams.
2) Using the average time of the traffic diagram of the San Antonio line and the Valparaiso line, and assuming that the running speed on the other line is 10 km/hr.
3) Assuming that delivery time is the same as the access time in inland cities by truck.
4) Assuming the same value as for trucks.
5)9) Using the data of the M.M.C.S..
6)10) Using the data of the M.M.C.S. for containers and estimating by the rate of delivery time for other products.
7)8)11) 12)14) Using the data of the M.M.C.S. for containers, and estimating by the rate of the tariff in the ports for other products, which mean the handling cost.
13) Using the data of the M.M.C.S. and estimating by tariff function as shown in Fig. VI-4-4.
15) See Table VI-4-21 - VI-4-25.

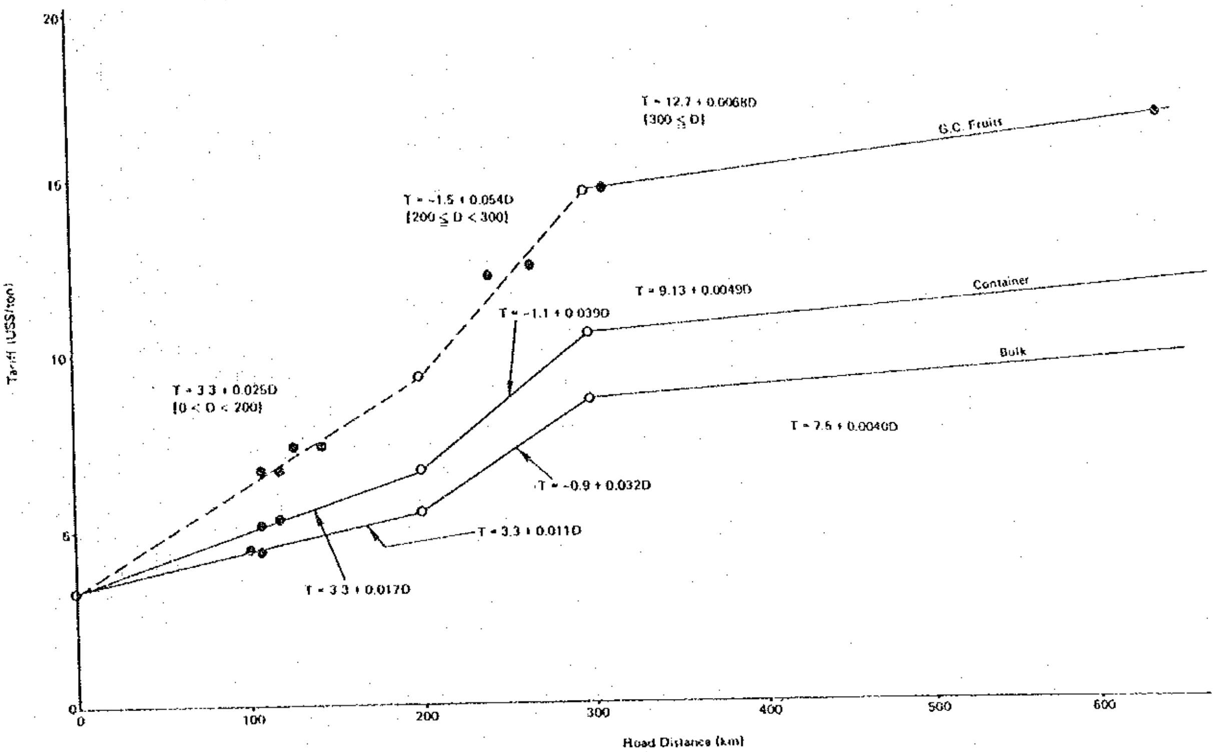


Fig. VI-4-3 Transport Tariff Function by Truck

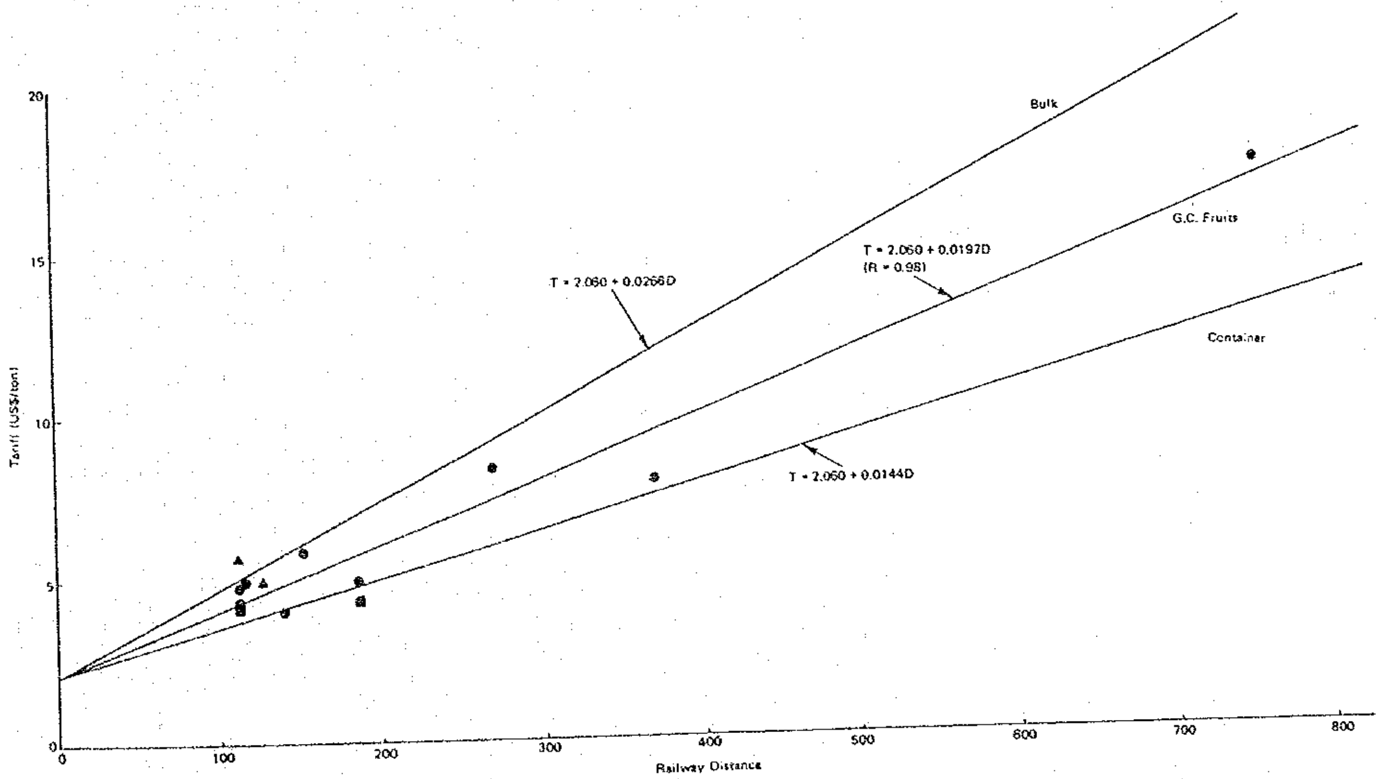


Fig. VI-4-4 Transport Tariff Function by Railway

Table VI-4-21 User's Cost of Containers (FCL) in the Port

Item		Port of Valparaiso			Port of San Antonio		
		Truck		Railway	Truck		Railway
		Direct	Indirect	Indirect	Direct	Indirect	Indirect
Tarifa de Transferencia	1)	37.14	37.14	37.14	36.64	36.64	36.64
Tarifa de Portaje	1)	8.5	53.0	53.0	13.5	46.5	46.5
Llevar a Revision en Cosuion	2)	-	-	4.7	-	-	4.7
Transfer a FF.CC.	2)	-	-	6.2	-	-	3.5
Tarifa de Almacenje	1) 2)	-	10.2	40.32	-	12.0	42.96
Revision Aduana	2)	8.6	8.6	8.6	8.6	8.6	8.6
Otras (Arriendo de contandor)	2)	5.0	20.0	40.0	5.0	20.0	40.0
Total US$/TEU		59.24	128.94	189.96	63.74	123.74	182.9
US$/ton		4.94	10.75	15.83	5.31	10.31	15.24

Note 1) Using the data of EMPORCHI's tariff and the private sector tariff.
2) Using the data of the Multi-Modal Corridor Study.
3) Assuming handling by the private sector.

Table VI-4-22 User's Cost of General Cargo in the Port

Item		Port of Valparaiso			Port of San Antonio		
		Truck		Railway	Truck		Railway
		Direct	Indirect	Indirect	Direct	Indirect	Indirect
Tarifa de Transferencia	1)	5.97	5.97	5.97	7.47	7.47	7.47
Tarifa de Portaje	1)	3.00	7.00	7.00	3.00	4.00	4.00
Llevar a Revision on Cosuion	2)	-	-	0.39	-	-	0.39
Transfer a FF.CC.	2)	-	-	0.52	-	-	0.29
Tarifa de Almacenje	1) 2)	-	0.75	2.73	-	0.50	2.71
Revision Aduana	2)	0.72	0.72	0.72	0.72	0.72	0.72
Others		-	-	-	-	-	-
Total US$/ton		9.69	14.44	17.33	11.19	12.69	15.58

Note 1) Using the data of EMPORCH's tariff and the private sector tariff.
2) Using the data of the Multi-Modal Corridor study.
3) Assuming handling by the private sector.

Table VI-4-23 User's Cost of Bulk Cargo in the Port

Item		Port of Valparaiso			Port of San Antonio		
		Truck		Railway	Truck		Railway
		Direct	Indirect	Indirect	Direct	Indirect	Indirect
Tarifa de Transferencia / Tarifa de Portaje	1)	5.55	10.97	10.97	6.10	10.12	10.12
Llevar a Revision on Cosuion	3)	-	-	0.39	-	-	0.39
Transfer a FF.CC.	3)	-	-	0.52	-	-	0.29
Tarifa de Almacenje	2)3)	-	0.65	2.56	-	0.84	3.01
Revision Aduana	3)	0.72	0.72	0.72	0.72	0.72	0.72
Others		-	-	-	-	-	-
Total US$/ton		6.27	12.34	15.16	6.82	11.68	14.53

Note 1) Assuming the cost is 1.46 times the cost of container cargoes based on the ratio in Japan.
2) Using the data of EMPORCHI's tariff and the private sector tariff.
3) Using the data of the Multi-Modal Corridor Study.
4) Assuming handling by the private sector.

