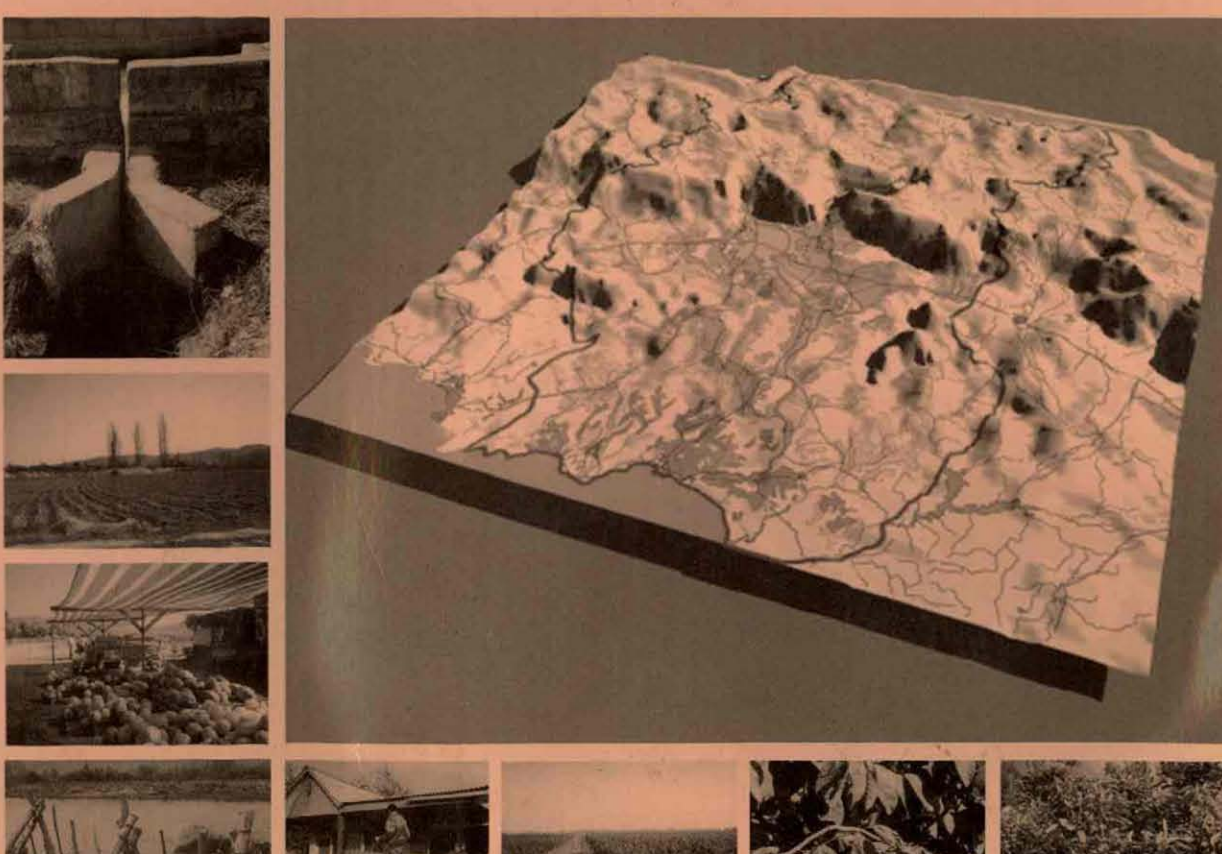
No. 15

JAPAN INTERNATINAL
COOPERATION AGENCY
(JICA)

THE STUDY
ON
AGRICULTURAL DEVEROPMENT AND WATER MANAGEMENT
IN METROPOLITAN AREA

MAIN REPORT

August, 1999



NAIGAI ENGINEERING CO., LTD.
ASIA AIR SURVEY CO., LTD.

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REPUBLIC OF CHILE
NATIONAL IRRIGATION COMMISION
(CNR)

JAPAN INTERNATIONAL
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THE STUDY ON AGRICULTURAL DEVELOPMENT AND
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COMPOSITION OF FINAL REPORT

1. EXECUTIVE SUMMARY

2. MAIN REPORT
   (Volume I)
   - PICTURES
   - ABBREVIATIONS
   - SUMMARY
   - MAIN REPORT
     - PART I MASTER PLAN
     - PART II FEASIBILITY STUDY
   - ATTACHMENT

3. ANNEXES
   (Volume II)

ANNEX A	GEOLOGY
ANNEX B	SOIL AND LAND USE
ANNEX C	METEO-HYDROLOGY
ANNEX D	AGRICULTURE
ANNEX E	WATER RESOURCES DEVELOPMENT
ANNEX F	WATER UTILIZATION
ANNEX G	AGRICULTURAL INFRASTRUCTURE
ANNEX H	RURAL INFRASTRUCTURE
ANNEX I	RURAL SOCIETY AND FARMER'S ORGANIZATION

   (Volume III)

ANNEX J	AGRICULTURAL ECONOMICS
ANNEX K	DESIGN AND COST ESTIMATION
ANNEX L	PROJECT EVALUATION
ANNEX M	ENVIRONMENT AND SANITARY
ANNEX N	SCOPE OF WORKS

Exchange Rate

The exchange rate is as follows:

1.00 $ = 0.002083US$ = 0.2352Yen

August 1998

PREFACE

In response to a request from the Government of Republic of Chile, the Government of Japan decided to conduct the study on Agricultural Development and Water Management in Metropolitan Area and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Chile a study team headed by Mr. Hisashi Terakado, Naigai Engineering Co., Ltd., three times between June 1998 and June 1999.

The team held discussions with the officials concerned of the Government of Chile, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Chile for their close cooperation extended to the team.

August 1999

Kimio Fujita

Kimio Fujita
President
Japan International Cooperation Agency

▲Large scale vineyard (Pirque)

▲Cultivation of avocado (Maria Pinto)

▲Cultivation of *chirimoya* (Mallarauco)

▲Collecting and shipping center of strawberry (San Pedro)

▲Direct sale shop by farmers (Talagante)

▲Raising seedling facility manged by a production enterprise of small and medium scale farmers (El Monte)

▲Milk collection facility of small scale dairy farmers (Maria Pinto)

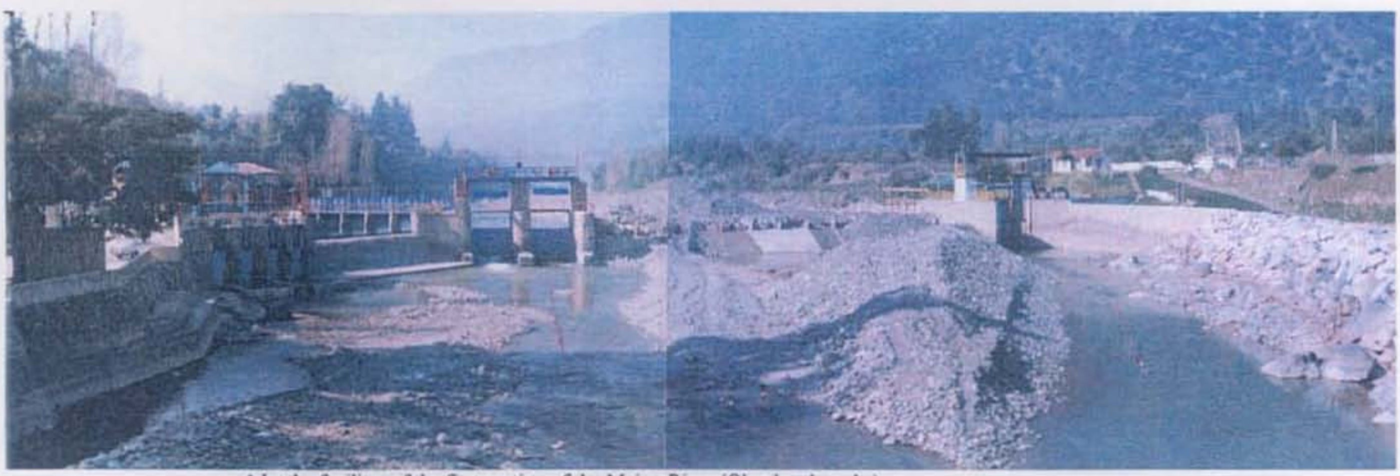
▲Raising seedling facility manged by a production enterprise of small and medium scale farmers (Isla de Maipo)

▲Grassland irrigation by center pivot system

▲Newly developed vineyard by a major winemaker (Casa Blanca)

▲Setting nursery stocks of grape and prevention nets against small amnimals with tube irrigation

▲Midstream of the Mapocho River where urban sewage is flew into



▲Intake facilites of the first section of the Maipo River (Obra head works)
Left; San Carlos canal for agricultural use, Right; intake canal for water supply managed by EMOS

▲Traditional intake facilities (Downstream of the Mapocho River)

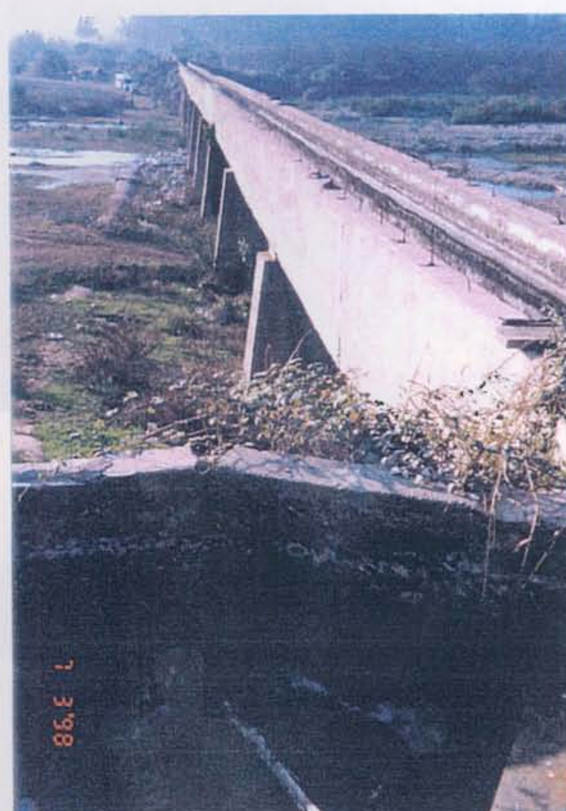
Traditional slit division works; the width of the slit is determined by the number of *acción*

▲Intake facilities in the midstream of the Mapocho River (Mallarauco canal)

▲Energy dissipator in the midstream of Mercedes canal

▲Division works after the exit of the tunnel of Mallarauco canal

▲Secondary canal and division works



▲Aqueduct across the river

▲Tertiary canal without lining

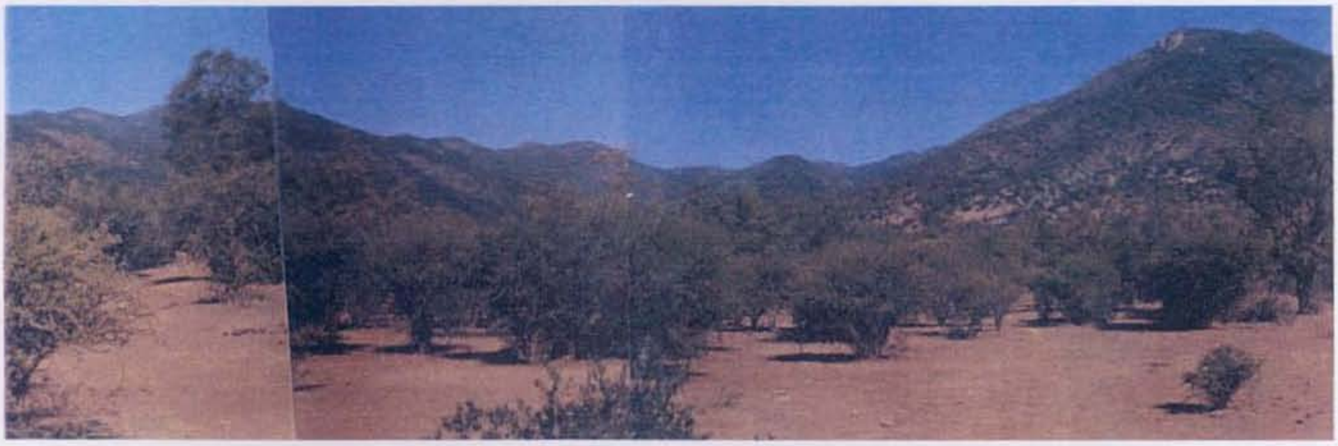
▲Proposed site for integrated intake weir in the upper stream (The third section of the Maipo River)

