No. 17

FEASIBILITY STUDY REPORT
ON
ESTABLISHMENT OF CARBIDE AND PVC PLANTS
IN THE REPUBLIC OF PERU
(SUMMARY)

JANUARY, 1984

JAPAN INTERNATIONAL COOPERATION AGENCY

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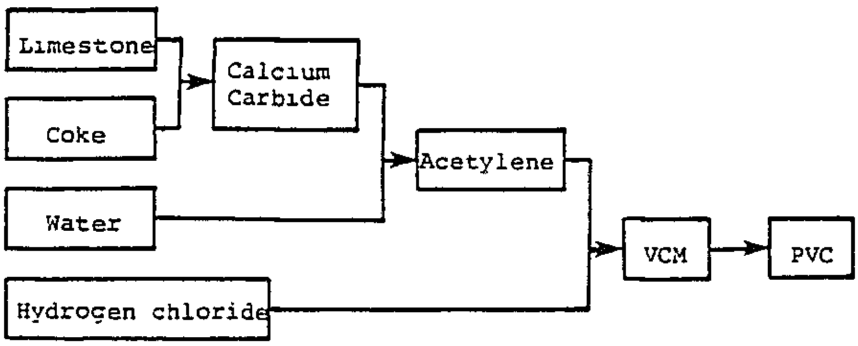
OVERVIEW, FEASIBILITY STUDY ON ESTABLISHMENT OF CARBIDE AND PVC PLANTS IN THE REPUBLIC OF PERU

1. Summary of Project

This project consists of establishing a series of process plants in Peru to manufacture PVC starting from limestone through calcium carbide and acetylene. The important feature is utilization of such domestic resources as limestone, hydroelectric power and hydrogen chloride that is now being disposed of in waste for lack of effective use.

(1) Manufacturing process

The manufacturing process may be schematically shown as:



(2) Material balance (tons/year)

Raw Material		Intermediate Products		Products	
Limestone	58,000	Calcium carbide	35,000	PVC	25,000
Coke	19,800	VCM	25,500		
Hydrogen chloride	15,300				

(3) Project promoter — Sociedad Paramonga Limitada (SPL)

(4) Plant location — The plant site next to the existing alkali and PVC plants in Paramonga.

(5) Market Domestic market

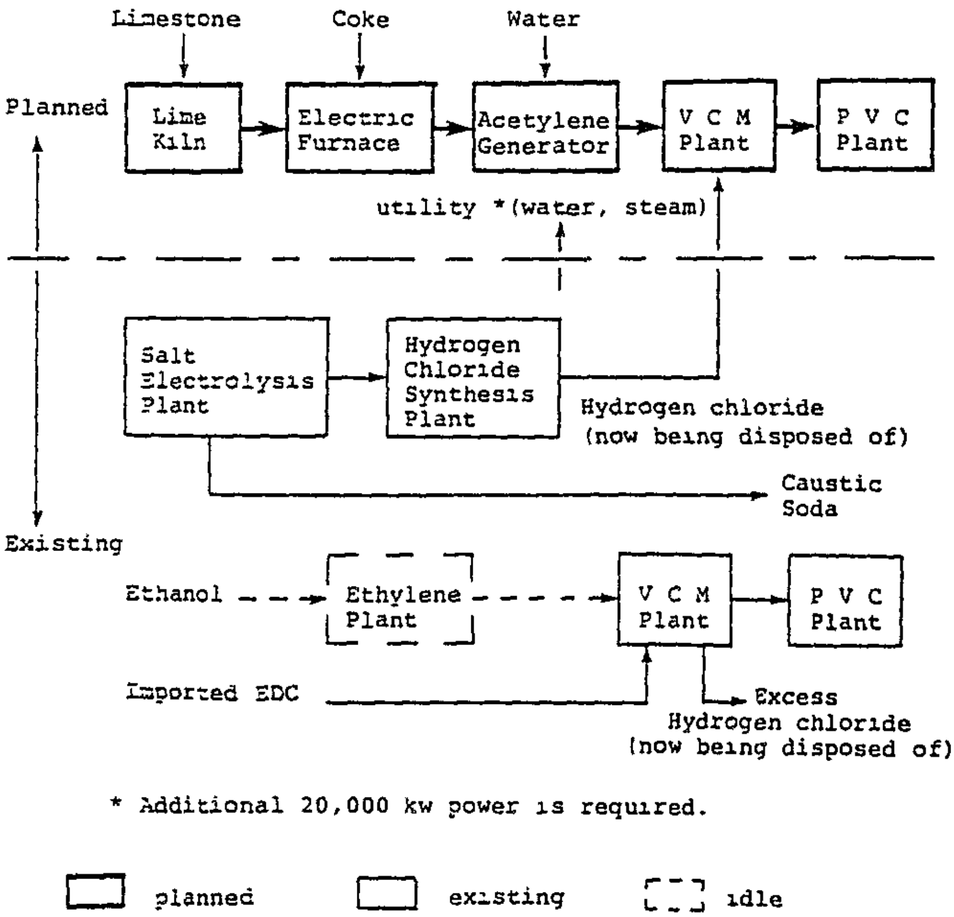
(6) Total capital requirement (1,000 US dollars)

Total Capital requirement including import duty	75,072
Total Capital requirement excluding import duty	59,845

(7) Project schedule

Start up, year	mid 1988
Operation rate, percent	
First Year	80
Second year	90
Third year and onward	100
Operation period, year	20

(8) Relation with the existing plants



2. Evaluation of Project

(1) Items for evaluation

Raw material
Market
Technology
Financial analysis
Socio-economic analysis
Natural conditions
Social conditions
Socio-political environment
Human resources, local technology
Promoter

(2) Raw material

A. Limestone

Pariahuanca deposits will be developed.

- Quality:	Satisfactory
- Reserve:	Sufficient
- Techinical difficutly:	None
- Transportation to Paramonga:	Easy
- Pollution problems:	None

B. Hydrogen chloride

Hydrogen chloride is supplied by the existing alkali plant.

- Quantity (tons/year)	Availability:	20,000 to 25,000
	Requirement:	15,300
- Technical problems:	None	
- Pollution problems:	Reduces present pollution problem	

C. Coke

Imported cokes will be used for the initial period of the project with possibility of replacement by domestic anthracite.

- Quantity: Easy to secure by import
- Quality: Satisfactory

D. Other inputs

Other inputs will be imported.

(3) Market

- Domestic market: Supports 25,000 tons per year capacity.
- Quality: Low residual monomer product desired.

(4) Technology

- Manuacturing technologies: All proven
- Plant Site: Good
- Pollution: Not expected

(5) Financial analysis

	FIRR on I		FIRR on E	
	Before Tax	After Tax	Before Tax	After Tax
Case 1	11.2	5.3	8.9	Minus
2	13.2	6.3	12.8	5.7
3	13.2	6.3	12.8	6.2
4	14.1	7.1	14.5	8.1
5	14.1	10.3	14.7	11.5
6	16.8	11.9	19.7	15.5

	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Hydrogen chloride price (US$/Ton)	101	0	0	0	0	0
Loss carry over	No	No	Yes	Yes	Yes	Yes
Internal tax refund	No	No	No	Yes	Yes	No
Income tax reduction for reinvestment	No	No	No	No	Yes	Yes
Exemption of import duty	No	No	No	No	No	Yes

Case 6 falls in the viable range but FIRR on E after tax of 15 percent is not good enough as compared with 13.5 percent interest rate employed for evaluation. Therefore a finance of favorable condition is desired.

(6) Socio-economic analysis

- Contribution to balance of payments: 108 million US dollars
- Indirect benefits
  - Direct employment opportunities: 250
  - Abatement of pollution by hydrochloric acid
  - Employment of local engineering and construction companies

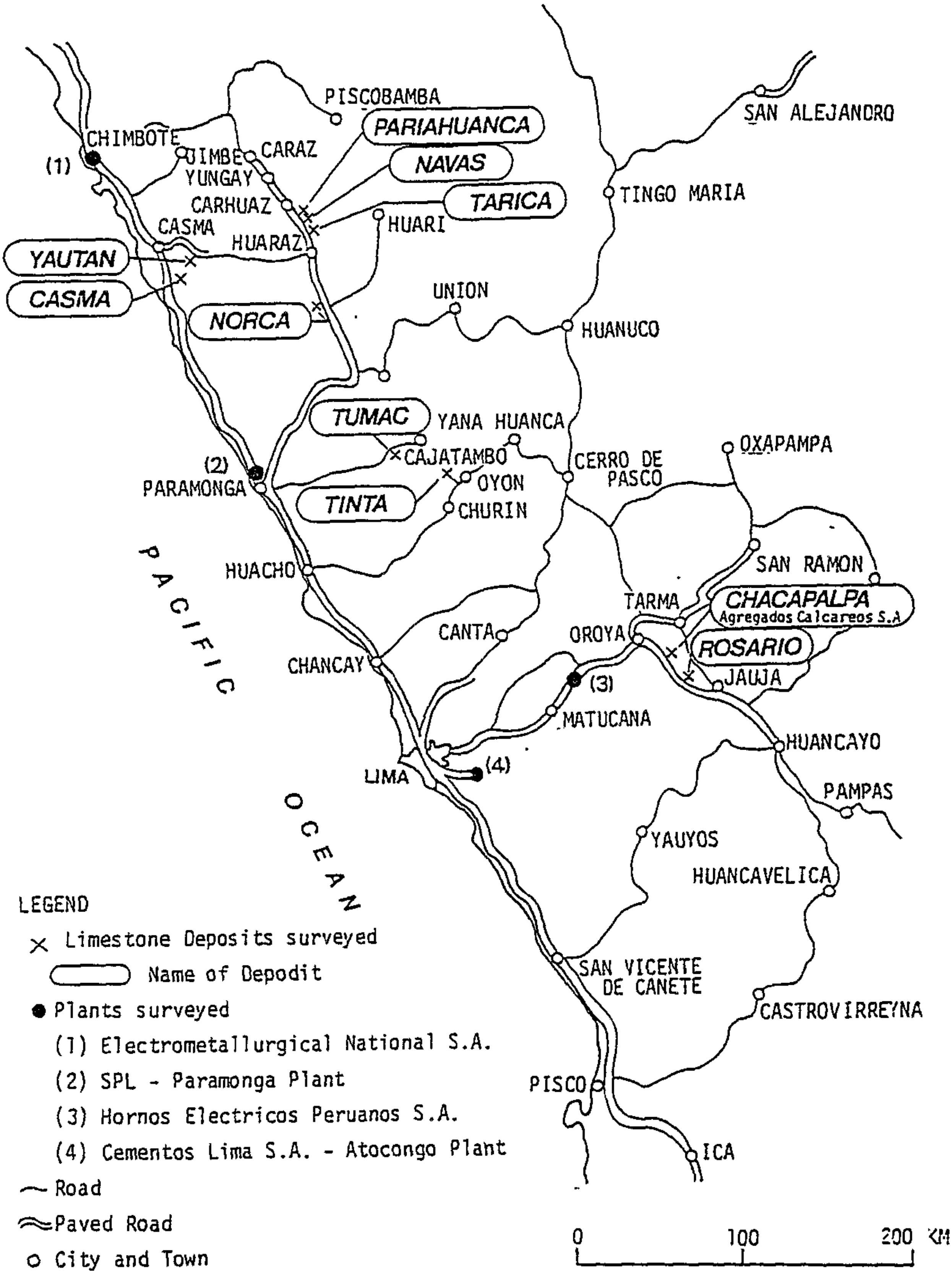
(7) Natural conditions — Very gentle

(8) Social conditions and infrastructure: — Adequate

(9) Socio political environment — Reasonably good

(10) Human resources, loCal technology — Good

(11) Promoter — Very good



Location Map of the Surveyed Limestone Deposits and Plants

INTRODUCTION

This report is a summarized concise version of FEASIBILITY STUDY REPORT ON ESTABLISHMENT OF CARBIDE AND PVC PLANTS IN THE REPUBLIC OF PERU. This concise version contains items of importance only. For more details reference should be made to the original full report.

This feasibility report concerns a project for establishment of carbide and PVC plants in the Republic of Peru which consists of quarrying limestone of required quality and transporting it to the plant site in Paramonga, a small city some 200 kilometers to the north of Lima, where the existing PVC and alkali plants and also sugar and paper factories are located, and installing a series of manufacturing facilities at the plant site to produce PVC from limestone and coke through calcium carbide and acetylene. Hydrogen chloride, another important raw material, is available in sufficient quantity as an excess product at the existing electrolysis plant at Paramonga. Pariahuanca, some 200 kilometers from Paramonga, has been chosen as quarry of limestone from a number of candidate limestone deposits.

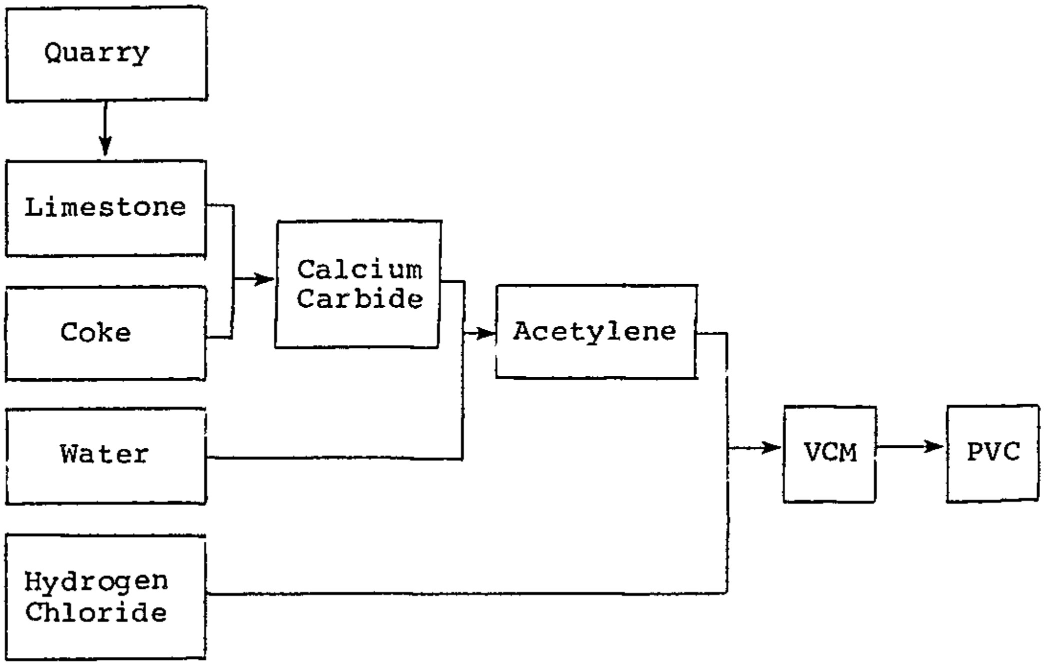
What this project means to sociedad Paramonga Limitada (hereinafter referred to as SPL) and the nation can be very great. SPL has facilities to manufacture some 7,000 tons per year of PVC from fermentation alcohol from molasses but operation by this route has been suspended since November 1981 when fermentation alcohol became incompetitively expensive. Presently SPL produces about 7,000 tons per year of PVC from imported ethylene dichloride, or EDC. Besides this amount Peru now imports about 7,000 tons per year of product PVC. This means Peru pays valuable foreign currency to buy product PVC as well as the raw material for it. This project is expected to bring about various advantages. First and foremost, this project would realize savings of foreign currency by producing PVC domestically by using mainly domestic raw materials. Secondly, this project would promote utilization of domestic resources, particularly limestone and electricity. Thirdly, this project would absorb a great portion of excess hydrogen chloride now being discharged to the sea, thereby reduce environmental pollution of the sea, a very valuable resource to a large fishing country like Peru.

There would also be expected other advantages such as increased employment opportunities, increased tax incomes to the central and local governments, transfer of technology from abroad, stabilization of domestic market prices of PVC, stimulation of related domestic industries.

As the following pages show, the results of this feasibility study confirms such advantages. The results of the study indicate an area in which this project becomes financially viable specified by realistic ranges of investment cost, product PVC price and operation cost, notably cost of electricity under a certain set of conditions. This feasibility study report also presents recommendations on how this project should be implemented.

SUMMARY AND MAJOR FINDINGS

1. This project is to establish in Peru a series of facilities to manufacture PVC starting from domestic limestone. The simplified representation of the process is shown below:



2. At the request of the Government of the Republic of Peru, JICA has developed this feasibility study report on behalf of the Japanese Government as agreed between SPL and JICA on February 3, 1983 in Lima between Mr. Carlos Orams Basadre, General Manager SPL, Mr. Alvaro Vargas Guacucano, Engineering Manager SPL and Mr. Kenji Iwaguchi, Leader, Preliminary Survey Team, JICA. A field survey was conducted from June 4, 1983 to July 14, 1983 by a study team headed by Mr. Tanaka.

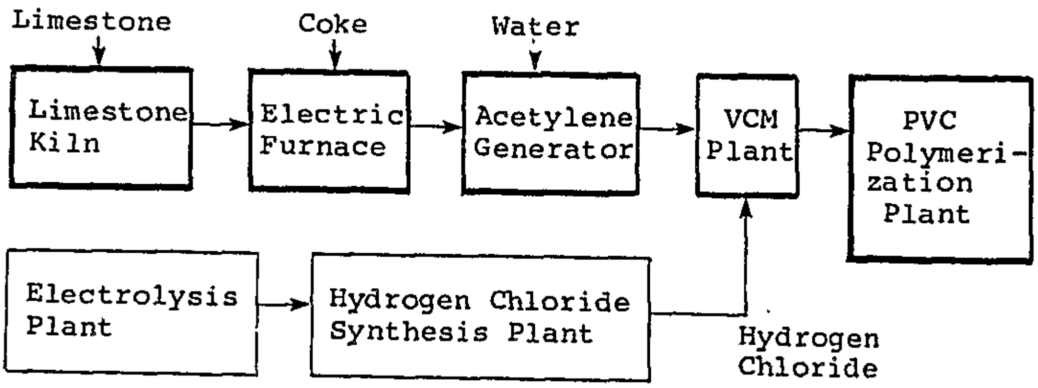
3. The capacity of this project is 25,000 metric tons per year as PVC product. (Hereinafter "ton" always means "metric ton", unless otherwise indicated.)

4. SPL is supposed to implement this project. SPL, or Sociedad Paramonga Limitada, is a Peruvian company owned essentially by Corporacion Financiera de

Desarrollo, a governmental financing organization. SPL ranks first in Peru in the field of chemical industry manufacturing such products as paper, cartons, salt, caustic soda, chlorine, hydrogen chloride, sodium hypochlorite, bleaching powder, acetic acid, alcohol, beverages, PVC. The head office is located in Lima. SPL has 12 plants in six different places in Peru. The major production center is in Paramonga where paper, alcohol, alcali and PVC plants are located.

5. The city of Paramonga is located some 200 kilometers north of Lima along Pan American Highway. The city is on the Pacific coast. Paramonga has a population of about 30,000 with adequate infrastructure and township.

6. All the manufacturing facilities; namely, a limestone kiln, electric furnace, acetylene generator, VCM plant and PVC plant, will be located at Paramonga plant site beside the existing alkali and PVC plants. JICA has pondered on the possibility of locating the limestone kiln and electric furnace at or near the quarry apart from other facilities in Paramonga plant site. JICA, however, has chosen to locate all the facilities in Paramonga. The manufacturing facilities to be constructed are shown below. Those in thick and fine lines represent new and existing facilities, respectively.



7. Of a number of candidate limestone deposits, Pariahuanca, some 200 kilometers from Paramonga, in the central region of Ancash has been chosen as quarry. The limestone deposit of Pariahuanca lies just along a very good highway which directly leads to Paramonga and transportation of about 200 tons per day of limestone would not present difficulty.

There is a small village nearby but it does not seem difficult to buy their land. It is also necessary to protect an electric cable and an agricultural canal that runs along the deposit from damages.

The owners of the quarry are identified as Comunidad Campesina de Shumay, a farmers' organization, and an individual, Eduardo Navas.

8. The forecast market situation justifies a capacity of 25,000 tons per year as PVC product. The annual production of intermediate products and major inputs are as follows:

	(Tons per year unless otherwise stated)
Intermediate Products	
VCM	25,500
Acetylene*	9,945,000
Hydrogen chloride	15,300
Calcium carbide	35,000
Quick lime	32,200
Slaked lime	42,000
Major Inputs	
Limestone	58,000
Coke	19,800

*Cubic meters per year at normal temperature and pressure

9. Along with limestone, coke is also an important input. This could also be anthracite. There are deposits of anthracite around Oyon. However, anthracite is not produced in commercial scale; therefore, neither supply nor quality is dependable. JICA, therefore, chooses to use imported coke which is uniform in quality, shape, size and price competitive, with possibility of future replacement by domestic anthracite or coke.

10. There is a sufficient amount of hydrogen chloride available to this project at Paramonga Plant. This situation would not change in the future after development of possible utilization of excess chlorine.

11. There are other inputs like electrode, catalysts, dispersants for polymerization, silica gel. These could be obtained without difficulty perhaps by import from U.S.A. and others. The electrode paste may be imported from Brazil.

12. Since this project will be supplied by the exsisting plants with hydrogen chloride and utilities. In this connection, the conditions of the existing facilities are very important. The existing facilities at Paramonga are generally in good conditions. The electrolysis plant and hydrogen chloride synthesis plant are both mechanically healthy and could be used for the project life provided that they are properly maintained.

13. However, the existing hydrogen chloride strippers, the operation of which has been suspended since November 1981, have to be replaced by new units.

14. The planned plant site beside the existing alkali and PVC plants is adequate and large enough to accommodate all processing facilities, limestone/coke stockyards and product storage house, although the soil is a little too soft and piling is planned for foundations of heavy equipment.

15. SPL presently operates a 7,000 (7,230 to be exact) tons per year polymerization plant. JICA considered two possibilities to install 25,000 tons per year capacity; that is, (1) keep operating the existing 7,000 tons per year plant and istall an 18,000 tons pear year unit, the balance of the required capacity, or (2) suspend the operation of the existing unit and install a 25,000 tons per year unit. JICA has chosen the latter alternative. The incremental investment cost of a 25,000 tons per year unit over an 18,000 tons per year unit is marginal. Disadvantage of operating two plants with a double manpower requirement and various operating inefficiencies would far outweigh the savings in the investment cost.

16. The infrastructure around Paramonga is generally satisfactory although telephone communication is not as easy and quick as it should be.

17. Additional electricity required by the project is 20,000 kilowatts. This amount of electricity can be secured at the plant site by installing a cable of 2,000 meters going around the land owned by the farmers' cooperative.

18. Paramonga Plant as a whole will have more than enough industrial water with implementation of planned closing down of four steam turbines. However, a small cooling tower of 1,800 tons per hour capacity will be installed for the operation of the new facilities.

19. The consumption of steam by the project is small, about 10 tons per hour. Directly from the boiler plant runs a six inch line sufficiently capable of supplying this amount of steam.

20. Other minor utility facilities like an inert gas generator, instrument air system, pneumatic air system, fire-fighting system, etc. will be installed in the plant site.

21. As far as the JICA study team was able to survey, official written standards for environmental protection or pollution control do not exist in Paramonga Area. Irrespective of whether or not such standards exist or will be enforced in the future, with proper management this project is not expected to cause environmental problems in view of the circumstances in which this project is implemented.

Limestone quarrying will be done in a sparsely populated area. Limestone will be transported on the highway where traffic is not very busy. The processing facilities will be designed and operated to the modernest standards. Instead, this project will consume a great portion of excess hydrogen chloride, a very strong acid, being discharged to the sea and will, therefore, help reduce environmental pollution of the sea.

If so desired by SPL, instead of mercury catalyst normally employed for the reaction between acetylene and hydrogen chloride, a noble metal catalyst may be employed without necessity for modification of the facility.