Table VI-4-24 User's Cost of Fruits & Vegetables in the Port

Item		Port of Valparaiso			Port of San Antonio		
		Truck		Railway	Truck		Railway
		Direct	Indirect	Indirect	Direct	Indirect	Indirect
Tarifa de Transferencia Tarifa de Portaje	1)	6.81	13.45	13.45	7.48	12.40	12.40
Llevar a Revision on Cosuion	3)	-	-	0.39	-	-	0.39
Transfer a FF.CC.	3)	-	-	0.52	-	-	0.29
Tarifa de Almacenje	3)	-	0.65	2.56	-	0.84	3.01
Revision Aduana	2)3)	0.72	0.72	0.72	0.72	0.72	0.72
Others	3)	-	-	-	-	-	-
Total US$/ton		7.53	14.82	17.64	8.20	13.96	16.81

Note 1) Assuming the cost in 1.79 times the cost of container cargoes based on the ratio in Japan.
2) Using the data of EMPORCHI's tariff and the private sector tariff.
3) Using the data of the Multi-Modal Corridor study.
4) Assuming handling by the private sector.

Table VI-4-25 User's Cost of Copper in the Port

Item		Port of Valparaiso			Port of San Antonio		
		Truck		Railway	Truck		Railway
		Direct	Indirect	Indirect	Direct	Indirect	Indirect
Tarifa de Transferencia Tarifa de Portaje	1)	4.34	8.56	8.56	4.76	7.90	7.90
Llevar a Revision en Cosuion	3)	-	-	0.39	-	-	0.39
Transfer a FF.CC.	3)	-	-	0.52	-	-	0.29
Tarifa de Almacenje	3)	-	0.65	2.56	-	0.84	3.01
Revision Aduana	2)3)	0.72	0.72	0.72	0.72	0.72	0.72
Others	3)	-	-	-	-	-	-
Total US$/ton		5.06	9.93	12.75	5.48	9.46	12.31

Note. 1) Assuming the cost is 1.14 times the cost of container cargoes based on the ratio in Japan.
2) Using the data of EMPORCHI's tariff and the private sector tariff.
3) Using the data of the Multi-Modal Corridor Study.
4) Assuming handling by the private sector.

3) Results of the Futrure Desirable Modal Split Forecast

We now obtain the futrure modal split of the inland transportation by using the modal split model presented above equation (6.13) and the data on the number of trips and the trip costs in 2010 by product and by OD.

Then, using the social cost for the trip cost, we obtain the desirable modal split from the socioeconomic viewpoint. This implies that the present transport tariff system should be changed to one which would counterbalance the social costs. Trip time are calculated on the premise that route H-66-G and G-830 have been improved.

The results of the estimation of the desirable modal split in 2010, using the data of Tables VI-4-26 - VI-4-29, are presented in Tables VI-4-30.

Table VI-4-26 Fruits & Vegetables

O	D	Mode	Distance (Km)	Trip Time (hours) Inter-Urban	In City	Waiting in Port	Total	Trip Cost (US$/ton) Social Cost Inter-Urban	Access	Feeder City	Feeder Port	Total	User's Cost Inter-Urban	Feeder City	Feeder Port	Total
III-IV (La Selena)	Valparaiso	T	389	9.7	1.0	9.7	20.4	22.67	0.82	5.67	0.48	29.64	15.4	7.46	7.53	30.39
V (San Felipe)	"	T	127	3.2	1.0	9.7	13.9	13.77	0.82	5.67	0.48	20.74	7.4	7.46	7.53	22.39
M (Santiago)	"	T	119	2.9	1.5	9.7	14.1	12.97	1.34	5.67	0.48	20.46	6.7	7.46	7.53	21.69
VI-VII (Rancagua)	"	T	202	5.3	1.0	9.7	16.0	18.65	0.82	5.67	0.48	25.62	9.2	7.46	7.53	24.19
V (San Felipe)	San Antonio	T	241	4.9	1.0	9.7	15.6	18.06	0.67	5.67	0.48	24.88	12.2	7.46	8.20	27.86
VI-VII (Curico)	"	T	268	6.7	1.0	9.7	17.4	21.91	0.67	5.67	0.48	28.73	12.5	7.46	8.20	28.16
		T	(205)	(5.1)	(1.0)		(15.8)	(16.76)				(23.58)	(9.6)			(25.26)

Table VI-4-27 Wheat

O	D	Mode	Distance (Km)	Trip Time (hours) Inter-Urban	In City	Waiting in Port	Total	Trip Cost (US$/ton) Social Cost Inter-Urban	Access	Feeder City	Feeder Port	Total	User's Cost Inter-Urban	Feeder City	Feeder Port	Total
San Antonio	V (San Felipe)	T	241	4.9	1.0	4.0	9.9	11.19	0.76	4.63	0.48	17.06	6.8	6.08	6.82	19.70
"	M (Santiago)	T	108	2.7	1.5	4.0	8.2	6.98	1.24	4.63	0.48	13.33	4.4	6.08	6.82	17.30
"	VI-X (Curico)	T T	268 (205)	6.7 (5.1)	1.0	4.0	11.7 (10.1)	12.44 (9.58)	0.76	4.63	0.48	18.31 (15.45)	7.7 (5.7)	6.08	6.82	20.60 (18.60)
San Antonio	V (San Felipe)	R	235	8.5	0.5	4.0	13.0	11.59	0.33	7.20	4.22	23.34	8.3	8.22	14.53	31.05
"	M (Santiago)	R	112	6.0	0.8	4.0	10.8	6.10	2.13	7.20	4.22	19.65	5.6	8.22	14.53	28.35
"	VI-X (Curico)	R	255	21.6	0.5	4.0	26.1	12.58	0.33	7.20	4.22	24.33	8.8	8.22	14.53	31.55

Table VI-4-28 General Cargo

O	D	Mode	Distance (Km)	Trip Time (hours) Inter-Urban	Trip Time In City	Trip Time Waiting in Port	Trip Time Total	Trip Cost (US$/ton) Social Cost Inter-Urban	Social Cost Access	Social Cost Feeder City	Social Cost Feeder Port	Social Cost Total	User's Cost Inter-Urban	User's Cost Feeder City	User's Cost Feeder Port	User's Cost Total
I-IV (La Selena)	Valparaiso	T	389	9.7	1.0	5.0	15.7	23.15	1.50	7.48	0.48	32.61	15.3	9.84	9.69	34.83
V (Los Andes)	"	T	143	3.6	1.0	5.0	9.6	9.81	1.50	7.48	0.48	19.27	6.9	9.84	9.69	26.43
M (Santiago)	"	T	119	2.9	1.5	5.0	9.4	8.52	2.44	7.48	0.48	18.92	6.7	9.84	9.69	26.23
VI-XII (Curico)	"	T	312	7.8	1.0	5.0	13.8	18.57	1.50	7.48	0.48	28.03	14.8	9.84	9.69	34.33
V (Los Andes)	San Antonio	T	188	4.7	1.0	5.0	10.7	12.90	1.50	7.48	0.48	22.36	8.0	9.84	11.19	27.53
M (Santiago)	"	T	108	2.7	1.5	5.0	9.2	8.47	2.11	7.48	0.48	18.54	6.7	9.84	11.19	27.73
VI-VII (Curico)	"	T	268 (205)	6.7 (5.1)	1.0	5.0	12.7 (11.1)	15.95 (12.20)	1.50	7.48	0.48	25.41 (21.66)	13.0 (9.6)	9.84	11.19	32.53 (30.63)
Valparaiso	I-IV (La Selena)	T	389	9.7	1.0	5.0	15.7	19.86	1.50	7.48	0.48	29.32	15.3	9.84	9.69	34.83
"	V (Los Andes)	T	143	3.6	1.0	5.0	9.6	8.42	1.50	7.48	0.48	17.58	7.4	9.84	9.69	26.93
"	M (Santiago)	T	119	2.9	1.5	5.0	9.4	7.31	2.44	7.48	0.48	17.71	1.7	9.84	9.69	26.23
"	VI-XII (Concepcion)	T	650	15.8	1.0	5.0	21.8	26.25	1.50	7.48	0.48	35.71	17.1	9.84	9.69	36.63
San Antonio	I-IV (La Selena)	T	503	12.6	1.0	5.0	18.6	25.68	1.50	7.48	0.48	35.14	16.1	9.84	11.19	37.13
"	V (Los Andes)	T	188	4.7	1.0	5.0	10.7	11.07	1.50	7.48	0.48	20.53	8.0	9.84	11.19	27.53
"	M (Santiago)	T	108	2.7	1.5	5.0	9.2	7.26	2.11	7.48	0.48	17.23	6.7	9.84	11.19	27.73
"	VI-XII (Conception)	T	606 (543)	14.7 (13.6)	1.0	5.0	20.7 (19.6)	27.41 (24.56)	1.28	7.48	0.48	36.65 (33.80)	16.8 (16.4)	9.84	11.19	37.83 (37.43)
M (Santiago)	Valparaiso	R	116	4.0	0.8	5.0	9.8	7.54	2.13	11.63	12.83	34.13	4.9	13.29	17.33	35.52
VI-XII (Curico)	"	R	371	23.0	0.5	5.0	28.5	11.16	0.33	11.63	12.83	35.95	7.9	13.29	17.33	38.52
M (Santiago)	San Antonio	R	112	6.0	0.8	5.0	11.8	5.46	2.13	11.63	6.00	25.22	4.3	13.29	15.58	33.17
VI-XII (Curico)	"	R	255	21.6	0.5	5.0	27.1	7.67	0.33	11.63	6.00	25.63	7.1	13.29	15.58	35.97
Valparaiso	I-IV (La Selera)	R	738	68.5	0.5	5.0	74.0	23.61	1.33	11.63	12.83	49.40	16.6	13.29	17.33	47.22
"	V (Los Andes)	R	140	3.5	0.5	5.0	9.0	11.00	1.33	11.63	12.83	36.79	4.0	13.29	17.33	34.62
"	M (Santiago)	R	186	4.0	0.8	5.0	9.8	9.97	2.13	11.63	12.83	36.56	4.9	13.29	17.33	35.52
"	VI-XII (Concepcion)	R	754	61.3	0.5	5.0	66.8	24.13	1.33	11.63	12.83	49.92	16.9	13.29	17.33	47.52
San Antonio	V (Los Andes)	R	250	9.0	0.5	5.0	14.5	9.19	1.33	11.63	6.00	28.15	7.0	13.29	15.58	35.87
"	VI-XII (Concepcion)	R	638	59.9	0.5	5.0	65.4	15.96	1.33	11.63	6.00	34.92	14.6	13.29	15.58	43.47