▲Proposed site for integrated intake weir in the lower stream (The third section of the Maipo River)

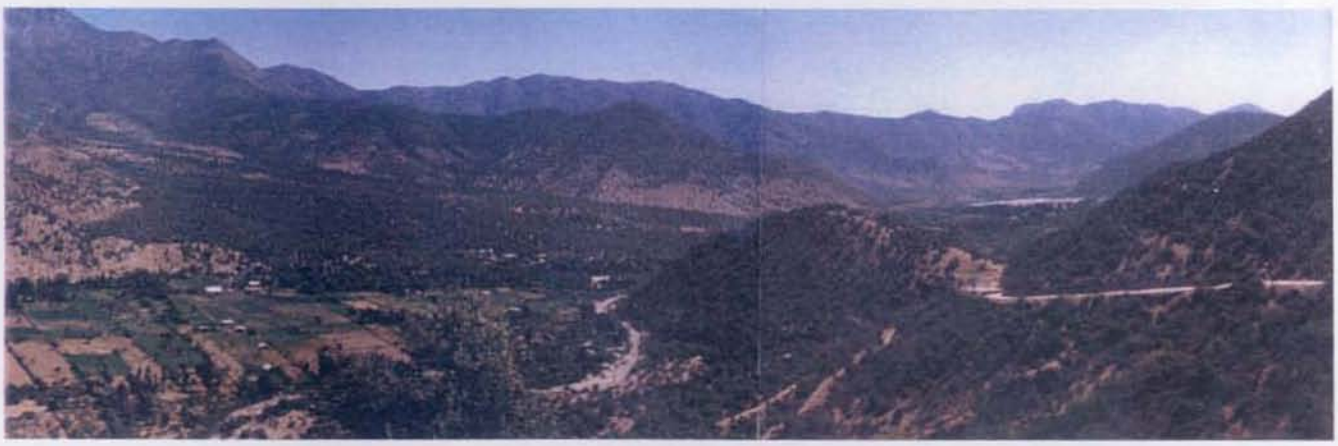
▲Proposed site for middle scale dam in Culipran area

▲Proposed site for new irrigation area in Culipran area

▲Proposed site for new irrigation area in Popeta area



▲Proposed site for new irrigation area in Popeta area



▲Proposed site for new irrigation area in Alhué area

▲Existing large scale grape cultivation area in Yali area

▲Water contamination in the terminal part of Mallarauco canal

▲Water contamination in the terminal part of Mallarauco canal

▲Water contamination in the terminal part of Mallarauco canal

▲Farm pond for drip irrigation in Mallarauco area

▲Complete view of Mallarauco - Manzano area

▲Proposed site for a sewage treatment plant in Mallarauco - Reforma area

▲South main canal in Mallarauco - Las Carrera area

▲Proposed site for a sewage treatment plant in Mallarauco - Las Carrera area

▲Explanation and discussion on Inception Report

▲Signing for M/M on Ic/R

▲Explanation and discussion on Progress Report 1

▲Signing for M/M on Progress 1

▲Explanation and discussion on Interim Report

▲Signing for M/M on Interim Report

▲Explanation and discussion on Progress Report 2

▲Signing for M/M on Progress 2

ABBREVIATION

Institutions and Organizations

• AGCI	Agency for International Cooperation of Chile
• BCC	Central Bank of Chile
• CASEN	Survey of Socioeconomic Characterization (Ministry of Planning)
• CEPAL	Economic Commission for Latin America and the Caribbean
• CIREN	Center of Natural Resources Information
• CNR	National Irrigation Commission
• CONAF	National Forest Corporation
• CONAMA	National Environmental Commission
• COREMA	Regional Environmental Commission
• CORFO	Production Development Corporation
• DGA	General Department of Waters
• DOH	Department of Hydraulic Works (Former Department of Irrigation)
• DR	Department of Irrigation
• EMOS	Metropolitan Company of Sanitary Works
• ESSEL	El Libertador Company of Sanitary Services
• ESVAL	Valparaiso Company of Sanitary Works
• FAO	Food and Agriculture Organization of the United Nations
• FOSIS	Solidarity and Social Investment Fund
• FUCOA	Foundation of Communications, Training and Farming Culture
• IDIEM	Institute of Materials Testing Research
• IGM	Military Geographic Institute
• INDAP	Agricultural Development Institute
• INE	National Statistics Institute
• INIA	National Institute of Agricultural Research
• INN	National Standards Institute
• IRM	Intendency of the Metropolitan Region
• MINAGRI	Ministry of Agriculture
• MI	Ministry of the Interior
• MIDEPLAN	Ministry of Planning and Coordination
• MINVU	Ministry of Housing and Urbanism
• MOP	Ministry of Public Works
• ODEPA	Office of Studies and Agricultural Policy
• SAG	Agriculture and Livestock Service
• SMAPA	Municipal Service of Drinking Water and Sewer System
• PROMM	Program of Medium and Small Irrigation Works
• SECPLAC	Communal Secretariat of Planning and Coordination
• SEREMI	Ministerial Regional Secretariat
• SERNAGEOMIN	National Service of Geology and Mining
• UFOCO	Union for the Development of Competitiveness
• MEFR	Ministry of Economy, Development and Reconstruction

Others

• $	Chilean Peso
• US$	United States Dollar

- B/C Benefit Cost Ratio
- IRR Internal Rate of Return
- SDR Social Discount Rate
- NPV Net Present Value
- EC Electric Conductivity
- BOD Biochemical Oxygen Demand
- DO Dissolved Oxygen
- pH Hydrogen Ion Concentration
- S.S. Suspended Sediment
- mm Millimeter
- cm Centimeter
- m Meter
- km Kilometer
- g Gram
- kg Kilogram
- t Ton
- m^2 Square Meter
- km^2 Square Kilometer
- ha Hectare
- HRB Hectáreas de Riego Básico (= Basic Irrigation Area)
- m^3 Cubic Meter
- MCM Million Cubic Meter
- l Litter
- l/s Litter per Second
- m/s Meter per Second
- m^3/s Cubic Meter per Second
- t/ha Ton per Hectare
- % Percentage
- °C Degree Centigrade
- MSL Mean Sea Level

Republic of Chile

The Study on Agricultural Development
and
Water Management in Metropolitan Area, Chile
Main Report

SUMMARY

I MASTER PLAN STUDY

1 Introduction

(1) Authority

The Government of Chile requested the Government of Japan to undertake a study on "Agricultural Development and Water Management in Metropolitan Area, Chile" in July 1996. The study aims mainly to formulate a master plan for agricultural development and water management reflecting upon environmental conditions in metropolitan area, Chile and to conduct a feasibility study for the agricultural development plan(s) in the priority project area(s). The study covers 3,200 km^2 of farm land located in outskirts of Santiago metropolitan area. In response to the request, the Government of Japan dispatched the Preparatory Study Team from November 3,1997 to November 21, 1997 through JICA, and agreed on the Scope of Work for the Study. The study was conducted in two steps; Phase I and Phase II from June, 1998 to March 1999. During the Phase I study, master plan on the agricultural development in the whole study area was formulated. In the Phase II study, feasibility study on priority areas selected among the master plan was carried out. This report describes results of field study and detailed development plans derived from the analysis of present situation of the study area.

(2) Background

The Republic of Chile faces the Pacific Ocean of the South American continent and stretches about 4,300 km from south to north. Andian mountains are the east frontier by Argentine, the north is bordered by Peru and Bolivia, and the south reaches to the Antarctic Ocean. Total population is 15 million and GDP per capita is US$ 5,000 in 1998. The secondary industry is mainstay of economical activities in Chile.

In the beginning of 1970s, economic policy of Chile advanced to the market oriented and open economy. Continuous economic growth is lasting at 6.4 % of average economic growth rate after overcoming the debt crisis in the beginning of 1980s. Recent national economy is also stabilized as shown in the economic parameters such as 8.2 % of inflation rate and 5.5% of unemployment rate. Agriculture and fisheries sector occupies around 7 % of GDP, 14% of employment and 10% of exports, and takes position which next to mining industry in the national economy. Agricultural development policy of the government toward 2000 puts stress on increase of agricultural production and export. And policy also aims at the balanced development of agriculture through supporting and strengthening of small scale farmers.

Agriculture in Chile has large varieties depending on the land condition derived from a long and narrow shape stretching from south to north. Metropolitan region having capital city of Santiago is the important areas of agriculture in the nation because of irrigation facilities provided for a long time, fertile soils and abundant variable climatic condition that is cultivable from sub-tropical till temperate crops. Since the late 1970s, metropolitan area has been expanded drastically with population growth and industrial development in the capital city of Santiago. This phenomena causes urban sprawl and tightness of water utilization due to increase of demand such industrial water use as water works, hydraulic generation and mining industries.. Moreover, agriculture in the metropolitan area suffers on negative effects by contaminated irrigation water because kinds of crop cultivation are limited. Various water demand in the metropolitan area depends on surface water and groundwater in the Maipo river basin originated in the Andes mountains. According to the situation mentioned above, the evaluation of available water resources, optimum allocation of water, and the conservation of the basin environment have been recognized their necessities.

Reflecting these situations, the government of Chile has been started the study on "Maipo Project" in 1979 by the National Irrigation Commission as the competent authorities. Major objectives of the project were the water source development for the new irrigation scheme, the overall basin irrigation study contributing to the coordination and the management of the present water utilization on the Maipo river basin. The study consisted of four stages; to grasp the natural condition of the basin, to grasp the water demand of the basin, to establish the water utilization plan of the basin and evaluate the project. The first stage had been completed, however, the study had been suspended by the domestic affairs. Review of the first stage study results and the execution of the further stages are the urgent issues

(3) Objectives of the Study

The objectives of the study are; to formulate a master plan for agricultural development and water management reflecting upon environmental conditions in metropolitan area, Chile, to conduct a feasibility study for the agricultural development plan(s) in the priority project area(s) and to carry out technology transfer to the Chilean counterpart personnel through on-the-job training in the course of the study.

(4) Study Area

The study covers the Metropolitan Region and the part of V and VI Regions. Total area for the master plan is about 3,200 square kilometers, which consists of actual and potential irrigated areas.

2 The Present Situation of the Study Area

(1) Rural society

Rural society in Chile was drastically changed from the simple structure, which there are the owners of large plantations and their labor farmers, by Agrarian Reform in 1962. The present rural society is a newly created society which consists of new and old landholders. Therefore, establishing communal society as an unity of inhabitants has been not matured, yet.

The names of administrative division; *Ciudad* (city), *Pueblo* (town), and *Aldea* (village) do not represent the community as a social unit but are just classifications by geographical location.

The unit of the most fundamental organization in rural society is Community Council (*Juntas de Vecinos* - JJVV) which is the divided organization of *Comuna* or the terminal organization of national administration. JJVV consists of those who have settled down there and are older than 18 years old. The unity of JJVV is called *Unidad Veecinal* (UV). The self-government right of both JJVV and UV is established, legally. JJVV is formed by territorially related connection and can be regarded as the community unit. Thus, hereafter, when the report says "community," it refers to JJVV. The communities in the study area are extended into main roads and shape row communities.

Under JJVV which plays a main role as an organization, various activity groups such as improvement of education groups, volunteer activity groups and clubs are working. Moreover, there are canal associations and producers' organizations as farmers' organizations. These are not limited by UV but established as regional wide organizations by their purposes and functions.

(2) Administrative division and sub-basin division in the study area

According to the Census in 1992, the population in the study area was about 546,000 persons. While 96% of the total population concentrates in urban areas, 4% of those lives in rural areas. Administrative divisions are Region, Province, and *Comuna*. To grasp the basins' characteristics in the study, the study area is divided into 12 sub-basins by *Comuna* based on natural and agricultural conditions.

(3) Geology

Chile locates the part of volcanic and seismic zones in the Pacific Rim. The downgoing plate from the Pacific Ocean forms the upheaval of the Andes mountains and volcanic and seismic zones exist in the country. Geology in the study area consists of sedimentary and volcanic rocks which deposited from the Mesozoic Jurassic period to the Mesozoic Cretaceous period.

(4) Climate

The climate in the study area is the Mediterranean climate. Annual average temperature is 16℃ and annual rainfall is 438mm. The rainy season is from April to September (fall / winter) and the dry season is from October to March (spring / summer). About 90% of total rainfall is concentrated in the rainy season.