22. As was agreed between SPL and JICA and recorded in Interim Report, the financial and economic evaluations are based on the value in US dollar as of June 1983 without escalation. The total capital requirement is estimated at 75,072 thousand US dollars. At this total capital requirement, the following indicators for profitability are obtained:

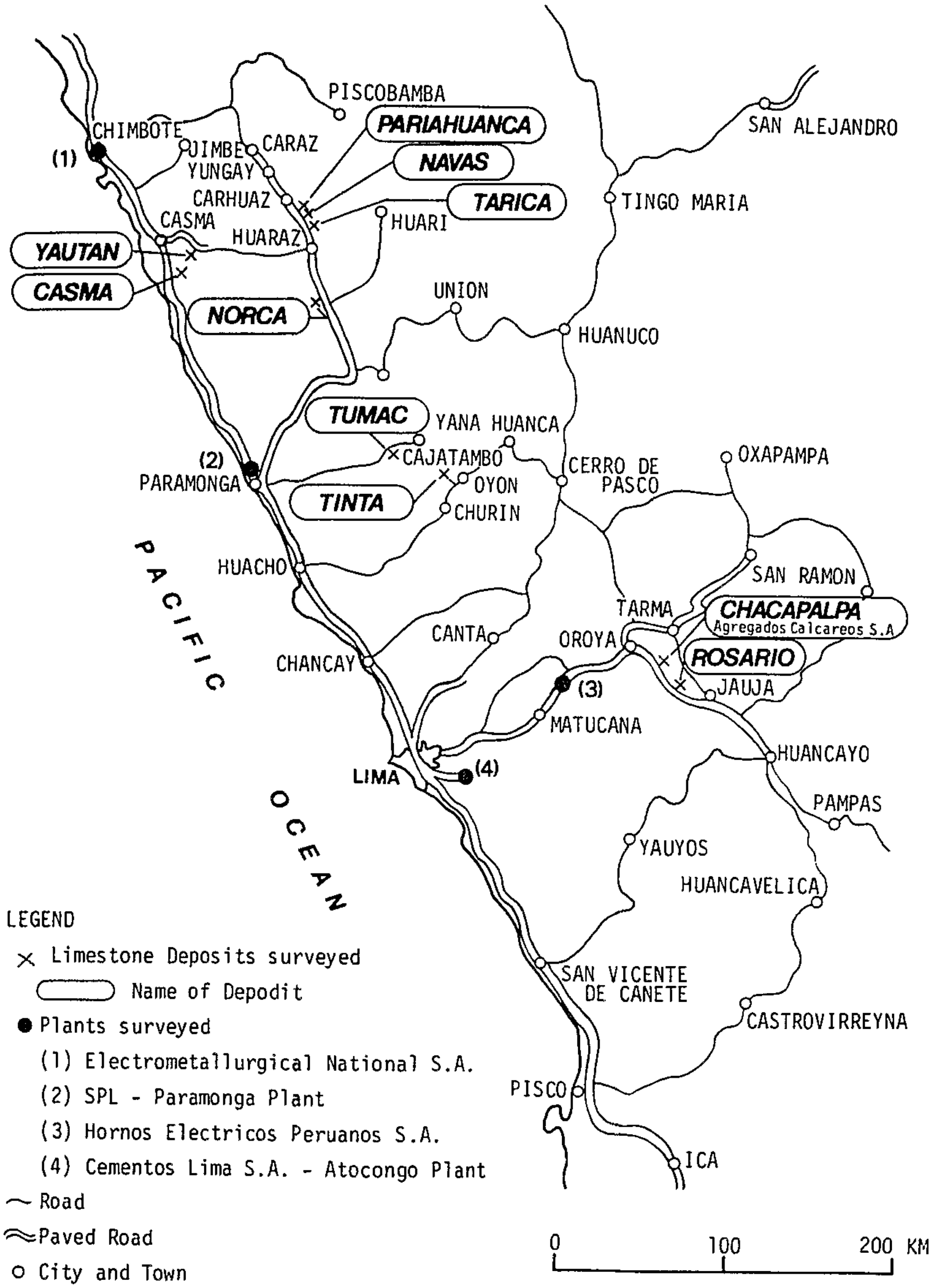
IRROI, % after tax	10.3
IRROI, % before tax	14.1

About 20 percent of this total capital requirement is attributable to import duty on equipment without which this figure could be reduced to 59,845 thousand US dollars. At this reduced total capital requirement the following indicators are obtained:

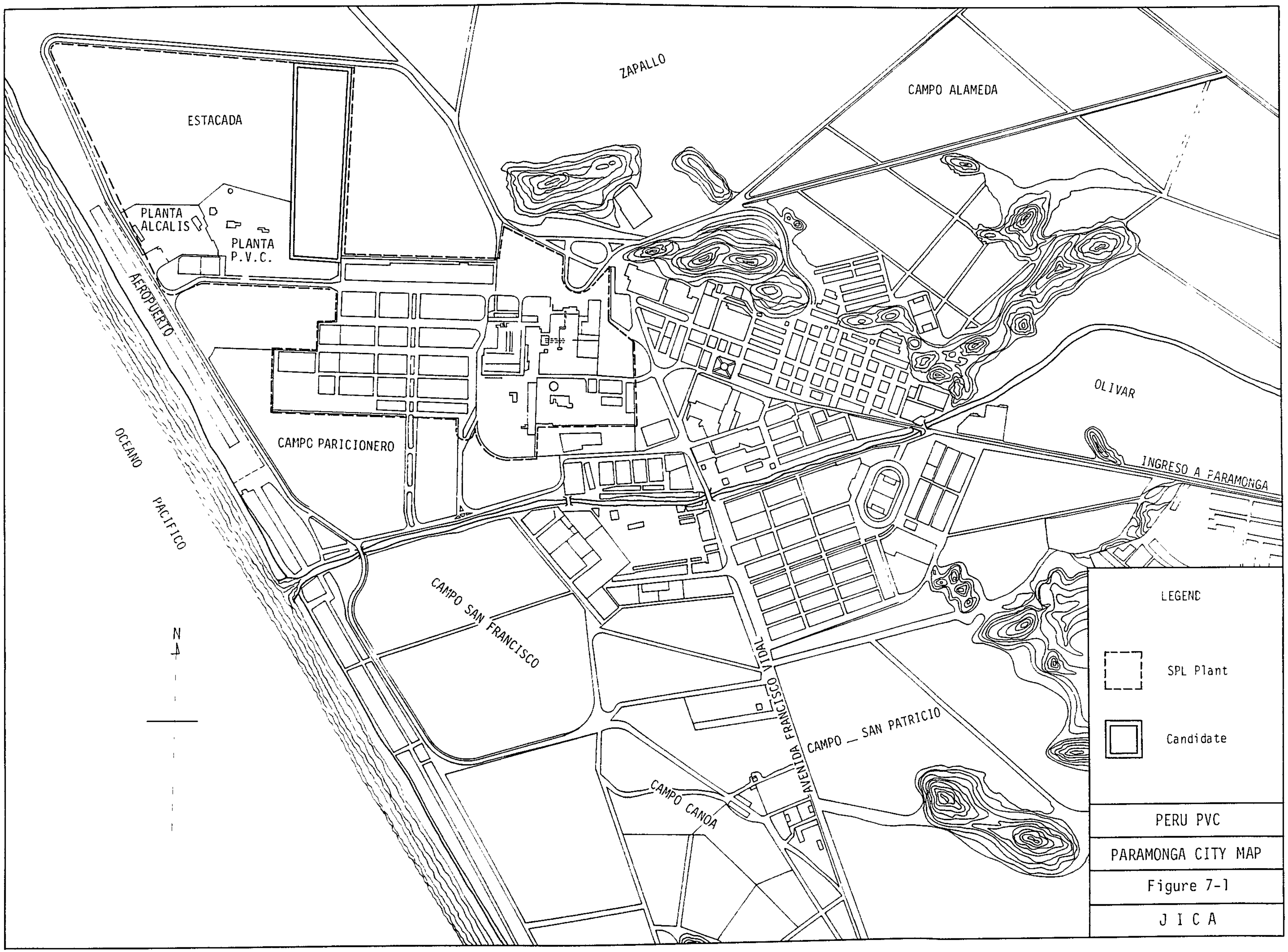
IROOI, % after tax	11.9
IRROI, % before tax	16.8

23. JICA therefore considers that exemption of import duty on imported equipment would be very beneficial to the project.

24. This project also have very favorable socio-economic effects as are explained in CHAPTER 13, ECONOMIC ANALYSIS. Also as stated in CHAPTER 14, OVERALL EVALUATION, JICA regards this project as recommendable for implementation.



Location Map of the Surveyed Limestone Deposits and Plants

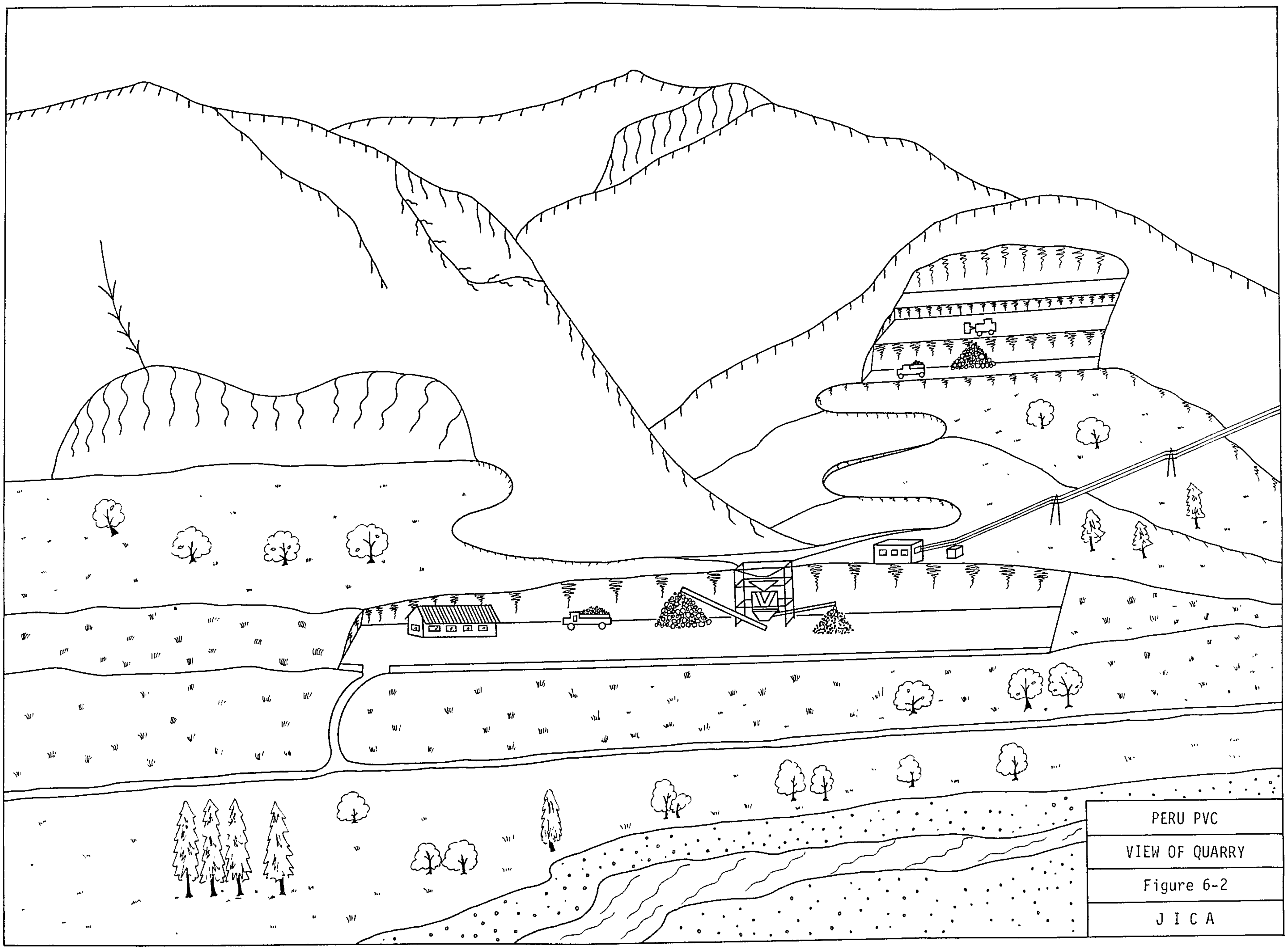


PERU PVC

PARAMONGA CITY MAP

Figure 7-1

J I C A

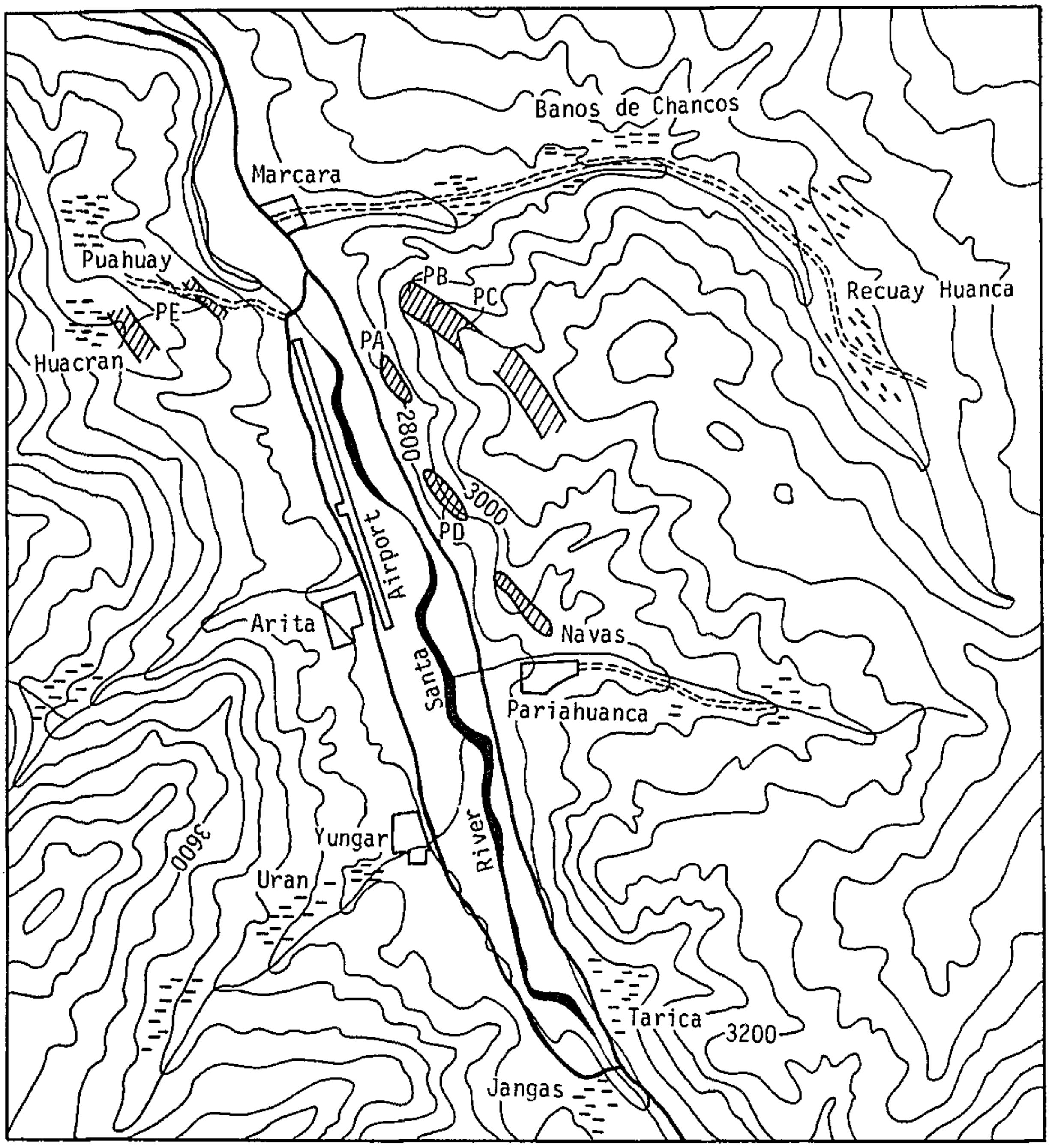


PERU PVC

VIEW OF QUARRY

Figure 6-2

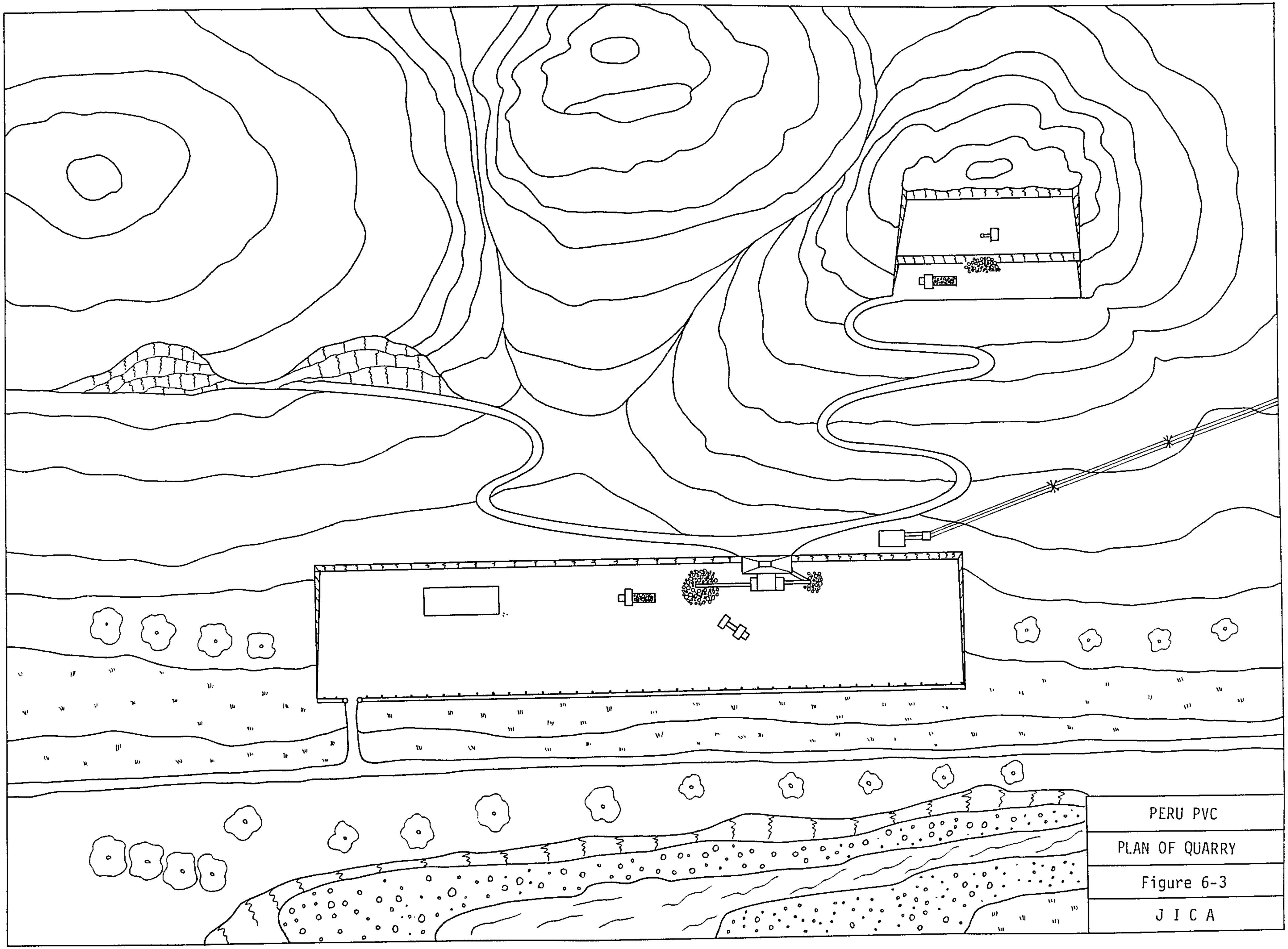
J I C A

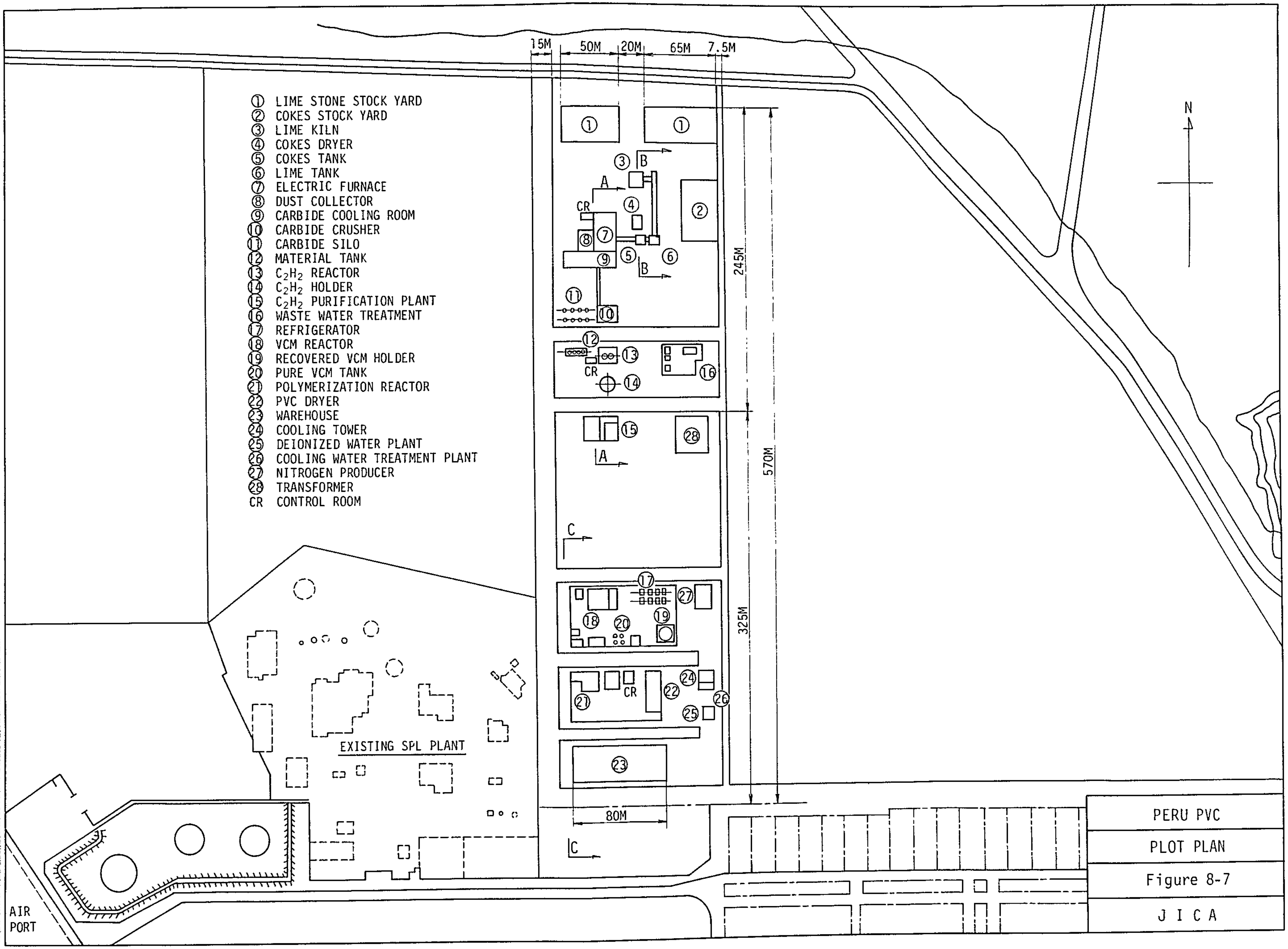


Topography of Pariahuanca Area

LEGEND

(hatched oval)	Limestone deposit	(town symbol)	Town
PA-PE	Location of sampling	(village symbol)	Village
(solid line)	Asphalt road	(river symbol)	River
(dashed line)	Sand road		


PERU PVC
PLAN OF QUARRY
Figure 6-3
J I C A

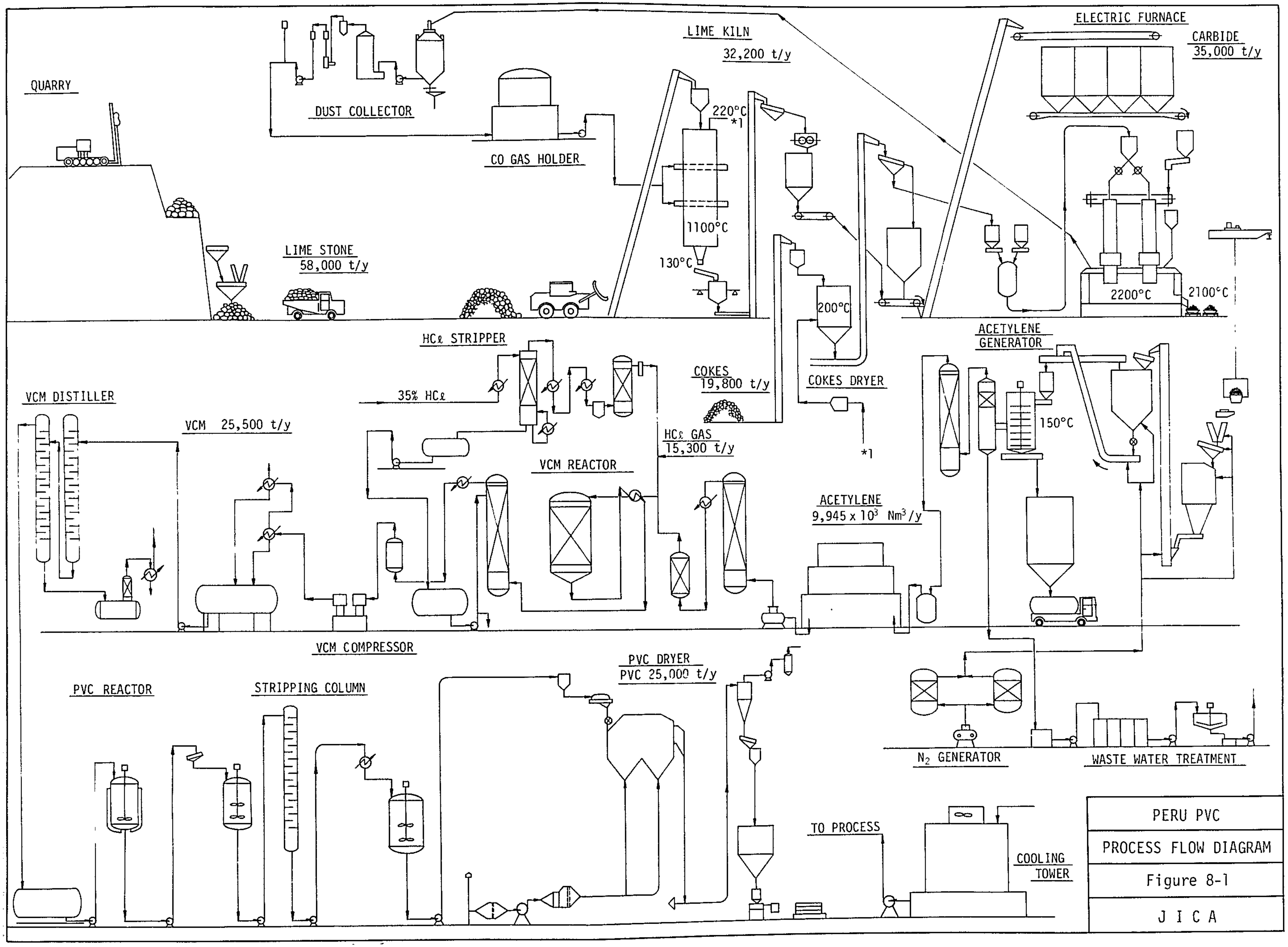


PERU PVC

PLOT PLAN

Figure 8-7

J I C A



PERU PVC
PROCESS FLOW DIAGRAM
Figure 8-1
J I C A

CHAPTER 1 BACKGROUND

1.1 Background of the Study

There is a firm and growing demand for PVC in Peru, particularly for manufacture of PVC pipes, sheets and films, shoes and electric wires. The domestic production meets about half of the domestic demand, the rest being supplied by import. SPL, the only manufacturer of PVC in Peru, had been producing PVC from fermentation alcohol made from molasses until November 1981. The reason for suspending this operation is that price of alcohol became too expensive as well as unstable. Ever since SPL has been producing PVC from imported EDC.

Under such circumstances SPL formulated a plan to produce PVC from limestone abundantly available in Peru and hydrogen chloride that SPL was producing as a by product of caustic soda but was disposing of for lack of adequate uses. In August 1982, the Government of Peru asked the Japanese Government for technical assistance in the form of a feasibility study of this concept. Upon receipt of the formal request, the concerned offices of the Japanese Government including JICA examined and found the project as a rational one. JICA sent to Peru a preliminary survey mission headed by Mr. Iwaguchi and finalized the scope of work with SPL. Thus this feasibility study was realized.

1.2 Purposes and Scope of Study

Needless to say, the purposes of this feasiblitly study are, in short, (1) to examine the technical and economic viability of this project, and (2) present appropriate recommendations regarding the execution of this project based on the overall assessment of this project. The full scope of work for this feasibility study agreed by SPL and JICA is shown in the APPENDIX. The scope of work consists mainly of : (1) studying marketing potential of the products; (2) studying technical aspects ranging from limestone quarrying, transportation of the limestone to the carbide plant site, all the manufacturing facilities from the limestone kiln and electric furnace to produce calcium carbide, a facility to generate acetylene, (a) faciliti(es) to produce vinyl-chloride monomer (VCM), (a) faciliti(es) to polymerize VCM to PVC and associated facilities to handle PVC, and related studies on site, utilities, auxiliary facilities, infrastructure; and (3) conducting financial and economic analyses of the project and presenting appropriate recommendations.

1.3 Methods of Study

The study flow diagram on the next page schematically illustrates the method of this feasibility study. The study period may be broadly broken down into four; namely, (1) Period of preparation for the field survey, (2) Field Survey, (3) Work in Japan, and (4) Draft meeting to the final report submission. As is seen on the study flow diagram the entire study may be considered as consisting of a total of 29 work units covering these four work periods.

Actually these work units were faithfully followed. The JICA study team made full preparations before the field survey. With full cooperation by SPL the field survey was very fruitful. At the closing stage of the field survey, the project scheme was formulated and agreed on by SPL and the JICA study team. The project scheme was checked again at Work Unit, C-6, and was reconfirmed again as the appropriate one. All the evaluations were done on the project scheme. The 29 work units are given full accounts in the original report to which reference should be made for details.