Table VI-4-29 Containers

O	D	Mode	Distance	Trip Time (hours)				Trip Cost (US$/ton)						User's Cost			
								Social Cost									
				Inter-Urban	In City	Waiting in Port	Total	Inter-Urban	Access	Feeder City	Feeder Port	Total	Inter-Urban	Feeder City	Feeder Port	Total
			(Km)													
I-IV (La Seleno)	Valparaiso	T	389	9.7	1.0	7.2	17.9	22.67	1.39	3.17	0.89	28.12	11.0	4.17	4.94	20.11
V (San Felipe)	"	T	127	3.2	1.0	7.2	11.4	9.24	1.39	3.17	0.89	14.69	5.5	4.17	4.94	14.61
M (Santiago)	"	T	119	2.9	1.5	7.2	11.6	8.73	2.27	3.17	0.89	15.06	5.2	4.17	4.94	14.31
VI-XII (Rancagua)	"	T	202	5.3	1.0	7.2	13.5	13.35	1.39	3.17	0.89	18.80	6.8	4.17	4.94	15.91
I-IV (La Selena)	San Antonio	T	503	12.6	1.0	7.2	20.8	25.00	1.20	3.17	0.89	30.26	11.6	4.17	5.31	21.08
V (San Felipe)	"	T	204	5.1	1.0	7.2	13.3	15.25	1.20	3.17	0.89	20.51	10.1	4.17	5.31	19.58
M (Santiago)	"	T	108	2.7	1.5	7.2	11.4	8.71	1.97	3.17	0.89	14.74	5.1	4.17	5.31	14.58
VI-XII (Concepcion)	"	T	606	14.7	1.0	7.2	22.9	30.12	1.20	3.17	0.89	35.38	12.1	4.17	5.31	21.58
			(543)	(13.6)			(21.8)	(26.99)				(32.25)	(11.8)			(21.28)
Valparaiso	I-IV (La Selena)	T	389	9.7	1.0	7.2	17.9	19.29	1.39	3.17	0.89	24.74	11.0	4.17	4.94	20.11
"	V (San Felipe)	T	127	3.2	1.0	7.2	11.4	7.86	1.39	3.17	0.89	13.31	5.5	4.17	4.94	14.61
"	M (Santiago)	T	119	2.9	1.5	7.2	11.6	7.43	2.27	3.17	0.89	13.76	5.2	4.17	4.94	14.31
"	VI-XII (Runcagua)	T	202	5.3	1.0	7.2	13.5	11.36	1.39	3.17	0.89	16.81	6.8	4.17	4.94	15.91
San Antonio	I-IV (La Selena)	T	503	12.6	1.0	7.2	20.8	21.27	1.20	3.17	0.89	26.53	11.6	4.17	5.31	21.08
"	V (San Felipe)	T	204	5.1	1.0	7.2	13.3	12.97	1.20	3.17	0.89	18.23	10.1	4.17	5.31	19.58
"	M (Santiago)	T	108	2.7	1.5	7.2	11.4	7.41	1.97	3.17	0.89	13.44	5.1	4.17	5.31	14.58
"	VI-XII (Concepcion)	T	606	14.7	1.0	7.2	22.9	30.12	1.20	3.17	0.89	31.52	12.1	4.17	5.31	21.58
			(543)	(13.6)			(21.8)	(26.99)				(28.79)	(11.8)			(21.28)
M (Santiago)	Valparaiso	R	186	4.0	0.8	7.2	12.0	7.18	2.13	4.93	10.00	24.24	4.3	5.63	15.83	25.76
VI-XII (Runcaqua)	"	R	263	12.7	0.5	7.2	20.4	9.27	1.33	4.93	10.00	25.53	5.9	5.63	15.83	27.38
VI-XII (Concepcion)	San Antonio	R	638	59.9	0.5	7.2	67.6	14.38	1.33	4.93	6.65	27.29	11.25	5.63	15.24	32.12
Valparaiso	M (Santiago)	R	186	4.0	0.8	7.2	12.0	8.19	2.13	4.93	10.00	25.25	4.3	5.63	15.83	25.76
"	VI-XII (Runcaqua)	R	268	12.7	0.5	7.2	20.4	10.51	1.33	4.93	10.00	26.83	5.9	5.63	15.83	27.38
San Antonio	M (Santiago)	R	112	6.0	0.8	7.2	14.0	5.93	2.13	4.93	6.65	19.64	4.10	5.63	15.24	24.97
"	VI-XII (Concepcion)	R	638	59.9	0.5	7.2	67.6	14.19	1.33	4.93	6.65	27.10	11.25	5.63	15.24	32.12

Table VI-4-30 OD Structure by Product

Product	Origin	Destination	1984 OD Volume (1,000 tons)	1984 Modal Split (%)		2010 OD Volume (1,000 tons)	2010 Modal Split (%)	
Fruits & Vegetables	Region I - IV	P. of Valparaiso	33	T	100	61	T	100
	Region V	P. of Valparaiso	95	T	100	117	T	100
		P. of San Antonio	unknown	T	100	31	T	100
	Region Metropolitan	P. of Valparaiso	81	T	100	111	T	100
	Region VI-XII	P. of Valparaiso	197	T	100	308	T	100
		P. of San Antonio	unknown	T	100	125	T	100
Wheat	P. of San Antonio	Region I - IV	1	unknown		—	–	—
		Region V	86	T R	66 34	73	T R	19 81
		Region Metropolitan	592	T R	44 56	521	T R	1 99
		Region VI-XII	151	T R	40 60	130	T R	19 81
Copper	Region I-IV	P. of Valparaiso	5.4	R	100	-	R	100
	Region V	Ventanas	199	R	100	-	R	100
		P. of Valparaiso	2	R	100	-	R	100
		P. of San Antonio	53	T R	64 36	91	T R	52 48
	Ventanas	P. of Valparaiso	163	T R	80 20	210	T R	80 20
	Ventanas	P. of San Antonio	9	T R	80 20	-	T R	80 20
	Region Metropolitan	P. of Valparaiso	11	T	100	-	T	100
		P. of San Antonio	70	T	100	47	T	100
	Region VI-XII	P. of San Antonio	314	R	100	342	R	100
General Cargo (Non-containerized)	Region I- IV	P. of Valparaiso	2	T	100	12	T	100
	Region V	P. of Valparaiso	11	T	100	62	T	100
		P. of San Antonio	5	T	100	18	T	100
	Region Metropolitan	P. of Valparaiso	8	T R	89 11	51	T R	88 12
		P. of San Antonio	74	T R	82 18	309	T R	68 32
	Region VI-XII	P. of San Antonio	30	T R	19 81	127	T R	19 81
	P. of Valparaiso	Region I-IV	9	T R	62 38	11	T R	58 42
		Region V	10	T R	76 24	11	T R	73 27
		Region Metropolitan	359.2	T R	93 7	433	T	100
		Region VI- XII	52.2	T R S	71 16 13	63	T R S	71 18 11
	P. of San Antonio	Region I-IV	1.6	T	100	9	T	100
		Region V	8.5	T R	75 25	79	T R	87 13
		Region Metropolitan	57.2	T	100	512	T	100

Products	Origin	Destination	1984			2010		
			OD Volume (1,000 tons)	Modal Split (%)		OD Volume (1,000 tons)	Modal Split (%)	
		Region IV-XII	31.1	T R S	80 18 2	282	T R S	82 17 1
General Cargo (Containerized)	Region I-IV	P. of Valparaiso	5	T	100	59	T	100
		P. of San Antonio	0.6	T	100	1	T	100
	Region V	P. of Valparaiso	15	T	100	176	T	100
		P. of San Antonio	5	T R	99.4 0.6	12	T	100
	Region Metropolitan	P. of Valparaiso	31	T R	82 18	386	T R	74 26
		P. of San Antonio	5	T R	99.4 0.6	12	T	100
	Region VI-XII	P. of Valparaiso	18	T R S	66 21 13	218	T R S	13 86 1
		P. of San Antonio	24	T R	75 25	61	T R	74 25
	P. of Valparaiso	Region I-IV	9.3	T S	97 3	100	T	100
		Region V	11.5	T	100	120	T	100
		Region Metropolitan	125	T R	97 3	1,338	T R	98 2
		Region VI-XII	40.1	T R S	17 6 76	419	T R S	57 36 7
	P. of San Antonio	Region I-IV	8.6	T S	95 5	21	T	100
		Region V	17.6	T	100	42	T	100
		Region Metropolitan	106.8	T R	96 4	264	T R	49 51
		Region VI-XII	10.1	T R S	77 7 16	25	T R S	87 11 2
Containerized Fruits & Vegetables	Region I-IV	P. of Valparaiso	0.3	T	100	7	T	100
	Region V	P. of Valparaiso	4.4	T	100	84	T	100
		P. of San Antonio	unknown			10	T	100
	Region Metropolitan	P. of Valparaiso	1.2	T	100	95	T	100
	Region VI-XII	P. of Valparaiso	5.0	T	100	62	T	100
		P. of San Antonio	unknown			41	T	100
Domestic Cargo	Region Metropolitan	P. of Valparaiso	102	T R	2 98	105	T R	2 98
		P. of San Antonio	2	T	100	1	T	100
	P. of Valparaiso	Region Metropolitan	71	T R	2 98	73	T R	2 98
	P. of San Antonio	Region Metropolitan	108	T R	2 98	65	T R	2 98

(Note) 1. T: Truck, R: Railway
2. Excluding the ship mode.

(4) Desirable Inland Transport System Plan

1) Interregional Transport

i) Roads

Fig. VI-4-5 summarizes the OD traffic volume transported by truck estimated by the modal split model.

In order to express the traffic flow of the road in terms of equivalent vehicles, the following conversion factors based on the data of the Multi-Modal Carridor Study are used:

- Conversion from "tons" to "vehicles"

Containers	20 foot (60%)	12.2 tons
	40 foot (40%)	16.5 tons
	Average	13.92 tons/TEU vehicle
Non-Containerized	Small Trucks (15%)	6.7 tons
	Big Trucks (85%)	22.9 tons
	Average	20.5 tons/vehicle

- conversion from vehicles to equivalent vehicles:

  Trucks: 3.78 equivalent vehicles

Thus, Fig. VI-4-6 shows the road traffic flow of the port-related cargoes in 2010 in terms of equivalent vehicles.

We now assume that the growth ratio of other vehicles is similar to the one (1.64) of the hinterland population. Based on this assumption, the present and future traffic flows on Route 68 and Route 78, and the growth ratios are presented in Table VI-4-31.

Table VI-4-31 Growth Ratio of the Traffic Flows

Route	Year	Trucks	Others (equivalent vehicles)	Total	Growth Ratio (2010/1984)
68 1)	1984	1,182	4,474	5,656	1.90
	2010	3,418	7,341	10,759	
78 2)	1984	922	2,015	2,937	1.61
	2010	1,421	3,306	4,727	

(Note) 1) Using the data from the ZAPATA toll gate.
2) Using the data from the POMAIRE toll gate.