(4) Land use

The study area is highly irrigated area and total area of its agricultural and livestock farming development is about 1,465,000ha. 68% of this is utilized for cultivation. The metropolitan area of Santiago in 1992 is about four times as much as that in 1940. The progress of this has been accelerated and the metropolitan area of Santiago has sprawled out, rapidly. So as to regulate this disordered expansion and sprawling, "The Metropolitan Area of Santiago Regulation Plan (*Plan Regulador Metropolitano de Santiago*-SEREMI-MINVU 1994)" was established. On the other hand, there is the system which enables to sell farmland as 0.5ha sub-divided housing lot. This strengthens the sprawling.

(5) Water resource

1) Surface runoff

The major rivers in the study area are the main and branch streams of the Maipo river. Relevant to water use in the area, the surface runoff from each sub-basin under the condition of average year and 85% probability of exceedance is calculated as the table below.

Item	Annual Average year (MMC)	85% Probability of Exceedence (MMC)
Total annual runoff	5,822.1	3,396.6
Oct. to Mar.	2,989.6	1,756.0
Apr. to Sep.	2,832.5	1,640.6

Item	Annual Average year (MMC)	85% Probability of Exceedence (MMC)
Runoff from the Andean Mountains	4,060.2	2,448.5
Oct. to Mar.	2,867.7	1,689.1
Apr. to Sep.	1,192.5	759.4
Runoff from areas except the Andean Mountains	1,761.9	948.1
Oct, a Mar,	121.9	66.9
Apr. to Sep.	1,640.0	881.2

Surface runoff in the study area can be estimated around 58 MCM in the average year. 70% of total surface runoff is supplied by thaw in the Andes Mountains, furthermore, 70% of runoff from the Andes Mountains concentrates upon summer, from October to March. Runoff from areas except the Andes Mountains is estimated around 17.6 MCM and 90% of total runoff generates by precipitation falling in winter from April to September.

2) Groundwater

As the results of calculation by obtaining from the executed survey on aquifer distribution, depth of aquifer and effective porosity, the potential yield of groundwater in the study area is estimated at about 26,000 MCM. Among this, Maipo-Mapocho groundwater unit occupies more than half of it, 22,000 MCM.

(6) The present situation of water use

Water utilization in the study area is broadly divided into three categories, irrigation water use for about 180,000ha of farmland, drinking water supply for 5.5 million residents including Santiago city and the other industrial water utilization. This depends mostly on discharge from the upstream basin of the Maipo river.

Based on the required water for crops, the required irrigation water amount in the study area counts 4,370 MCM (surface runoff; 4,130 MCM, groundwater; 240 MCM). Including the return flow, about 2,460 MCM and about 2,240 MCM of surface runoff are used for irrigation in average year and 85% probability of exceedance. The water use for domestic water supply, and mining and the other industries is about 910 MCM. Among it, about 450 MCM of domestic use depends on the surface runoff of the Maipo river. On the other hand, during irrigation period, from October to March, the discharge from the upstream reach of the Maipo river is about 2,870 MCM and about 1,690 MCM in average year and 85 % probability of exceedance, respectively. The present utilization of surface runoff of the Maipo river has reached to its limit. Moreover, the tightness of water use leads to speculative acquisition of water right which focuses on the free trade of water right under the Law.

(7) Water balance

So as to clarify the present water use, water balance study of each sub-basin is carried out under the condition of average year and 85% probability of exceedance on rainfall and surface runoff. Present water utilization in each basin is presented in the table below.

Sub-basin	Demand (a) (MCM)		Average		85% probability of exceedance	
	Irrigation	Others	Deficit (b) (MCM)	Ratio (b/a) %	Deficit (b) (MCM)	Ratio (b/a) %
1. Río Maipo Alt	65.798	3.190	0.000	0.00	0.000	0.00
2. Río Clarillo	140.478	0.620	0.000	0.00	3.048	0.02
3. Río Mapocho Alt	242.758	804.310	0.000	0.00	0.000	0.00
4. Estero Lampa	392.614	38.470	158.857	0.37	194.815	0.45
5. Río Mapocho Bajo	725.123	28.085	0.000	0.00	62.610	0.08
6. Río Angostura	1204.022	9.726	508.621	0.42	594.097	0.49

Sub-basin	Demand (a) (MCM)		Average		85% probability of exceedance	
	Irrigation	Others	Deficit (b) (MCM)	Ratio (b/a) %	Deficit (b) (MCM)	Ratio (b/a) %
7. Estero Alhué	259.128	0.580	199.570	0.77	214.339	0.83
8. Melipilla	796.971	5.168	549.590	0.69	564.292	0.70
9. Estero Puangue	360.834	1.350	126.089	0.35	131.278	0.36
10. Estero Yali	39.495	0.690	5.746	0.14	7.315	0.18
11. San Antonio	13.625	7.010	7.855	0.38	8.774	0.43
12. Estero Casablanca	125.595	8.939	48.650	0.36	54.470	0.40
Total	4366.440	908.138	1604.978		1835.038	

(8) General situation of agriculture

In the study area, various types of agriculture by irrigation is carried out. Especially, large amount of grapes for wine production, table grapes and deciduous fruit trees are cultivated. Moreover, cultivation of semi-tropical fruit trees (avocado, citrus) has been increased in the hillside of hilly area, recently. Main cultivation crops and livestock raising situation are shown in the table below.

Crops	'75-'76 Census (ha)	'97 Census (ha)
Cereals, Processing crops	67,391	31,748
Vegetable, Flower	23,686	25,885
Fruits	28,411	43,506
Vineyard	2,985	6,703
Seeds and seedlings	N.A.	5,898
Forage	28,979	30,619
Total	151,452	144,359

Source: Domestic agriculture and livestock, Recent trend and forecast, , CORFO, 1998

Animals	Head		%
	Metropolitan Region	National	
Cow	229,531	4,141,545	5.5
Sheep	60,544	3,710,549	1.6
Swine	643,066	1,722,403	37.3
Horse	40,016	415,184	9.6
Goat	21,005	738,183	2.8

Source: 1997 Census

(9) Farmers and their agriculture

In the study, farmers are classified according to the landholding area as follows.

Landholding area (ha)	Name	Share in the study area (%)
0.5～15	Small scale farmers	74.7
15～100	Medium scale farmers	19.2
100 以上	Large scale farmers	6.1

Through the 12 sub-basins, farming in the study area can be summarized as following. In case of medium and large scale farmers, fruits growing or forage crop dominates their cultivation. While in case of small scale farmers, forage crop dominates their cultivation, then, vegetable and flower cultivation occupies the share in their cultivation.

(10) Agricultural infrastructure

1) Facilities

Irrigation system starts from the intake facilities in rivers or reservoirs. Then, the irrigation water flows through the settling basin, main canals, branch canals, and then to fields. Structures of existing intake facilities vary from concrete to gabion and/or rock-fill. Its structural level differs from each other. Both main and branch canals in the study area are generally unlined. Even though lining entire canals might be effective against the leakage from canals, it is hard to be facilitated because beneficiaries have to bear the cost for the rehabilitation works and it affects the downstream areas where return flow is used as the irrigation water. The incentive to rehabilitate the facilities is low because water balance is considered in the area as a whole. The irrigation method in the fields is furrow irrigation generally, but the areas where suffers from shortage of water adopt water saving irrigation methods (Californian method, drip irrigation). Most of the areas, where groundwater is used for irrigation, adopt pumping irrigation.

2) Operation and maintenance of irrigation facilities

O & M of irrigation facilities is handed by canal associations (*Asociación de Canalistas*) which are established by farmers and approved legally. The associations manage canal facilities including intake structures. O & M cost is paid by the burden charge according to the number of water right, or *Accións* which hold the water users.

(11) Market / Marketing

The Metropolitan Region is the central market of agricultural products domestically and also the consumption area. There can be seen economic activities of various industries concerned such as wholesalers, large scale retailers, exporters, processers and so on. The market which holds long history and traditional system has come not to adopt to the demand of the age, gradually. The market which has a new system such as wholesale market in Santiago city and a model market is planned. Generally, main buyers of agricultural products of small scale farmers in rural areas are middlemen, traditional wholesale markets and livestock markets. Selling to middlemen on the fields is one method, but its price is low. Direct sale along with roads is also often seen. Moreover, there is another selling method that farmers pay from 2 to 7% commission to intermediaries or traders with special contracts.

(12) Agricultural support

Government agencies concerned with agricultural support are MOP (Ministry of Public Works), MINAGRI (Ministry of Agriculture), and MEFR (Ministry of Economic Promotion and Reconstruction). Main support programs are providing information, establishment of organizations, technology transfer, providing credit and so on. The objects of the programs are farmers of all classes, but especially small scale farmers are put stress on. Nevertheless, the support system by public institutions is not enough from the aspect of personnel and budget. The fundamental condition to be provided the support from these institutions is holding water right. The applicants of the INDAP projects which is the support institution of small scale farmers have following limitations; they must be farmers who hold water right of 0.5 ~ 12ha irrigate area, the beneficiaries should be organized, and the project plan has already formulated and so on. The financial support for small scale farmers whose access to general financial institutions such as city banks is weak is executed by government agencies concerned such as INDAP and PROMM. INDAP provides long term credit for investment in facilities and short term credit for cropping budjet. PROMM provides financial and technical support for irrigation at the same time.

(13) NGOs

From the point of agricultural support, there are about 800 active NGOs (Non Governmental Organizations). In the study area, there are 450 organizations, and two of them are working on the field of agriculture concerned.

(14) Farmers' organizations

As farmers' organizations, there are canal associations, their upper organizations, farmers' association, producers' organizations and so on. However, there is not a cooperative including functions such as selling and purchasing, and providing credit. The farmers' association is the organization for protecting farmers' right but its activities are stopped at present. Producers' organizations are established by small scale farmers who hold less than 15ha land according to the purpose of production. They are working as *Asociación Gremial de Pequeños Agricultores* (small scale farmers production organization) and organizations provided the support from government agencies concerned.

(15) Rural infrastructure

On the whole, installation ratio of basic infrastructure is high. Nevertheless, installation of water supply facilities and sewerage system are behind in regional rural areas, especially mountainous areas.

(16) Environment

1) Environmental administration

The national steps to solve environmental problems are carried out by the Fundamental Law of Environment, systematically and CONAMA (National Environment Committee), institutionally.

2) Designated area for protection

In the study area, there are four conservation areas, one natural monument, four protection areas, and three sanctuaries. Among them, Estero el Yali, which belongs to conservation areas, was registered as the marsh of the Ramsar Convention.

3) Environmental pollution

The metropolitan area has took pride in its traditional characteristics of the particular scenery which urban areas and farmland are closely located. Transformation of farmland into housing lots or industrial areas with urban population growth impacts on not only change of the scenery but also on regional environment, ecologically. Furthermore, lack of proper sewage treatment system in Santiago city leads to contamination of irrigation water by urban sewage. This results in prohibition of some kind of vegetable cultivation by using surface flow of water entire part of the study area. According to this situation, sewage treatment plan in Santiago city which targets at 2024 has been established by EMOS. In the plan, Santiago city is divided into three treatment plant sections and three improvement stages (starting from 2001, 2004, and 2009). Treatment of sewage starts to implement, gradually. The third stage will be terminated in 2024.

3 Constraints and Development Potentials on Agricultural Development

According to the results of the study on the present condition, the problems on the agriculture in the study area can be summarized in following four points.

(1) Disparity caused by landholding scale

- The landholding structure in the study area is distorted. 6% of landowners who hold more than 100ha farmland occupy 86% of total farm land in the study area and more than 80% of landowners who hold less than 15ha occupy only 5% of that.

- Large and medium scale farmers have established their bases for farming and management. On the other hand, small scale farmers have not established stable farming and management. Thus, extended reproduction of agriculture is difficult for them.
- Migration of the small scale farmers from rural to urban areas has been increased.

According to the present problems, following points will be cared in the future.

- Quitting agriculture by small scale farmers and concentration of farmland to large and medium scale farmers
- Collapse of rural society and deterioration of rural ecosystem by quitting agriculture of small scale farmers
- Causing social problems in urban areas

(2) Tightness and competition of water use

- Increase of water use other than agriculture with urban expanding
- Available capacity of both surface runoff and groundwater reaches to their limits under the present water right.

According to the present situation, following points are given as direction of the future water use.

- It is hard to settle new water right through the easy method such as use of surface runoff.
- New water utilization will be promoted through the use of small scale groundwater development, obtaining the established water right in the water market, utilization of unused water right, storage of runoff of flood, rationalization of water use so far, and so on.

(3) Contamination of agricultural water

- Utilization of contaminated water by sewage from the metropolitan area irrigation water
- Prohibiting cultivation of designated vegetables by contaminated irrigation water
- It will take about 25 years to improve the present situation of contamination

In case that improvement of the present situation is not considered, following points are given.