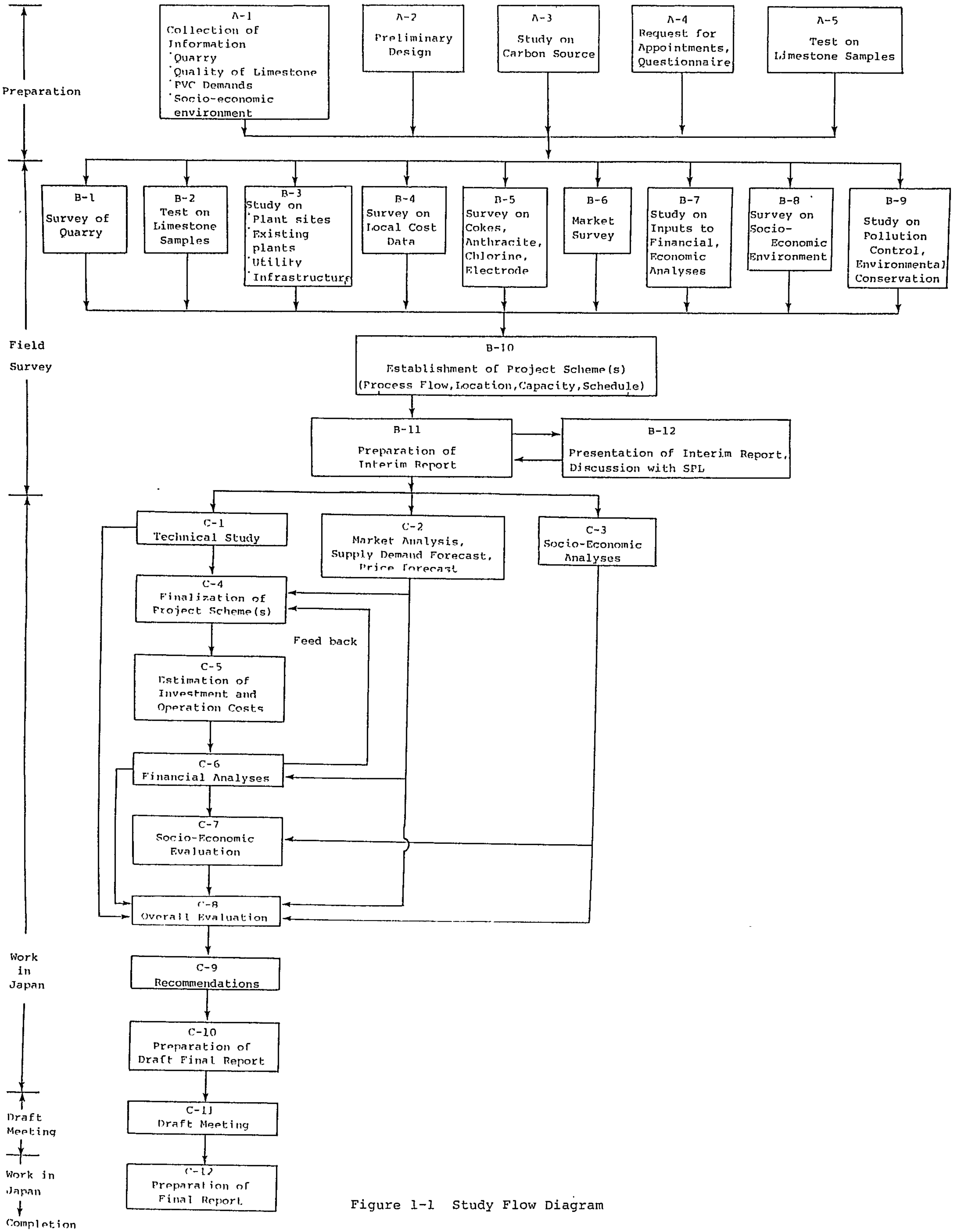


Figure 1-1 Study Flow Diagram

CHAPTER 2 PROFILE OF PERU AND ITS PLASTIC INDUSTRY

2.1 Natural Conditions and Population

Peru is the third largest country in South America with an area of about 1.3 million square kilometers, situated between 18th and 21st parallels south of the equator. Peru is bordered on the west by a 2,300 kilometers Pacific coast line. On the land Peru shares borders with Equador, Colombia, Brazil, Bolivia and Chile. The country may be broadly broken down into three geographical regions with distinct topographic and climatic characteristics; namely, a narrow coastal area, a mountaneous central zone and Amazon Basin called costa, sierra and selva, respectively. The selva occupies about half of the entire area, the rest being about equally divided into the costa and sierra.

Although Peru is situated in the tropical zone, the strong influence of a cold current known as Humboldt Current flowing northward along the coast makes the climate of the coastal area cooler than normal for such latitudes. The coastal area is very dry characterized by a wide stretch of arid barren terrain, except in river valleys and some low places where underground water seeps. Besides tempering the coastal climate, the cold current brings a variety of aquatic lives which provide the basis of the great Peruvian fishing industry.

The mountaneous central zone measures about 300 to 400 kilometers across with altitudes of 1,700 to 6,500 meters above sea level. The higher crests are covered with snow. Here are located principal mineral deposits. This area is also very rich in agricultural products like wheat, corn (maize), oats, potatoes, beans, etc.

The climate of Amazon Bazin is warm, humid with a heavy tropical precipitation reaching 2,500 millimeters a year or even more. The heat, rainfall, poor drainage and the resultant jungle growth combine to keep the population extremely low. This area has a great potential for agricultural development but presently the main industry in this area is forestry.

Peru's population is now estimated approximately at 18 million living mostly in the coastal and mountaneous areas with only a few percent living in Amazon Basin.

2.2 Socio-economic Background

Peru's present government under Fernando Belaunde assumed office in July 1980 after a long tenure of a military government which had lasted since 1968. The first priority of the Belaunde Government is to correct persistent economic problems. The Government is promoting economic development by encouraging more efficient utilization of resources, decontrolling the economy, and increasing participation of the private sector.

During the past years the economy of Peru has apparently expanded in terms of total GDP; however, the population increased faster than GDP.

Table 2-1 Gross Domestic Products

Gross Domestic Products

	Million of 1975 US$	Million of Current US$	Per Capita Current US$
1971	9,024	6,870	494
1977	10,914	12,267	757
1978	10,718	12,991	773
1979	11,123	14,945	864
1980	11,457	17,411	978
1981	11,902	19,892	1,087

(Source : Banco Continental)

Table 2-2 Population

	Million
1971	13.8
1977	16.2
1978	16.8
1979	17.3
1980	17.8
1981	18.3

Rate of growth over the period from 1971 to 1981 is 2.9 percent.

(Source : Banco Continental)

The sectorial breakdown of GDP is as follows:

Table 2-3 GDP Breakdown

	1973	1977	1978	1979	1980	1981
Agriculture	13.5	13.0	12.8	12.7	11.7	12.7
Fishing	0.8	1.0	1.3	1.3	1.2	1.1
Manufacturing	25.2	25.4	25.3	25.3	25.9	25.4
Mining & Petroleum	7.1	8.3	9.6	10.2	9.6	8.9
Construction	4.6	5.4	4.6	4.5	5.2	5.5
Government	7.9	8.2	8.3	7.9	7.8	7.7
Commerce & Service	40.9	38.7	38.1	38.1	38.6	38.7
Total	100.0	100.0	100.0	100.0	100.0	100.0

As is evident from Table 2-3 the industrial structure of Peru has remained basically static despite minor sectorial changes during the past decade.

With respect to contribution to export, mining and petroleum are predominantly important.

Table 2-4 Contribution to Export

(Million US$)

	1973**	1977**	1981*	1982*	Percent 1982
Fishery products	149	208	141	202	6.3
Copper	284	363	529	459	14.2
Other minerals	278	511	896	751	23.2
Petroleum	4	42	692	715	22.1
Agricultural products	246	391	172	218	6.7
Others	80	139	827	885	27.5
Total	1,041	1,654	3,255	3,230	100.0

Sources : * Institute Nacional de Estadistica
** Ministerio de Economia y Finanzas

The balance of payments position of Peru is not very good. As is evident from Table 2-6, Foreign Debt (Cummulative), the foreign debts both of the public and private sectors are very large.

Table 2-5 Balance of Payments

(Million US$)

	1975**	1980**	1981*	1982*
Trade balance	(1,099)	836	(548)	(557)
Export	1,291	3,898	3,255	3,230
Import	2,390	3,062	3,803	3,787
Service & transfer	(439)	(774)	(965)	(1,090)
Long-term capital account	1,135	460	635	1,264
Short-term capital account, SDR allocations, error	(173)	199	374	515
Overall balance	(576)	721	(504)	132

Sources : * Banco Nacional de Estadistica
** Institute Nacional de Estadistica

Table 2-6 Foreign Debt(Cummulative)

(Million US$)

	1975	1980	1981	1982
Long-term debt	4,352	8,125	8,172	9,629
Short-term debt	1,872	1,436	1,501	1,982
Total	6,224	9,561	9,673	11,611
Ratio of debt to GDP	0.45	0.56	0 .48	0.57
Breakdown of long-term debt				
Public sector	3,066	6,043	6,210	7,258
Central Bank	-	710	455	707
Private sector	1,286	1,370	1,507	1,664

(Source : Banco Central de Reserva)

Like many other Latin American countries, Peru has been chronically under heavy burden of foreign debt.

2.3 Plastic Industry

The manufacturing industry as a whole constitutes about 25 percent of GDP. Peru has a wide range of manufacturing industries to supply consumers' goods and durable household appliances. Besides these Peru has capital and technology intensive industries like the iron and steel mill in Chimbote, fertilizer plants in Talara, Cachimayo and Callao, automobile assembly plants, paper mill and sugar plants, and SPL's PVC plant.

In the field of upstream plastic industry, SPL's PVC plant is the only plant Peru has. While in the field of the downstream plastic industry Peru has a number of plants to process resin into pipes, sheets, films, bottles, toys, and other molded products.

Besides, there are industries which use resin as one of key raw materials. These industries include electric wire manufacturers, shoes makers, tile makers. Peru imports substantial amounts of polyethylene, polypropylane, PVC, polystyrene, all of which combine to reach some 40,000 tons per year.

CHAPTER 3 RAW MATERIALS AND ELECTRICITY

This chapter discusses availability in Peru of limestone, carbon source, electricity, chlorine, and electrode paste and their quality and cost based mainly on the results of the field survey. To sum up, limestone, electricity, and chlorine are domestically available whereas the carbon source and many of the auxiliar raw materials must, at least for the initial period of the project, be imported.

3.1 Quarry and Quality of Limestone

The quarry must meet the following requirements:

(1)	$CaCO_3$ content, %	98 minimum
(2)	SiO_2 content, %	1.5 maximum
(3)	Heating test	Retain sufficient strength after heating at 1,300°C for 2 hours
(4)	$MgO + Al_2O_3$, %	1.0 maximum

(5) Contain sufficient reserve to permit mining of 116,000 tons annual

(6) Acceptable cost of transportation to the plant site

The JICA survey team examined and took samples as necessary at Casma, Yautan, Tinta, Norca, Tarica, Pariahuanca, Tumac, Navas and Chacapalpa. These locations were shown on Figure 3-1. Of these limestone deposits Pariahuanca alone satisfies the requirement as feed.

The limestone quality and mining plan will be described in CHAPTER 6.

3.2 Carbon Sources

The sources of carbon used for calcium carbide manufacturing are required to have the following properties:

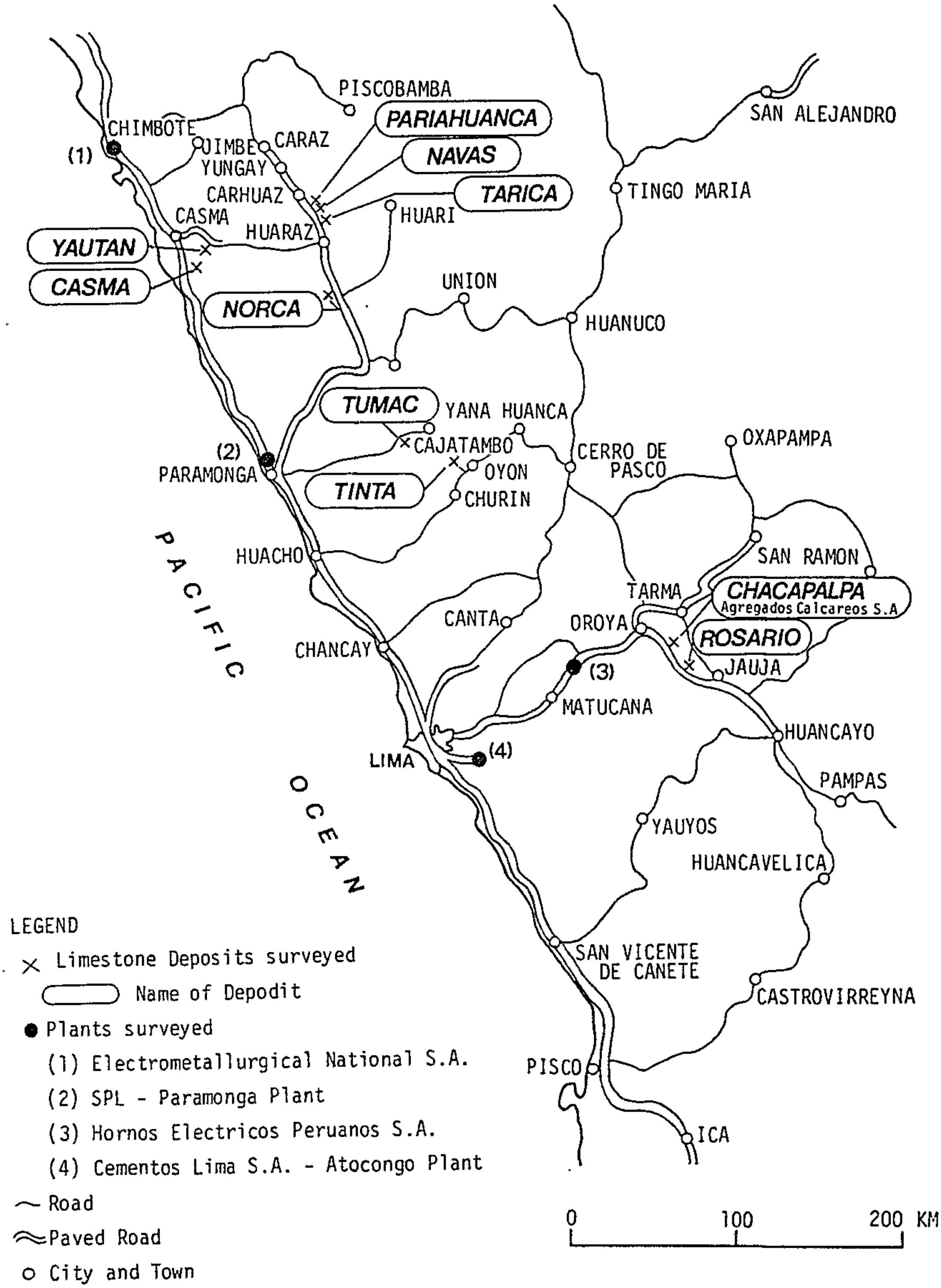


Figure 3-1 Location Map of the Surveyed Limestone Deposits and Plants

1. High specific electrical resistance
2. Good reactivity and high porosity
3. High fixed carbon content
4. Low ash content

During the initial years of the operation use of imported metallurgical coke and petroleum coke in a ratio of 70 to 30 is considered recommendable to satisfy the above requirements. Cost of imported coke available in Peru is considered to be 186.65 US$/ton.

When, in the future, sources of carbon of satisfactory quality is domestically produced in sufficient quantities, the use of such materials exclusively or in blends with imported materials may be considered.

3.3 Electricity

Because the manufacture of calcium carbide employs the electric furnace process which consumes a considerable amount of electricity, electricity may be regarded as the most important raw material rather than a mere utility. Accordingly, the conditions for the supply of electricity, particularly price and stability, are important factors affecting the viability of the carbide manufacturing facilities.

At present, SPL Paramonga Plant has a receiving facility for 42,000 KW. The additional 20,000 KW which will be required by the new plants can also be supplied by this trunk line. The present price for SPL Paramonga Plant is approximately US$ 0.035/kWh (average as of June 1983).

3.4 Chlorine Source

The existing salt electrolysis plant has a capacity to produce 42,000 tons per year of caustic soda and 37,275 tons per year of chlorine, with a hydrochloric acid synthesis capacity of 43,750 tons per year. Present consumption of chlorine or hydrochloric acid (liquid chlorine, bleaching solution, etc.) is approximately 12,000 to 17,500 tons per year, thus giving an excess of approximately 20,000 to 25,000 tons per year of chlorine.

The existing salt electrolysis and hydrochloric acid synthesis facilities were built in 1959 and are still operational. As is explained in the preceding paragraph they have sufficient capacities to provide 15,300 tons per year of hydrochloric acid required by the present project. SPL indicated 159,424 Soles per ton as price of chlorine. The cost of hydrogen chloride is calculated as follows:

$$\text{Cost of chlorine gas (159,424 Soles/ton)} \times \frac{35.5}{36.5} = 154,633$$

Therefore, cost of hydrogen chloride is 154,633 soles per ton or 100.6 US$ per ton.

3.5 Other Inputs

(1) Electrode paste

Hornos Electricos Peruano S.A., a Peruvian manufacturer of carbide uses a Soderberg-type electrode paste manufactured by Carboindustrials S.A. of Brazil under license of Elkem S.A. This electrode paste is considered to be of substantially the same quality as those in general use in large-capacity closed-type electric furnaces. This project presumes use of this electrode paste, of which estimated Peruvian price is US$ 1,240 per ton.

CHAPTER 4 MARKET AND DEMAND

4.1 Overview of Plastic Market

The domestic plastics market is relatively small. PVC consumption per capita is only 0.9 kilograms. Peru consumes such general-purpose plastics as PVC, polyethylene (PE), polypropylene (PP) and polystylene (PS), while consumption of special plastics like engineering plastics is virtually none. Diversification of plastic use will, however, proceed as industrization and modernization proceeds in Peru. Intensification of construction activity and substitution for wooden and leather products by PVC will increase demand of PVC. PVC demand in Peru is now about 14,000 tons per year, half of which is supplied domestically by SPL, the only manufacturer in Peru. Other general-purpose plastics (PE, PP, PS) are all supplied by import. The approximate amounts of import in 1982 are PE 25,000, PP 4,000 and PS 5,000 tons per year. Concerning the prices of imported plastics, PVC is the cheapest at 1,100 US$ per ton followed by low-density PE (LDPE) and high-density PE (HDPE) in the range of 1,200 to 13,00 US$ per ton, and PP and PS around 1,600 US$ per ton. The fact that PVC is sometimes imported at prices lower than the domestic produce creates a difficult situation to the domestic industry. Therefore the domestic PVC users wish for improvement of product quality and competitive and stable price vis-a-vis imported PVC. Major uses of PVC are rigid pipes, films and shoes which together account for more than 70 percent of the total consumption. The economy of Peru has not entirely recovered from the economic recession which holds down growth of PVC demand. PVC export from Peru is small, chiefly in the form of PVC finished products. Neighboring Andean countries are big potential markets for export. However the export to such countries is not necessarily easy. As will be explained, this project is justified by the domestic market and the export market is treated as a supplement.

4.2 The Domestic Market

(1) Market Size

Total demand for PVC in the domestic market in 1982 was 14,460 tons. Given the total population of approximately 18 million, this turns out to be 0.8 kilograms PVC consumption per annum per capita, a relatively small amount. Table 4-1 shows the size of the domestic market for PVC over the past eight years since 1975.

Table 4-1 Historical PVC Market in Peru

Year	Demand (t/y)
1975	10,376
1976	12,849
1977	14,270
1978	12,057
1979	11,454
1980	14,153
1981	16,280
1982	14,460

(Source : SPL)

(2) Demand by Sector and Use

1) Main uses for PVC

The main uses for PVC in Peru are:

a) Daily necessities
   - Edible oil containers
   - Cosmetic product containers
   - Film
   - Sheet
   - Shoes
   - Records

b) Construction materials
   - Piping and associated products
   - Flooring materials
   - Electrical insulation

c) Medical supplies

Transfusion and infusion equipment (disposable)

Tubing

d) Miscellaneous

2) Market scale by use

Table 4-2 shows market scale by use.

Table 4-2 PVC Demand Breakdown

(Unit: tons per year)

Year	Pipes	Film/Sheet	Bottle	Insulation	Shoes	Record	Floor	Others	Total
1978	5,115	1,438	1,473	1,315	1,922	399	367	28	12,057
(%)	(42.4)	(12.0)	(12.2)	(10.9)	(16.0)	(3.3)	(3.0)	(0.2)	(100.0)
1979	4,580	1,780	1,460	1,042	1,790	487	290	25	11,454
(%)	(40.0)	(15.5)	(12.7)	(9.2)	(15.6)	(4.3)	(2.5)	(0.2)	(100.0)
1980	5,100	1,743	1,770	1,500	2,754	703	500	83	14,153
(%)	(36.0)	(12.3)	(12.5)	(10.6)	(19.5)	(5.0)	(3.5)	(0.6)	(100.0)
1981	6,100	2,420	2,000	1,940	2.870	500	350	100	16,280
(%)	(37.5)	(14.9)	(12.2)	(12.0)	(17.7)	(3.0)	(2.1)	(0.6)	(100.0)
1982	6,250	2,370	17,30	1,410	2,070	340	240	50	14,460
(%)	(43.1)	(16.3)	(11.9)	(10.0)	(14.3)	(2.4)	(1.7)	(0.3)	(100.0)

3) Price

The prices of PVC resin and compounds sold domestically by SPL as of June 14, 1983, are shown in Table 4-3.

Table 4-3 SPL Domestic Sales Prices

Product	Price (US$/t)
Resin	
Homogenized polymer	1,100
Copolymer	1,316
Compounds	
Shampoo containers	1,794
Covering film	1,794
Medical equipment	1,868
General-use containers	1,868
Break-proof containers	1,943
Records	1,890
Dynamite fuses	1,645
Shoes	1,645
Shoes soles	1,868
Electrical insulation	1,566
Hosing	1,566
Tubing	1,418
Edible oil bottles	1,764

4.3 Import of Plastics

Peru imported in 1982 a total of 7,200 tons of PVC resin, amounting to almost half the total PVC demand. This section studies the importation of plastics and competitiveness of the domestic PVC.

(1) PVC

1) Import volume and price

Table 4-4 shows PVC demand and importation. As seen from the table Peru has been dependent on import during the past seven years for more than 50 percent supply.

Table 4-4 Historical PVC Demand and Import

Year	Demand (t/y)	Import (t/y)	Share (%)
1976	15,720	8,483	54
1977	18,443	12,468	68
1978	11,975	3,837	32
1979	13,392	6,166	46
1980	13,574	6,649	49
1981	16,280	10,087	62
1982	14,400	7,150	50

PVC imported is chiefly of suspension type and import of emulsion type PVC is very little.

Table 4-5 shows import price of PVC since 1982.

Table 4-5 Price of PVC Resin (Homopolymer)

(Unit: US$/ton)

Year/Month	FOB	C & F	CIF
1982 1	538.6	665.3	
2	528.8	637.9	
3	502.9	597.0	
4	497.2	577.1	
5	533.0	672.0	
6	435.0	552.4	
7	533.1	658.9	
8	500.5		521.8
9	441.0		566.7
10	457.3		582.8
11	448.0		563.1
12	467.1		584.9
1983 1	445.4		576.0
2	490.2		614.1
3	434.4		560.9
4	398.5		622.1

Total cost of imported PVC as of June 1983 was 871 US$ per ton. A typical example for calculating total cost of imported PVC is shown in Table 4-6.

Table 4-6 Typical Cost of Imported PVC

(as of June 14, 1983)

(1)	FOB	450 US$/ton
(2)	Freight	100 "
(3)	C & F	550 "
(4)	Insurance ((3) x 1.5%)	8.25 "
(5)		558.25 "
Taxes		
(6)	40 % CIF	223.30
(7)	Freight marine ((2) x 10%)	10.00
(8)	Financial Cost	37.80
(9)	Commission etc. ((6)+(7)) x 15%	34.995
(10)	Total Taxes	306.095
(11)	Freight (Callao to Lima)	7.000
(12)	Grand Total (5)+(10)+(11)	871,354 US$/ton --- Total Cost

$$\text{Relation} : \frac{(12)}{(1)} = 1.936$$

$$: \frac{(12)}{(5)} = 1.56$$

2) Sources of Import and Users

PVC is now imported mainly from South Africa, United States, West Germany, Mexico and Belgium. Major exporters are AECI of South Africa, B. F. Goodrich and CONOCO Chemicals of United States and Chemishe Werke Huls of West Germany. Import from south Africa and United States account for more than 70 percent of the total.

4.4 Price Trend

(1) General

PVC price in Peru fluctuates very much. FOB prices of imported PVC from 1975 to 1983 are shown in Table 4-7.

Table 4-7 FOB Price of Imported PVC

Year	FOB Price (US$/t)
1975	549
1976	357
1977	471
1978	441
1979	618
1980	741
1981	577
1982	490
1983 (Jan-Apr.)	442

(2) Production cost and sales price

Production costs of SPL's PVC in May 1983 are 914 US$ per ton for resin and 1,500 US$ per ton for compound. Table 4-8 shows historical PVC sales prices since 1977. Owing to the price control by the government, domestic PVC was cheaper than the imported PVC until 1979 but since then the situation has been changed; in other words, the imported PVC has been cheaper. Estimated average price difference for 1983 is 45 US$ per ton.

Table 4-8 Historical Sales Price of PVC

(Unit: US$ per ton)

Year	Domestic	Imported	
1977	892 *	-	
1978	961 *	-	
1979	995 *	1,310	
1980	1,434	1,119	
1981	1,119	980	
1982	843	825	
1983	1,107	1,052	Estimated

This difference prompted many domestic processors to change to imported sources.

The trade within the region is exempt from the 40 percent import duty on FOB price that is imposed on import from outside the region to stimulate intra-regional trade. Columbian manufacturers are reportedly planning to take advantage of this situation to offer Peruvian importers 750 US$ per ton C & F or Lima delivered price of 850 US$ per ton.

(3) Future Trend of Price

According to the recent information about chemical market, PVC demand in the United States is picking up with firm price along with general economic recovery. JICA generally agrees with this view.

4.5 Demand Forecast by Use Category

The following eight major use categories are employed for demand forecast.

1. Piping and related materials
2. Film and sheeting
3. Containers

4. Electrical insulation
5. Shoes
6. Reconds
7. Flooring material
8. Others

The forecast growth rates and demands obtained are shown on Tables 4-9 and 4-10. The processes for obtaining these results are explained in the original report.

Table 4-9 Demand Growth Rate by Use

Year	Pipes	Film/Sheet	Bottle	Insulation	Shoes	Record	Floor	Others
1982								
1983	3.0	3.0	3.0	5.0	4.0	3.0	3.0	5.0
1984	5.0	5.0	4.0	7.0	5.0	5.0	5.0	5.0
1985	8.0	8.5	6.0	10.0	7.0	6.0	7.0	5.0
1986	8.0	8.5	6.0	10.0	7.0	6.0	7.0	5.0
1987	8.0	8.5	6.0	10.0	7.0	6.0	7.0	5.0
1988	8.0	8.5	6.0	10.0	7.0	6.0	7.0	5.0
1989	8.0	8.5	6.0	10.0	7.0	6.0	7.0	5.0
1990	8.0	8.5	6.0	10.0	7.0	6.0	7.0	5.0

Figure 4-1 shows two dotted lines each representing a demand growth 10 percent higher and lower than the forecast growth. The shaded area beginning from 1984 indicates the range of demand if demand varies between 6 and 10 percent per annum. With such possibility of variation taken into account the demand in 1988 is forecast to be at least 19,000 tons per year.