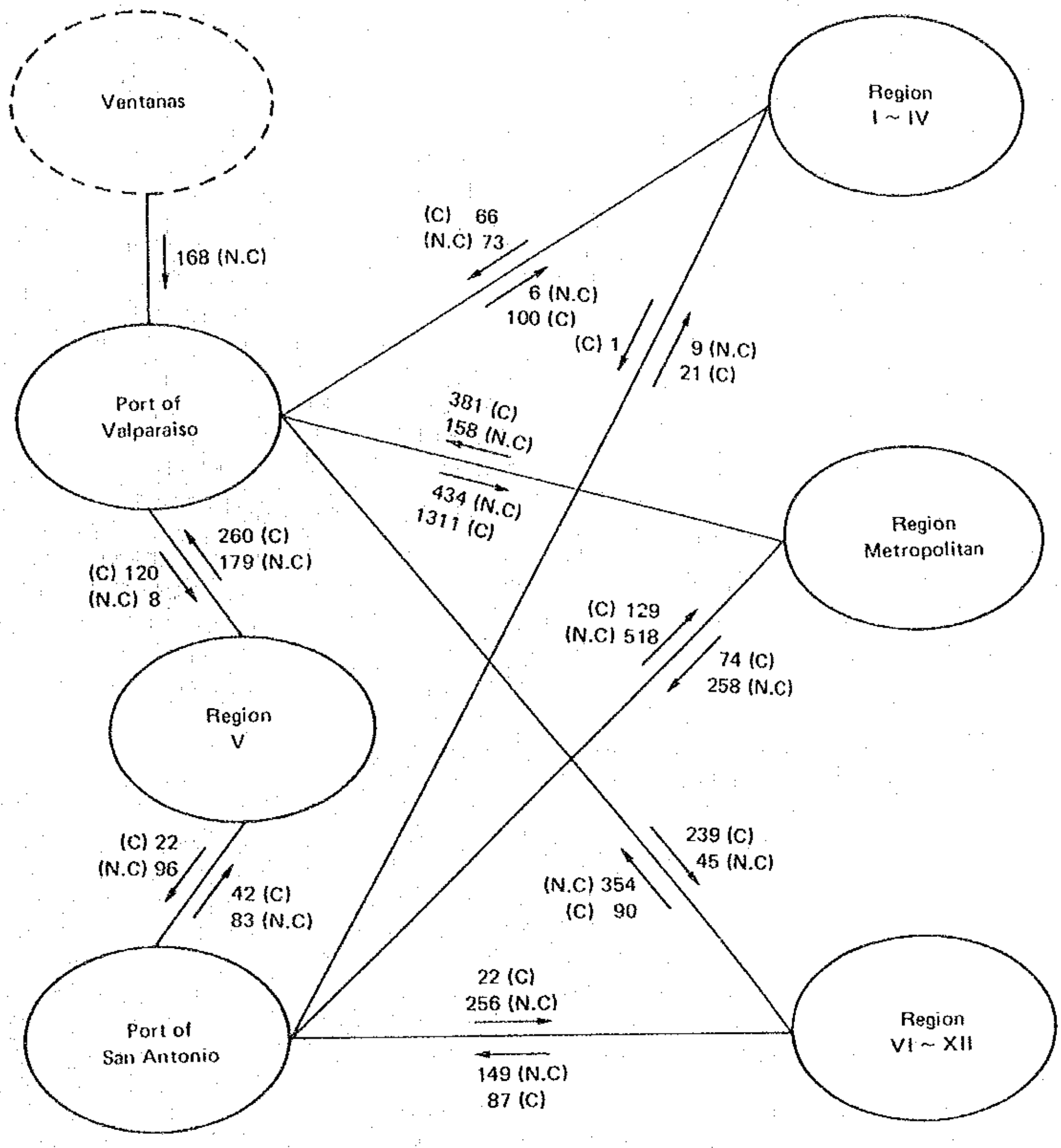
Using the growth ratios of each route calculated above, we can estimate the road service levels in 2010 as shown in Table VI-4-32 and VI-4-33. Judging from these tables, the traffic capacities on both routes throughout are sufficient. Even in the summer season which includes the months with the maximum traffic volume, there is no serious problem

Finally, based upon the above-mentioned analysis, we propose interregional road projects as shown in Table VI-4-34, which require a total investment of 37.4 million US$.

The double highway projects on Route 68 and Route 78 will reduce congestion, and these roads could also function as a lifeline in case of emergency. From the viewpoint of national security, such lifelines should be established between Santiago and the ports of Valparaiso and San Antonio. Therefore, the tunnels and the bridges on both routes should be designed, constructed or restored as aseismic structures, so that these lifelines would be fully functional in case of earthquake. The upgrading of these structures would involve another detailed study.

Restoring and paving projects on Route H-66-G and Route G-830 would create a shortcut of 63 Km between Pelequen and San Antonio. This shortcut would reduce the trip time by approximately 7.6 hours and the social transport cost by 5.15 US$/ton.
In addition, this project would reduce the harmful impact on the city environment by routing the through traffic to bypass the city of Santiago.

(Unit: '000 tons/year)



Note: C: Container N.C.: Non-Container

Fig. VI-4-5 OD Structure by Product in 2010
(Transported by Truck)

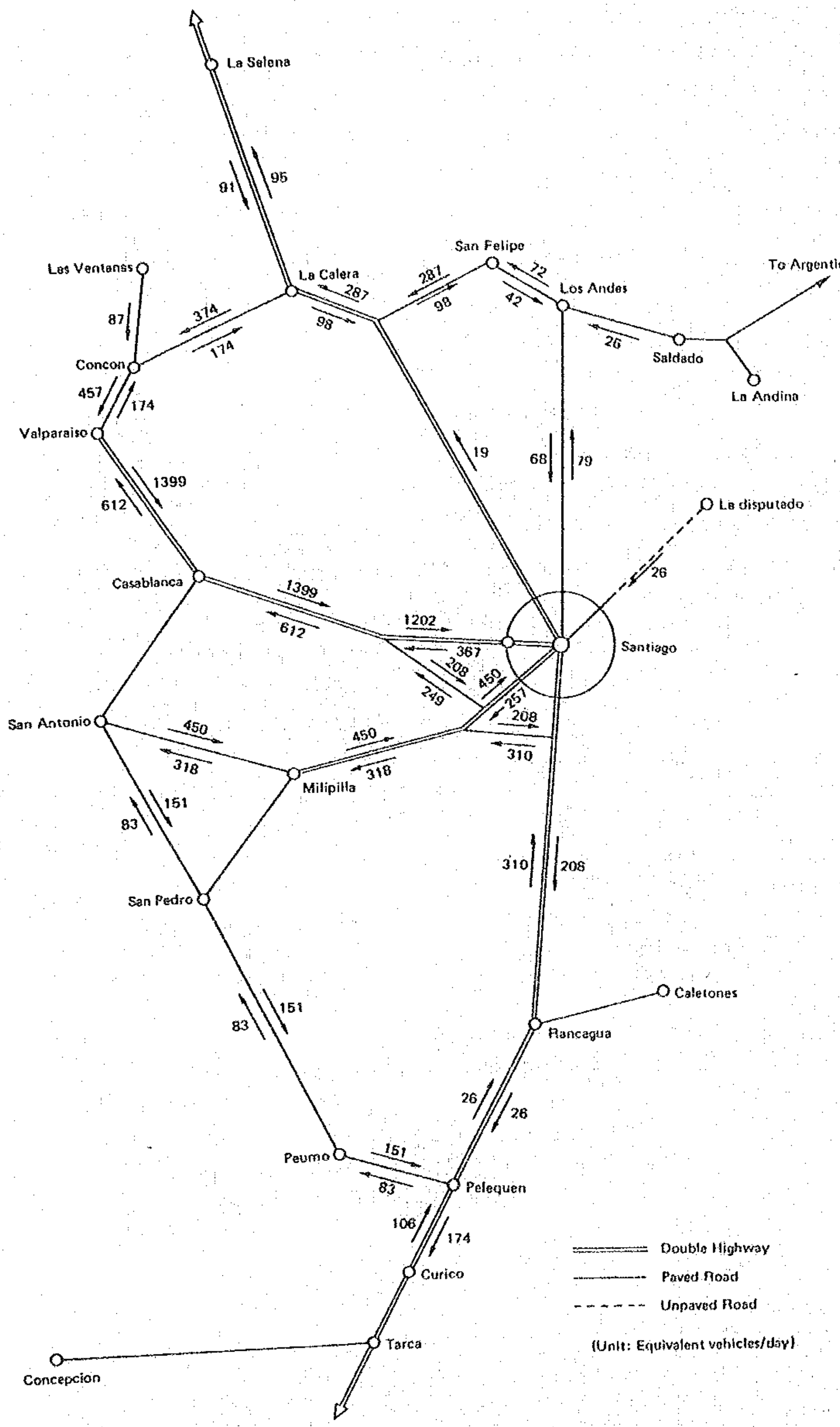


Fig. VI-4-6 Road Traffic Flow of the Port Related Cargoes in 2010

Table VI-4-32 Service Level on Route 68 in 2010

Section	km to km	Number of Lanes	Design Speed	Conditions	Capacity (Vehicles / day)	Annual Average Daily Traffic Volume	Average Daily Traffic Volume of Maximum Traffic Volume Month(Feb.)
		(2)	(2)	(1)(2)	(3)	(2)	(4)
Cruce Pajaritos acceso Aeropuerto Pudahuel y Maipu	6.3- 12.6	6	110	P	72,000		
Aerop.-desv. Oriente Tenel	12.6- 26.4	4	110	P	48,000	12,973	21,924
Desv. Oriente Túnel Lo Prado	26.4- 27.8	4	96	P	48,000		
Túnel Lo Prado	27.8- 30.6	4	60	P	44,000		
Salida Tunel a acceso Cuesta Barriga	30.6- 38.2	4	80	M	32,000		
A Cta. Barriga-acceso Oriente Curacavi	38.2- 47.9	4	96	P	44,000	9,804	16,569
A Oriente Curacavi-comienzo doble via	47.9- 55.8	4	96	P	48,000		
Doble via	55.8- 57.4	4	110	P	48,000		
Fin doble via-desv. Tunel Zapata	57.4- 62.0	4	80	O	32,000		
Desv. Oriente-T. Zapata	62.0- 62.2	4	80	O	32,000	10,705	18,091
Tunel Zapata	62.2- 63.5	4	64	P	44,000		
T. Zapata-Peaje Zapata	63.5- 66.7	4	80	O	32,000	10,759	18,183
De Peaje Zapata- -Pte. Rotunda	66.7- - 80.6	4	96	P	48,000		
Pte. Rotunda-Km. 84.7	80.6- 84.7	4	80	O	32,000	11,271	19,048
Km. 84.7-entrada reserva forestal Penuelas	84.7- 95.0	4	96	O	36,000		
Entrada reserva forestal Penuelas-Control Penuelas	95.0-102.8	-	-	-			
Control Pen.-Cruce Vina	102.8-112.4	4	110	O	36,000	15,354	25,948
Cruce Vina-Comienzo Zona Semiurbana	112.4-113.4	4	80	O	32,000		
Bajada Santos Ossa-comienzo Av. Argentina	113.4-118.8	4	64	M	32,000	8,183	13,829