- Lowering the credibility against the safety of Chilean perishable food in the world market
- Deteriorating health and sanitary environment of farmers

(4) Decrease of farmland

- Transformation of superior farmland into urban land use
- Existence of the system which approves the transformation of farmland

According to the trend of the present situation, following points are given on the future land use in the study area.

- Change of land use will be limited by establishment of urban planning
- Decreased farmland by urbanization will be developed for fruits growing

through utilizing micro climate condition in regional rural areas.

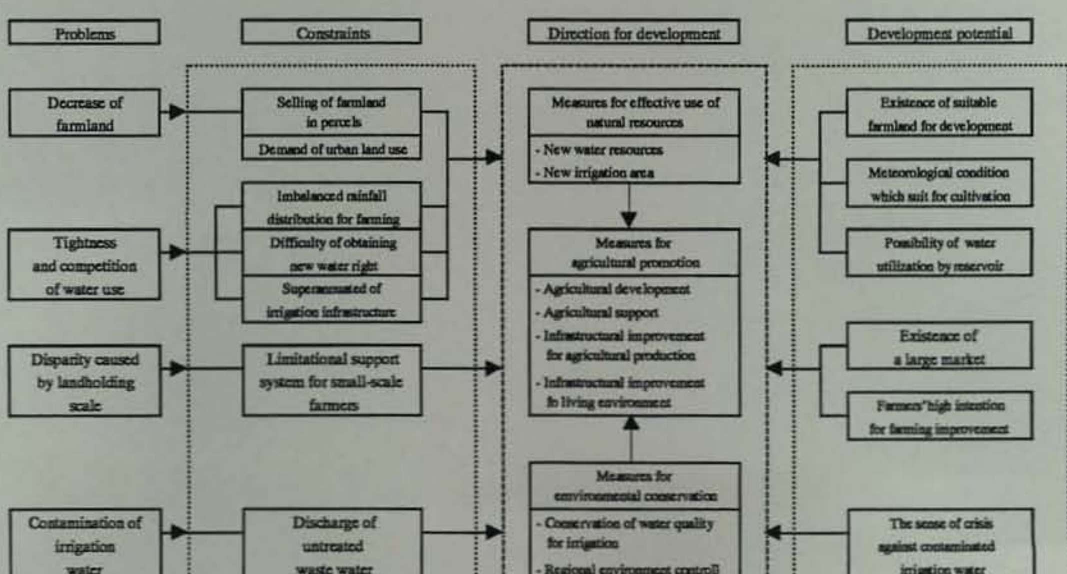
From the problems of the present situation and their future prospects as mentioned above, constraints and development potentials to examine the methods for solving the problems in the area are regarded as follows.

Constraints	Development Potentials
· Limited support system for small scale farmers	· Existence of a large market
· Decrepit infrastructure and facilities' environment	· Farmers' high intention for improvement of farming
· Little amount of rainfall and imbalanced rainfall distribution	· Meteorological and topographical conditions which suit for cultivation
· Difficulty of obtaining new water right	· Possibility of utilizing impounded water
· Discharge of untreated waste water	· The sense of crisis of farmers against contaminated agricultural water
· Demand of urban land use	· Existence of suitable farmland for development

As mentioned above, the problems of agriculture in the metropolitan area are

- Existence of disparity among farmers by landholding scale,
- Competition of land and water resources between agricultural and urban uses,
- Deterioration of regional producing and living environment that represents discharge of untreated sewage water into rivers.

The countermeasures to solve these problems are summarized in the following figure based on the future prospects of each problem, constraints on agricultural development, and development potentials mentioned before.



4 Basic Concept and Approach of Development Plan

From the recognition of present situation in the study area, agriculture in the metropolitan area is affected by sprawled expansion and contaminated irrigation water due to sewage by population growth. The development plan is envisaged to promote socio-economically well-balanced agriculture for the harmonized progress by effective use of limited sources of water and land considering environmental conservation

The plan should be accorded with "Strategic Agenda 1998/2000 Agricultural Development Targets" which is the national agricultural policy. The direction of the plan aims at alleviating disparity between urban and rural areas, coexistence of these areas, and harmonizing with environment. The target year in the plan is set up in 2010.

Based on the concept of development, the framework of the development plan is as follows.

- Agricultural promotion in the metropolitan area
- Effective utilization of potential land and water resources in the study area
- Environmental conservation in the entire basin

5 Agricultural Development and Water Management in Metropolitan Area

(1) Water resource development plan

1) Water source development plan

According to development constraints and potentials, the development constraints in the plan are the limited natural resources. Among them, the key resource is water. Considering that water is necessary for agricultural production and tightened at present, development of new water sources should be examined in the study area. Five methods can be given; a) reservoir facilities (large scale, medium and small scale reservoirs, b) new water creation by saving irrigation water, c) groundwater, d) water use by utilizing unused water right effectively, and e) treated sewage water. Among these, b) can be returned only to the farmers who save water under the present water use system. Groundwater is regarded as small scale supplementary water source, considering that new development of it is regulated by government agencies concerned. Accordingly, both of them are not included in the plan.

According to the topography, geography, scale of the reservoirs, and scale of the basins in the area, possibility of constructing reservoirs is examined in 14 sites, 6 rivers. Considering social, economic, and environmental conditions of each reservoir site, total four sites; one site for large scale and three sites for medium and small scale are selected. New water source amount by construction of reservoirs is estimated at 398.6MCM as presented in the table below.

River	Site	Area of basin (km^2)	River bed elevation (m)	Dam height (m)	Dam crest-length (m)	Storage capacity (MCM)
Maipo	El Ingenio	2,785	1,159	161	800	360
Colina	El Cepo	208	970	45	630	4.6
RosaRío	Patagua Chica	184	120	37	350	29.3
Curacavi	El Flamenco	244	331	27	250	4.7

It is also possible to construct small reservoirs in streams in the area beside the dams mentioned above. The small reservoirs can be used as storage of surplus water from irrigation canals and discharge of its basin by rainfall, and can be used as supplementary water source during irrigation period.

DOH has an undistributed but available water right of 25.0m^3/s (*Decreto* No.1039) for the irrigation project in the second section. In the development plan, the irrigation utilization plan is formulated through utilization of this water right held by DOH from the view of effective utilization of unused water right.

EMOS has the plan of using treated water of $3.5m^3/s$ as irrigation water because an urban sewage treatment plant, the first stage, in South Santiago will start the operation from 2001. Utilization of the treated water has some problems to be solved in near future, such as decreasing return flow in the downstream basin and water right on the treated water. Nevertheless, the development plan assumes the problems would be solved. Thus, this is included into the development plan.

2) Water resources distribution

Among new water source development plans, the water source which is available for domestic water is only the large scale dam plan. Therefore, concerning both irrigation and domestic water uses, expansion of domestic water use in 2010 will be 40 MCM among 360 MCM of newly developed water amount. Thus, the rest of it, 320 MCM is new irrigation water source. The irrigation area is expected to be about 18,500ha. On the other hand, available supply of middle and small-scaled dams, 39 MCM is regarded as new irrigation or supplementary water sources around reservoir sites. The water with unused water right in the downstream basin of the Maipo river is distributed only for irrigation use, and new irrigation area will be 21,000ha. Treated sewage by EMOS can irrigate about 3,000ha.

The water distribution mentioned above, the alternatives to newly developed water amount are summarized as follows;

Item	The alternatives of water source development plan			
	Without dams	With dams		
	A−1	A−2 (middle and small scale dams)	A−3 (Large scale dam)	A−4 (A-2+A-3)
Large dam	—	—	360 MCM	360 MCM
Middle and small dam	—	39MCM	—	39MCM
Water right of the 2nd section	25.0 m^3/s	25.0 m^3/s	25.0 m^3/s	25.0 m^3/s
Treated sewerage use	(3.5 m^3/s)	(3.5 m^3/s)	(3.5 m^3/s)	(3.5 m^3/s)
Water supply	—	—	40 MCM	40 MCM
Irrigation development (With existing water right)	21,000 ha	21,000 ha	21,000 ha	21,000 ha
Treated sewerage use	(3,000 ha)	(3,000 ha)	(3,000 ha)	(3,000 ha)
Total (1)	21,000 ha	23,300 ha	39,500 ha	41,800 ha
Total (2)	(24,000 ha)	(26,300 ha)	(42,500 ha)	(44,800 ha)

(2) Land resource development plan

In this plan, urbanization areas are to be established in accordance with "The Metropolitan Area of Santiago Regulation Plan (*Plan Regulador Metropolitano de Santiago* – SEREMI-MINVU 1994)" which is the regulation for controlling disordered expansion of Santiago city and sprawling. Except urbanization areas, the present land use will remain. As new irrigated farmland, about 112,000ha land is regarded in the northern, western, and southwestern parts of the area based on land productivity classification shown in the table below. The reclamation of these farmlands is limited by the location of water source and available water amount.

Division of basin	Land productivity potential I−IV
Est. Yali	26,002 *
Est. Casablanca	25,779 **
Est. Alhué	19,184 *
Est. Lampa	20,688 **
Est. Puangue (Curacaví, Maria Pinto)	9,634 *
Cue. Melipilla	10,383 *
	111,670

*Source : * CIREN , **REA*

(3) Agricultural promotion plan

Basic concept of agricultural promotion in the plan is social balance by economic development and coexistence of urban and rural areas as described in "Development concept and approach." From this meaning, plans of production infrastructure improvement for increasing agricultural productivity, both technological and financial supports required for production activities with this infrastructure, and alleviating disparity between urban and rural areas on living environment are to be established.

1) Agricultural production plan

a) New irrigation area

The agricultural production plan established in the study is backed up basically by the condition of new irrigation areas selected throuh the study. The production plan which is implemented at present is conditioned by economically successful export. Nevertheless, the basic approaches of the plan are supplementing insufficiency of small scale farmers' production opportunities and increasing their productivity because their productivity is low in agricultural production structure and modernization of agriculture burdens them. So as to promote agriculture in the metropolitan area, which is the target of the study plan, selection of new irrigation areas is required to deal with decreasing farmland. In the master plan, 6 areas (Popeta, Yali, Alhué, Puangue, Casablanca, and Lampa) will be new irrigation areas. These areas are selected based on examination of land and water resources from the view point of agricultural development.

The preconditions of the established crop cultivation plan are as follows;

- The farmland which plans to be newly irrigated is unirrigated land at present.
- The crop cultivation plan includes estimation of unused land area for production such as follow land, staircase land and meadow on both small scale farmers and large and medium scale farmers. Under the present condition, the area is estimated at from 27 to 69% with small scale farmers' and from 15 to 20% with large and middle scale farmers. In the plan, it is estimated at from 22 to 33% with small scale farmers and from 9 to 20% with large and medium scale farmers. The average percentage in the new irrigation areas is 12.7%.
- On the other hand, from the point of land use in the crop cultivation plan, one of the standards is not beyond largely the portion of intensive cultivation (fruits, vegetables, grapes for wine and table grapes, seed production, and seed) in Lampa, Mapocho Bajo, and Angostura where intensive cultivation has been already operated. In case of subjecting average regions, the degree of intensity in these three basins is realistic, feasible and best level for reaching under the present market condition and the framework of economic policy.
- In crop selection, available crops in basins of the Maipo river and crops whose planting and cultivation area is large in the project area and its suburb are selected.

The present cultivated crops and proposed crop cultivation plan are presented below based on geographical location in the study area.

- Popeta area

  The cultivation plan is mainly relevant to the present crop cultivation in present irrigated areas, Melipilla and Popeta. In irrigated areas in Popeta (including Cholqui, Carmen Alto, Culiprán, Tantehue, and Los Guindos), a lot of grapes, vegetables and fruits are cultivated due to its climatic condition. Many private investors promote cultivation by groundwater and rainfall in unirrigated area here.

- Alhué area
  It is planed that the present level of Alhué area, where large unirrigated land exists even it is blessed with fertile soil and fine climatic condition, alters to the level of Melipilla basin and irrigated areas in Cabras where a lot of fruit trees and grapes for wine are cultivated. This area is provided very appropriate climatic condition for grape cultivation as well as Casablanca area. High potentials of this area are supported by keen interest of many vineyards and investors on the expanding cultivation plan in this area. On the other hand, there is possibility of cultivation crop diversification on vegetables, flowers, crop cultivation for seed production because of advantage on the aspect from producing environment, which is isolated condition due to natural condition, the neighboring of markets, and blessed climatic condition.

- Yali area
  San Pedro area where much fruit trees, grapes, and crop cultivation for seed production have been cultivated in these years is provided with blessed climatic condition. Nevertheless, there is large area of unirrigated land. Because of this, the crop cultivation plan for fruit trees, grapes, seed production is planned.