Table 4-10 Demand Forecast by Use

(Unit: tons)

Year	Pipes	Film/Sheet	Bottle	Insulation	Shoes	Record	Floor	Others	Total
1982	6,250	2,370	1,730	1,410	2,070	340	240	50	14,460
1983	6,440	2,440	1,780	1,480	2,150	350	250	50	14,940
1984	6,750	2,560	1,850	1,580	2,260	370	260	60	15,690
1985	7,290	2,780	1,960	1,740	2,420	390	280	60	16,920
1986	7,870	3,020	2,080	1,920	2,590	410	300	60	18,250
1987	8,500	3,270	2,200	2,100	2,770	440	320	60	19,660
1988	9,180	3,550	2,340	2,320	2,960	460	340	70	21,220
1989	9,920	3,850	2,480	2,550	3,170	490	360	70	22,890
1990	10,710	4,180	2,630	2,800	3,390	520	390	70	24,690

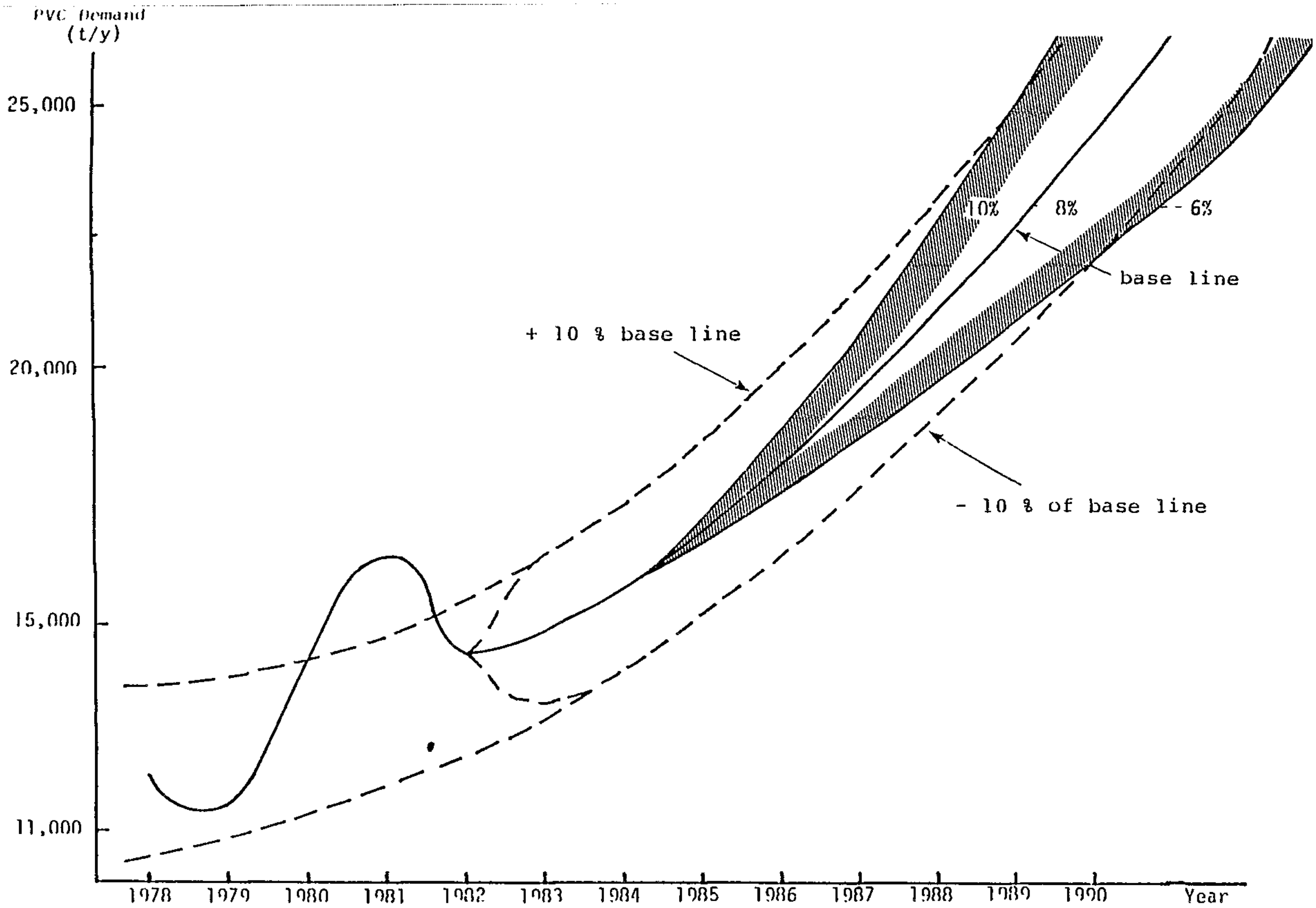


Figure 4-1 Historical PVC Demand and its Forecast until 1990

Figure 4-2 shows the aggregated demand thus estimated until 1990 as well as the extrapolated values for 1995. Also shown are projections assuming growth rates 10 percent higher as well as 10 percent and 15 percent lower than the base case. As is seen from the base line, 1995 demand is estimated at approximately 29,6500 tons per year. The 25,000 tons per year demand figure will be reached in 1989 if growth is 10 percent higher than forecast, 1992 if it is 10 percent lower than forecast, and mid-1993 if it is 15 percent lower than forecast.

4.6 Demand Forecast by Correlation Analysis

As no single method is completely dependable, correlation analysis was applied to future demand forecast of PVC in Peru along with forecast by use category. Relations between Gross Domestic Product (GDP) per capita and PVC demand per capita was studied based on such data for 30 countries at various levels of economic development.

(1) Method of analysis

The original data given in Table 4-11 are plotted on a graph with GDP per capita and PVC consumption per capita on the horizontal and vertical axis, respectively, and a logistic curve which best fits these data was obtained.

Figure 4-3 shows both original plots and the logistic curve obtained.

(2) Result and Discussion

Although the original data somewhat scatter but with the exception of a few data they lie along the logistic curve indicating existence of correlation between GDP and PVC demand, which means that PVC demand per capita can be obtained on a set of assumptions from GDP per capita. A range of growth rates from 2 to 6 percent are assumed to calculate the future GDP. Population is assumed to grow at 2.8 p.a. Using the 1982 data, 18.28 million people, the number of population in 1988 will reach 22.18 million. By multiplying the PVC demand per capita and population, PVC total demand in 1988 was calculated. The results are summarized in Table 4-12. In 1981 GDP per capita of Peru was 1,100 US$ against which PVC demand per capita was

0.89 kg, a small consumption of less than 1.0 kg. However, if GDP per capita increases at 2 percent p.a., a rather low growth rate, 34,600 tons per year of PVC demand will be expected by 1988. This demand is much larger than the forecast demand obtained by end use category, which is about 21,200 tons per year in 1988, as presented in previous Section 4.5. This means that Peru consumes less PVC on per capita basis compared with other countries of the same GDP level. We conclude, therefore, that the forecast demand by correlation analysis is too much on the optimistic side in view of the present market situation of Peru and it shoud not be used to support a more optimistic project size. Instead, it should be interpreted as an indication of the level of consumption Peru could attain through industrialization and modernization of the society.

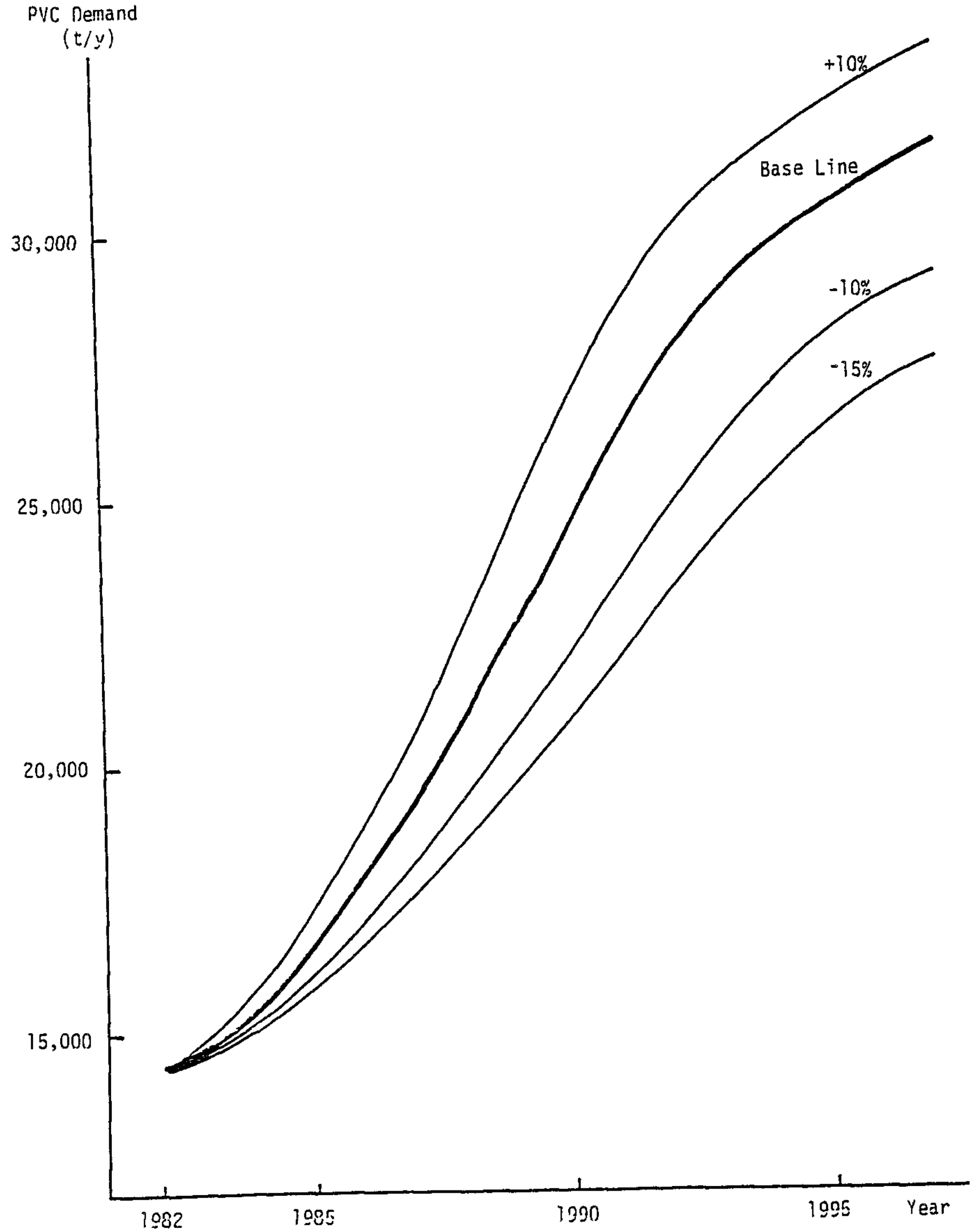


Figure 4-2 PVC Demand Forecast until 1995

Table 4-11 GDP vs. PVC Demand

No.	Country	GDP per capita (US$)	PVC demand per capita (kg)	Remarks
1	Korea	1,698	6.28	
2	Japan	9,878	9.65	
3	Thailand	765	1.12	
4	Malaysia	1,680	2.29	
5	Philippines	785	1.09	
6	Indonesia	456	0.72	
7	India	241	0.12	*
8	Australia	10,888	11.10	
9	Canada	11,724	9.38	
10	United States	12,569	12.79	
11	France	10,561	13.68	
12	Spain	5,640	5.48	*
13	Greece	4,181	4.90	*
14	Rumania	6,227	9.25	**
15	Turkey	1,254	0.64	*
16	Hungary	2,334	10.55	
17	Norway	13,937	17.07	
18	Sweden	13,521	14.42	
19	Denmark	11,246	13.48	
20	United Kingdom	9,353	5.81	*
21	Netherland	9,798	11.94	
22	Belgium	12,080	10.75	*
23	W. Germany	11,142	20.66	
24	Switzerland	15,926	8.32	*
25	Mexico	2,591	1.75	*
26	Colombia	1,218	1.16	*
27	Venezuela	4,315	4.46	*
28	Peru	1,100	0.89	
29	Chile	2,530	1.17	*
30	Brazil	2,021	2.82	*

Remarks: * 1980 data
** 1980 GNP data

Table 4-12 Result of Correlation Analysis

GDP per capita (US$)	PVC demand per capita (kg)
500	1.27
1,000	1.45
1,500	1.67
2,000	1.90
2,500	2.17
3,000	2.47
3,500	2.81
4,000	3.18
4,500	3.59
5,000	4.05
5,500	4.55
6,000	5.09
6,500	5.67
7,000	6.29
7,500	6.95
8,000	7.64
8,500	8.37
9,000	9.11
9,500	9.87
10,000	10.63
11,000	12.15
12,000	13.60
13,000	14.93
14,000	16.11
15,000	17.11
16,000	17.95
17,000	18.64
18,000	19.18
19,000	19.63
21,000	19.95

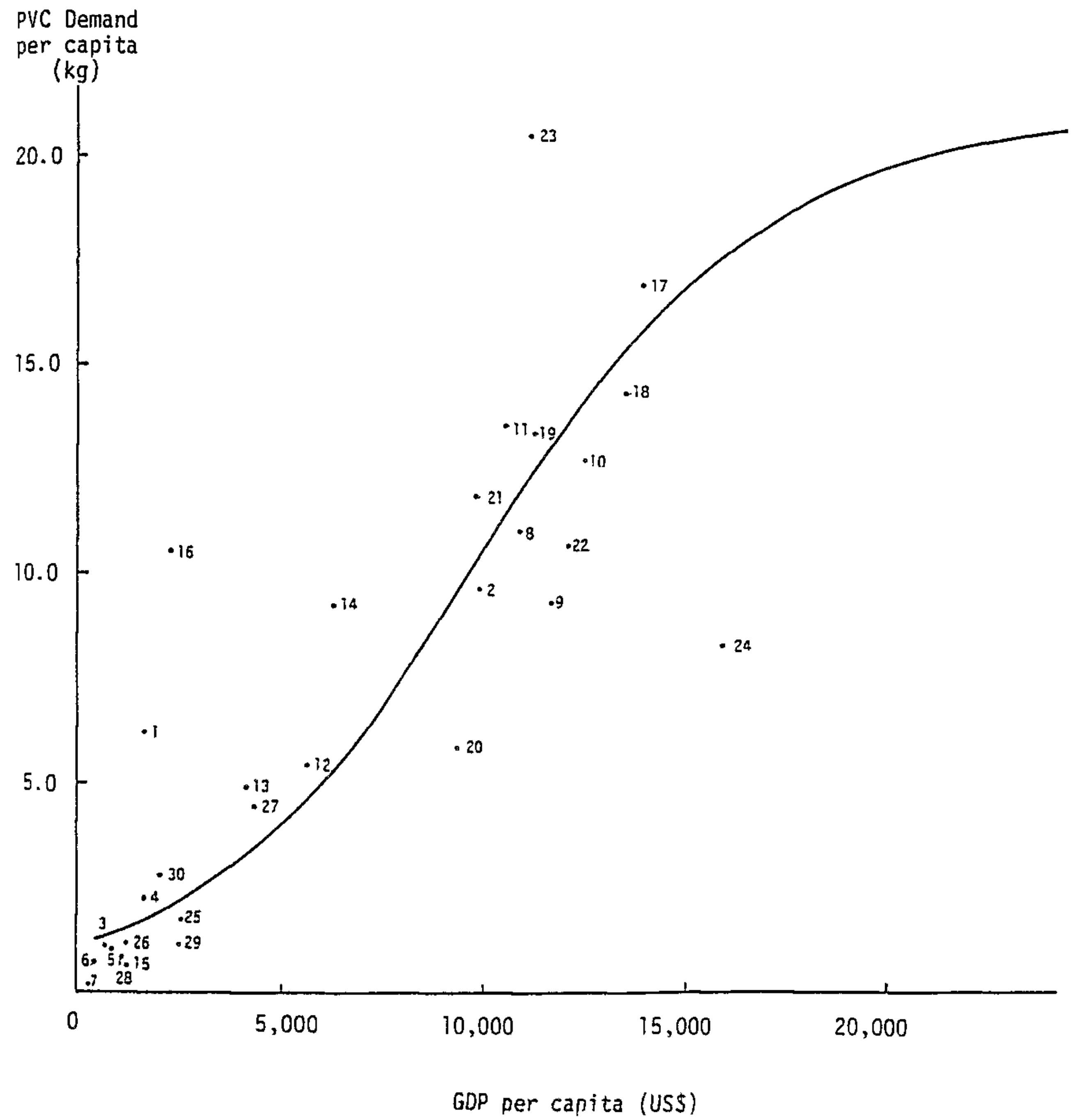


Figure 4-3 Original Plot and Logistic Curve for Correlation Analysis

Table 4-13 GDP Growth Rate vs. PVC Demand

GDP per capita Growth Rate (%)	1988 GDP per capita (US$)	PVC demand per capita (kg)	PVC demand in 1988 (t/y)
2	1,264	1.56	34,600
3	1,353	1.60	35,500
4	1,448	1.64	36,400
5	1,548	1.69	37,500
6	1,654	1.74	38,600

4.7 Possibility for Substitution for Other Plastics

There is possibility of PVC and other plastics, particularly, PE and PP, replacing each other. It is hard to draw any definitive conclusion as to which replacement is more likely. Therefore, this Possibility for substitution is not counted in PVC demand forecast.

4.8 Exports to Other Andean Countries

PVC Production and Demand in the Andean Countries

There are three Andean countries currently producting PVC. They are Columbia, Venezuela, and Peru. Supply capacities are shown in Table 4-15.

Table 4-15 PVC Production Capacities for Andean Countries

Country	Production Capacity (t/y)
Columbia	46,500
Venezuela	36,000
Peru	7,200
Total	89,700

The manufacturers in Colombia are Petroquimica Colombiana and Colcarburo, in Venezuela Petroplas and Tablazo, and in Peru SPL.

Petroquimica Colombiana plans to expand the capacity from 42,000 to 72,000 tons per year. Colcaruburo of Columbia is also studying the feasibility of raising its carbide-method production capacity from 4,500 to 12,000 tons per year. If both plans are implemented, Colombian production capacity will increase to 84,000 tons per year with a significant surplus to be exported to other Andena countries.

Table 4-16 shows the estimated balance of supply and demand for Andean countries with the added supply by this project included. The supply shortage will be supplemented by imports from outside the region. This may be taken to indicate that there is possilibity of this project exporting to other Andean countries if the domestic demand does not achieve the projected level of approximately 20,000 tons per year in 1988. This in turn further substantiates the conclusion that markets exist to sustain this proposed project.

Table 4-16 PVC Supply and Demand in 1988

(Unit: ton/year)

Country	1982	1983
Columbia	46,500	84,000
Venezuela	36,000	36,000
Peru	7,200	25,000
Total	89,700	145,000
Estimated Demand	131,900	233,700 (168,700)
Supply Shortage	42,200	88,700 (23,700)

4.9 Demand for Calcium Carbide, Calcium Cyanamide, Quick Lime and Slaked Lime

The demands for calcium carbide, calcium cyanamide, quick lime and slaked lime were studied. The domestic demand for calcium carbide is fully met by the existing plant of the Hornos Electricos Peruanos S.A. Any substantial growth is not expected for the foreseeable future. The demands for calcium cyanamide, quick lime and slaked lime do not exist nor will be expected in the near future.

4.10 Conclusions of Market and Demand Study

From the foregoing discussions are drawn the following conclusions. To summarize:

(1) Size of the domestic PVC market

The forecast domestic demand obtained by use category method which gives about 20,000 and 25,000 tons per year demands for 1988 and 1990, respectively, appears more realistic than the more optimistic demand given by the correlation method. In view of the inherent uncertainty of the market behavior, 10 to 15 percent deviations on both plus and minus sides must be taken into consideration when deciding the project size. Therefore, the results of the correlation method should not be used to support a larger capacity so that the project will not run a risk of having too big a capacity and under-utilizing it.

(2) Price of PVC

The price of domestic PVC, 1,100 US$ per ton as of June 1983, has been competitive with imported PVC, although there have been relative advantages and disadvantages depending upon the CIF prices and rate of customs duty and associated expenses with the duty. Therefore, use of 1,100 US$ per ton price for the financial analysis is recommended.

(3) Possibility of substitution for other plastics

The possibility of substitution by PVC for other types of plastic is not counted in forecasting the future domestic demand of PVC. This possibility certainly exists. On the other hand, however, there exists equally certain possibility of other plastics replacing PVC. Which possibility is more likely is not quantitatively assessed at this moment. Therefore these possibilities are both included in the demand forecast. It might be added that by establishing good reputation for quality, SPL could penetrate food wrapping plastic market so far occupied by PE.

(4) Possibility of export

Likewise, the possibility for exporting PVC to other Andean countries is not counted in the demand forcast. Depending upon the price of domestic PVC and import duty rate, there exist both possibilities; that is, possibilities of Peru exporting and importing PVC. It is far more important for this project to command the domestic market than try to sell under severe international conditions.

(5) Demands for intermediate, side productions and byproducts

The demands for intermediate products, side products or byproducts are neglgble. Therefore, any added investments for the purpose of producing these products are not recommended. During the final stage of the study, the study team was informed that SPL's test on the slaked lime sample the study team left with SPL confirmed the possibility of using 9,000 tons per year of the slaked lime in Paramonga complex.

(6) Quality control

In view of the importance of the quality of the products in its competitive strength against imported products, establishment of quality control organizaitons in SPL is recommended.

CHAPTER 5 PROJECT SCHEME

5.1 Conceivable Alternatives

Before the field survey started, JICA had prepared three basic alternative schemes as shown on Figures 5-1, 5-2, and 5-3 on Pages 5-3, 5-4, and 5-5.

Project Scheme (1) on Figure 5-1 is the simplest. All the operations from limestone quarrying to PVC polymerization are geared to the production of PVC only. Project Scheme (2) on Figure 5-2 produces calcium cyanamide, a nitrogenous fertilizer, together with PVC. Calcium cyanamide is a very good nitrogenous fertilizer with insecticide and soil nutralizing effects and can be easily produced by blowing nitrogen into a bed of hot calcium carbide. In both Project Schemes (1) and (2) VCM is supplied by the reaction between acetylene and hydrogen chloride to be produced in Paramonga Plant.

Project Scheme (3) is different in this respect. Project Scheme (3) assumes producing more PVC than possible with hydrogen chloride obtainable from the existing electrolysis plant. This project scheme leaves the present VCM production line from imported EDC operating which supplies additional VCM and hydrogen chloride.

After an intensive study Project Scheme (Final) on Figure 4 based essentially on Project Scheme (1) was selected. The capacity was decided on 25,000 tons per year. The processes for arriving at Project Scheme (Final) and the capacity are described in detail in the original report.

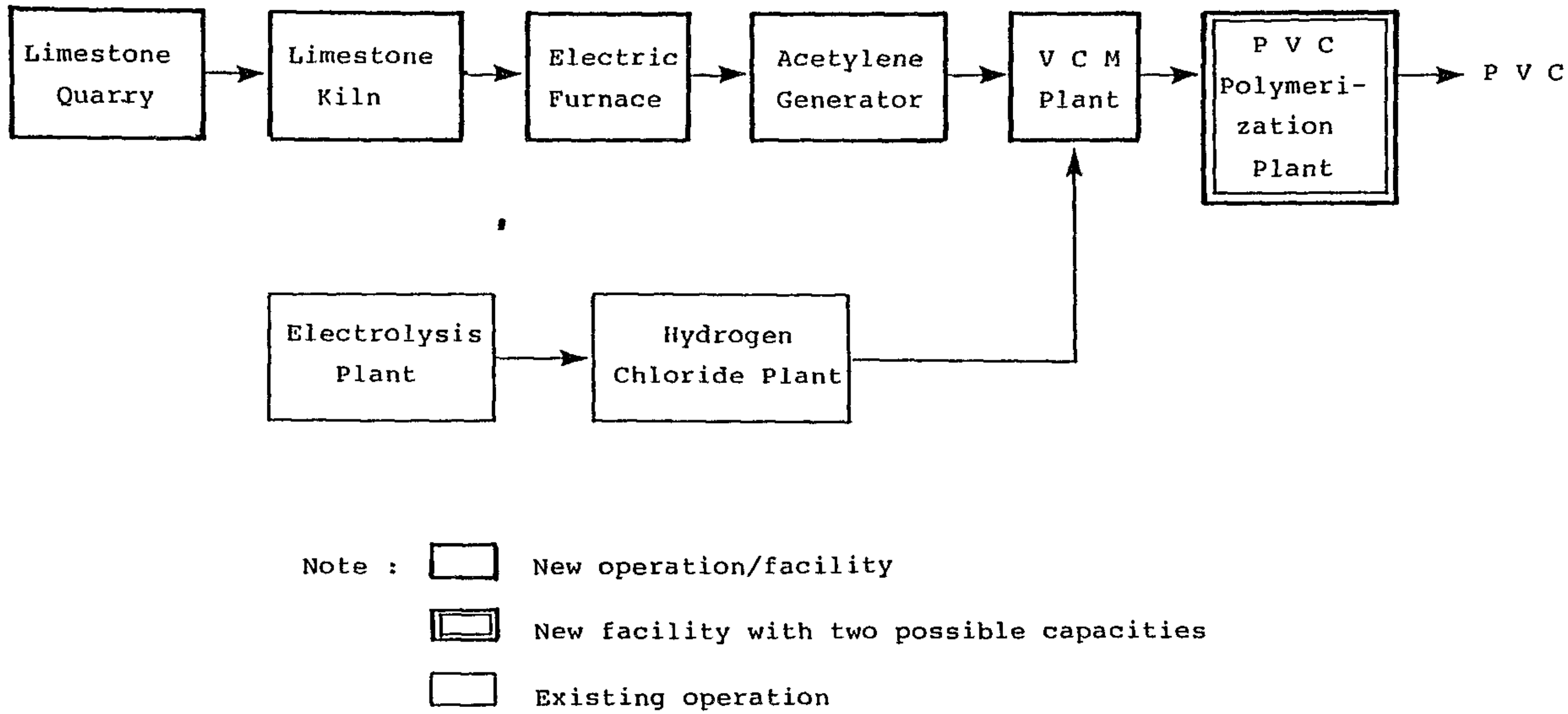


Figure 5-1 Project Scheme (1)