(Note) 1) P: Plain M: Mountainous O: Undulation
2) Derived from Multi-Modal Corridor Study
3) Calculated by the Japanese Standard
4) Using a ratio of 1.69 at the Zapata Toll Gate (See Fig. VI-2-2)
5) Assuming the completion of the following double highway projects
- Route 68 (Throughout)
- Route 78 (Desvio Poniente-Melipilla)

Table VI-4-33 Service Level on Route 78 in 2010

Section	km to km	Number of Lanes	Conditions	Design Speed	Capacity (Vehicles/day)	Annual Average Daily Traffic Volume	Average Daily Traffic Volume of Maximum Traffic Volume Month
		(2)	(1)(2)	(2)	(3)	(2)	(4)
Fin Zona Urb. Cerrillos -Acc. Malpu	8.8- 13.9	4	P	96			
A. Maipú-Padre Hurtado	13.9- 21.2	4	P	96	48,000	23,532	44,946
P. Hurtado-Autopista	21.2- 25.0	4	P	80	44,000		
Autopista	25.0- 50.7	4	P	110	48,000		
Desvio Poniente-Autop.	50.7- 51.2	4	P	64	44,000	22,782	43,514
Desvio Poniente-Melipilla	51.2- 64.0	4	P	80	44,000		
Melipilla -Km 77.5 (Fin zona parcelas)	64.0-77.5	2	P	80	14,000	4,727	9,029
Km. 77.5-Cumbre subida Sepultura	77.5- 85.4	2	O	72	9,000	6,102	11,655
Cam. sal. Sepult.-Km. 94.2	85.4- 94.2	2	P	96	14,000		
Km. 94.2-Cruce Cartagena	94.2-104.0	2	O	80	10,000	6,421	12,264
Cam. Cartag.-entrada San Antonio	104.0-108.2	2	M	64	9,000	4,215	8,051

(Note) 1) P: Plain M: Mountainous O: Undulation
2) Derived from Multi-Modal Corridor Study
3) Calculated by the Japanese Standard
4) Using a ratio of 1.91 at the Pomire Toll Gate (See Fig. VI-2-2)

Table VI-4-34 Summary of the Interregional Road Project

① Double Highway Project on Route 68	
- Desvio Oriente-Tunnel Lo Prado	4.2 Km
- A Cta. Barriga-Comienzo double via	17.6
- Fin double via - Tunnel Zapata	6.1
- De Peaje Zapata-Pte. Rotunda	13.9
- Km 84.7-Control Penuelas	27.7
	69.5 Km
② Double Highway Project on Route 78	
- Desvio Poniente-Melipilla	12.8 Km
③ Paving Project on Route G-66-H	
- Las Cabras-San Pedro	49.0 Km
④ Restoring and Paving Project on G-830	
- San Pedro-Reten Atalaya	21.0 Km

(Investment Cost)

- Project ①: 69.5 km x (311×10^3) US$/km = US$21.6 x 10^6
- Project ②: 12.8 km x (311×10^3) US$/km = US$ 4.0 x 10^6
- Project ③: 49.0 km x (108×10^3) US$/km = US$ 5.3 x 10^6
- Project ④: 21.0 km x (311×10^3) US$/km = US$ 6.5 x 10^6

US$37.4 x 10^6

(Note) Investment cost per km is estimated based on the data of MOP Direction General De Obras Publicas Direction De Vialidad.

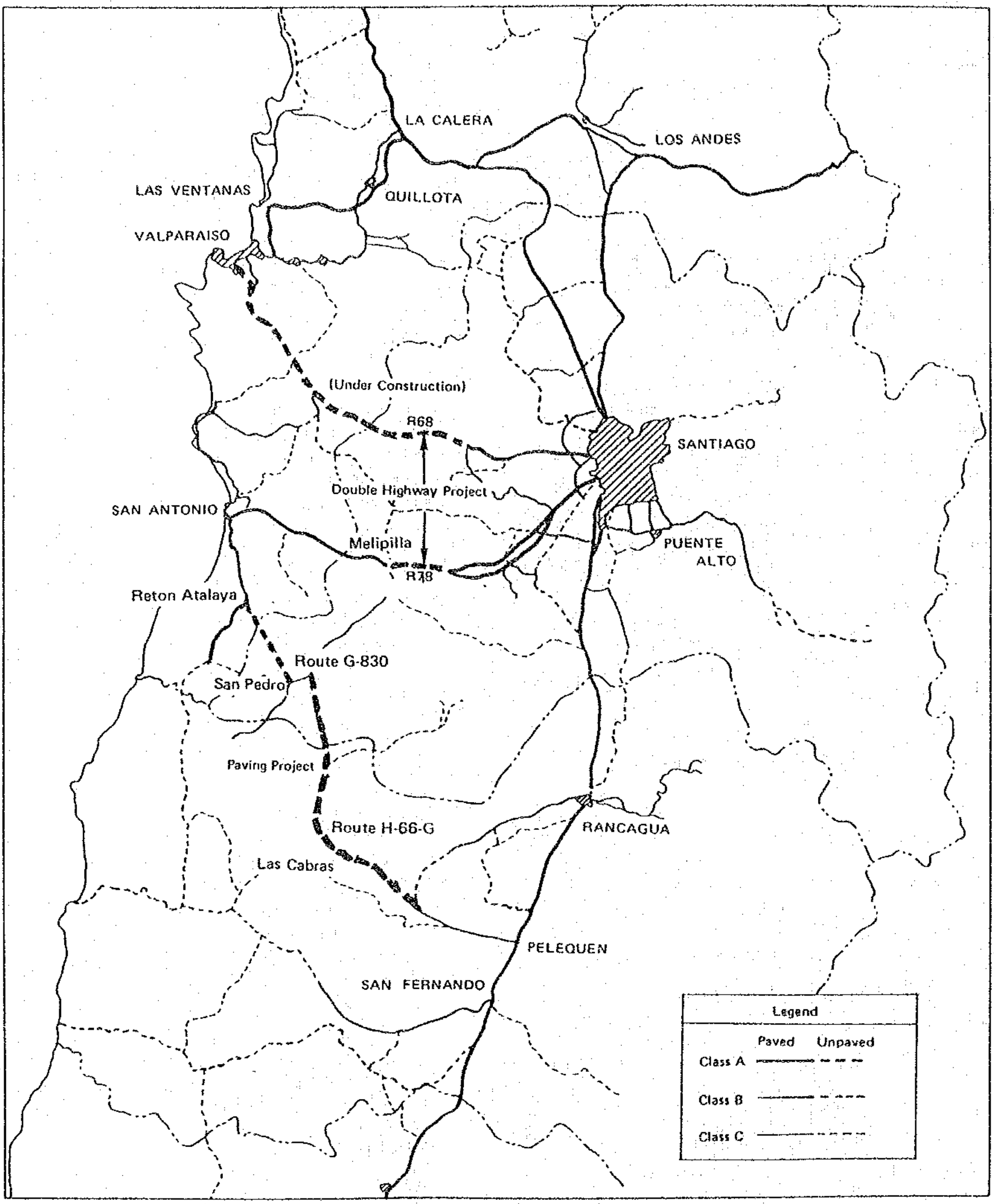


Fig. VI-4-7 Locations of the Proposed Interregional Road Projects

ii) Railways

Fig. VI-4-8 summarises the OD traffic volume transported by railway estimated by the modal split model. Fig. VI-4-9 illustrates this railway traffic volume allocated by line.

Based on Fig. VI-4-8, we can obtain the number of trains required in 2010 on the lines between Santiago and the ports of Valparaiso and San Antonio as shown in Table VI-4-35. Judging from this table, there is no problem with the line capacities of the present railway infrastructure.

With regard to the train working conditions, a system as shown in Table VI-4-36 is desirable considering the traffic flow by product.

It is desirable that the private sector obtain and maintain special wagons for the unit trains.

Further, the execution of the following items is very important in order to gain more demand for the railways.

- Develop and introduce container wagons on appropriate lines
- Increase the maximum loaded weight per wagon:

  prsent 30 - 50 tons/wagon

  future 80 tons/wagon

  Reference: the maximum permitted weight per vehicle in Chile is currently 45 tons.