- Puangue area (Curacaví, Maria Pinto, and Ibacache)
  The idea of the crop cultivation plan in this area mainly connects with the crop cultivation system of present irrigated area in Puangue and Melipilla basin. In the plan, mainly fruit tree growing and secondly grape cultivation for wine will be major cultivation crops. Besides them, vegetable and flower cultivation will occupy some potion because this area is the suburb of Santiago.

- Casablanca area
  The idea of crop cultivation plan mainly connects with present irrigated area in Casablanca basin and rapid growth of grapes for wine cultivation in these years. Therefore, grapes and fruit tree growing is planned as main crops in this area. The portion of forage crop cultivation will decrease compared to the present level, but it will remain an important crop especially in the area where irrigation water is not distributed. Furthermore, vegetable cultivation also has a certain level of possibility because main road to the central coast is passed through in this area.

- Lampa area (Colina and Polpaico)
  Crop cultivation relates to crop cultivation system of the present irrigated area in Lampara basin where a lot of vegetables, fruit trees, and crop cultivation for seed production are cultivated. At present, cultivation of vegetables, fruit trees, and crops for seed production occupy 69% of farmland. Yet, cultivation of vegetables and crops for seed production which need small investment will be stressed.

b) Area for rehabilitation of existing irrigation facilities

The farming in the areas for rehabilitation of existing irrigation facilities will remain the present farming type but fruit tree growing will increase at hilly and sloping areas. Accordingly, based on the present cultivation crops, proposed main cultivation crops in each area are presented in the table below.

Farmers' scale	Small scale farmers				Medium and large scale farmers			
Farming area	24,562.9 ha				105,165.7 ha			
Sub-basin	Decreased crops		Increased crops		Decreased crops		Increased crops	
Clarillo	Cereals	17.1ha	Fruit tree	24.2ha	Cereals	120.7ha	Fruit tree	63.3ha
	Fallow land	21.4ha	Forage crop	14.3ha	Forestation	65.5ha	Forage crop	60.5ha
							Seed	62.4ha
Lampa	Cereals	65.2ha	Fruit tree	65.2ha	Forestation	155.2ha	Fruit tree	155.2ha
	Fallow land	97.9ha	Forage crop	97.9ha				
Angostura	Cereals	69.2ha	Fruit tree	34.6ha	Cereals	442.1ha	Fruit tree	443.7ha
			Vegetable / Flower	34.6ha	Forestation	492.2ha	Forage crop	490.6ha
Melipilla	Cereals	82.2ha	Fruit tree	106.8ha	Cereals	259.4ha	Fruit tree	257.8ha
	Fallow land	106.8ha	Forage crop	82.2ha	Forestation	265.2ha	Vegetable	266.8ha
Puange	Cereals	49.4ha	Fruit tree	64.2ha	Cereals	105.9ha	Fruit tree	88.8ha
	Fallow land	64.2ha	Forage crop	49.4ha	Traditional crops	102.4ha	Forage crop	119.5ha
Total		573.4ha		573.4ha		2,008.6ha		2,008.6ha
Crop transformation ratio	2.3 %				1.9 %			

c) Area for the water quality improvement

Crop cultivation plan in the improvement area of irrigation water quality, cropping ratio of vegetables will be increased in case of small scale farmers by introducing the chard, cabbage, cauliflower, and so on which prohibited the cultivation at present. Even the quality of irrigation water is improved, utilization of irrigation water will be made mainly on prevailing fruit cultivation in case of large and medium scale farmers. Quality of fruits cultivated by the improved irrigation water has high marketability. Accordingly, the present cultivation of fruits will be followed on the crop production plan for the large and medium scale farmers.

2) Agricultural support plan

More than 80% of small scale farmers among those who engage in agriculture live in rural areas, and they are in charge of main role in rural and regional society in fact. Therefore, it is important for vital and stable development of rural areas to make the small scale farmers vital and settled down. The support institutions for changing the present situation of small scale farmers and supportive methods for implementing the plan are ordered by support institutions such as SECPLAC, INDAP and FOSIS or as support programs of each institutions.

In order to be provided financial and technical supports from the support institutions, the basic condition is establishment of small scale farmers' organizations. Based on the present situation of the existing support system, in the support plan, establishing organization of unorganized small scale farmers is mainly promoted. Advancing the functions of the existing producers' organizations and construction of the base facilities for various activities to develop regional agriculture which each organization can use are also proposed.

3) Rural infrastructure improvement plan

The infrastructure relevant to living is relatively highly installed in rural areas, the study area. The disparity between rural and urban areas has been shrunk in the points of living environment. Therefore, in the plan, improvement of roads in mountainous areas, drinking water supply facilities, and sewage treatment plants in regional urban areas are proposed. Proposed amount of installation is as follows;

Basin	Installation of rural water supply	Sewage treatment plants	Local road installation
	Unit	Unit	Km
1.Río Maipo Alto	-	2	-
2.Río Clarillo	4	1	-
3.Río Mapocho	-	6	-
4.Est. Lampa	3	3	-
5.Río Mapocho	-	6	-
6.Río Angostura	4	6	15
7.Est. Alhué	8	2	35
8.Melipilla	5	1	20
9.Est. Puangue	9	2	12
10.Est. Yali	8	3	55
11.San Antonio	3	3	28
12.Est. Casablanca	8	4	26
Total	52	39	191

4) Agricultural infrastructure improvement plan

The agricultural infrastructure improvement plan in the objective area is irrigation facility improvement. The irrigation facility improvement consists of rehabilitation in the existing irrigated areas and construction of facilities in new irrigation areas.

Irrigation facilities rehabilitation plan in the existing irrigation area, Clarillo, Angostura, Puangue, Lampa and Melipilla in which indicate significant shortage of irrigation water are selected as the objective areas. Reduction of O & M cost of irrigation facilities and alleviation of water shortage at the field level are intended. Moreover, regarding the rehabilitation of the existing intake structures in the second and third sections in the Maipo river, those structures are to be integrated into the proposed intake weirs of new irrigation areas. In accordance with establishment of *Junta de Vigilancia* which manages water utilization among water users, water management is handed by and supported from the structural aspects. Summary of the improvement plan by area is presented in the table below.

Sub-basin	Area (ha)	Main improvement structures		
		Intake structures (unit)	Diversion works (unit)	Canals (km)
Río Clarillo	2,500	-	12	16
Río Angostura	45,105	22	47	235
Est. Puangue	13,412	6	17	98
Est. Lampa	13,381	-	14	63
Melipilla	28,690	5	34	211
Total	103,088	33	127	623

New irrigation plan is proposed based on the water amount created by unused water right, large scale dam, and medium and small scale dams in accordance with a plan for water source development described in the water resource development plan. Irrigation by unused water right uses DOH's water right of $25m^3/s$ in the second section of the Maipo river. The objective areas are sub-areas of Yali, Alhué, and Popeta (21,000ha). Expected available supply of 320 MCM by construction of a large scale dam distributes to sub-areas of Lampa and Curacavi (18,500ha) relevant to location of a constructed dam. Expected available water of 39 MCM by construction of middle and small dams is distributed as new irrigation water around the dam sites and supplementary water source for areas of Colina and Curacavi (550ha). The objective area of irrigation plan by using treated sewage is Curacavi area (3,000ha).

(4) Environmental conservation plan

1) Irrigation water conservation plan

As the countermeasure against the problem of contaminated irrigation water in Santiago city, there is a sewage treatment plant construction plan by EMOS. In this plan, the treatment plants are to be constructed in three sites step by step in Santiago city. The plants will start to operate from 2001 to 2009. Nevertheless, it takes about 25 years to obtain adequate irrigation water from the rivers sanitarily after completing the plants.

The present situation which Chilean agricultural products gains good reputation in the international market should not be lost and be sustained for long time from now on. Taking a long time to solve a problem of the contaminated irrigation water should be considered as anxiety relevant to sustainability of good reputation in the international market. Thus, the countermeasures should be prepared as soon as possible. In the plan, the countermeasures for water quality improvement from agricultural side are proposed in order to accelerate recovering the function of the suburban agricultural area as a perishable food supply center for consumers in the metropolitan area and to protect the inflow of unexpected negative information into the international agricultural product market where competition is very severe before it happens.

The objective areas do not include the proposed areas by EMOS in the plan. On changing water source, there is the only possibility to avoid contamination by groundwater after the confluence of the Maipo and Mapocho rivers as adopted methods for countermeasures. Two methods; avoiding the source of contamination by bypass and water quality improvement are practicable. The sewage treatment is planned by the method of Standard Activated Sludge as well as the treatment method planned by EMOS. The targets for improving water quality are less than 23/100ml groups of colitis germ, BOD of 20mg/l, and SS of 30mg/l.

The measures for improvement of water quality with canals are summarized as follows;

Measures for improving water quality	The objective canals	Intake amount (m^3/sec)
Avoiding contamination sources (through bypass)	Canal La Polvora	0.5
	Canal La Punta	5.8
	Canal Casas de Pudahuel	0.8
	Total	7.1 m^3/sec (3 canals)
Improving water quality	Canal Las Mercedes	10.5
	Canal Esperanza Alto	0.7
	Canal Esperanza Bajo	1.7
	Canal Romero	1.0
	Canal Castillo	2.0
	Canal Domingano	0.8
	Canal Mallarauco	8.5
	Canal El Paico	2.5
	Canal San Miguel	4.2
	Canal Lo Aguirre	3.6
	Canal Lo Chacon	3.6
	Canal La Manresa	1.2
	Total	40.3 m^3/sec (12 canals)

2) Promotion of environmental education

Urban areas in the study area have the problems of illegal disposal of wastes and untreated discharge of contaminated water, while rural areas have the problems of the canal contamination by domestic wastes, miscellaneous sewage and waste of animals. An areal approach is to play an important role based on the national environmental conservation policy in order to solve these problems. This is also expected to have a positive impact. In the plan, "countermeasures against contamination campaign" implemented by CONAMA expands to rural areas, and environmental education and enlightenment activities are to be carried out under the cooperation with SECPLAC by *Comuna*.

3) Promotion of agriculture concerned environment

Agricultural promotion plan formulated in the plan aims at sustainment of farmers' farm management by improving their farming and maintains the present ecosystem and environment by promoting sustainable agriculture. Therefore, the plan is based on environmental consideration, and considers avoiding environmental pollution and destruction from agriculture itself as much as possible. On the purpose of penetrating and extending farming methods relevant to environmental consideration, technological instruction to farmers is implemented by INIA, universities, and so on.

4) Establishment of an environmental monitoring system

Conservation areas related with the Ramsar Convention, sanctuaries and protection areas exist in the objective area. Although these areas are excluded from the objects of the development plan, the study on the present situation around these areas is needed to be implemented early because impact of the plan on these areas might be considered. The impact caused by further development should be observed and supervised, certainly. Moreover, regular environmental monitoring on change of land use pattern in the future and change and impact of ecosystem with promotion of agriculture is required in the area. Thus, establishment of the system by institutions concerned for this is planned.

5) Selection of the development scenario

Based on the alternatives of water resource development in the study area described in the water source development plan, four development scenarios are proposed. According to the alternatives of new water sources, irrigable areas and available water amount, development scenarios are presented in the table below.

New water source	Water volume			Generation	Irrigation	Scenario			
	Creation	For water supply	For irrigation use	of electricity (ヶ所)	area (ha)	S - 1	S - 2	S – 3	S – 4
I. Unused water right	$25m^3/s$	-	$25m^3/s$	4	21,000	○	○	○	○
II. Large dam	360MCM	40MCM	320MCM	4	18,500	-	-	○	○
III. Middle and small dam	39MCM	-	39MCM	-	550	-	○	-	○
The areas						Objective area (ha)			
New irrigation						21,000	21,550	39,550	40,050
Rehabilitation of irrigation facilities						9,400	9,400	9,400	9,400
Water quality improvement						53,000	53,000	53,000	53,000
Rehabilitation of irrigation facilities and water quality improvement						93,700	93,700	93,700	93,700
Total						177,100	177,650	195,650	196,150

The structural components and the project cost of each scenario are presented in the table below.