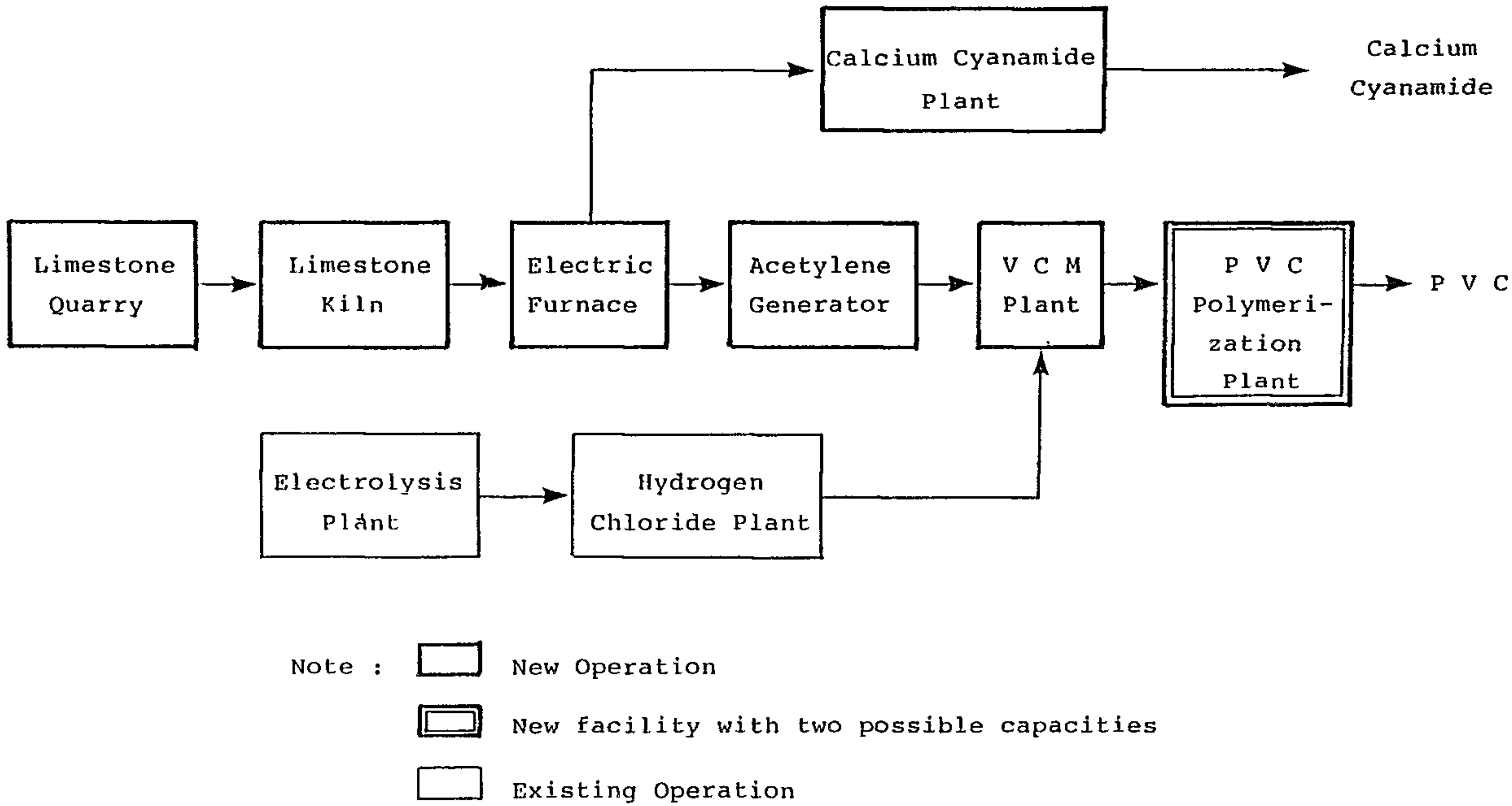


Figure 5-2 Project Scheme (2)

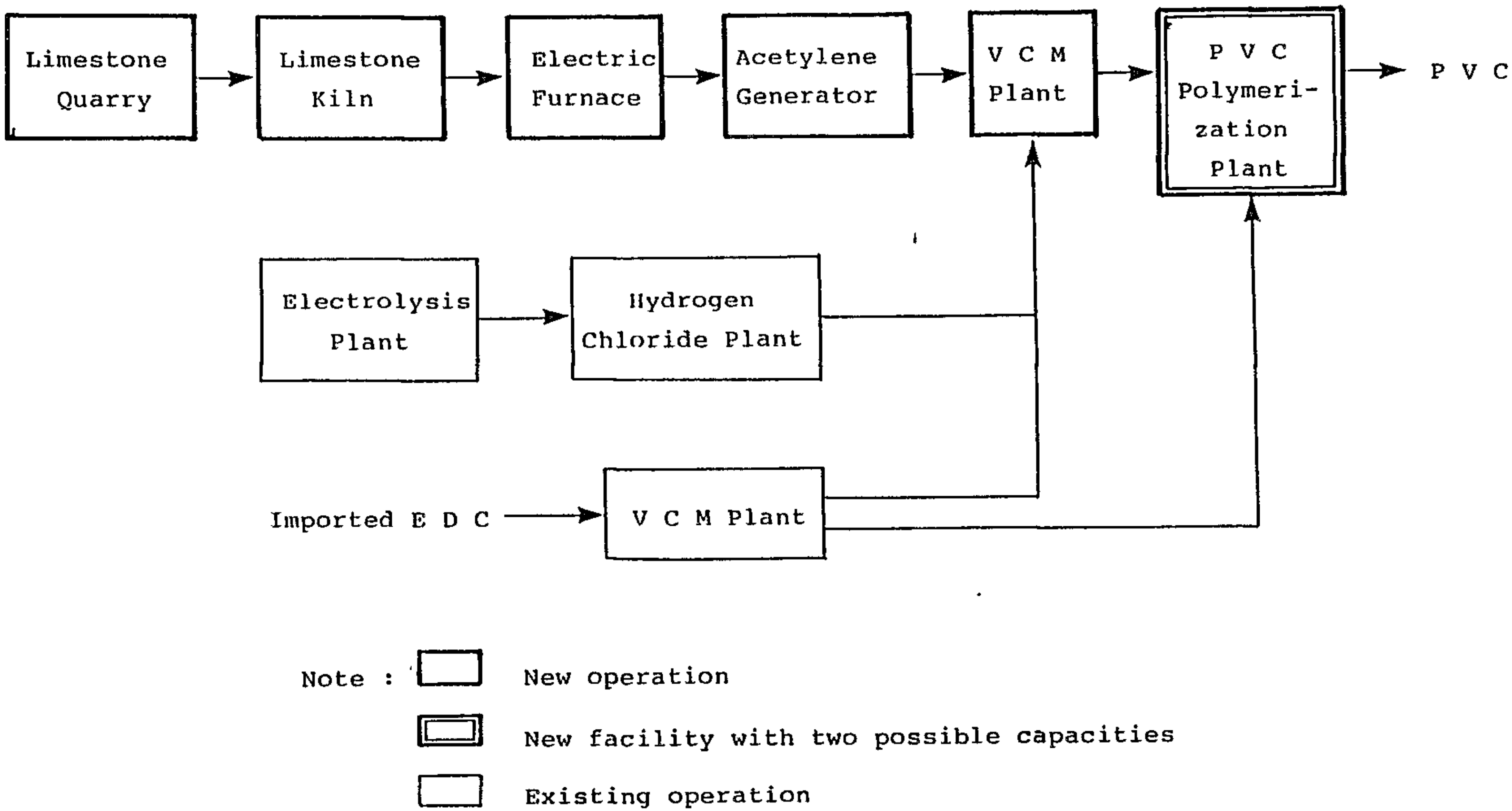


Figure 5-3 Project Scheme (3)

5.2 Selection of Quarry

The JICA study team investigated the following nine candidate quarries:

Casma
Yautan
Tinta
Norca
Tarica
Pariahuanca
Tumac
Navas
Chacapalpa

Of these only Pariahuanca satisfies the standards for quality, infrastructure, distance from the plant site, quantity of reserves. Therefore, Pariahuanca is selected as quarry.

5.3 Plant Site

SPL has prepared a plant site of very good conditions immediately next to the existing Alkali and PVC plants at Paramonga. This feasibility study examined possibility of locating the lime kiln and electric furnace at Pariahuanca close to the quarry separate from the downstream facilities. This alternative was, however, found not to be advantageous compared to locating all the facilities at Paramonga. The site SPL has prepared is decided as the plant site.

5.4 Project Scheme

To summarize the project scheme is defined as:

Capacity	25,000 tons per year as PVC
Flow	As shown on Figure 5-4 on the next page
Site	Paramonga
Limestone quarry	Pariahuanca

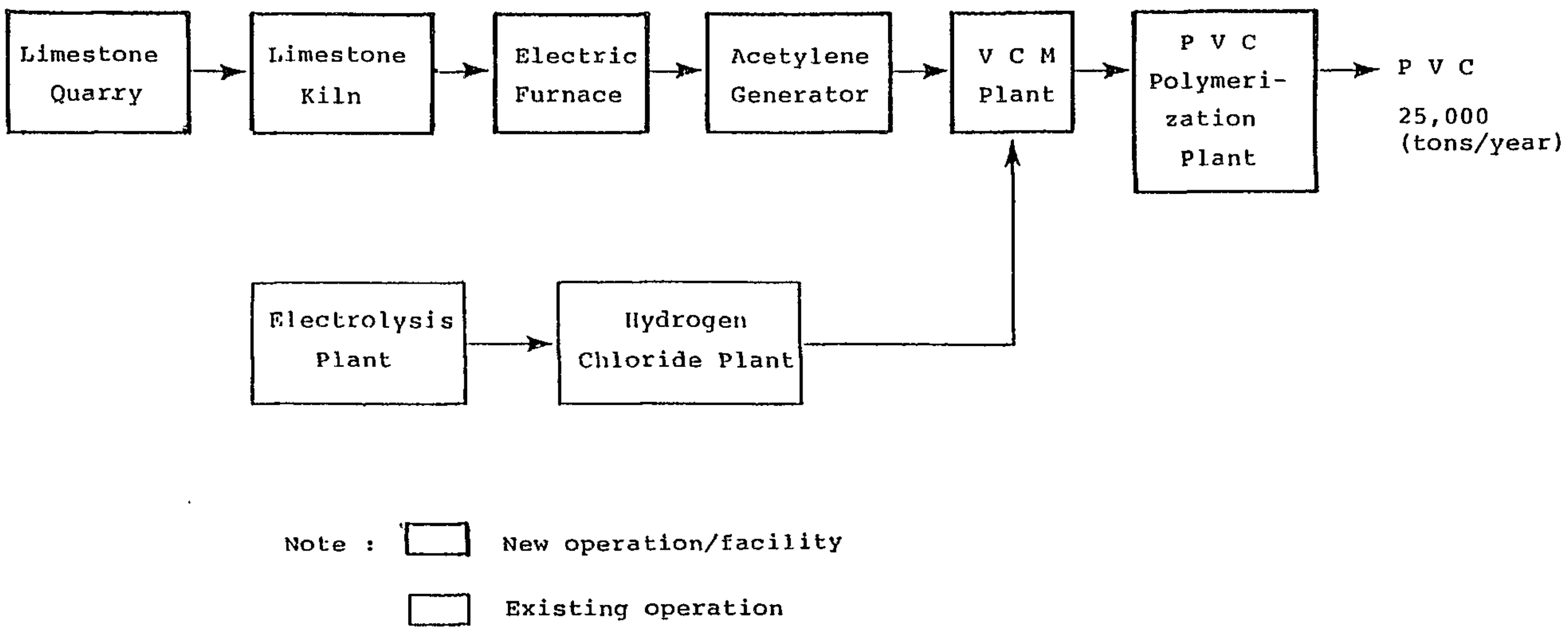


Figure 5-4 Project Scheme (Final)

CHAPTER 6 LIMESTONE

As is said previously Pariahuanca alone satisfies all the conditions required for the quarry, therefore the discussion in this chapter is limited to Pariahuanca. For other candidate quarries reference should be made to the original report.

6.1 Quality of Limestone

The Pariahuanca deposit has upper and lower outcrops running intermittently in almost the same direction. The lower formation has three blocks all forming a wall facing the west.

The limestone of the lower deposit is generally of acceptable quality though it contains white and pink-white mudstone at the middle and upper portions of the limestone layer. The analysis shows an average content of 1.01% SiO_2 in eight samples.

The thermal property is also regarded as acceptable on heating at 1,300°C for two hours. The results of the laboratory tests are shown on Table 6-1 contained in the original report.

6.2 Quarry Plan

A detailed geological survey, trial borings and calculation of accurate quantity of the limestone and formulation of the optimum method of quarrying must be accomplished before excavation can actually start. The mining should start both at the upper and lower deposits from the startup of the project to have greater production capacity and wider latitude to control the chemical composition.

The preliminary design calls for installation of the crushing plant at the foot of PA deposit on the slope between PA and PD deposit. Storage yards for the sized limestone (30-70 mm) and the fine particles (less than 30 mm) will be located on the flat area—partly cultivated—down the hill.

116,000 tons per year of limestone will be mined by what is known as bench-cut method. The rock face is drilled by a crawler drill followed by blasting by explosives. The bench is by standard eight meters with an average of 60 degree inclination.

For the transportation of blasted limestone the wheel-loader will carry them for not more than 200 meters beyond which dump trucks will take over.

The crusher process will consist of a scalping unit for primary screening, a jaw crusher, and a double-screen type screen for secondary screening to 70 mm and 30 mm size. Stones larger than 70 mm will be recycled to the crusher. By this arrangement stones from 30 to 70 mm may be obtained at 50 percent yield.

Stones smaller than 30 mm will be rejected. The sized limestones will be temporarily stored in the yard and then loaded by the wheel-loader to dump trucks which will carry the limestone to Paramonga Plant.

Table 6-1 Specifications of Mining and Crushing Equipment

Name of Machine	Qty.	Specification
Crawler drill	1	Rod length: 3 m; bit gauge: 60 mmø
Portable compressor	1	17 m^3/min.
Bulldozer	1	20-ton class, with ripper
Wheel-loader	1	Bucket capacity: 3.1 m^3
Dump truck	12	11-ton capacity
Pneumatic hammer	1	Bit gauge: 30 mmø
Scalping feeder	1	Mesh: 70 mm (vibrating or oscilating)
Crusher	1	Shinko Dyna-Jaw D-900, 220 kW
Screen	1	Double screen type; mesh: 70 mm and 30 mm
Conveyer belt	4	Width: 600 mm; 20 m x 2, 20t/h x 2

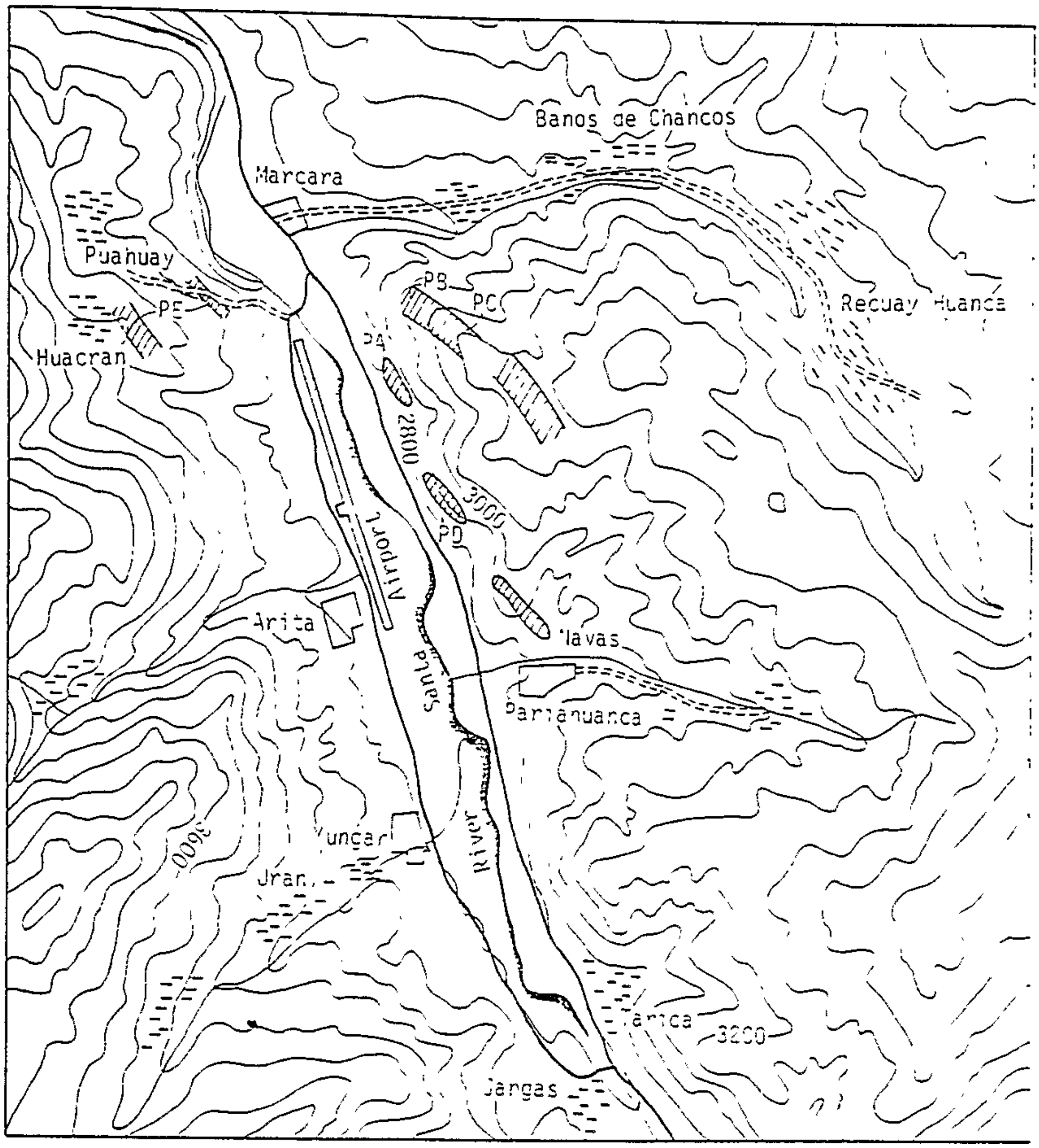


Figure 6-1 Topography of Pariahuanca Area

LEGEND

Limestone deposit

PA–PE Location of sampling

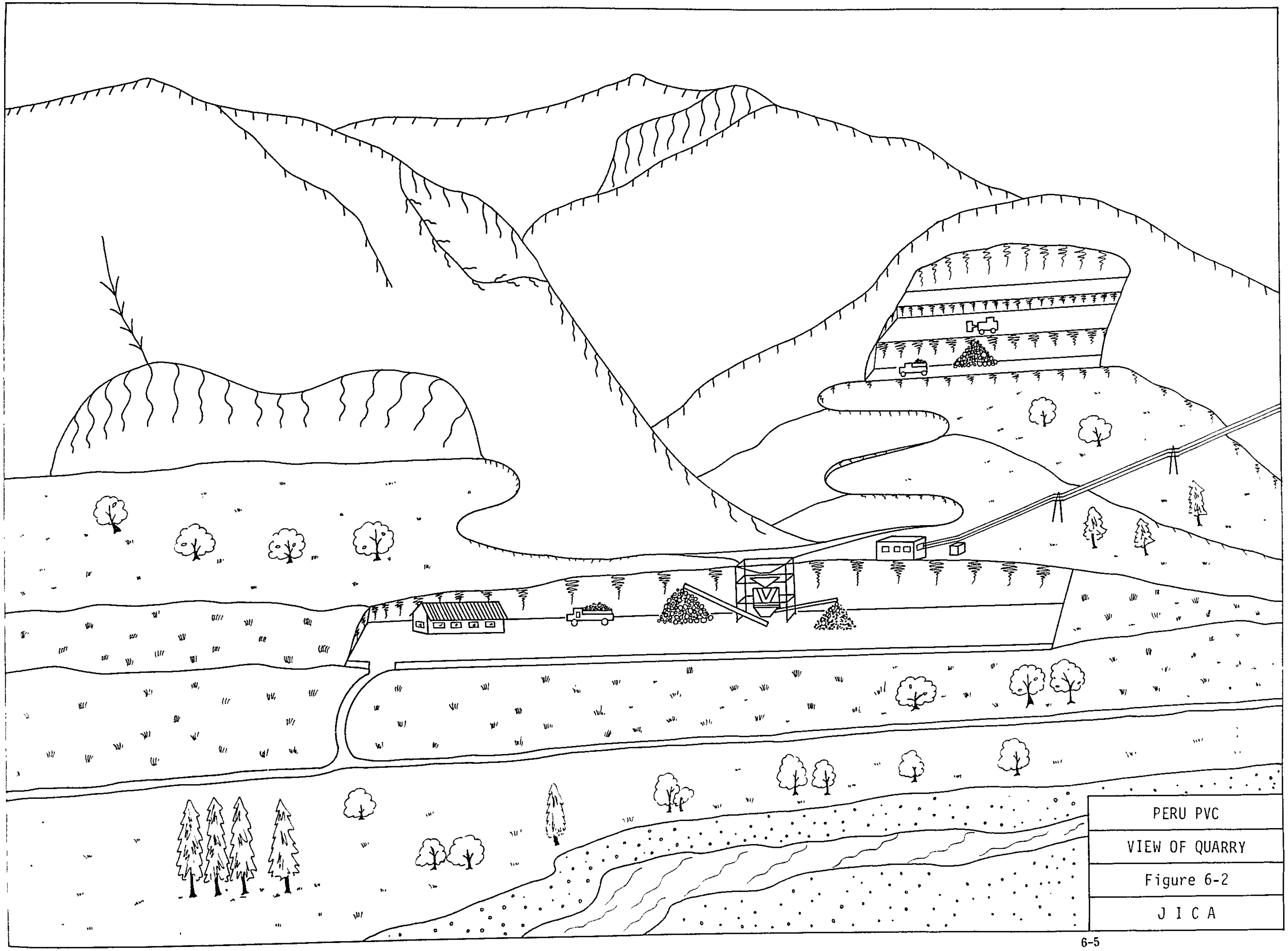
Asphalt road

Sand road

Town

Village

River

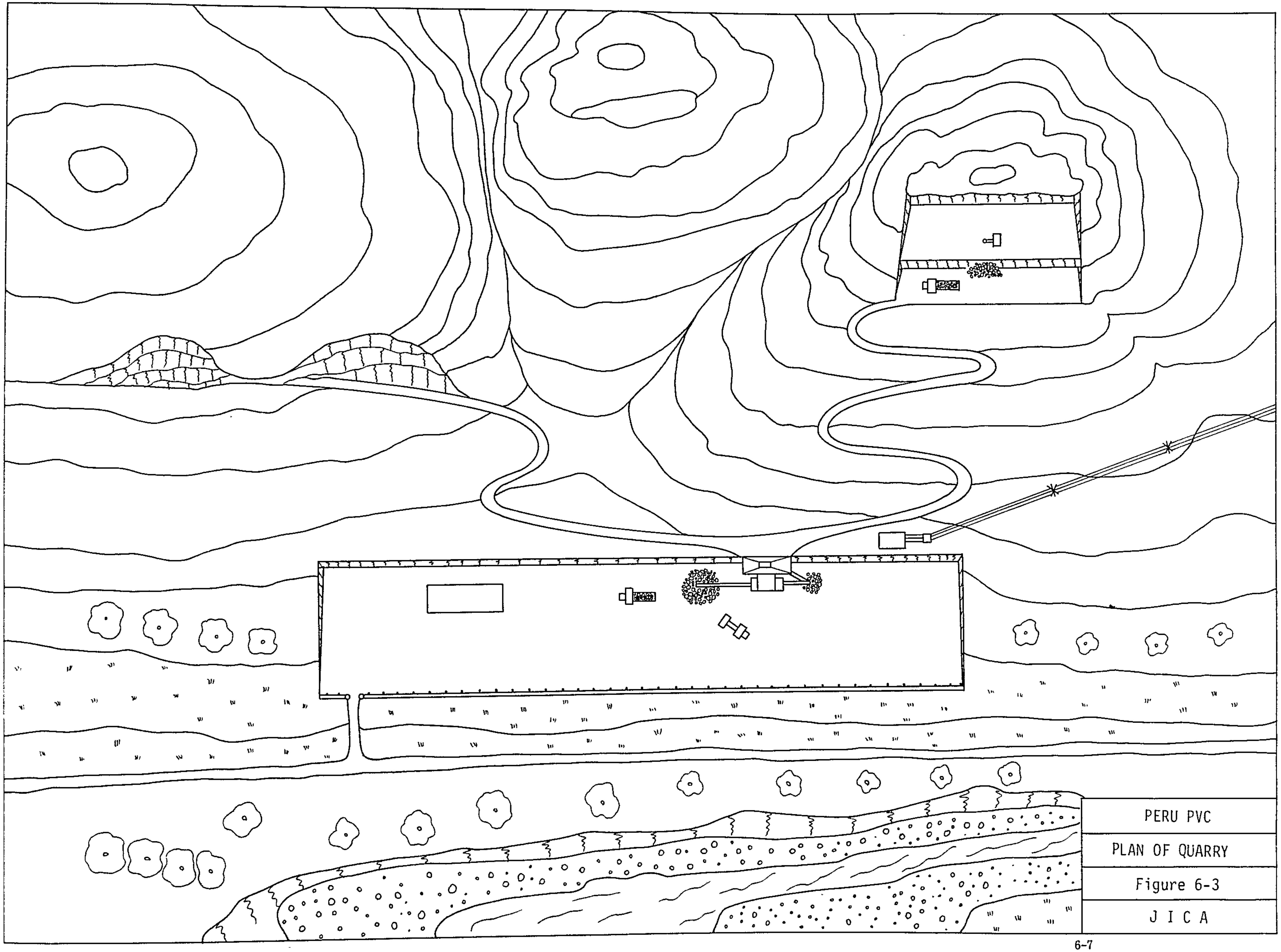


PERU PVC

VIEW OF QUARRY

Figure 6-2

J I C A


PERU PVC
PLAN OF QUARRY
Figure 6-3
J I C A

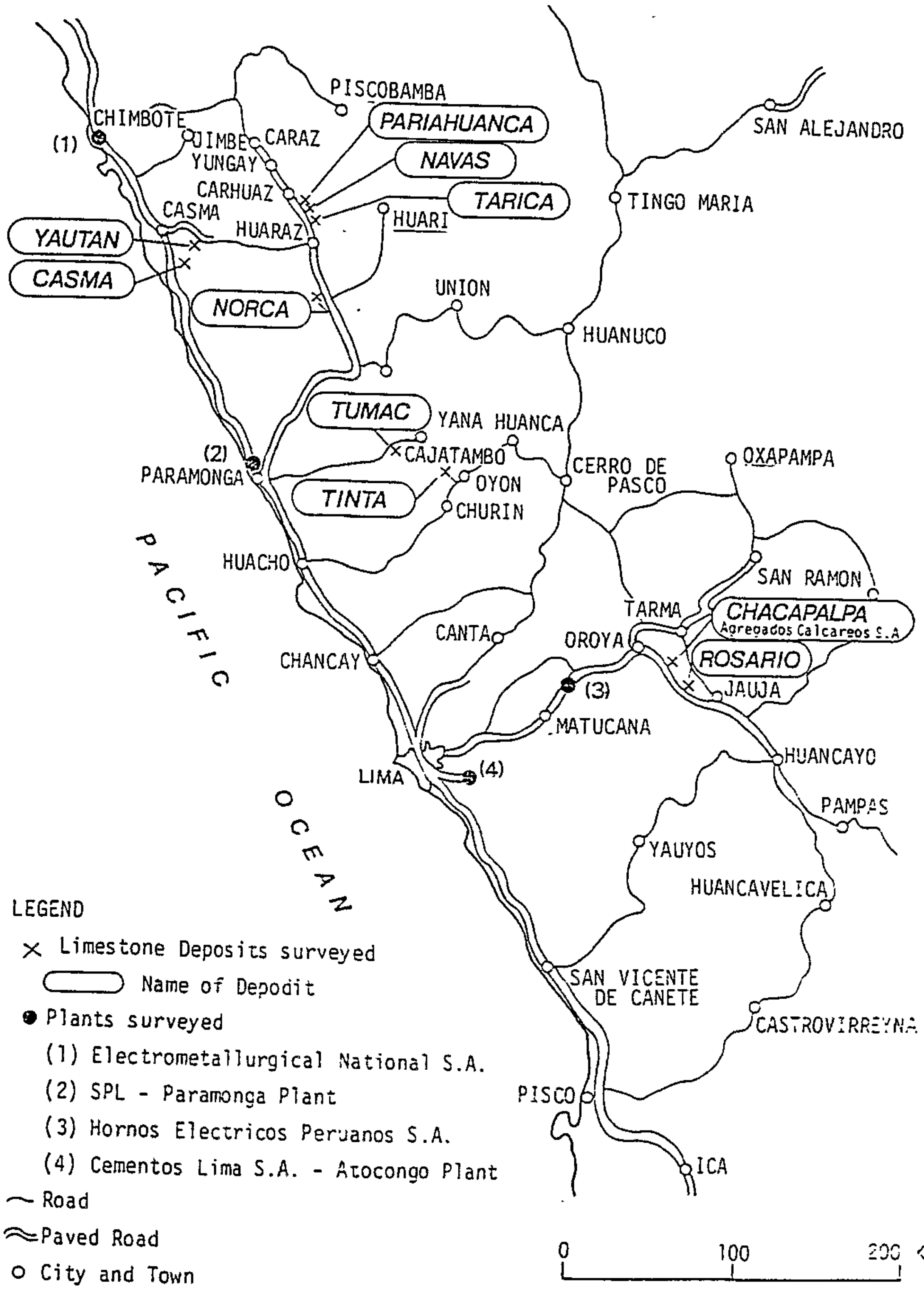


Figure 6-4 Location Map of the Surveyed Limestone Deposits and Plants

The preliminary design calls for protection of the agricultural canal and power transmission line running parallel to the deposit and also purchase of the farm house.