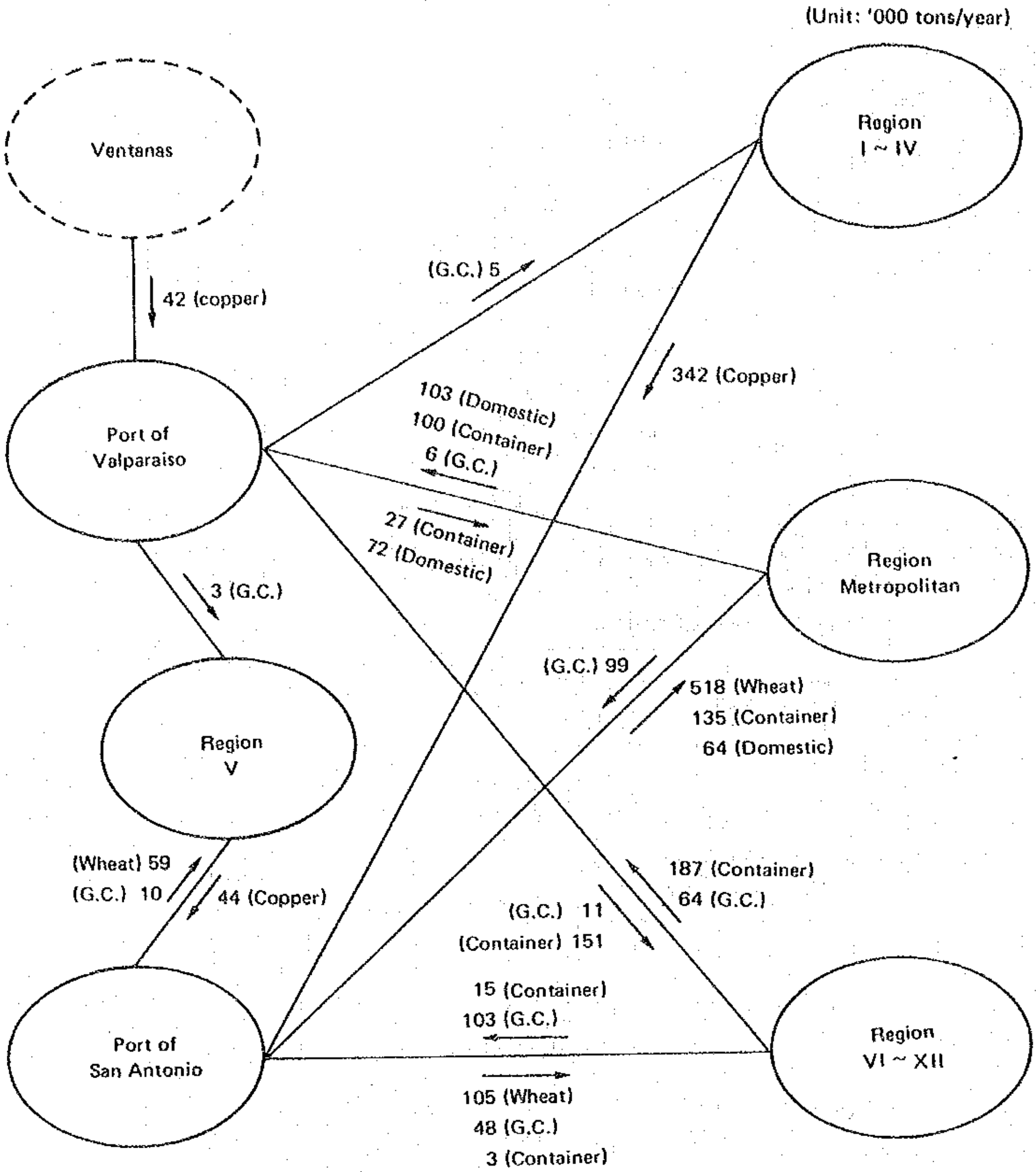


Fig. VI-4-8 OD Structure by Product in 2010
(Transported by Railway)

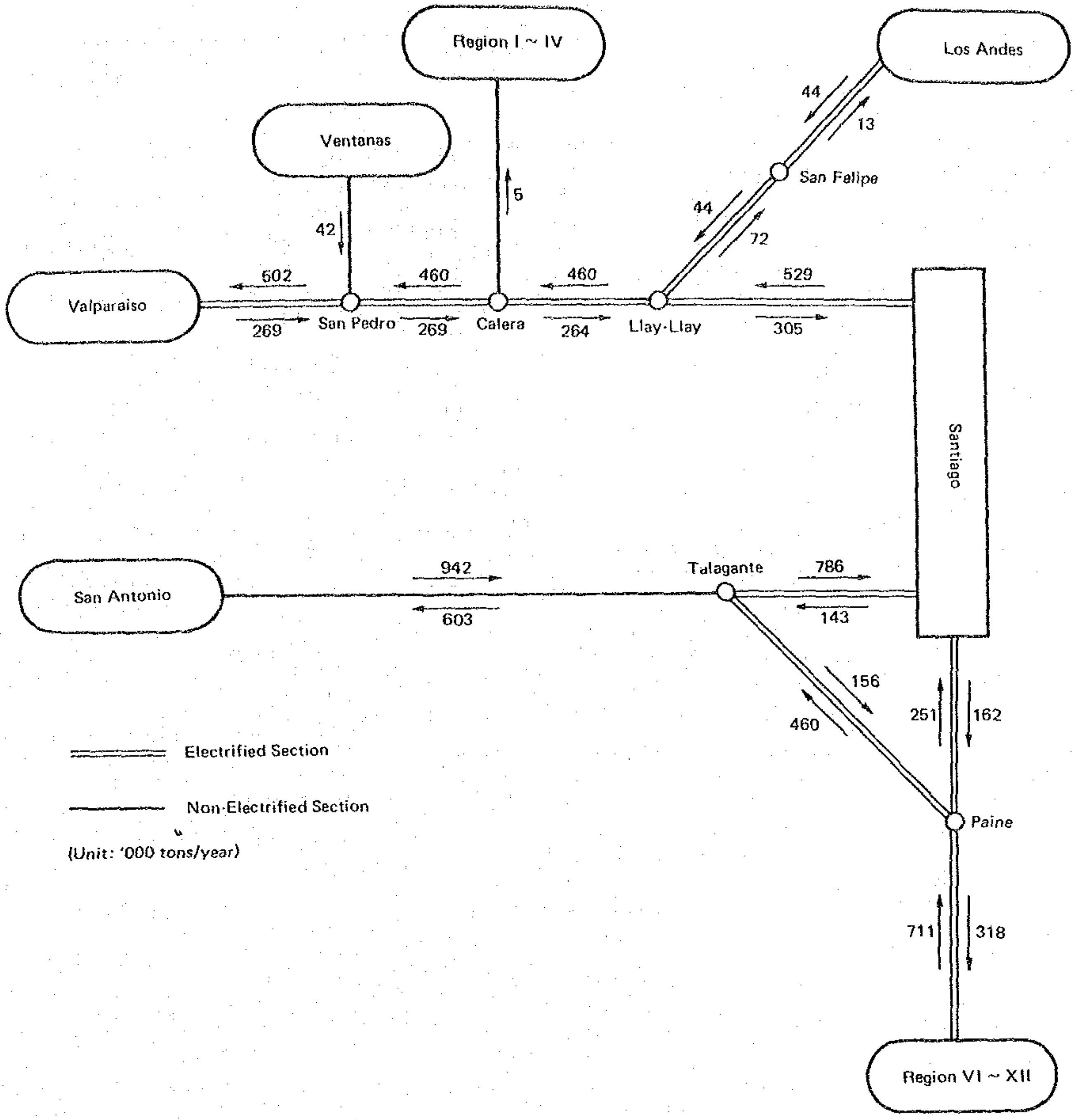


Fig. VI-4-9 Total Railway Traffic Flow of the Port Related Cargoes in 2010

Table VI-4-35 Number of Trains Required in 2010

Line	Most Risky Section	Traffic Volume (ton/day)	Number of Trains (trains/day)		
			Required	Present	Maximum
Valparaiso Line	CaLera → Llay-Llay	753	2	2	6
	" ← "	1,260	3	2	
San Antonio Line	San Antonio → Talagante	2,581	3	6	12 (at least)
	" ← "	1,652	2	6	

Table VI-4-36 Train Working System in 2010

Line	Section	Kind of Train	Number of Running Trains (trains/day)
Valparaiso Line	Valparaiso → Santiago	Container Unit Train	1
		General Train	1
	Santiago → Valparaiso	Container Unit Train	2
		General Train	1
San Antonio Line	San Antonio → Santiago	Wheat Unit Train	2
		General Train	1
	Santiago → San Antonio	General Train	1
	(Sewel) → Runcagua → San Antonio	Copper Unit Train	1

2) Terminals and Accesses

i) Inland Container Terminals and Accesses

The volume of container cargoes transported between Region Metropolitan and the ports of Valparaiso and San Antonio represents 65% of the total container cargo volume handled at the ports as shown in Fig. VI-4-10, which summarises the OD traffic volume by mode estimated by the modal split model.

Therefore, it is desirable that inland container terminals with the function of customs clearance be established in Santiago City for the following reasons:

- It increases the production by decreasing congestion, that is the volume of customs clearance, at the ports.
- It decrease the land area required in and around the ports and should there by also decrease the overall investment cost.

  - Value of land
    - US\$ 250/m^2 for Valparaiso
    - US\$ 100/m^2 San Antonio
    - US\$ 5.2 - 10/m^2 for Santiago

- It decreases the interference between the port-related traffic and the urban activity related traffic since it would be easy to establish a hierarchy of the urban roads, with specific roads identified as the main transport roads, with specific roads for the main transport roads between the terminals and as delivery roads. This would also lead to improvement of the urban environment.

With regard to the location in Santiago City of the inland container terminals, we recommend the area pointed out in Fig. VI-4-11 as the inland container terminal zone which should be developed and managed by private firms.

The reasons for this are:

- Three container transport firms, without the function of customs clearance, are currently located at Renca, Yungay and Lo Valledor. However, the Renca location has the most advantages from the viewpoint of possible expansion (available land).
- Container unit trains will be introduced between Santiago and Valparaiso.
- The location of new factories will progress in the northern part of Santiago so as to minimize the harmful impact of air-borne pollutants on the residential zone.

Then, the desirable terminal location and road hierarchy is shown in Fig. VI-4-11. Main inter-terminal transport roads are R5, R68, R78 and Ave. Americo Vespucio, and other urban roads should be used as the delivery roads. For the establishment of this road system in Santiago City, it would be necessary to complete the Avenue Americo Vespucio Throughout and to formulate regulations limiting the roads available for heavy trucks such as trucks with 3 or more axles. This would also help safeguard the urban road surface and the urban environment, thus saving maintenance cost on urban roads.

Table VI-4-37 Projects on Ave. Americo Vespucio

- New Sections
  - Recoleta ∿ El Salto (Under Construction)
  - El Salto ∿ La Piramida
  - Ochagavia ∿ Pedro Aquirre Cerda
- Resufacing Project
  - Quilicura ∿ Pudahuel (In Progress)
- Widening Project
  - Gran Avenida ∿ Ochagavia