Item	Component	S - 1	S - 2	S - 3	S - 4
1 Agricultural infrastructure Development					
Irrigation development					
Colina-Casablanca	Irrigation area (Colina, Porpaico, Curacavi, Casablanca)	-	-	18,500 ha	18,500 ha
	Water source facilities (Maipo Dam) V=360 MCM, H=161 m, L=800 m	-	-	1 site	1 site
	Main canal	-	-	296.5 km	296.5 km
	Related structures (tunnels、 siphons)	-	-	21.7 km	21.7 km
	Power station	-	-	4 sites	4 sites
Colina	Irrigation area (Colina)	-	270 ha	-	270 ha
	Water source facilities (Colina Dam) V= 4.6 MCM, H= 45 m, L=230 m	-	1 site	-	1 site
	Main canal	-	4 km	-	4 km
Curacavi	Irrigation area (Curacavi)	-	280 ha	-	280 ha
	Water source facilities(Cracavi Dam) V= 4.7 MCM, H= 27 m, L=150 m	-	1 site	-	1 site
	Main canal	-	30 km	-	30 km
Yali -Popeta	Irrigation area (Yali, Alhué, Popeta)	21,000 ha	21,000 ha	21,000 ha	21,000 ha
	Headworks (Integration)	1 site	1 site	1 site	1 site
	Main canal	140.5 km	140.5 km	140.5 km	140.5 km
	Related structures (tunnels、 siphons)	13.6 km	13.6 km	13.6 km	13.6 km
	Power station	4 sites	4 sites	4 sites	4 sites
Improvement of existing irrigation system	Objective sites (Clarillo, Angostura, Lampa, Puangue, Melipilla)	5 sites	5 sites	5 sites	5 sites
	Objective area	103,088 ha	103,088 ha	103,088 ha	103,088 ha
	Objectives for improvement				
	rehabilitation of intake structures	33 sites	33 sites	33 sites	33 sites
	:rehabilitation of main canal	623 km	623 km	623 km	623 km
2 Rural Living infrastructure Development	Rural water supply	52 sites	52 sites	52 sites	52 sites
	Rural sewerage system	39 sites	39 sites	39 sites	39 sites
	Local roads improvement	191 km	191 km	191 km	191 km
3 Environmental conservation	Improvement of water quality				
	Bypass canal	3 sites Q= 7.1 m^3/s	3 sites Q= 7.1 m^3/s	3 sites Q= 7.1 m^3/s	3 sites Q= 7.1 m^3/s
	Treatment of water quality	12sites Q=4.74m^3/s	12sites Q=4.74m^3/s	12sites Q=4.74m^3/s	12sites Q=4.74m^3/s

Regarding internal rate of return on each scenario, S-1 and S-2 are 16.99% and 14.77%, respectively. Those on S-3 and S-4 are not beyond 12% of social discount rate set up by MIDEPLAN. On evaluation of social and environmental impact, that on S-1 and that on S-2 are equal. In the plan, considering effective use of water resource in the study area, S-2 which plans to construct facilities for new water source is selected as the agricultural development scenario (the master plan on agricultural development) whose target year is 2010.

6 Priority Projects

On selection of the priority projects, model or pilot projects / areas for agricultural promotion in the objective area will be selected among the projects proposed as the master plan projects.

In the existing irrigation area, agricultural infrastructure improvement concerned environmental conservation consisting water quality improvement for irrigation and rehabilitation of the existing irrigation system will be proposed as the priority project in the area where improvement of water quality for irrigation is required. This priority project is settled as the pilot scheme related to the water quality improvement. Moreover, in the existing unirrigated farmland, agricultural development with effective use of present water resources is proposed as the priority project. As for living environment improvement, the plan relevant to living environment improvement is established in the areas where priority projects will be implemented.

(1) Selection of the area for agricultural infrastructure improvement concerned environmental conservation

Required areas of the rehabilitation on the existing irrigation system are 5 areas, Clarillo, Puangue, Lampa, Melipilla and Angostura. Entire part of Puangue and Melipilla areas and some parts of Clarillo, Lampa and Angostura areas use contaminated river flow for irrigation. Out of three areas, bypasses method to avoid contamination sources is applied for the Lampa area. Both Cralillo and Angostura areas are excluded from the objective area of improvement because water quality will be improved by the plan of EMOS up to the target year of 2010.

Contaminated water of the Mapocho river is used for irrigation water through Canal Las Mercedes, and Canal Mallarauco in the area of Puangue and Melipilla, respectively. EMOS has the plan to use the treated sewage for irrigation in the Puangue area. So, the agricultural infrastructure improvement concerned with environmental conservation is planned as a pilot plan in the existing irrigation area with Canal Mallarauco where water quality will not be improved up to the target year of 2010 because EMOS does not have the treated sewage use plan. 1,500ha is selected as the objective areas to be ameliorated in its farming and farm management due to improvement of water quality.

(2) Selection of the area for agricultural development with water resource utilization

The areas for agricultural development with water resource utilization are three. They are Yali-Alhué-Popeta irrigation areas by utilizing unused water right and Colina and Curacavi to be irrigated by construction of small scale dams. Based on the comprehensive evaluation applied the standard of project evaluation method by PROMM-World Bank, Popeta area is selected as the area for agricultural development with water resource utilization.

7 Conclusion and Recommendation

(1) Conclusion

According to recognition of the present situation in the study area, the master plan on "Agricultural development and water management in metropolitan area" targeted year of 2010 is examined. Main points of the master plan are effective use of land and water resources, environmental conservation and agricultural promotion. In the examination, development scenarios of the study area are set up based on the alternatives of newly available water resource development. After evaluation on the social and economic impacts of each scenario, the adequate scenario is proposed as the master plan. The components of the master plan are creating new irrigation areas of 21,550ha by utilizing the existing water right and small reservoirs, rehabilitating five existing irrigation systems of 103,088ha, water quality improvement projects relevant to 15 existing irrigation canal systems and rural infrastructure improvement consisting of rural water supply, sewage of regional urban areas, and local roads.

(2) Recommendation

1) Proposed integration of the existing intakes in the master plan supports management of water use among water users. Early implementation of the project is proposed.

2) In Chile, water belongs to personal property based on the water right. At the same time, water is also a social common capital. Unused water right and reusable water right are required to be dealt with some legal measures from the point of effective use of limited resource.

3) Quality improvement of contaminated water by domestic waste water is indispensable not only to maintain the good reputation of Chilean agricultural

products in the international markets and diversify cultivation crop but also to improve living environment. However, the investment of this project is huge compared to direct benefit. Therefore, it is difficult to implement the project by only private sector, and thus required introducing governmental budget as a public work.

4) Water sources for reclamation of farmland caused by present animated agricultural export mostly depends on groundwater. This situation brings about decline of water level and interference of groundwater. Thus, groundwater for agricultural use should be limited only to small scale development or supplemental use.

5) Water saving effect by lining of main canals should be appreciated. It is proposed that rehabilitation of major infrastructure among the existing irrigation systems should be promoted, actively.

6) Countermeasures to regulate sprawling are needed from the aspect of taxation system.

II Feasibility Study

1 Agricultural Development Plan in Popeta area

1.1 The Present Situation of the Objective Area

(1) Society

Popeta area where is the objective area of Feasibility Study belongs to *Comuna* Melipilla and is located in the southern part of the Maipo river. Popeta area administratively consists of eight (8) *Unidad Vecinal* (United community), and each *Unidad Vecinal* consists of several *Junta de Vecinos* (Council of community). According to Census '92, population of the area is 8,447 persons.

The smallest unit as a group is *Junta de Vecino* in the area. It is possible to consider that the *Junta de Vecino* is an unit of community because it is organized based on territorially related connection.

The ratio of the extremely poor in *Comuna* Melipilla is high, compared to that in whole the Metropolitan Region. Yet, the ratio is 3.4% and is about 60% of national average. That of the poor is also low, 17.5% and 76% of national average. The other indicators also tend to be more improved, compared with the national average. Nevertheless, illiteracy rate is 1.5 times as much as national average and 2.7 times as much as the Metropolitan Region's one, or 7.2%.

(2) Geology

Popeta basin consists of a plain where old riverbed deposit and terrace deposit of Quaternary age cover the valley formed by impervious bed rock. However, the surface layer is a tableland composed by Alluvial pumice volcanic ash. The existing rivers flow and erode these tableland. Diluvium aquifers are overlain by the volcanic ash deposit, and development of alluvial deposit along the existing rivers is poor. Pumiceous volcanic ash deposit is not distributed at Yali and Alhué areas. Deposits of Diluvium and Alluvium accumulates continuously and forms terraces ranging from 2 to 5m high along the existing river bed. Groundwater is taken from deep Diluvium layer for agriculture and from shallow Alluvium layer for drinking water at present. The

(3) Climate

The objective area of the study categorizes in the Mediterranean climate and the division of winter and summer seasons is clear. While most of annual rainfall is concentrated in winter season, dry and fair climate continues in summer season. General climate is as follows.

Annual rainfall	400 mm	Annual average temperature	14.8℃
Annual average maximum temperature	28.0℃	Annual minimum temperature	3.3℃
Annual average relative humidity	69.7%	Annual average wind velocity	1003.6km/month
Annual average sunshine hours per day	6.9 hr	Annual average evaporation	1,212 mm

(4) Soil and land use

According to agricultural landholding survey (REA) in 1995, the objective area coves 60,826ha, and among this, farmland occupies 23,243ha. Crop cultivation suitability of soils in new irrigation area is clarified based on land productivity classification by REA.

	Land productivity classification	Area by REA (ha)
Ⅰ	(No limitation for cultivation)	0.0
Ⅱ	(A little limitation)	479.0
Ⅲ	(Necessary to select crops)	647.0
Ⅳ	(Serious limitation for cultivation)	2,393.3
Ⅴ	(Difficult for farmland)	0.0
Ⅵ	(Impossible excluding pasture land)	1,436.0
Ⅶ	(Impossible for farmland)	336.8
Ⅷ	(Impossible for whole land use)	34.8
	Total	5,326.9

(5) Water resource

Discharge at Chiñihue of the Maipo river which is to be a water source of new irrigation area is estimated by regression formula with correlation of discharge at Cabimabao. Annual average discharge and discharge at 85% probability of exceedance at Chiñihue are as follows;

Item	Unit	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Chiñihue														
Average	m^3/s	117.7	74.8	47.3	45.8	70.0	101.7	131.4	118.2	54.2	42.6	90.9	132.8	
	MCM	315.11	181.36	126.65	118.61	187.55	263.63	352.06	316.58	142.36	114.14	235.47	355.68	2709.2
85%	m^3/s	31.83	18.29	18.31	22.98	43.28	49.47	66.99	54.04	33.51	25.28	33.42	35.25	
	MCM	85.25	44.25	49.04	59.56	115.92	128.23	179.43	144.74	86.86	67.71	86.62	94.41	1142.0

In the objective area, average coefficient of permeability is 5×10^{-4} m/sec. Percolation coefficient is from 2 to 5 l/s/m in a part of Alhué and less than 2 l/s/m in the others areas. In Popeta area, total number of wells is 234. Wells that use for irrigation is 125 and for domestic use is 16 of 234. According to the results of long term observation of groundwater fluctuation, groundwater level of each basin tends to be declined, or has the possibility to be reduced in the future. It is judged that the large scaled development of groundwater for irrigation is limited in the areas near future.

(6) Agriculture

As farmers in the project area are classified by scale of landholding, farming pattern in the objective area is shown in the table below.

Farming Size		No. of Farmers	Total Area (ha)	Average Farming Area (ha)
Small scale	0.5 – 15	172	506.8	3.0
Medium Scale	15.1 – 100	54	2,285.6	42.3
Large Scale	Over 100.1	8	2,534.5	316.8
Total		234	5,326.9	22.8

Approximately thirty percent (30%) of total area, 5,326ha belongs to class IV of the land productivity classification. Small scale farmers are usually situated in high productive farmland of the lower land except a few cases.

Fruit growing area in Melipilla Province has increased by 12.4 % in the last four years. On the other hand, its cultivation has decreased by 9.7 % in the same period in the Metropolitan Region. The objective area is included in a part of the increased areas. Recently in the objective area, enterprises implement agricultural development projects for fruits and forage crop cultivation. Most of the projects are carried out with irrigation by using groundwater and surface flow of small streams in the farmland which belongs to class IV and VI of the land productivity classification. Those area of the project reach 1,000ha. However, a problem of reducing groundwater that is the water source is raised in those projects.

Regarding wine production, a very effective winery whose production capacity is 1,000,000 liters has been constructed in a small vineyard (72ha), San Juan de Popeta, recently. The wine produced in this winery is called "*Aurelio Montes*" and has achieved prestige as one of export wines and recorded good sale. This suggests a possibility of further expansion of vine cultivation in the objective area. Moreover, the objective area has the similar climate characteristics to Alhué area where is one of the most promising areas for expanding wine production in the country.

As an important crop in Popeta area, there is vegetable cultivation such as pumpkins, melons, watermelons, tomatoes, green beans and others by small and large scale farmers. Forage crop cultivation shares an important portion in the objective area. The products are sold mainly as dried feed to other regions. Seed production is also important even though the produced area is small.