6.3 Transporatation of Limestone

The route between Paramonga Plant and Pariahuanca is approximately 230 kilometers long. The maximum variation in altitude along the road is 4,200 meters. The road is paved with asphalt except for a short distance between Tarica and Pariahuanca which is gravel covered but would permit the passage of large-capacity trucks. At an assumed average speed of 50 km/h, a one-way trip requires approximately 4.5 hours; including loadings and restings, a round trip at the same speed requires approximately 10 hours. Since one truck can carry 16 tons, the transportation of 175 tons/day will require 11 dump trucks.

6.4 Environmental Conversation

Peru appears to have no specific laws regarding environmental conservations associated with mining and transportation of limestone. JICA, however, considers the following steps necessary to insure the safety and the protection of the environment. Therefore, these are included in this plan.

(1) Removal of private houses,

(2) Protection of irrigation canal and power transmission line,

(3) Measures to prevent stones from falling or flying,

(4) Measures to prevent dust, noise, and vibrations associated with use of explosives,

(5) Provisions for dumping surface soil,

(6) Prevention of surface water contamination in case of rain,

(7) The public authorities and the private sector must be consulted for an early resolution to these problems.

CHAPTER 7 PLANT SITE

7.1 Outline

Construction work will take place at two locations; one for limestone mining and processing facilities and the other for carbide and PVC manufacturing facilities.

The limestone mining and processing facilities will be located in Pariahuanca, at an altitude of approximately 3,500 meters in the Andes. A more detail of this site is given in Chapter 6.

This chapter concerns the SPL Paramonga Plant site where the carbide and PVC manufacturing facilities will be constructed.

7.2 Natrual Conditions of the Candidate Site

The records for temperature, humidity, wind, rainfall, earthquakes, thunderstorms and flood for this area was reviewed. Overall, the site has a very favorable weather conditions.

7.3 Site Survey

The SPL Paramonga Plant site is located in Paramonga, a city some 200 kilometer north of Lima, the capital of Peru. The construction site is a vacant lot immediately next to the north boundary of the existing Paramonga Plant's PVC plant.

The site is virtually flat and requires no special land grading. The area is 700 meters from east to west and 400 meters from north to south. The area is large enough to allow sufficient safety distances between facilities. Specifically, the electric furnace and lime kiln may be laid out sufficiently apart from the facilities which manufacture flammable and ignitable acetylene and VCM.

Geologically Paramonga area is an old river basin. Accordingly, the layer just below the surface is mainly of gravel with cobble stones and the lower formation is also believed to be of similar composition. In view of the soil bearing strength of 10 tons per square meter as indicated by the data furnished by the Paramonga Plant, it will be necessary to conduct a boring survey in order to determine the necessity for pile driving for foundations of large structures and heavy machines.

7.4 Utilities

(1) Water

Water is furnished to the plant Via a 36-inch (900 mm) diameter underground pipeline from an intake weir situated approximately 3 kilometers southwest-by-west of the plant on a branch of Fortareza River that flows to the north of Paramonga city. The temperature is 22°C on average. This pipeline can accommodate the entire water requirements for the existing and the planned facilities. In association with the construction of the plant a cooling tower with a capacity of 1,800 m^3 per hour will be built for recycling water back to the new plants. Normally, only 43 m^3 per hour of fresh make-up is required.

(2) Electricity

1) Receiving facilities

As was described in Chapter 3, Paramonga Plant has a substation capable of receiving 42,000 kW branched out at 300 meters northwest of the Plant directly from Hidradina's power transmission line. A new receiving system will be installed to supply the additional requirement of the approximately 20,000 kW.

A breaker and a 138,000 V/13,800 V transformer will be installed in the existing substation.

A cable of 2 kilometers supported by 25 meters high steel towers will be installed from the substation to the site. Switchgears and transformers will be installed to all individual plants to supply power to all pieces of equipment.

2) Electric power rate (price)

Billing of electricity charge uses a two-tier system, basic charge and excess charge on top of the former. Both basic charge and the excess charges are the products of consumption and unit tariff in their respective categories. The total bill is the sum of the basic charge and the excess charge and 25 percent tax on the sum.

The average power rate at Paramonga Plant is US$ 0.035/kWh, as of June 1983.

(3) Steam

At present, Paramonga Plant has five boilers with a total capacity of 740,000 lb per hour (333 tons per hour) at a pressure of 450 psi (32 kg/cm^2). A 6-inch (150 mm) diameter pipeline runs from the boiler room to the existing PVC facilities for the supply of approximately 14,000 lb per hour (6.3 tons per hour).

The new plant will require approximately 10 tons per hour. Extension of the existing piping will suffice.

(4) Other utility facilities

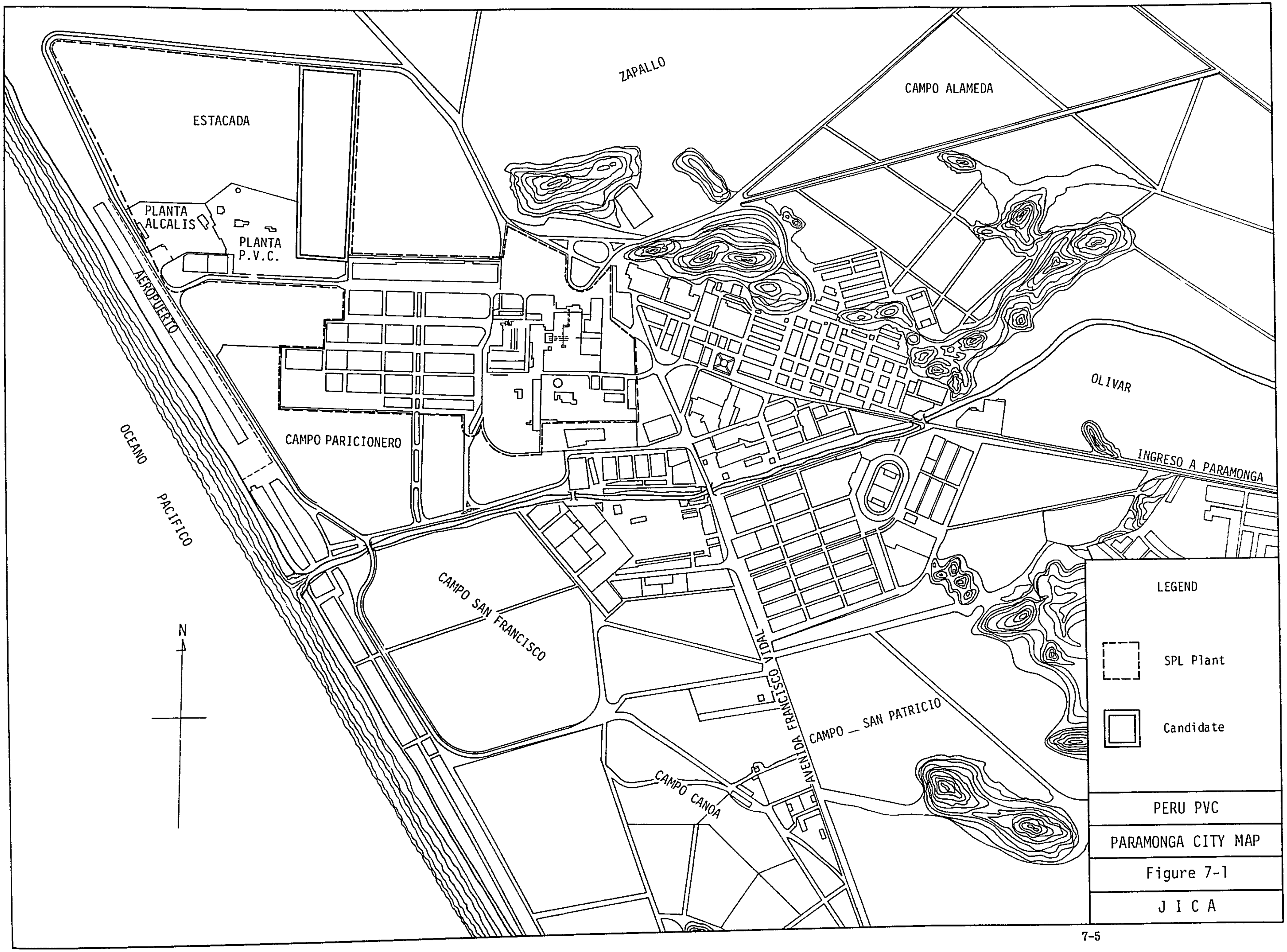
Other utility facilities like inert gas generator, instrument air system, general-purpose air system, and brine circulating system will be provided.

7.5 Infrastructure

Paramonga has a population of about 30,000. The city has a good township. Schools, hospitals, markets, restaurants, banks and other municipal facilities are provided. The roads connecting Paramonga to Lima and other important cities are relatively in good conditions.

Two ports are capable of receiving international ocean vessels; Callao Port near Lima, 200 km to the south of Paramonga and Chimbote Port, 220 km to the north.

Construction machines and materials can be unloaded at Callao Port, and raw material coke, at Chimbote Port.


ZAPALLO
CAMPO ALAMEDA
ESTACADA
PLANTA ALCALIS
PLANTA P.V.C.
AEROPUERTO
OLIVAR
CAMPO PARICIONERO
OCEANO PACIFICO
INGRESO A PARAMONGA
CAMPO SAN FRANCISCO
N
AVENIDA FRANCISCO VIDAL
CAMPO — SAN PATRICIO
CAMPO CANOA
LEGEND
SPL Plant
Candidate
PERU PVC
PARAMONGA CITY MAP
Figure 7-1
J I C A

CHAPTER 8 MANUFACTURING FACILITIES

8.1 Plant and Equipment

This project will install the following plants and equipment.

(1) Pariahuanca

Table 8-1 Quarrying Equipment

Name of Machine	Qty.	Specification
Crawler drill	1	Rod length: 3 m; bit gauge: 60 mmø
Portable compressor	1	17 m^3/min.
Bulldozer	1	20-ton class, with ripper
Wheel-loader	1	Bucket capacity: 3.1 m^3
Dump truck	12	11-ton capacity
Pneumatic hammer	1	Bit gauge: 30 mmø
Scalping feeder	1	Mesh: 70 mm (vibrating or oscilating)
Crusher	1	Shinko Dyna-Jaw D-900, 220 kW
Screen	1	Double screen type; mesh: 70mm and 30 mm
Conveyer belt	4	Width: 600 mm; 20 m x 2, 20 t/h x 2

(2) Paramonga

Table 8-2 Manufacturing Plants

Name of Plant	Qty.	Capacity
Lime kiln	1	167 tons/day as limestone
Coke dryer	1	58 tons/day as coke
Electric furnace	1	101 tons/day as carbide
Carbide crusher	1	10 tons/hour as carbide
Acetylene generator	2	750 m^3/h as acetylene
Hydrochloric acid stripper	1	
VCM plant	1	25,500 tons/year as VCM
PVC plant	1	25,500 tons/year as PVC
PVC bagging machine	4	

8.2 Process Flow

The process flow diagram of this project is shown on Figure 8-1 from the quarry down to PVC bagging shown. On the process flow diagrams are major plants and facilities, flow rates of materials and some important temperatures and pressures. All these processes are commercially proven. Figures 8-2 and 8-3 show conceptual designs of the lime kiln and electric furnace.

8.3 Existing Facilities

(1) Common salt electrolysis and hydrochloric acid synthesis

At Paramonga Plant SPL operates common salt electrolysis and hydrochloric acid systhesis plants and manufactures PVC with imported EDC as raw material. The capacity is about 7,000 tons per year. Figure 8-4 shows the capacities of the existing plants and raw material/product material balance.

The capacity of the electrolysis/hydrochloric acid synthesis plants is 42,000 tons per year of caustic soda and 37,275 tons per year of chlorine. SPL produces 40,000 tons per year of caustic soda and corresponding amount of chlorine of which only about 12,000 to 17,000 tons per year of chlorine or hydrochloric acid is used on the premises, meaning that about 20,000 to 25,000 tons per year is discharged to the sea after dilution with water. This excess hydrochloric acid now discharged to the sea is therefore available to the manufacture of VCM by this project.

(2) Ethylene and EDC

SPL formerly manufactured ethylene by dehydrating alcohol from molasses and converted it to EDC. However, this operation was discontinued in November 1981. Since then SPL has been importing EDC.

The EDC plant has a hydrochloric acid stripper unit with a capacity of 14 tons per day hydrogen chloride (4,900 tons per year). This unit has not been operated for nearly two years and is seriously corroded. The design calls for installation of a new unit.

(3) VCM

SPL imports aobut 10,000 tons per year of EDC from which manufactures about 6,500 tons per year of VCM by the VCM plant (EDC cracker). This operation generates approximately 3,800 tons per year of hydrochloric acid as byproduct which is discharged to the sea.

(4) PVC

The plant had three glass-lined 15 m^3 polymerization autoclaves, one rotary dryer and associated facilities and produces 6,000 to 7,000 tons per year of suspension polymerization/straight and vinyl acetate copolymer.

The unit consumptions of VCM, cooling water, steam, and power are relatively large. The productivity of polymerization is rather low.

Although the PVC facilities — polymerization, dehydration, drying, bagging, etc. — are still serviceable, they have only one third the planned capacity of the present project. Use of the existing facilities along with the new ones would save equipment costs only slightly but would involve possible operational difficulties and inefficiencies. Operation of two PVC plants requires more raw materials, auxiliary materials, utilities, and personnel. Therefore, this project decides to suspend the operation of the existing plant.

8.4 Material, Utility, and Fuel Balances

The overall material, utility and fuel balances are given on Figure 8-1 and Table 8-3.

8.5 Environmental Consideration

The operations and processes considered for this project will not cause environmental problems. On the contrary, this project will utilize a portion of hydrogen chloride now being discharged to the sea and thereby reduce the hydrogen chloride pollution of the sea.

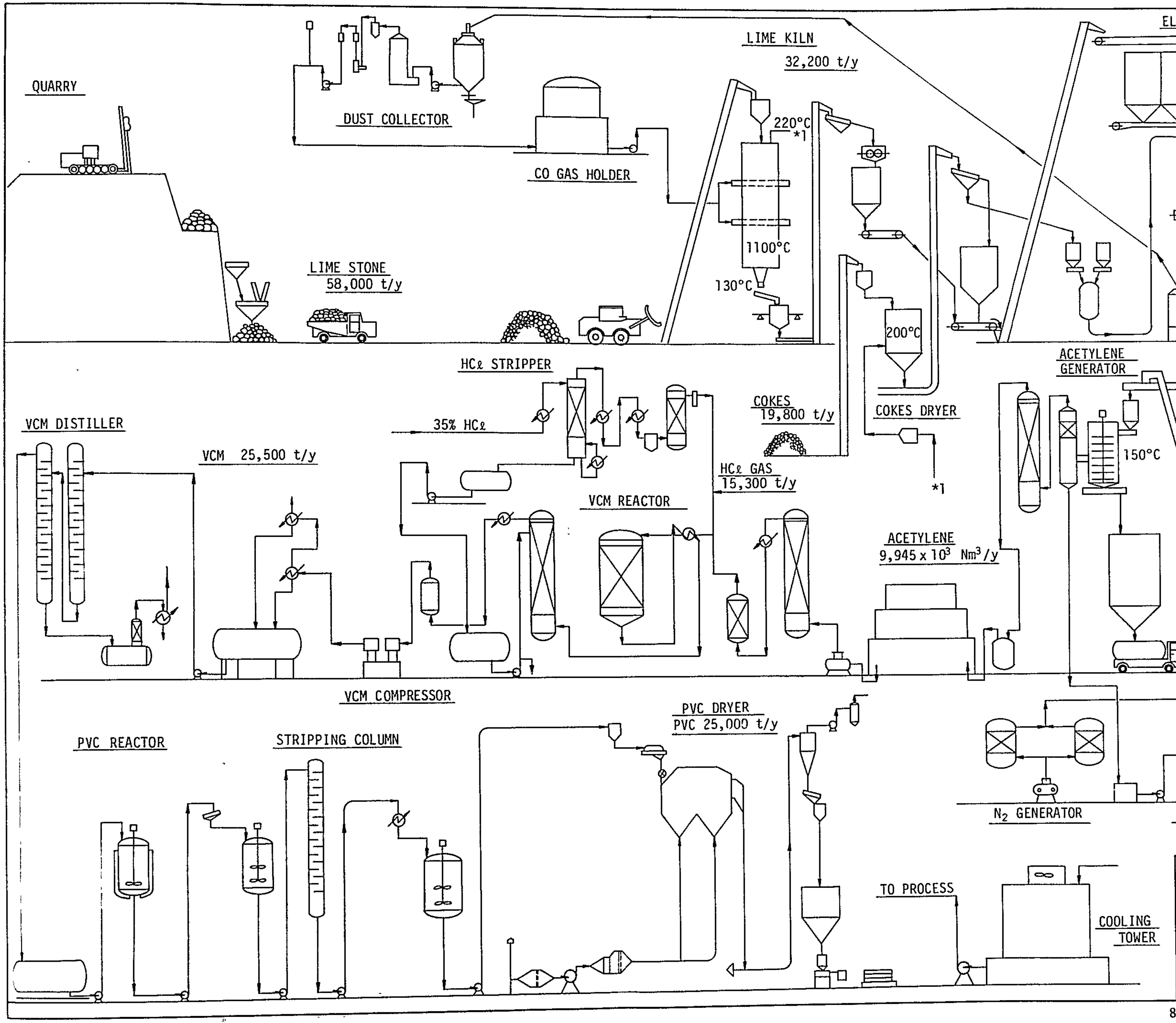
8.6 Organization

This project would require an organization given on Figure 8-9 with a total personnel of 250 as given on Table 4.

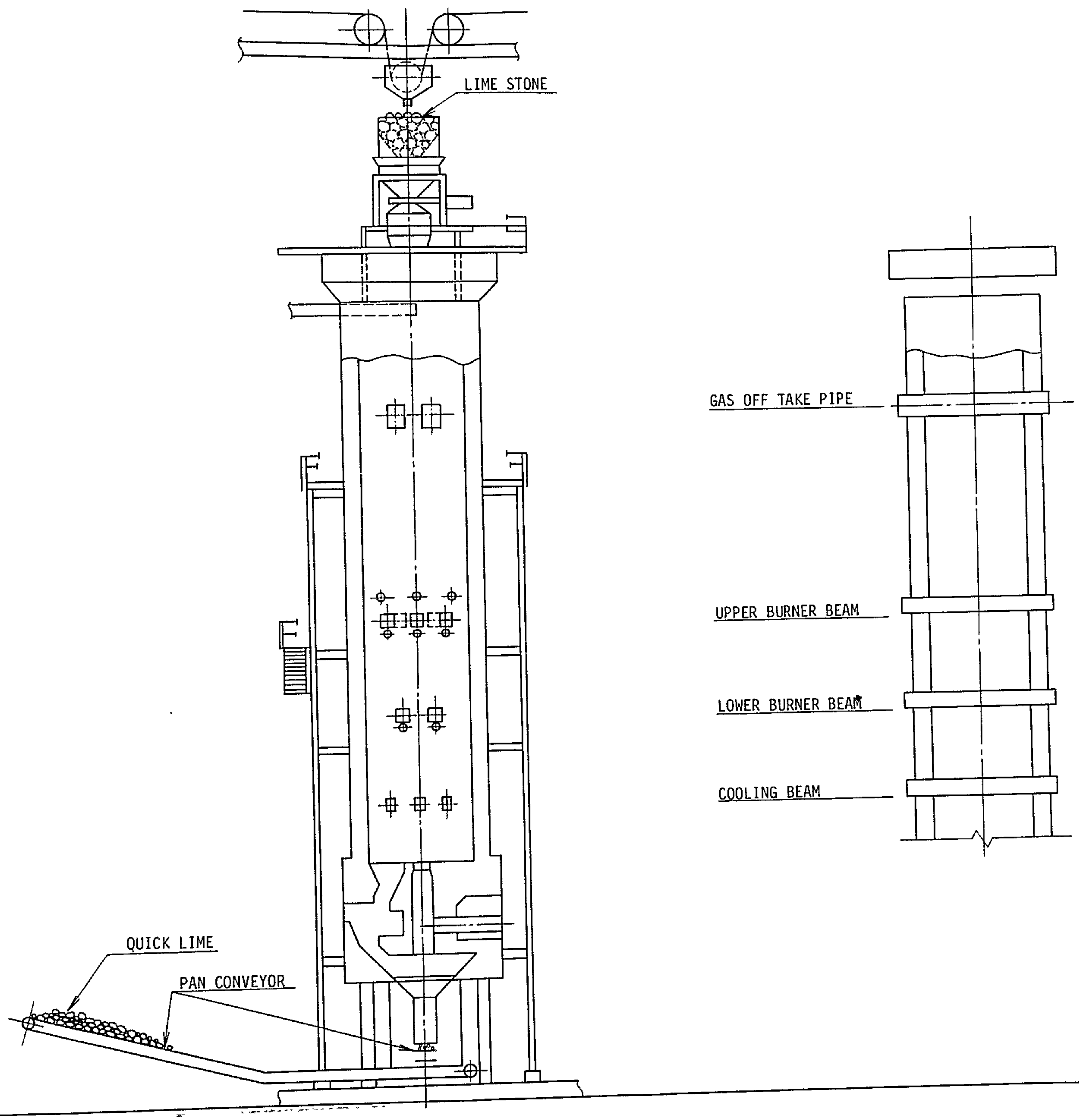
Table 8-3 Utility and Fuel Balance (25,000 ton PVC)

(Unit: per year)

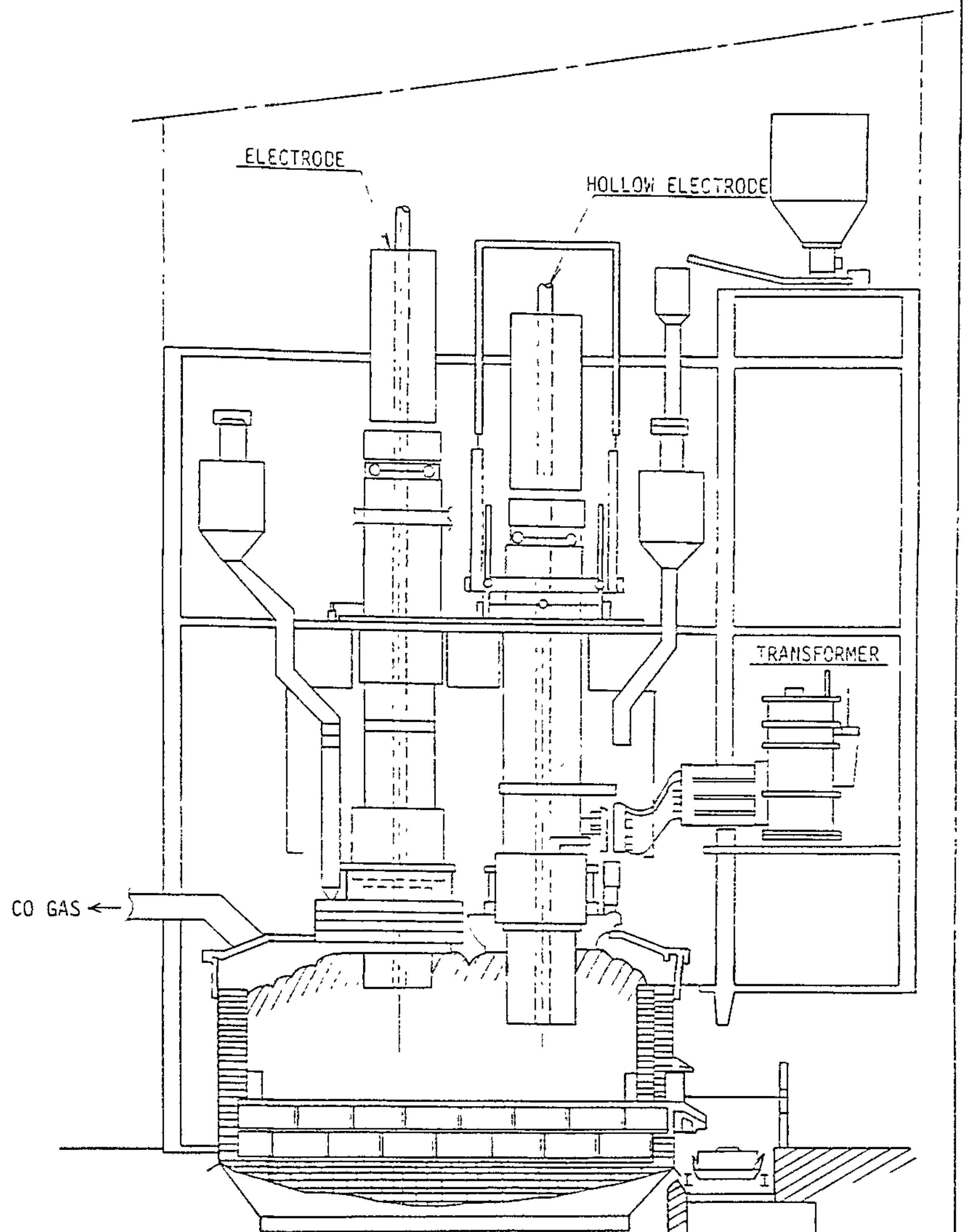
	Electricity (10^3kWH)	Fuel (10^6Kcal)	Steam (ton)	DMW (ton)	CW (10^3ton)	Notes
Quarry	122	-	-	-	-	Limestone 58,000 ton
Limestone Kiln	2,254	33,810	-	-	8	Quick Lime 32,200 ton
Coke Dryer	554	2,970	-	-	-	Coke 19,800 ton
Electric Furnace	115,710	-39,690	-	-	30	Carbide 35,000 ton
Acetylene Generator	1,740	-	-	-	398	Acetylene $9,945 \times 10^3 Nm^3$
VCM Reactor	8,925	-	33,150	12,750	153	VCM 25,500 ton
PVC Reactor	5,000	-	37,500	87,500	60	PVC 25,000 ton
Common	5,120	-	-	-	9	Compressors, Cooling Tower, Office, etc.
Plant Total	139,425	-2,910	70,650	100,250	658	