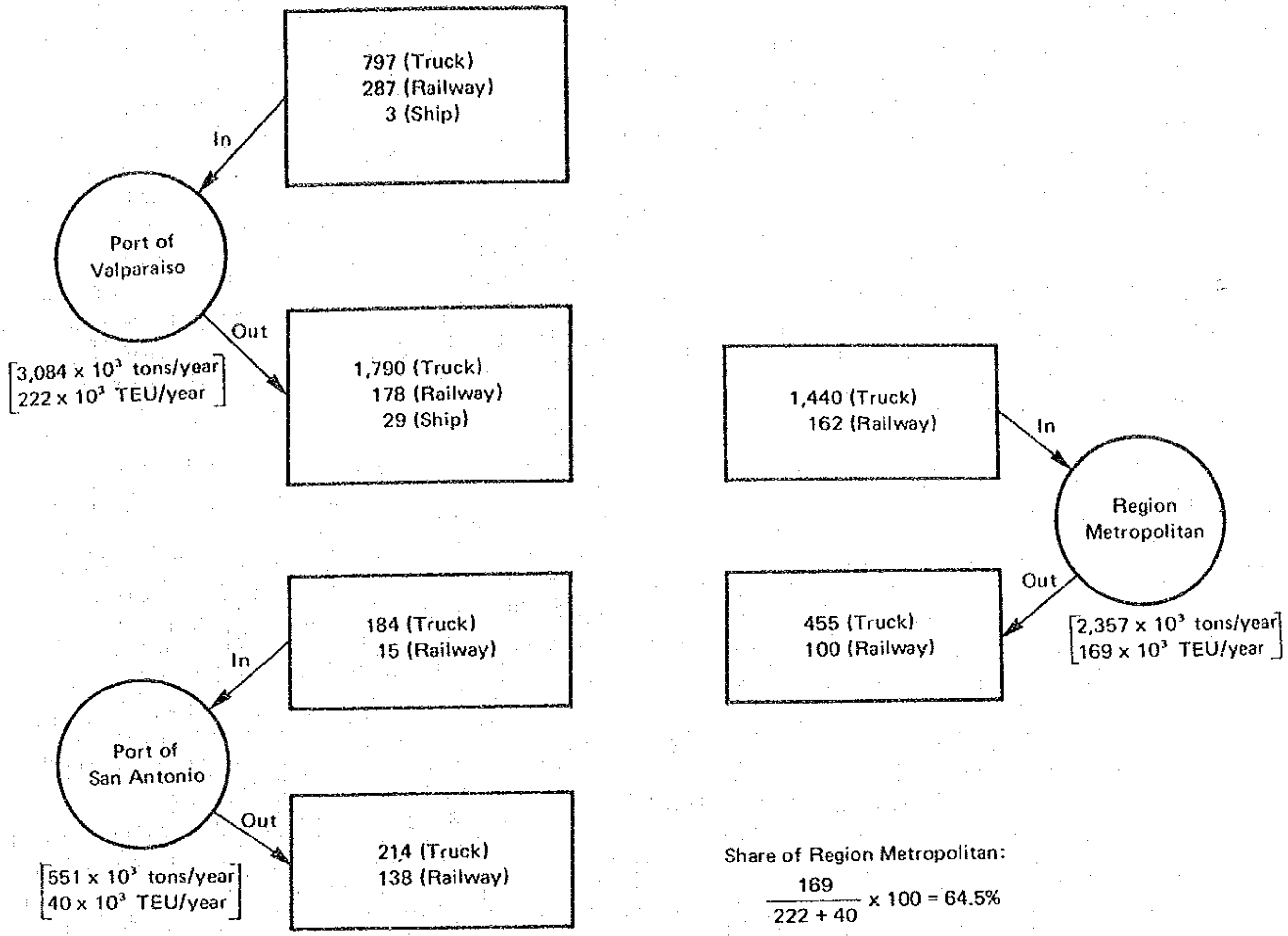


Fig. VI-4-10 Container Volumes Handled at Main Areas in 2010

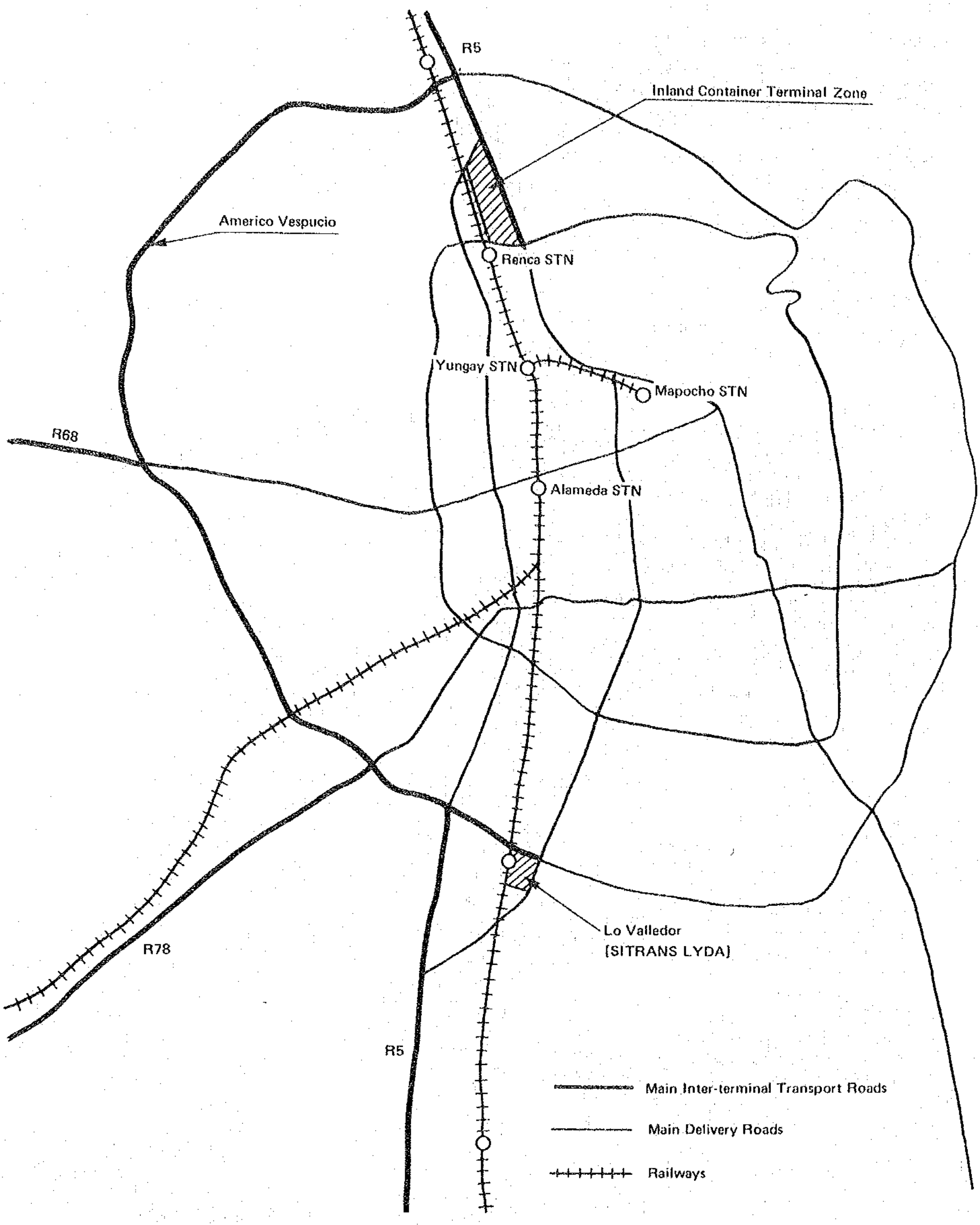


Fig. VI-4-11 Location of Inland Container Terminal Zone and Access Roads

ii) Access for the port terminal

As for the port terminal access, there is no problem at the port of San Antonio considering the new access road which is under construction, but at the port of Valparaiso there is a problem with the access from ave. Argentina (R68) to the port area, as traffic cannot turn left directly.

With regard to the railway at Valparaiso, it is desirable that the railway system be rearranged as shown in Fig. VI-4-12.

Considering the situation outlined above, we propose a new access path as shown in Fig. VI-4-13 with the construction of a new under-pass for turning left directly from Av. Argentina to Av. Errazuriz, and the widening of Av. Errazuriz. This new path would also function as the approach path to the urban area with a core passenger terminal tentatively named Valparaiso STN.

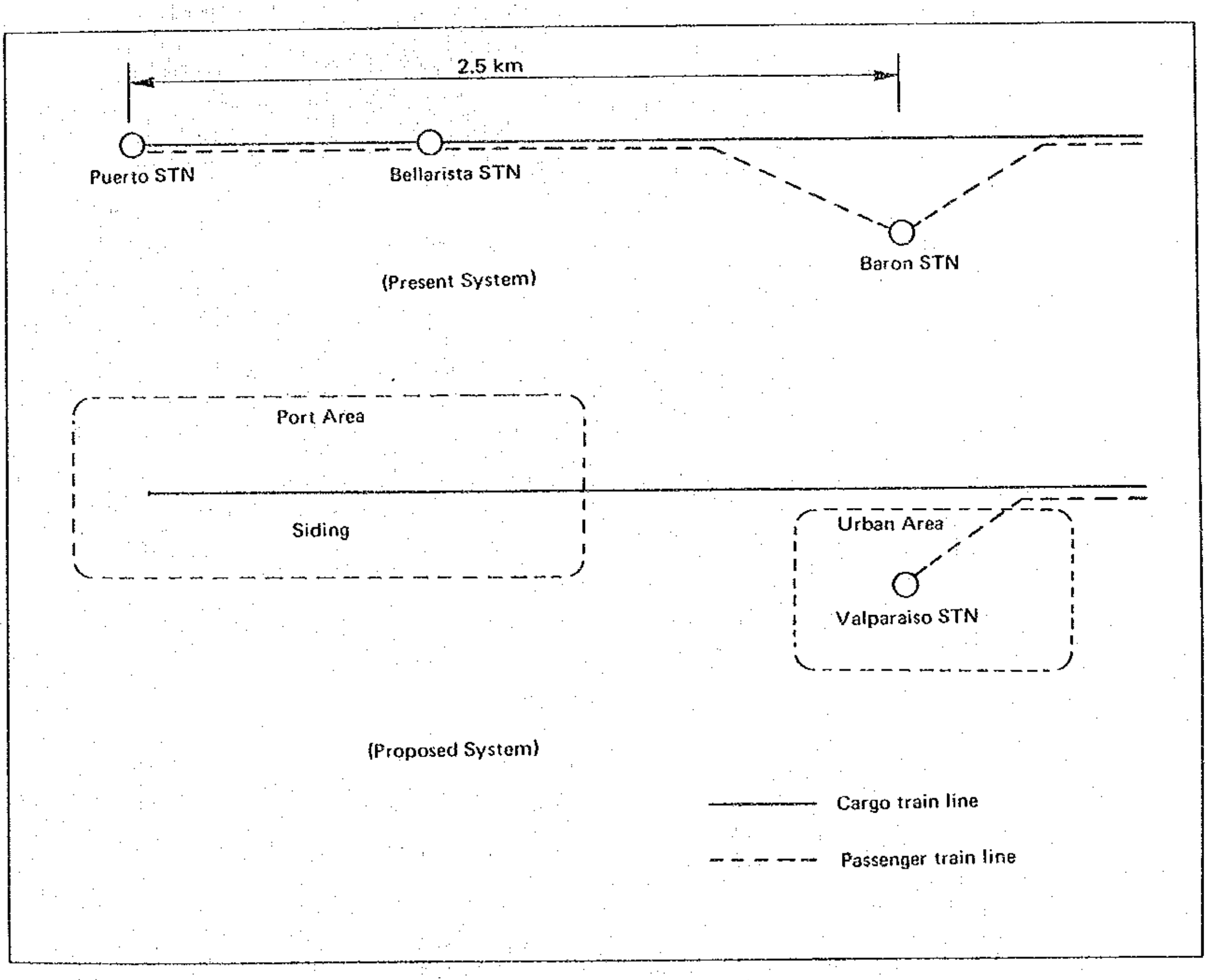


Fig. VI-4-12 Rearrangement of the Railway System in Valparaiso

Table VI-4-38 Summary of Access Improvement Project

- Construction of the Under-Pass	0.315 Km	US\$ 4.6×10^6
- Widening	0.390 Km	US\$ 60.6×10^3