On the other hand, the present land use of the proposed new irrigation area is utilized for farming minimally because there is arid area. Minimum farming means that poor cattle raising or wood collection for charcoal. There are agricultural activities whose gross income ranges between \$50,000/ha of cattle raising and \$30,000/ha of charcoal in the proposed irrigation area at present. However, income from these activities are so small that farmers must depend on non-agricultural income for their living. Otherwise, the present proposed irrigation area exists as abandoned land because land price increase can be expected due to land use opportunities for other purposes.

Agro-processing in the new irrigation area needs to consider that Popeta area is located in 65～80 km from Santiago and roads to Santiago are installed. In Santiago, many fields of agro-processing are operated. Different fields from Santiago's are also operating in the suburbs of Santiago such as Paine, Pirque, Linderos, Lampa, Isla de Maipo and Talagante. Any of those areas are located within 90 km from Popeta area and some of them are within 25 km. In *Comuna* of Melipilla Province where the objective area is located, there are food processing facilities.

(7) Agricultural Support

Agricultural support in Chile is principally conducted through INDAP. The INDAP's local office which covers Melipilla Province is established in the Melipilla city. In order to utilize the service system of INDAP, farmers are required to be organized by themselves. This was a big bottleneck on extension of INDAP services. Area Advisory Services (SAL), Project Advisory Services (SAP) and Specialized Advisory Services (SAE) were newly established in 1997 so as to promote and expand INDAP's services for conducting works step by step including forming organizations.

At present, agricultural supports are not provided by NGOs at all in the Project Area. On the contrary, private agricultural consultants and private agricultural extension workers are utilized as advisers. They give consulting services on INDAP services; formation of organizations, application for projects, and financial procedures. Then, they also continue to give guidance on operation and maintenance after the project.

(8) Farmers' organizations

There are five types of farmers' organizations. Beside canal associations, there are irrigation organization, milk collecting cooperatives, potato production organization and flower production organization as producers' organizations in the Study area. In Popeta area, there are seven canal associations; Canal Chocalan, Canal Carmen Alto, Canal Cholqui, Asoc. Canal Wode House, Canal Culipran, Culipran la Higuera, and Canal Basurero. These associations are working by unit of association, and mainly deal with fair distribution of irrigation water and operation and maintenance of irrigation canals.

Irrigation organization (*Grupo de Riego*) as a producers' organization was established by 91 small scale farmers who lived in Culipuran and Popeta by SAL of INDAP. A milk collecting cooperative is a producer's organizations. This is a milk producers' cooperative and managed by 15 small scale dairy farmers. The bases of them are milk collection centers which equipped with a fixed temperature storing facilities by INDAP projects. Based on the centers, the cooperatives intend to control milk quality for maintaining the selling price through controlling animal raising, feed and milking of each farm. A flower production organization (*Taller Tierra Verde*) is managed by 8 women of farm households in Carmen Bajo area. The organization was set up by PRDEMU which is a rural women support program of INDAP. The center of its activity is carnation cultivation. It deals with production up to shipment to a central market, and promotes improvement of rural women's status and entrance into socio-economic activities.

(9) Marketing of agricultural products

Marketing of farm products in the objective area is divided into two; (a) individual, in which the producer sells his/her products to an intermediary without a contract, generally obtaining low prices, and (b) group marketing, or through a trade association of the producers themselves, which not only improves marketing by replacing intermediaries, but permits access to credit and technical assistance. The marketing channels of small producers are intermediaries, direct sale from producers to consumers, a market of agricultural products, and contract production, generally involving agro-industry or packing plants. Small collective milk marketing centers in the Objective area include Codigua, Culiprán, Popeta, Puerta and Colorada.

(10) Farm Income

The income and expenditure of farm household who hold less than 15ha in the objective area is presented below.

Popeta Total Small Farms

Item	Area (ha)	Income ($)	Expenses ($)	Result ($)
Farm Area	4.91			
Used Area	3.61			
Gross Farm Income		943,808		
General Expenses			265,028	
Net Farm Income				678,780
Family Labor		97,529		
Off-farm Income		313,719		
Family Expenses			757,538	
Household Income				332,490

The results presented above indicate that the small farm is in a difficult situation, requiring off-farm income to make the farm viable.

(11) Agricultural infrastructure

The agricultural development project in the objective area is a part of "Popeta-Yali-Alhué" agricultural development plan proposed in the Master Plan. Irrigation facilities consist of commonly used facilities for three areas of Popeta, Yali and Alhué. New irrigation areas are uncultivated land and do not have any organized irrigation systems. There are some small irrigation areas where take water for irrigation from small streams, but water shortage is always occurred.

In each area, existing irrigation area in the objective area is basically excluded from the object of newly irrigated areas. The existing irrigation areas where locate close to proposed canals and shortage of water has been occurred such as Culiprán is required to be supplied irrigation water. In Yali area, the basin of the Yali river includes new irrigation area where does not have irrigation system by using river flow. Construction of large scale irrigation system using groundwater has increased recently. In Alhué area, the new irrigation area is located in the Alhué river basin. At present, there is an irrigation system taking water from branch of the downstream Rapel river. Beside this, irrigated areas by pumping groundwater up are also distributed.

Around Chiñihue of the Maipo river which is the water source of new irrigation, eight intake facilities of existing canal associations are located. Three intake facilities, San José, Puangue, and Picano are located in the left bank of the weir and the rest is located in the right bank. Volume of these intakes and of water right is shown in the table below.

Unit: m^3/s

Item	San José	Puangue	Picano	Calmen Alto	Cholqui	Chocalan	Culiprán	Codigua	(Total)	P-Y-A	Total
Capacity of existing canals	3.7	2.9	8.7	1.0	3.2	2.7	3.0	2.7	27.9	-	-
Water right	5.7	3.6	9.2	8.0	2.0	5.0	5.0	4.8	43.3	25.0	68.3

(12) Rural infrastructure

Present condition of basic infrastructure in the objective area is shown in the table below.

Unit: %

Area		*Unidad Vecinal*	Electricity	Water supply	Sewerage facility
Popeta	UV15	Chocalán	100	100	30
	UV16	Carmen Bajo	100	100	23
	UV17	Carmen Alto	85	80	0
	UV20	El Pabellon	100	100	5
	UV21	Cholqui	100	100	12
	UV23	Culiprán	100	95	8
	UV25	Popeta	100	90	5
	UV26	Los Guindos	90	80	5
	Total		99	92	14

Source : Melpilla - SECPLAC

Among basic infrastructure in the objective area, installation of electricity and water supply is almost completed. Electricity is supplied by an electric supply company. Drinking water is all from groundwater. Water supply facilities are constructed by the rural water supply projects of MOP based on the community unit. On the other hand, installation of sewage facilities has almost not proceeded, and there are no sewerage treatment facilities even in the communities where water supply facilities have already installed.

(13) Environment

Designated areas in Popeta, Yali, and Alhue such as natural parks are shown in the table below.

Type of designation	Name of areas	Size	Place (Basin)
National Reserve	ROBLERIA DEL COBRE DE LONCHA (DECRETO No.62 1996/7/25)	5,870 ha	Est.Alhué
	ESTERO EL YALI (DECRETO No.41 1996/5/23)	520 ha	Est. Yali

to be continued

Type of designation	Name of areas	Size	Place (Basin)
Protected Area	HACIENDA TANTEHUE (DECRETO No.427 1968/8/30)	11,775 ha	Cue. Melipilla
Wild Life Protection Area	LAGUNA DE ACULEO, ALTOS DE CANTILLANA Y TANTEHUE (DECRETO No.382 1998/1/24)	156,117 ha	Cue. Melipilla, Rio Angostura, Est. Alhué y Est. Yali

ROBLERIA DEL COBRE DE LONCHA in the Caren Basin is designated as National Reserve where its original animals and plants are distributed. ESTERO EL YALI is a marsh registered as the marsh of Ramsar Convention in December 1996.

The analyses were made three times on the point where the Maipo River joins the Mapocho River, three times on the point of the Alhue river, and once of the Canal Culipran. Compared to Chilean Standard for Irrigation, all three points in all seasons meet the standard requirement of water for agricultural use as to pH and Cu^{2+}, while some of points meet as to Cl^-. Concerning $SO4^{2-}$, all points in all seasons exceed the standard value. As to fecal coliform, except for two analyses on the Alhue river, all points in all seasons exceed the standard value of water for recreation use and water for growing the specified vegetables.Based on the construction of sewage treatment plant plan by EMOS, the table below shows the predicted value of BOD in 2010 in each of the maximum, minimum, and average flow of water selected from the average annual flow at the intake points of the Maipo river. The BOD value in 1998 is an average value of the water analysis made in this study.

Point of prediction	River flow (m^3/seg)		BOD in 1998 (mg/l)	BOD in 2010 (mg/l)
Intake of Canal Mallarauco at Mapocho River	Qmax	35	64	44
	Qmin	16	64	20
	Qave	25	64	35
Up Maipo River joining Mapocho River	Qmax	96	14	12
	Qmin	29	14	12
	Qave	63	14	12
Intake at Maipo River	Qmax	131	38	20
	Qmin	45	38	15
	Qave	88	38	19

According to the table above, the BOD value at the intake points for Popeta-Yali-Alhue will be 20 mg/l or less in 2010, that results in the water quality improvement. Moreover, because number of fecal coriform group of treated water is determined to be satisfied with the national standard, less than 1000MPN, it is expected to be improved through dilution effect as well as BOD.

(14) Problems and approach of development in the objective area

Examining the present situation of agriculture in Popeta area, existence of large number of small scale farmers who are not blessed with the favor of the farming infrastructure, and proceeding of agricultural development by a form of enterprise using groundwater are risen as typical problems of the area. The measures to solve them and to promote a well-balanced rural development are recognized improvement of farming condition of the small-scale farmers through agricultural development, which utilizes water and land resources in the area. The contents of development plan should be proposed are not only improvement of production and living infrastructure but also farming support should be a core through using improved productionmeasures. On the other hand, for large and medium scale farmers who hold land in the projected area, implementation of the new irrigation system is to alleviate dependency on groundwater for development. Thus, it contributes to conservation of groundwater, which is reaching its limit.

1.2 Agricultural Development Plan

(1) Basic concept

Agricultural development plan for approximately 5,000ha of Popeta Area described in the Master Plan consists of agricultural infrastructure improvement establishing a new irrigation system with Yali and Alhué areas. The projected areas cover about 21,000ha totally and utilize the unused water right of the Maipo river. The project also consists of agricultural production plan including the support system and rural infrastructure improvement plan.

New agricultural development in Popeta area by installation of irrigation facilities aims at agricultural promotion by replenishment of water supply to the agricultural area located in the southwestern part of the Metropolitan Region. The development in the area should be made along with the agricultural policy of "Strategic Agenda" by Ministry of Agriculture. The policy aims at installation of infrastructure on agricultural production by improvement of irrigation facilities, and development contents to contribute for the supporting and strengthening of small and medium scale farmers. Regarding the facilities relevant to new irrigation, structural composition is planned to possible the smooth management of water use in the upstream reach of the third section of the Maipo river and stable supply of irrigation water to the downstream reach of the existing irrigation system. Through them, it is planned to contribute to future water management of the Maipo river basin as a whole from the structural aspect.

(2) Agricultural production plan

The present crop cultivation reflects the conditions of agricultural production in the objective area such as landholding scale, ability for investment, farming technology, opportunities of non-agricultural activities and labor forces. On the other hand, changes of farming environment by introduction of irrigation develop the present cultivation system more intensive in the objective area.

The prospect mentioned above is realistic for two kinds, medium and large scale, of farmers, while expanding landholding scale is unrealistic for small scale farmers. Therefore, cultivation crops which is highly realistic and includes farming support are selected for the cultivation system of small scale farmers proposed by introduction of irrigation. On the selection of cultivation crops, prospects on respective crops are as follows.

Fruit tree growing	Recently, cultivation of stone fruits (peaches, nectarines, plums and apricots) and avocados has been started in the enterprise scale.
Grape vines	Private investment for grape vines has started. A distinguish vineyard made a contract with small scale farmers. This contract tends to expand in the future.
Vegetables	A medium scale agricultural development plan by private sector which includes vegetable cultivation is planned. The cultivation area tends to expand in the area.
Seed production	F1 hybrid seeds of maize, sunflower, and vegetables are produced.
Forage crops	Alfalfa shares 22% of crop cultivation in Melipilla Province. Most of them is sold to out of the Region after drying. Forage crops are highly profitable and important components of crop rotation.
Traditional crops	The Objective area is close to the Santiago among the potato production areas and very popular in rural markets.
Flowers and green house products	They become more important crops in future because the location of the objective area is close to Santiago and the seaside resorts.