PERU PVC
PROCESS FLOW DIAGRAM
Figure 8-1
J I C A



PERU PVC
LIME KILN
Figure 8-2
J I C A



PERU PVC

ELECTRIC FURNACE

Figure 8-3

J I C A

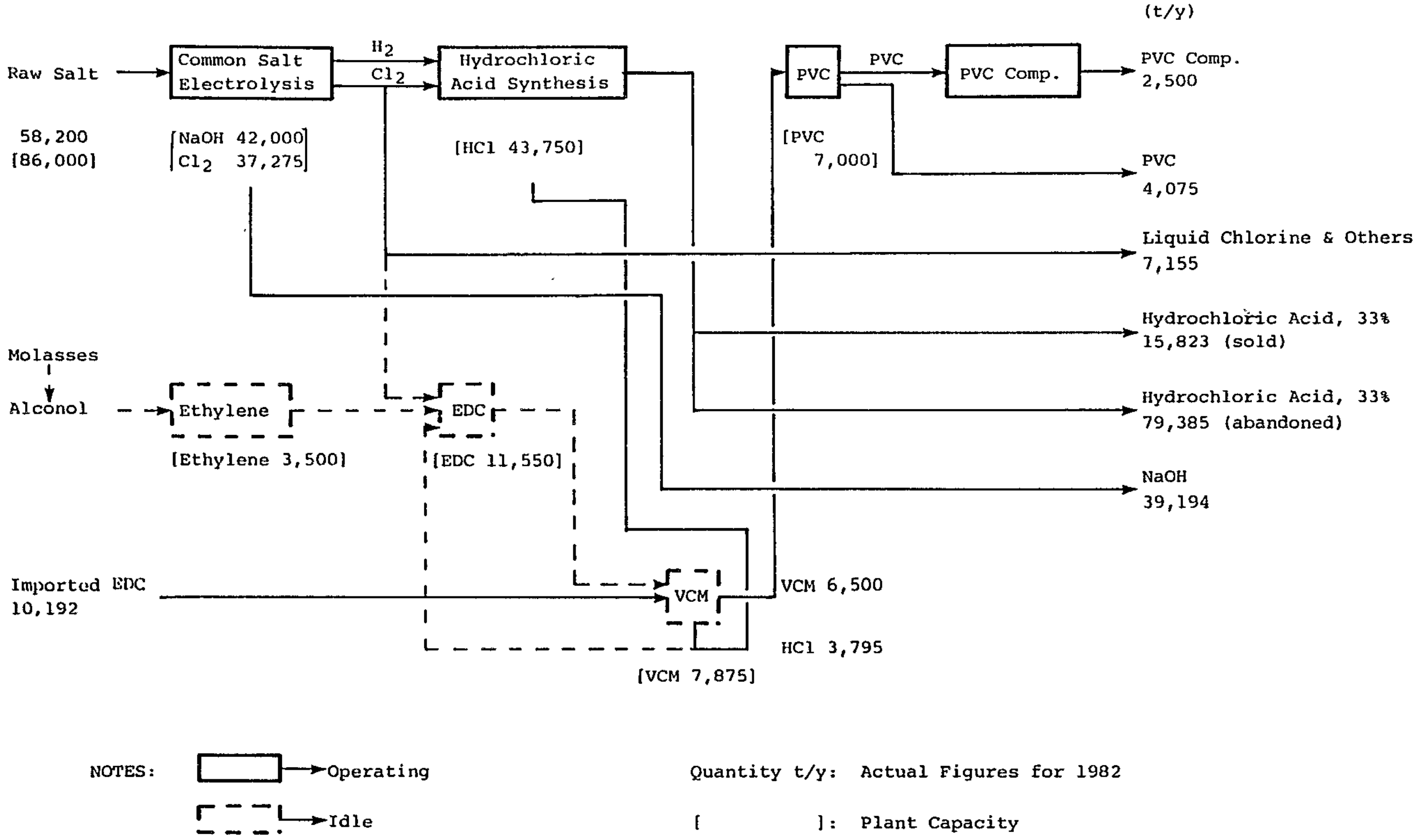
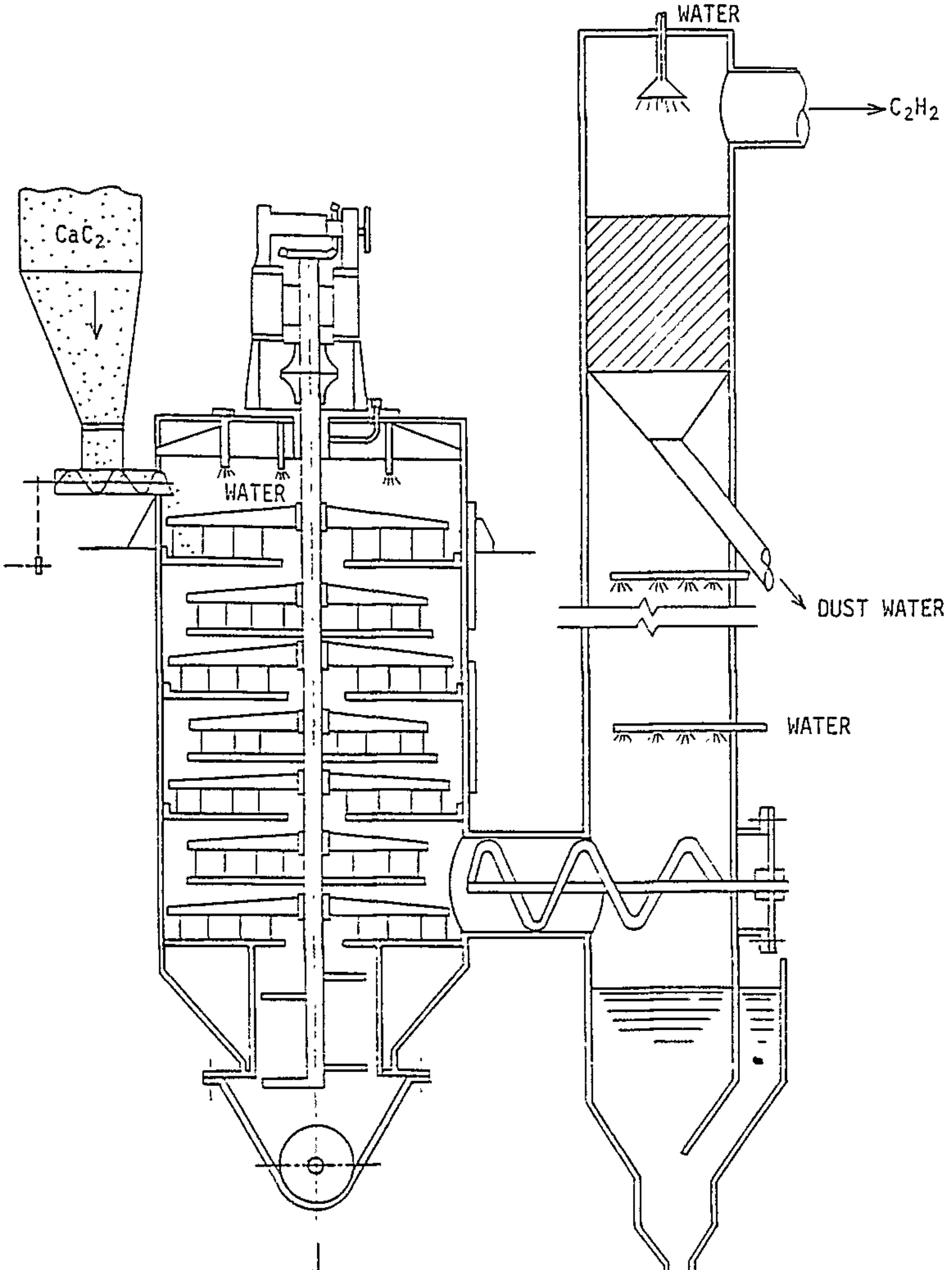


Figure 8-4 Capacity and Material Balance of Existing Plant



PERU PVC
ACETYLENE GENERATOR
Figure 8-5
J I C A

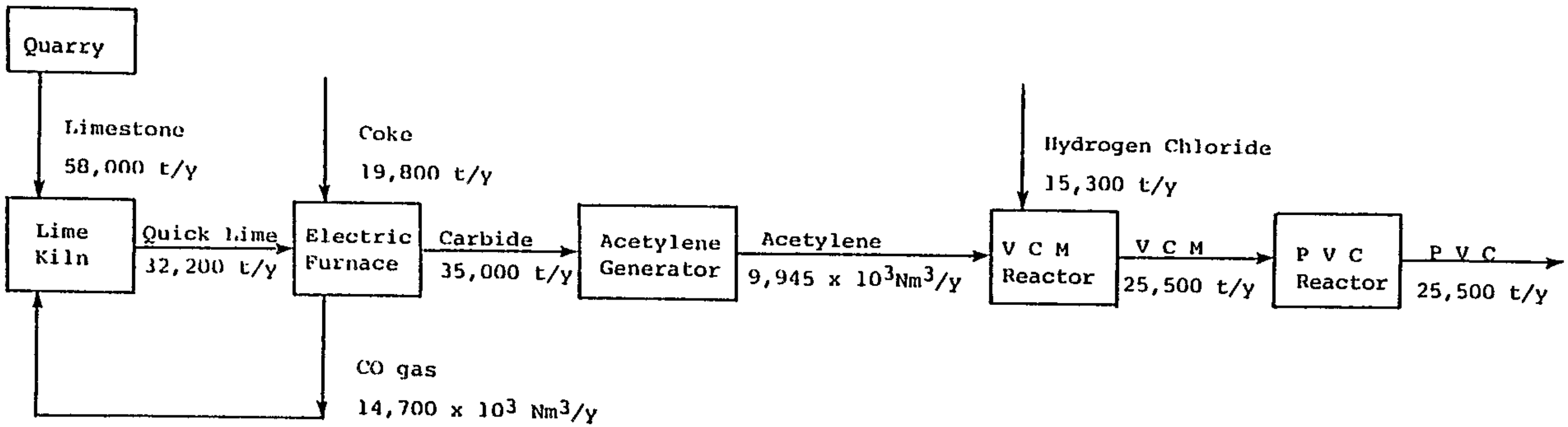
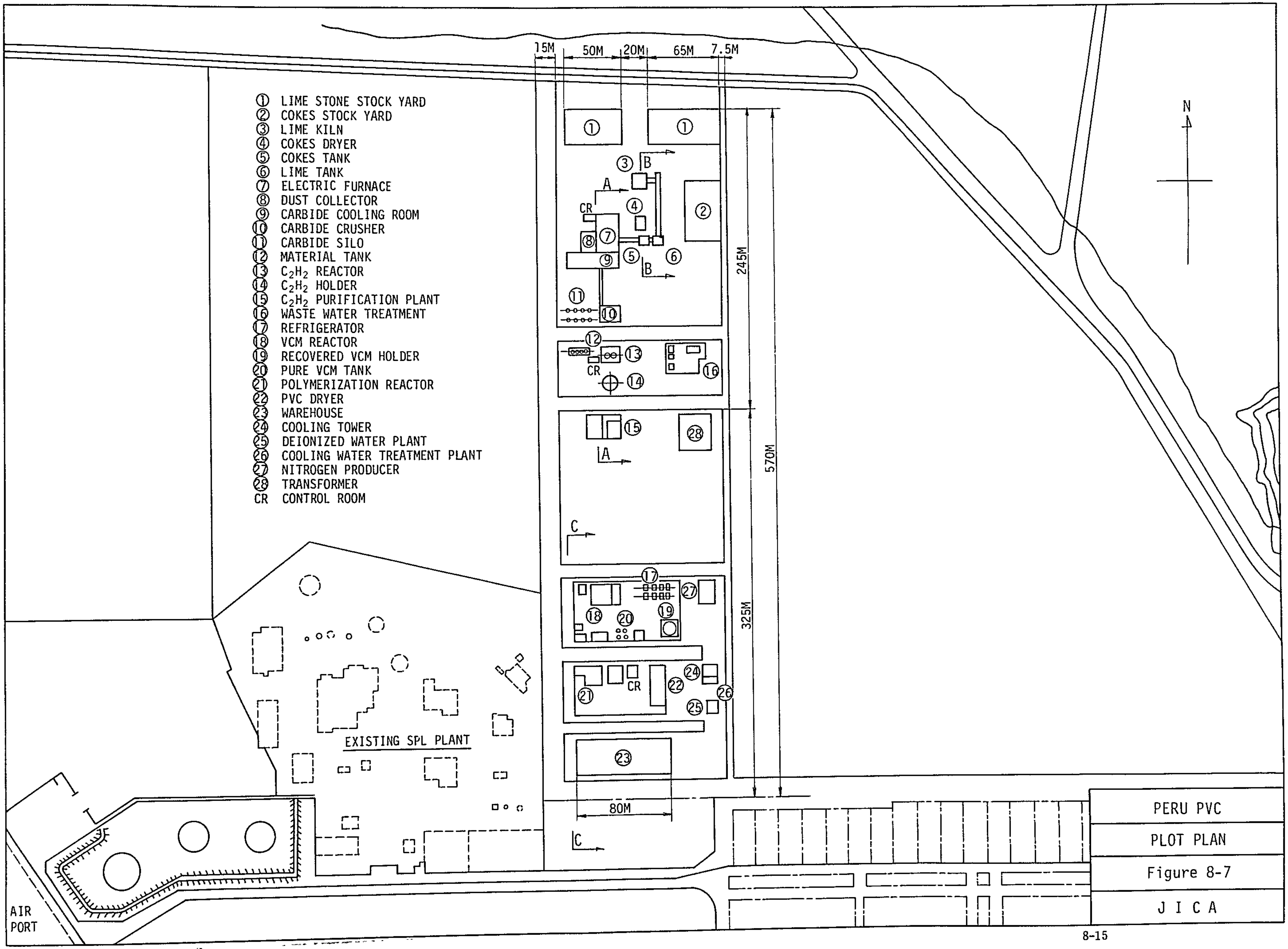
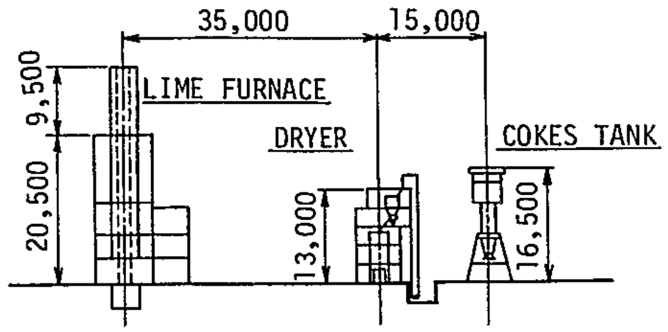


Figure 8-6 Overall Material Balance

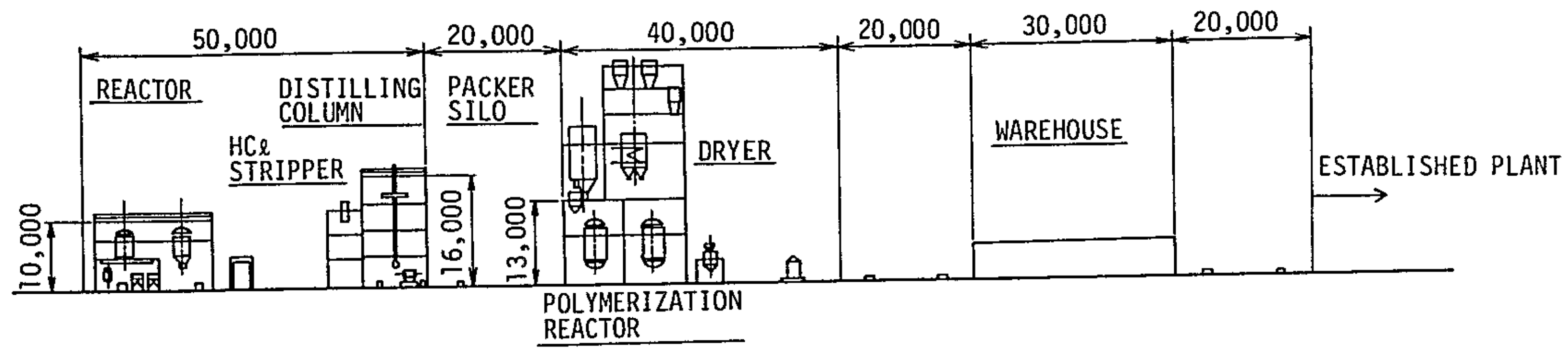


① LIME STONE STOCK YARD
② COKES STOCK YARD
③ LIME KILN
④ COKES DRYER
⑤ COKES TANK
⑥ LIME TANK
⑦ ELECTRIC FURNACE
⑧ DUST COLLECTOR
⑨ CARBIDE COOLING ROOM
⑩ CARBIDE CRUSHER
⑪ CARBIDE SILO
⑫ MATERIAL TANK
⑬ C_2H_2 REACTOR
⑭ C_2H_2 HOLDER
⑮ C_2H_2 PURIFICATION PLANT
⑯ WASTE WATER TREATMENT
⑰ REFRIGERATOR
⑱ VCM REACTOR
⑲ RECOVERED VCM HOLDER
⑳ PURE VCM TANK
㉑ POLYMERIZATION REACTOR
㉒ PVC DRYER
㉓ WAREHOUSE
㉔ COOLING TOWER
㉕ DEIONIZED WATER PLANT
㉖ COOLING WATER TREATMENT PLANT
㉗ NITROGEN PRODUCER
㉘ TRANSFORMER
CR CONTROL ROOM
15M
50M
20M
65M
7.5M
245M
570M
325M
80M
N
A
B
C
CR
EXISTING SPL PLANT
AIR PORT
PERU PVC
PLOT PLAN
Figure 8-7
J I C A

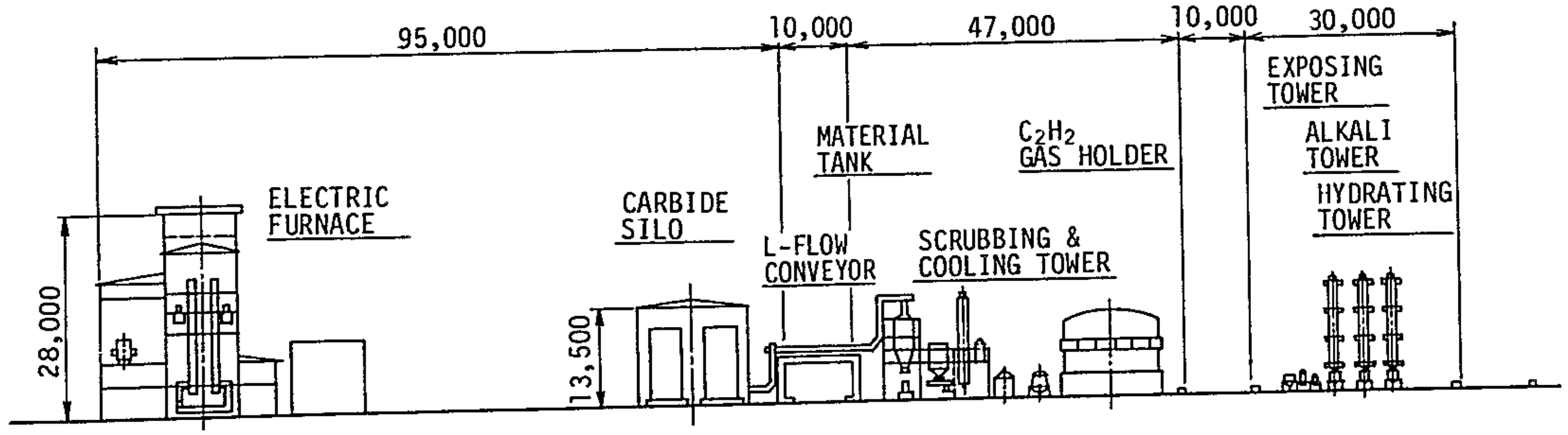
SCALE 1/1000



VIEW - B~B



VIEW - C~C



VIEW - A~A

PERU PVC
ELEVATION VIEW
Figure 8-8
J I C A

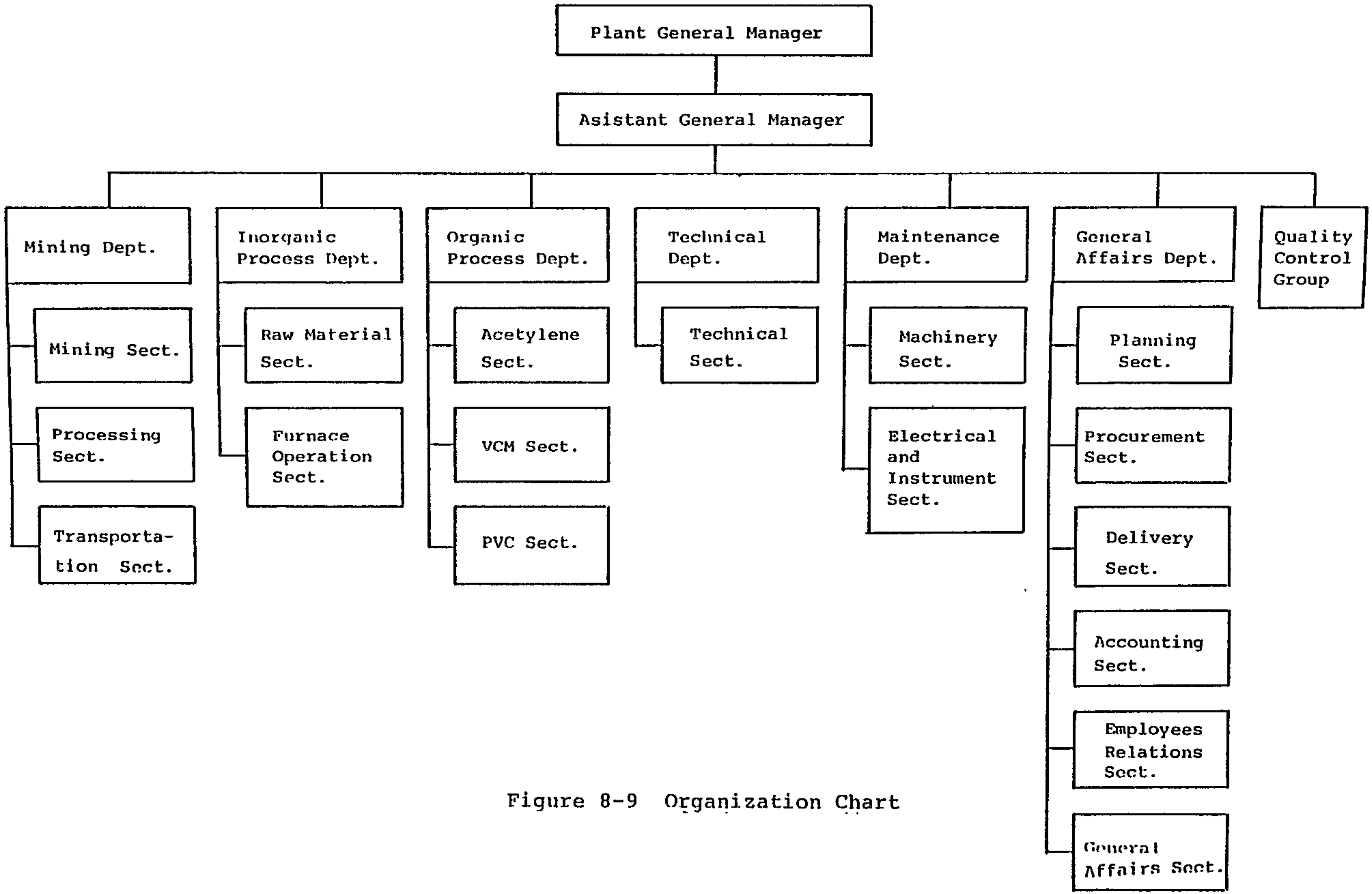


Figure 8-9 Organization Chart

CHAPTER 9 CONSTRUCTION

9.1 Quarry Development

The following works are required for the development of the quarry:

(1) Construction of the access road to quarry site from the existing road running near Pariahuanca limestone quarry (Refer to Section 6.2)

(2) Construction of benches and preparation of processing plant site (300m x 150m) and surface soil dumping site (200m x 100m).
Construction of roads between benches.

(3) Construction of auxiliary facilities such as offices, operators' quarter and stock-houses within the processing plant site.

(4) Protection of the irrigation canal and power transmission line and other environmental conservation work as described in the Section 6.6.

9.2 Plant Construction

This feasibility study discovered that almost all equipment and machinery required for this project have to be imported. This study also found out that, among the construction materials required at the site, only cement, aggregate, general-purpose rolled steel products, and general-purpose electric wires can be procured in Peru.

Construction works at the site will be carried out by domestic subcontractors as long as they arr competitive in cost and skill. However, availability of machine and materials, ability to employ skilled labor and experiences in properly controlling sequences of works during construction at the site should be checked before employing domestic subcontractors to avoid any serious delays.

For this reason, steel frames and large-diameter piping materials will be fabricated to the extent possible in the countries of export to reduce the works at site. In other words, the works on site should desirably be limited to assembling operations only in order to achieve the quality of work and maintain the schedule of construction.

9.3 Construction Equipment and Machinery

Plant and machines that are manufactured and assembled at the manufacturers' plants will be subjected to careful inspection and testing and will then be transported by sea to Callao Port. Imported machines, after customes clearance, will be transported by land to the site via Pan-Am highway and will then be carefully unloaded at prescribed and prepared locations at the site.

9.4 Civil Engineering

(1) Preliminary work

As described in Paragraph 7.3, a boring survey will be conducted. Based upon the results of this survey, pile foundations will be constructed for heavy structure. Reinforced concrete piles will be driven at the site. Standard foundations for light structures will be constructed on the solid soil after the surface layer is removed.

(2) Buildings

Because Paramonga has only slight rainfall and wind, only those buildings relating to the manufacture of carbide and control rooms will be roofed and side walled; other building will be, wherever possible, of simplified structure without roof or side walls.

Structures for supporting or housing the electric furnace, lime kiln, acetylene generator, VCM reaction vessel, PVC polymerization vessel and other heavy machines will be constructed with reinforced concrete or heavy-steel frames. Other structures will be constructed with light steel frames.

A seismic force with a horizontal coefficient of 0.2 is considered to be the potential external force; consideration of wind velocity is unnecessary.

Roofs and side walls will be of slate, with the exception of the rooms of control rooms which will be reinforced concrete and brick. The VCM and PVC control rooms will be internally pressurized and double-doored.

9.5 Plant Construction

The construction of related buildings and foundations for machines should be completed prior to the installation of machines at the site. The construction machines, vehicles, materials and supplies for such installation should all be ready for work at the site.

After pre-fabrication operations such as cutting, bending and drilling have been finished in the countries of export, steel members for the electric furnace, lime kiln, gas holder and large storage tanks will be imported. Operations at the site include welding, assembling, brick-laying, insulating, and painting.

Smaller devices, towers and tanks will be imported as completed. Large-diameter steel pipes and stainless steel pipes will be fabricated to the extent possible in the coutries of export. Domestically manufactured small-diameter pipes are expensive; therefore, importation will reduce the cost of these items.

Principal electrical equipment and instruments must be imported. Some electrical wires and communication lines are domestically available, but importation may reduce the cost of these items.