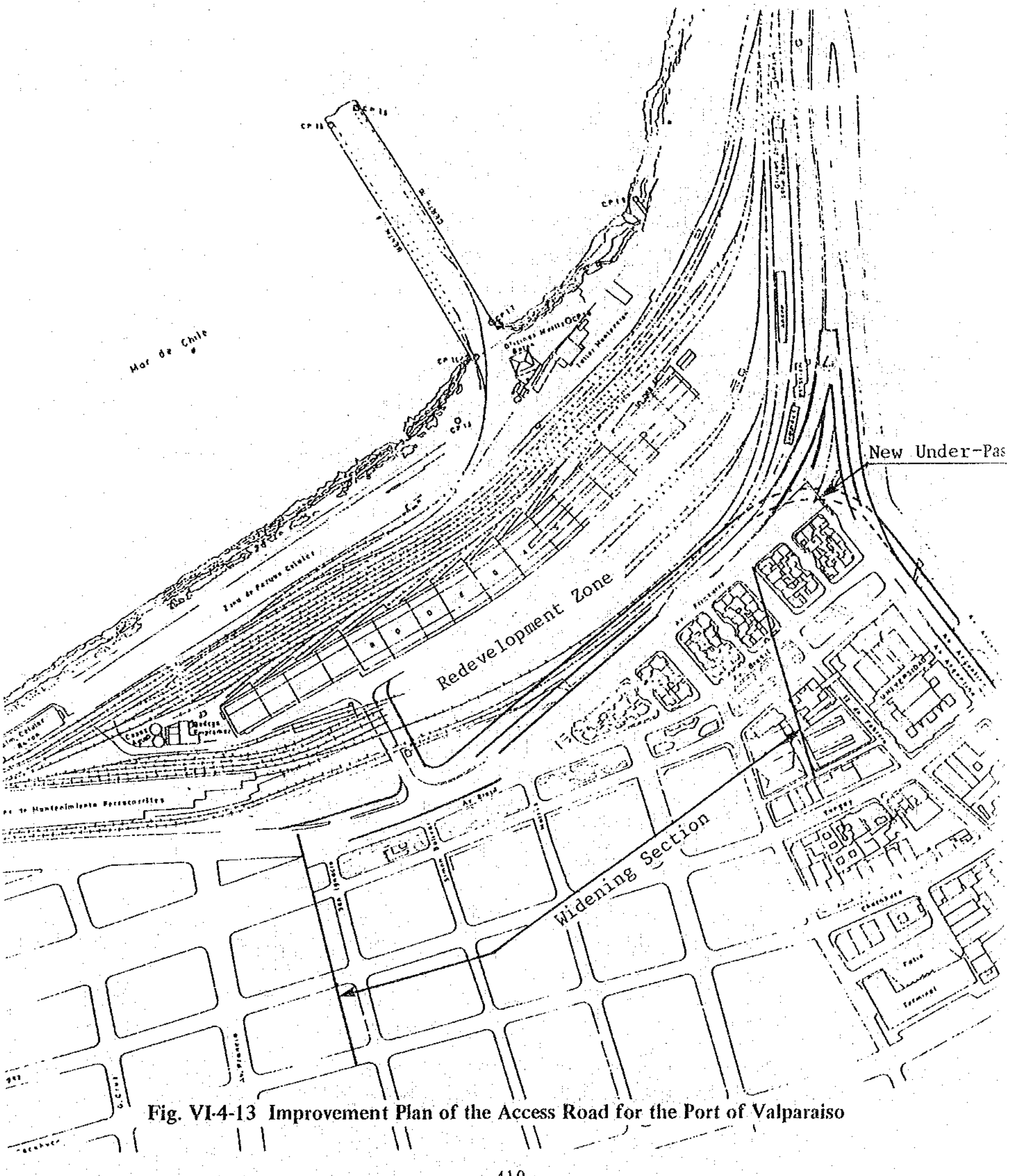


Fig. VI-4-13 Improvement Plan of the Access Road for the Port of Valparaiso

(5) Roles of the Private Sector

The main roles of the private sector in the formulation of the future inland transport system are as follows:

- Development and management of the inland container freight station zone at Renca.
- Ownership and management of the wagons for unit trains
- Transport and handling of the cargoes from door to ship

In addition, a for the railway, the quality of the maintenance of the equipment influences the transport efficiency and the maintenance cost. Therefore, taking into consideration the life cycle cost of the whole railway system, a reasonable maintenance system must be established. Moreover, to reduce the running cost, F.F.C.C. should entrust the private sector with the maintenance works. This would lead to a reduction of personnel expenses.

On the other hand, with regard to trucks, since there is no need to apply for a special licence in order to operate as a truck hauler in Chile, too many small trucking companies are competing with each other. Therefore, the truck haulers themselves should be reorganized into a smaller number of bigger firms. Some of the haulers with sufficient capital to invest in trucks drivers, an efficient management system and so on should be encouraged to do so as part of the modernization of the road transport system, especially for the container transport system.

(6) General Desirable Inland Transport System

Table VI-4-39 and Fig. VI-4-14 present a summary of the desirable future inland transport system in the hinterland of the ports of Valparaiso and San Antonio studied in this chapter. In Table VI-4-39, the stages of each individual project are presented.

The stage strategy is as follows:

- 1st Stage (1986 - 1990)
  - projects already under construction
  - urgent projects
  - projects with sufficient demand at present

- 2nd Stage (1991 - 1995)
  - projects which require a long term to complete
- 3rd Stage (1996 - 2010)
  - projects related to containerization

Further, the role of the private sector in the above-mentioned system is as follows:

- Development and management of the inland container terminal zone
- Ownership and management of wagons for unit trains
- Transport and handling of the cargoes from door to ship
- The maintenance work of the railway system
- Reorganization of the trucking firms

Table VI-4-39 Summary of the Projects for the Future Hinterland Transport System

Item	Projects

Inter-regional Roads	- Double highway projects
	  - Route 68 completion of the route throughout ①
	  - Route 78 (El Paico - Melipilla) ②
	- Paving projects ②
	  - Routes H-66-G and G-830
	    (Las Cabras - Reten Atalaya)

Access Roads	- Port access road projects ①
	  - Valparaiso (Av. Argentina-Av. Erraqurif by under-pass
	  - San Antonio (New access to the east of city)
	
	- Inland container terminal access road projects (in Santiago) ③
	  - Av. Americo, Vespucio (Completion of route throughout)

Railways	- Improvement of carrying capacity projects ③
	  - Develop and introduce container wagons
	  - Increase the maximum loaded weight per wagon
	- Unit train projects
	  - The Valparaiso Line ③
	    - Container cargo unit train (Freight Liner)
	  - The San Antonio Line ①
	    - Wheat unit train (Freight Liner)
	    - Copper unit train (Freight Liner)

Inland Terminal	- Inland container terminal zone ③ - Located at Renca, also functions as a customshouse.

(Note) ①: 1st stage ②: 2nd stage ③: 3rd stage

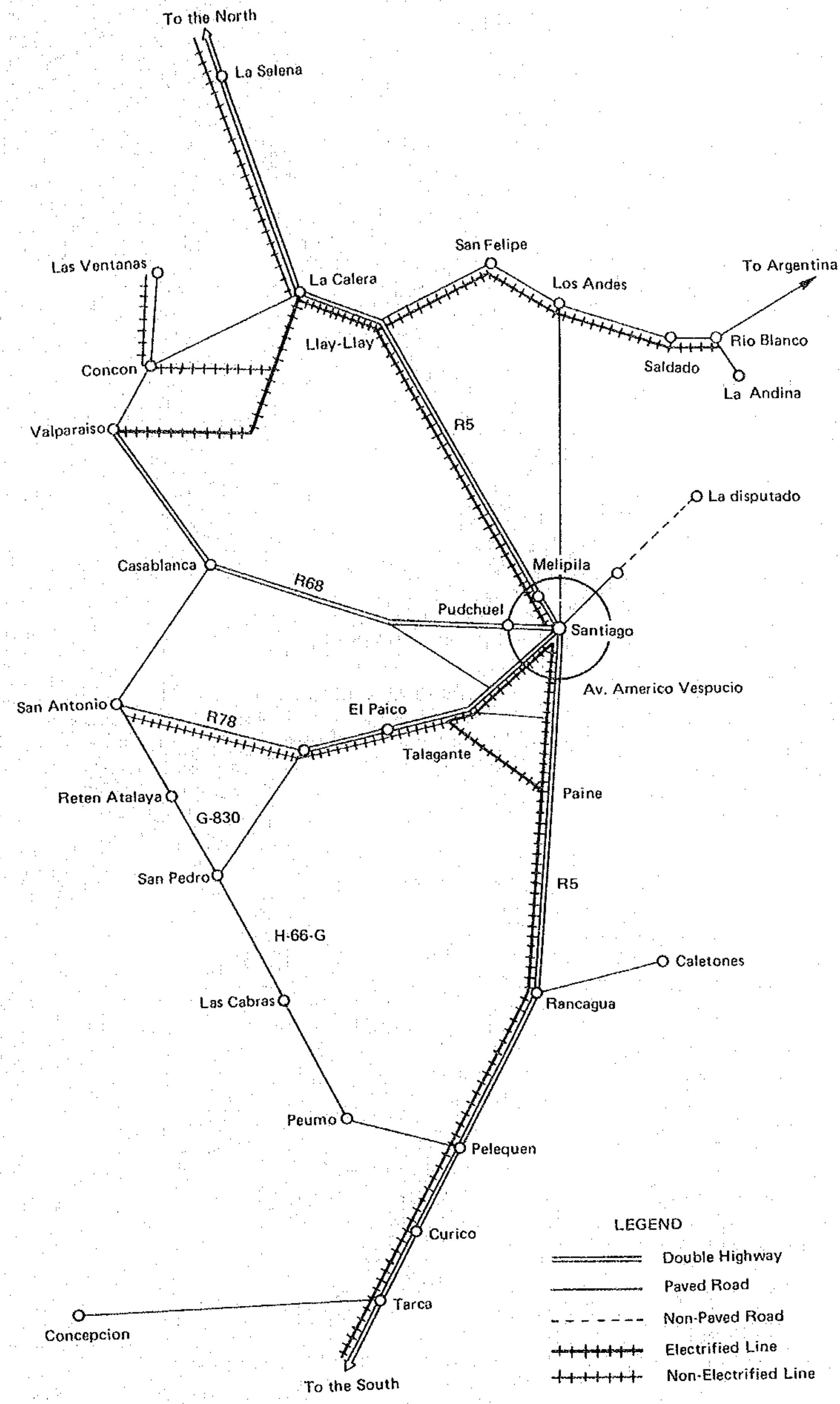


Fig. VI-4-14 Desirable Future Transport Network in the Hinterland