A considerable labor force, including skilled and unskilled workers, will be required during the construction at site. If a sufficient number of skilled workers are not available, it will be necessary to use foreign skilled workers.

If facilities for lodging workers at the site are insufficient, a camp shall be prepared near the site.

Manufacturers of important unit equipment and facilities like gas holders that require assemblying at the site will be requested to dispatch installation and test operation supervisors to insure satisfactory operation.

9.6 Construction Schedule

The construction schedule shall cover the period from the award of contract to the prime contractor to the start of actual production. Figure 9-1 shows the overall schedule.

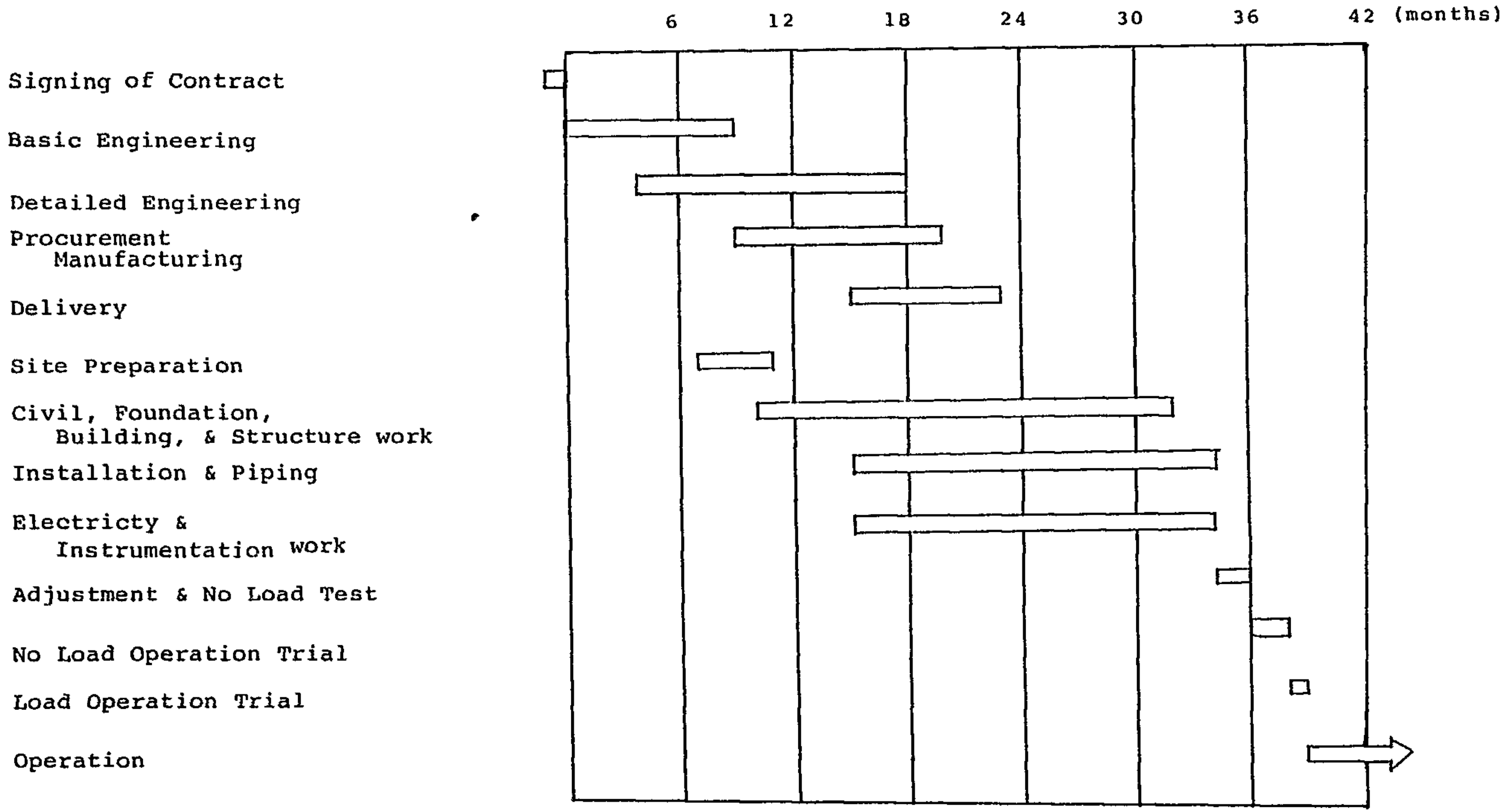


Figure 9-1 Estimated Plant Construction Schedule

CHAPTER 10 TOTAL CAPITAL REQUIREMENT

The total capital requirement is calculated as per Table 10-1 for both with and without import duty cases.

Table 10-1 Fixed Capital Requirement

(Unit: 1,000 US$)

	Foreign Currency Portion	Domestic Currency Portion		Total
		Domestic Works	Duty	
Construction cost				
Construction of mine	1,918	1,499	1,257	4,674
Construction of plant				
Site preparation	0	579	0	579
Equipment and machinery	22,953	0	12,135	35,088
Inland transportation	0	82	0	82
Erection works	0	7,197	0	7,197
Civil works	2,235	3,372	992	6,599
Engineering fee	5,165	0	0	5,165
Contingency	1,756	0	0	1,756
Construction expenses	5,165	0	0	5,165
Sub-total	39,192	12,729	14,384	66,305
Pre-operating expense	278	1,540	96	1,914
Initial working capital	566	1,896	378	2,840
Interest during construction				
Without duty (const.)	3,170	0	0	3,170
With duty	4,013	0	0	4,013
Total capital requirement				
Without duty (const.)	43,206	16,165	474	59,845
With duty	44,049	16,165	14,858	75,072

For more details reference should be made to the original report.

CHAPTER 11 OPERATING COST

The total operating cost is calculated as per Table 11-1 for both with and without hydrogen chloride price.

Table 11-1 Operating Cost Summary

(25,000 ton/year PVC)

	Annual Con-sumption	Unit Price (US$/*)	Annual Cost ($x10^3$US$) A	Annual Cost ($x10^3$US$) B	Cost per 1 ton of PVC (US$)
Variable Costs (*)					
Coke (ton)	19,800	187	3,703	3,703	148.12
Hydrogen chloride (ton)	15,300	0	0	-	0
Hydrogen chloride (ton)	15,300	101	-	1,545	61.80
Auxiliary materials			2,051	2,051	82.04
Electricity($x10^3$kwh)	139,425	35	4,880	4,880	195.20
Steam (ton)	70,650	21	1,484	1,484	59.36
Sub-total			12,118	-	484.72
Sub-total			-	13,663	546.52
Fixed Costs					
Labor expense			1,014	1,014	40.56
Plant overhead			1,142	1,142	45.68
Maintenance			1,240	1,240	49.60
Insurance			332	332	13.28
Local tax			24	24	0.96
Sub-Total			3,752	3,752	150.08
Total			15,870	-	634.80
Total			-	17,415	696.60

Note A: Hydrogen chloride priced zero

B: Hydrogen chloride priced at 101 US$ per ton

For more details reference should be made to the original report.

The quarry machinery, VCM synthesis section, hydrogen chloride treating unit and electric furnace require reinvestment to the place important machinery and equipment. The followings are the costs required for the reinvestment.

Table 11-2 Reinvestment

(Unit: 1,000 US$)

	8	10	13	15	Total
Mining machinery	2,171	0	0	2,171	4,342
Plant equipment	0	2,406	2,597	0	5,003
Total	2,171	2,406	2,597	2,171	9,345

CHAPTER 12 FINANCIAL ANALYSIS

This chapter could be very lengthy if all the processes to arrive at the results are to be included. Therefore, only the premises for analysis and the results are presented here. For details, the original report should be referred to.

12.1 Premise for Financial Anlaysis

(1) Project life, years

Construction	3
Operation	20

(2) Exchange rate

Sol/Dollar	1,536.65
Yen/Dollar	242.00

(3) Price base year 1983

(4) Plant capacity, tons per year as PVC 25,000

(5) Operation rate, %

First year	80
Second year	90
Third year and after	100

(6) Short-term loan

Interest, % p.a.	16
Debt repayment	All debt is paid back in the earliest possible year

(7) Depreciation and Amortization

	Year	Method	Salvage value, %
Machinery and equipment for quarry	5	st. line	0
Machinery and equipment for plant	10	st. line	0
Civil and building	30	st. line	0
Preoperation cost and interest during construction	10	st. line	0

(8) Industrial community tax and income tax

Profit Before Tax (1,000 US$)	Industry Community	Tax Rate	Total
Less than 107	27	30	48.90
From 107 to 1,074	27	40	56.20
From 1,074 to 2,148	27	50	63.50
More than 2,148	27	55	67.15

(9) Local tax, for new plant the followings will apply.

Local city tax	20 thousand US$/year
Licence fee	4 " "
Total	24 thousand US$/year

(10) Loss carry forward, year 5

(11) Income tax credit for reinvestment

Net profit X	X	
Industrial community, 27%	0.27X	
Income tax, Y%	0.73XY/100	(a)
Profit before reinvestment	X - 0.27X - 0.73XY/100	
Credit additional	0.146 XY/100	(b)
Credit reinvestment	Y/100 x (X - 0.73XY/100)..	(c)
Tax amount		
Tax	0.27X Y/100	(a)
Credit additional	0.146 XY/100	(b)
Credit reinvestment	Y/100 x (X - 0.73XY/100)..	(c)
Net tax	(a) - (b) - (c)	

Note: Maximum reinvestment is limited the value shown below X - 0.27X - 0.73X Y/100

The result of calculation on industrial community and income tax is as follows;

(Unit: %)

Profit Before Tax (1,000 US$)	Without Reinvestment			With Reinvestment		
	Industrial Community	Income Tax	Total	Industrial Community	Income Tax	Total
Less than 107	27	30	48.90	27	2.19	29.19
From 107 to 1,074	27	40	56.20	27	5.84	32.84
From 1,074 to 2,148	27	50	63.50	27	10.95	37.95
More than 2,148	27	55	67.15	27	14.052	41.052

(12) Internal tax refund

1) FOB
\+ Freight
\+ Insurance
CIF = Taxable value

2) Duty

3) D.L.N'22342 1% of 1)

4) Internal tax 16% of 1) + 2) + 3)

(13) Disbursement schedule

(Unit: %)

	Year		
	- 3	- 2	-1
Construction cost	10.7	52.4	36.9
Pre-operating expense	6.3	6.3	87.4
Working capital	0	0	100.0
Interest during construction	0	14.5	85.5

Note: (-) in year indicates construction period.

(14) Debt/Equity ratio 60/40

(15) Interest rate, % p.a. 11 (+ 2.5% guarantee)

(16) Import duty on equipment without

(17) Sales volume and revenue

(Unit: 1,000US$)

		Year		
		1	2	3 - 20
Sales volume, t/y	PVC	20,000	22,500	25,000
	Slaked lime	7,200	8,100	9,000
Unit price, US$/t	PVC	1,100	1,100	1,100
	Slaked lime	50	50	50
Revenue, 1,000 US$/yr		22,360	25,155	27,950

(18) Prices of products, US$/ton

PVC	1,100
Slaked lime	50

(19) Costs of inputs, unit US$/ton unless otherwise stated Coke 187.00

Coke	187.00
Explosive	2.58
Fuel, US$/kl	201.00
Tire, US$/Unit	103.30
Hydrogen chloride	101.00
Electrode paste	34.72
Electrode case	1.68
VCM catalyst	21.48
PVC catalyst	2.76
PVC dispersant	2.48
Electricity, US$/Kwh	0.035
Steam	21.00
Cooling water	0.097

(20) Personnel expense, 1,000 US$ 1,014

(21) Plant overhead, 1,000 US$ 1,142

(22) Maintenance, 1,000 US$ 1,240

(23) Insurance, 1,000 US$ 332

12.2 Results of Financial Analysis

Shown below are FIRR's on I and E for six different cases.

(Unit: %)

	FIRR on I		FIRR on E	
	Before tax	After Tax	Before tax	After tax
Case 1	11.2	5.3	8.9	minus
Case 2	13.2	6.3	12.8	5.7
Case 3	13.2	6.3	12.8	6.2
Case 4	14.1	7.1	14.5	8.1
Case 5 (B)	14.1	10.3	14.7	11.5
Case 6 (A)	16.8	11.9	19.7	15.5

Case 1: Duty included, hydrogen chloride cost 101 US$/ton, without loss carry forward, without internal tax refund, without income tax reduction for reinvestment.

Case 2: Hydrogen chloride cost zero, all other conditions remain as Case 1.

Case 3: 5 year loss carry forward included, all other conditions remain as Case 2.

Case 4: Internal tax refund included, all other conditions remain as Case 3.

Case 5 (B): Income tax reduction by reinvestment included, all other conditions remain as Case 4.

Case 6 (A): Exemption of duty and associated expenses included, all other conditions remain as Case 5.

This table shows FIRR's on I and E in the order of increasing incentives. Without any incentive this project shows too bad a profitability as represented by Case 1. With elimination of hydrogen chloride cost the profitibility shows improvement but these indices are still too low to justify this project. Zero prices is based on the fact that more hydrogen chloride than required for this project is now discarged to the sea. The loss carry forward, internal tax refund, and income tax reductions are all legalized incentives and this project should enjoy such incentives.

However, with all such incentives profitability is not quite satisfactory as represented by Case 5. As Case 6 represents, this project is viable with import duty reduction. However, FIRR on E of 15.5 is not good enough when interest rates are high. Therefore a finance of soft conditions would further strengthen the viability of this project.

CHAPTER 13 ECONOMIC ANALYSIS

13.1 General

Now that financial analysis has been done to evaluate the project viability, this chapter evaluates the project in terms of benefits and costs to the nation rather than to SPL. The more important items studied here are economic costs and benefits, economic internal rate of return (EIRR), tax income to the government and effects on balance of payments situation. When calculating the economic internal rate of return, national parameters are introduced to convert some of the financial values to economic values. The national parameters used are listed in Table 13-1.

Table 13-1 National Parameters

(as of 1982)

Foreign exchange premium	Φ = 2.65
Unskilled labor premium	λ = 0.33
Domestic skilled labor premium	X = 0.69
Social rate of discount	i = 6.00%

13.2 Economic Cost and Benefit

Major items of importance that constitute the economic costs and benefits are those given in Table 13-2.

Table 13-2 Economic Cost and Benefit

Cost	Benefit
Investment cost	PVC production
Raw materials and utilities	Slaked lime production
Labor cost	Development of infrastructure
Other expenses for plant operation	Increased employment opportunities
	Utilization of HCl now disposed of
	Foreign currency saving

13.3 Economic Benefit

(1) Direct benefit

The economic benifit of products at full operation is as follows:

Table 13-3 Economic Value of Products

	Unit Price (US$)	Production (t/y)	Benefit (1,000 US$)
PVC	558*	25,000	13,950
Slaked lime	50	9,000	450
Total			14,400

Note: *PVC price is on CIF as of 1983

(2) Indirect benefit

(1) Increase in employment opportunities

The direct employment opportunities for the operation are estimated at 250.

(2) Ripple effects on other industries

Ripple effects on other industries include increased demand for local supplies for plant construction and operation. The demand for human resources would be the most important. This project would also provide a stable demand for anthracite. Those small-scale deposits of anthracite may be developed once dependable demand is created. This project also means effective utilization of hydroelectric power.

(3) Other indirect effects

First and foremost, a portion of hydrogen chloride now being disposed of to the sea is effectively recovered and made use of. This means better utilization of valuable natural resources on one hand. Perhaps more important is the amelioration of the pollution of the sea which could be a potential hazard to the fishing industry.

It is expected that this project will have a stabilizing effect on the domestic price of PVC.

13.4 Economic Cost

Economic costs caused by this project is mentioned below:

- Initial investment
- Labor cost
- Other production expense

(1) Initial investment

Table 13-1 indicates the economic cost for investment.

(2) Labor cost and other costs

Table 13-2 is the economic costs for operation. The taxes, loan, interest and insurance are not included in the cost, because such costs are transfer items in economic analysis.

13.5 Economic Internal Rate of Return (EIRR)

Major premises for EIRR calculation are the same as those described in the financial analysis. Relevant cost and benefit are quantitatively evaluated to calculate EIRR values.

Table 13-1 Economic Cost for Investment

	Foreign Currency Portion						Domestic Currency Portion												Total
	-3		-2		-1		-3				-2				-1				
	Persn'l	Mat'l	Persn'l	Mat'l	Persn'l	Mat'l	U.S.L.	S.D.L.	Mat'l	Duty	U.S.L.	S.D.L.	Mat'l	Duty	U.S.L.	S.D.L.	Mat'l	Duty	
1. Land Acquisition	-	-	-	-	-	-	-	-	0	-	-	-	0	-	-	-	0	-	0
2. Land Preparation for Mining	-	-	-	-	-	-	4	16	35	-	0	0	0	-	0	0	0	-	55
3. Access Road	-	-	-	-	-	-	28	70	60	-	-	-	-	-	-	-	-	-	158
4. Civil & Buildings	-	-	-	30	-	7	0	0	0	0	1	3	3	0	1	4	4	0	53
5. Mining Machinery	-	-	-	1,644	-	237	-	-	-	0	-	-	-	0	-	-	-	0	1,881
6. Construction Work	-	-	-	-	-	-	0	0	0	-	11	28	24	-	13	34	32	-	142
7. Inland Transportation	-	-	-	-	-	-	-	-	0	-	-	-	5	-	-	-	1	-	6
A. Sub-Total	-	-	-	1,674	-	244	32	86	95	0	12	31	32	0	14	38	37	0	4,674
8. Land & Site Preparation	-	-	-	-	-	-	12	50	109	-	0	0	0	-	0	0	0	-	171
9. Civil	-	0	-	151	-	0	0	0	0	0	10	17	38	0	30	52	114	0	412
10. Buildings	-	0	-	1,633	-	451	0	0	0	0	46	25	362	0	31	17	242	0	2,807
11. Equipment & Machinery	-	0	-	16,100	-	6,853	-	-	-	-	-	-	-	0	-	-	-	0	22,953
12. Erection Works	-	-	-	-	-	-	0	0	0	-	74	125	275	-	219	376	826	-	1,895
13. Inland Transportation	-	-	-	-	-	-	-	-	0	-	-	-	25	-	-	-	6	-	31
B. Sub-Total	-	0	-	17,884	-	7,304	97	50	109	0	130	167	700	0	280	445	1,188	0	28,269
14. Engineering & Consultants Fee	2,410	-	1,210	-	1,545	-	-	-	-	-	-	-	-	-	-	-	-	-	5,165
15. Contingencies -Physical-	0	0	200	678	200	678	-	-	-	-	-	-	-	-	-	-	-	-	1,756
16. Construction Expenses	-	1,722	-	1,722	-	1,721	-	-	-	-	-	-	-	-	-	-	-	-	5,165
C. Sub-Total	2,410	1,722	1,410	2,400	1,745	2,399	-	-	-	-	-	-	-	-	-	-	-	-	12,086
TOTAL (A+B+C)	2,410	1,722	1,410	21,958	1,745	9,947	44	524	204	0	142	198	732	0	294	483	1,225	0	42,650
17. Pre-Operating Expenses	-	-	-	-	134	144	-	32	-	0	-	121	-	-	0	116	321	0	779
18. Working Capital	-	0	-	0	-	566	-	-	-	-	-	-	-	-	-	-	715	0	1,281
19. Interest During Construction	-	-	-	0	-	0	-	-	-	-	-	-	0	-	-	-	0	-	0
GRAND TOTAL	2,410	1,722	1,410	21,958	1,879	10,657	44	168	204	0	142	230	732	0	294	599	2,261	0	44,710

Person'l: Personnel
Mat'l : Material
U.S.L. : Unskilled labor
S.D.L. : Domestic skilled labor

Table 13-2 Economic Cost for Operation

	Foreign Currency Portion		Domestic Currency Portion					Total
	Personnel	Material	U.S.L.	S.D.L.	Material	Duty	Total	
Variable Cost								
1. Raw Material								
Coke	-	2,220	-	-	-	0	0	2,220
Hydrogen Chloride	-	-	-	-	0	-	0	0
2. Utilities								
Electricity	-	-	-	-	1,842	-	1,842	1,842
Steam	-	-	-	-	560	-	560	560
Cooling Water	-	-	-	-	-	-	-	nil
3. Auxiliary Materials	-	1,231	-	-	-	0	0	1,231
Sub-Total	-	3,451	-	-	2,402	0	2,402	5,853
Fixed Cost								
4. Direct Labor	-	-	83	91	-	-	174	174
5. Plant Overhead	-	-	-	167	189	-	356	356
6. Maintenance	-	806	-	-	164	-	164	970
7. Insurance	-	-	-	-	0	-	0	0
8. Tax	-	-	-	-	-	0	0	0
Sub-Total	0	806	83	258	353	0	686	1,500
GRAND TOTAL	0	4,257	83	258	2,755	0	3,096	7,353

Person'l : Personnel
Mat'l : Material
U.S.L. : Unskilled labor
S.D.L. : Domestic skilled labor

Table 13-3 Calculated EIRR

(Unit: %)

Base Case	Case 1	Case 2	Case 3	Case 4
12.0	17.5	5.2	9.6	15.4

Case 1: Economic benifit +20%
Case 2: Economic benifit -20%
Case 3: Economic cost for investment +20%
Case 4: Economic cost for investment -20%

The obtained EIRR of this project is 12.0. This value is not very good but still it may be regarded as being in the viable range.

13.6 Industrial Community and Tax Income

The cumulative industrial community and tax income from this project totals 54 million US$ during the 20 years commercial operation.

13.7 Balance of Payments

The implementation of this project and 20 years operation will realize 108 million US$ of savings of foreign currency in total.

CHAPTER 14 OVERALL EVALUATION

14.1 Summary

Upon completion of the study, the project is given an overall evaluation. This project is financially viable; however, the impact of the import duty on the viability of the project is significant. Technically the processes are proven. The supply of raw materials, condition of the site, infrastructure, natural conditions, technical level of SPL, none of which would interrupt smooth implementation and operation of this project. The forecast demand of PVC supports the planned capacity. This project will have very favorable socio-economic effects. This project would not cause environmental problems. On the contrary this project would lessen the pollution of the sea by hydrogen chloride.

14.2 Technical Evaluation

This project may be considered to be technically sound. Pariahuanca will produce limestone of desired quality. Pariahuanca deposits lie along an important highway directly leading to Paramonga which facilitates transportation of limestone to the plant site. The traffic distance is about 230 kilometers which is easily covered by a fleet of trucks. Coke, the other important raw material, will be imported. Coke of uniform quality and size is available for importation. Electricity, steam and water may be made available to the project. The manufacturing processes are all commercially proven. The capacity, 25,000 tons per year, is within the economical range of the processes. The conditions of the planned plant site and surroundings are generally satisfactory. Construction of the plants is possible under the existing conditions. SPL has a strong technical background to operate all the facilities to be installed provided that technology is duly transferred. All these combined, this project may be evaluated to be technically sound.

14.3 Market Evaluation

As is elaborated in CHAPTER 4, MARKET STUDY, the domestic demand is forecast to exceed 25,000 tons per year as PVC around the year 1900. All approaches employed in this study support this view. SPL will be the only producer of PVC in

Peru. Provided SPL's PVC is competitive in price and quality with imported PVC this project can expect to fill the entire domestic market. This project is designed to be as economical as possible and at the same time to be able to produce the highest standard products.

There are virtually no domestic markets for calcium cyanamide, quick lime and slaked lime. The domestic market of carbide is also negligible. Therefore this project plans to produce only PVC. There exists possibility of using byproduct slaked lime in the Paramonga complex to a maximum of 9,000 tons per year.

Provided that SPL makes the utmost effort to reduce the cost of production and to meet the stringent quality requirement, in conclusion the marketing aspect of this project may be regarded as good enough to justify this project.

14.4 Financial Evaluation

The total capital requirement is estimated at 75,072 and 59,845 thousand US dollars respectively with import duty fully included and with import duty exempted. It should be noted that the import duty is very substantial. With import duty fully paid this project gives Internal Rate of Return of 10.3 percent after tax for standard case. Without the import duty, IRR is 11.9 percent for standard case.

The effect of interest on ROE is great. This means that a finance of very soft conditions must be used. Upon these conditions this project may be regarded as Viable.

14.5 Socio-economic Evaluation

This project yields economic internal rate of 12.0 percent which is not very good but still justifies this project from national economic viewpoint. This project has a very favorable effect on the balalnce of payment. During the project period, the foreign currency gain totals 108 million US dollars, a contribution that should be highly valued in view of the large amount of debt from which Peru is suffering. This project would provide incentives to the development of anthracite deposit by creating a steady demand for anthracite. Needless to say this project generates employment opportunities. Also important is the amelioraton of the pollution of the sea by effectively utilizing a substantial portion of the excess hydrogen chloride now being discharged to the sea.

14.6 Overall Evaluation and Comparison with Possible Alternatives

The above discussions combine to mean that this project is technically and economically sound provided that a certain set of conditions is prepared as stated in the next chapter, RECOMMENDATION.

Regarding the comparison with other routes; production of PVC from alcohol or imported ED, this project has definite advantages. As is explained in CHAPTER 13, the continuation of the present operation, EDC route, has definite disadvantage in contribution to balance of payments. In addition, the EDC route increases the discharge of hydrogen chloride to the sea. The alcohol route is technically possible but SPL has once tried this route and abandoned it in favor of the EDC route. It is also found that supply and price of molasses, the raw material for alcohol, is not dependable under the existing circumstances, whereas this project has a dependable supply of the raw materials.

Overall, this project would have various favorable effects upon SPL as well as on the nation and may be evaluated as recommendable.

CHAPTER 15 RECOMMENDATION

In the light of the outcomes of this feasibility study JICA presents the following recommendations:

(1) JICA evaluates this project as worthy of realization. Therefore, JICA recommends that SPL implement this project. However, in implemeting this project the following arrangements should be made.

(2) In view of the significant impact of the import duty on the viability of the project, the exemption of import duty on the equipment has a very favorable effect and therefore should be sought.

(3) SPL should seek finances of favorable conditions for this project. Government sponsored institutional finances are preferable in view of the facts that Peru has already been heavily in debt and that private finances with less favorable conditions are hurting the Peruvian economy.

(4) SPL should establish firm marketing channels to PVC processors like pipe manufacturers, insulated wire manufacturers, shoes makers, floor tile manufactures, manufacturers of molded products such as toys, household utensils, office supplies, sheet makers, and wholesale deales of plastic resins. This effort should precede the startup of this project.

(5) In connection with the above (4), SPL should install organizations for quality control both at head office and Paramonga Plant independent of the production department. The organization for quality control at head office should collect information on the requirements of the market and have the production reflect such requirements. And the quality control team at the plant should insure that no product failing to meet market requirement will be delivered.

(6) As is stated in CHAPTER 12, any increase in the price of electricity jeopardizes the economy of this project. SPL should do its best to negotiate preferential price of electricity in cases on future price increase.

(7) The entire manufacturing scheme from limestone quarrying down to PVC polymerization contains various elements which are more of an art than science. Therefore SPL should employ only commercially proven processes and experienced process licensors and engineering companies.

(8) SPL should train its engineers and operators for the startup, operation, shutdown, maintenance of the manufacturing facilities and also laboratory tests on limestone, carbide, coke, etc. Training should preferably be done in actual operating circumstances.

(9) Before actually starting development of quarry detailed geological surveys, boring tests, estimation of reserves and the preparation of a quarry development plan should be carried out by professionals.

JICA