Based on the considerations above, crop cultivation plans are formulated for four farming types classified according to landholding scale in the objective area. In the plans, the basic crops are intensive cultivation crops. Cereals and forage crops are added to them from the point of profitability, self-consumption, and crop rotation. Number of farmers in each landholding scale is as follow.

Average landholding area	5ha	15 ha	40ha	200ha
No. of farmers	132	40	54	8

Cropping pattern by land holding scale is as follows;

Small scale farmers(Average land holding area; 5ha)

Crop	Cultivation area (ha)		Share of cultivation (%)	
Cereals	0.65		13.0	
Wheat		0.65		13.0
Chacras	0.50		10.0	
Potato		0.50		10.0
Vegetables	0.80		16.0	
Pumpkin		0.20		4.0
Onion		0.20		4.0
Water melon		0.20		4.0
Kidney beans		0.20		4.0
Forage crops	0.70		14.0	
Alfalfa		0.70		14.0
Fruit trees	1.00		20.0	
Avocado		1.00		20.0
Sub-total	3.65		73.0	
Others	1.35		27.0	
Total	5.00		100.0	

Small scale farmers(Average land holding area; 15ha)

Crop	Cultivation area (ha)		Share of cultivation (%)	
Cereals	1.3		9.00	
Maize		1.3		9.00
Vegetables	1.0		6.66	
Pumpkin		0.2		1.33
Onion		0.3		2.00
Water melon		0.2		1.33
Kidney beans		0.3		2.00
Forage crops	1.5		10.00	
Alfalfa		1.5		10.00
Fruit trees	4.0		26.60	
Avocado		4.0		26.60
Grape vines		3.0		20.00
Seed production	0.5		3.32	
Vegetable seeds		0.5		3.32
Sub-total	11.3		75.3	
Others	3.7		24.7	
Total	15.0		100.00	

Medium scale farmers (Average landholding area; 40ha)

Crop	Cultivation area (ha)		Share of cultivation (%)	
Cereals	5.0		12.50	
Wheat		1.6		4.00
Maize		3.4		8.50
Vegetable	1.6		4.00	
Pumpkin		1.6		4.00
Flowers	1.2		3.00	
Forage	6.0		15.0	
Alfalfa		6.0		15.0
Fruit trees	14.4		36.00	
Avocado		4.0		10.00
Grape		3.2		4.00
Peach		5.6		14.00
Yellow peach		1.6		4.00
Grape vines	5.0		12.50	
Seed production	3.2		8.00	
Seed of vegetables		0.8		2.00
Seed of maize		2.4		6.00
Sub-total	36.4		91.00	
Others	3.6		9.00	
Total	40		100.00	

Large scale farmers (Average landholding area; 200ha)

Crop	Cultivation area (ha)		Share of cultivation (%)	
Cereals	27		13.50	
Wheat		27		13.50
Vegetable	23		11.50	
Melon		12		6.00
Kidney beans		11		5.50
Forage	20		10.00	
Alfalfa		20		10.00
Fruit trees	72		36.00	
Avocado		20		10.00
Grape		32		16.00
Peach		20		10.00
Grape vines		24		12.00
Seed production	12		6.00	
Seed of maize		12		6.00
Sub-total	178		89.00	
Others	22		11.00	
Total	200		100.00	

Gross income by farming scale is presented below.

Small scale producers	(Average farming area 5ha)	$	3,072,500
Small scale producers	(Average farming area 15ha)	$	10,830,000
Medium scale producers	(Average farming area 40ha)	$	42,060,000
Large scale producers	(Average farming area 200ha)	$	184,150,000

(3) Farmers' organization / Agricultural support plan

Organizations of beneficiaries which are recipients of the project required to be improved in the objective area for proceeding to implement projects, and utilization and promotion of effective use of improved facilities. Basically, following two systems are to be established in the plan.

- Organization for installation of major irrigation facilities

Acquisition of the new water right, construction of integrated diversion weirs and new irrigation canals are planned in the Popeta area. In the third section of the Maipo river, nine canal associations are established at present. Therefore, Association of United Canals (Asoc. UCM3: Asoc. Unidad Cnalista Maipo 3ra Sección) which established by existing canal associations and canal association relevant to new irrigation canals (Canal PYA: Canal Popeta-Yali-Alhué) is required to be established for construction of an integrated diversion weir. Asoc. Canalista PYA is established with new irrigation canals. This is the organization for proceeding to implement the projects such as distribution of the new water right. Based on the Irrigation Promotion Law, financial support for the main facility is to be received from MOP-DOH. Asoc. UCM3 is to be the recipients of financial support service as the organization of beneficiaries.

Area	Related Project	New Organization	Implementation Body
Popeta	New Integrated Diversion Weir	Asoc. UCM3	Asoc. UCM3
	New Irrigation Main Canal	Asoc. PYA Canal association	Asoc. PYA Canal association
	Intake & Distribution of New Water right	Asoc. PYA Canal association	Asoc. PYA Canal association

- Organization for effective use of irrigation facilities

Regarding financial support required for construction of branch canals, the subsidy systems of the Irrigation Promotion Law (The Law No. 18450) and INDAP will be utilized. A recipient organization of the Project is formulated by organizing canal association of terminal beneficiaries. A part of work, which can be handled by existing canal associations and irrigation organizations, is coped with by expanding the function of the association. When a new canal association or a new irrigation organization is required to be established, an organization is established by the support of OMPC organized in Cumuna.

Regarding technical and financial supports against producers' groups for management of irrigation water at field level and for improving farming, INDAP service systems are to be utilized. An advisor is to be employed to promote grouping producers through arrangement of OMPC. On the promotion of the project implementation by INDAP, SAL, SAP, or SAE is to be utilized according to the level of organization.

The base facility for rural activation, Communication Center for *Unidad Vecinal* (CECUV: *Centro de Communicación para Unidad Vecinal*) is constructed to activate *Unidad Vecinal*, and promote communication among inhabitants in the area and the support activities for farmers in each *Unidad Vecinal*. Among agricultural support activities of CECUV, promotion of uniting, extension and technological guidance are undertaken by advisors organized by OMPC through cooperation with external support organizations (INIA, universities, private consultants and NGOs). Seven CECUVs are to be constructed in the area.

(4) Agricultural infrastructure improvement

A new irrigation development area is a part of "Popeta-Yali-Alhué development plan" by unused water right ($25m^3$/sec) of the Maipo river. The diversion weir and the main canal are planned to use commonly considering a water source and the location of the irrigation area. Accordingly, feasibility study will cover two development aspects, one is a development plan in the objective area (Popeta), and the other is the development plan in Yali and Alhué areas such as determination of irrigation area and its water requirement, design of the main and secondary canals.

In the newly irrigated farmland of Popeta-Yali-Alhué, existing farmland irrigated by groundwater is excluded from the project. The farmland of 21,000ha which includes a part of irrigated farmland by pumping (2,232ha) in Yali and Alhué areas shown in the table below is the objective areas of the project.

Area			Gross Irrigation Area (ha)	Net Irrigation Area (ha)	Remark groundwater irrigation Area (ha)
1	Popeta	Carmen	540	486	60
		Choluqui	535	481	420
		Popeta	4,454	4,008	544
		Sub-Total	5,529	4,975	1,024
2	Yali		10,905	9,815	1,850
3	Alhue		6,993	6,294	758
		Total	23,427	21,084	3,632

On construction of the intake weir in new irrigation areas, existing intake structures are integrated to simplify management of water use in the third section of the Maipo river. Four sites in the left bank and two sites in the right bank of existing intake structures are integrated. Intake amount is $45m^3$/sec and $12.8m^3$/sec in the left and right banks, respectively.

Total length of the proposed main canal is 56.2 km and design with open channel under gravity flow. Diversion of water from the new canals is planned for the existing irrigated areas where diversion of water is possible at the points which new canals pass through. Regarding canal routes, nine sites where the canals need to detour peninsular ridges, about 20km are planned to penetrate the mountains by tunnels. The generation of electricity at 3,200kw is also planned in four sites where surplus cascade can be obtained. Moreover, regulation reservoirs are planned at 10 sites where can be dammed up by banking, geographically. Dam height of these reservoirs is considered about 10m. Through this, effective use of water resource is aimed by impounding redundant water during non-irrigation period.

(5) Rural infrastructure improvement plan

Rural infrastructure development plan promotes from the point of settlement in the rural area through agricultural promotion, soundness and safety of inhabitants in the area. Accordingly, infrastructure whose installation is behind; connecting roads (14 routes, 66.1km), water supply facilities (2 sites), rural sewage treatment facilities (8 sites), and meeting facilities (7 sites), is planned to be improved based on the analysis of the present situation.

(6) Environmental conservation plan

According to the construction plan of the sewage treatment plant in Santiago by EMOS, three plants will be completed along the Mapocho river in 2024 and then the treated water of approximately $25m^3$/sec will be discharged into the Mapocho river. Consequently, water quality of the Maipo river joining the Mapocho River will be greatly ameliorated. Based on the predicted results of water quality at target year of 2010, water quality at the intake point of Popeta-Yali-Alhué irrigation system will be achieved less than 20mg/l in BOD according to the stage-wised completion of the treatment plant of EMOS.

Unidad Vecinal, the smallest unit of the organizations for administrative support in *Comuna*, has a role of promoting to abide the hygiene regulation, of carrying out the activities for the environmental hygiene, pushing on the environmental conservation, and keeping the balance of ecosystem. In this project, it is planned that a campaign for enlightenment on the-village-basis with respect to the environmental conservation to maintain high quality of water. The promotion campaign of environmental education is also planned by recommending to have a qualification to be engaged in the environmental conservation among the youth group of *Unidad Vecinal* or other groups, and farmers' groups.

In order to prevent environmental pollution by expansion of utilization on pesticide and fertilizer and to promote sustainable agriculture, skill guidance and technology transfer to farmers concerning the reduction of using pesticide and fertilizer are executed by the public institutions such as INIA. These activities are carried out on the farmers' organizations formed to receive the agricultural support services from INDAP.

EIA System in Chile provides the object to be assessed from the environmental view. Related items between the EIA System and the development plan of Popeta area including Yali and Alhué are: "projects giving a great influence on waterworks, dams, drainage, and natural water system"; and "works or activities in the natural parks designated officially." The Chile side conducts environmental assessment with regard to the EIA System when the execution of the project is determined definitely.

1.3 Project Cost

The construction period of the project is to be 7 years including detailed design, preparation of contract and tender documents, tendering procedure, and construction works. The project cost is estimated at the price level as of December, 1998 based on the results of field survey on costs of labor, construction materials and equipment. Construction works are executed by constructors under contract. Summary of the project cost is presented in the table below.

Unit: Thousand Pesos.

	Component	F.C	L.C	Total
1	Preparation cost	1,376,694	1,882,527	3,259,221
2	Construction cost			
	Agricultural production infrastructure development	26,572,601	35,803,362	62,375,963
	Rural infrastructure development	961,281	1,847,184	2,808,465
3	Land acquisition and compensation cost	-	40,894	40,894
4	Engineering and administration cost	2,716,686	4,479,185	7,195,871
5	Physical contingency	3,162,262	4,405,315	7,568,041
	Total	34,789,988	48,458,467	83,248,455

Total project cost on agricultural development project in Popeta area is estimated at 83,200 million pesos.

The integrated diversion weir which is constructed in the Maipo river, and the main irrigation canals from the integrated diversion weir to the objective area, are proposed in the structural plan. Capacity of these facilities is added the capacity of the integrated diversion weir which integrated six existing diversion weirs and irrigation water of the main canals which cover three existing irrigated areas and Yali, Alhué areas. Therefore, construction cost has to be allocated in order to estimate the individual economic evaluation on the objective area. Construction cost of the integrated diversion weir and the main canals is allocated by ratio of water right. The allotments are shown in the table below.

Cost allocation of integrated diversion weir			Cost allocation of main canals					
Related canals	Intake volume (m^3/sec)	Allotment	Related canals	Discharge (m^3/sec)	Related length (km)	Ratio of discharge	Ratio of length	Allotment
1 Puange	3.6	0.062	1 Carmen Alto	6.52	5.6	0.181	0.022	0.019
2 Picao	9.2	0.159	2 Cholqui	1.4	20.6	0.039	0.081	0.015
3 Carmen Alto	8	0.138	3 Culiprán	3.2	20.6	0.089	0.081	0.035
4 Cholqui	2	0.035	4 Popeta	5.9	59	0.163	0.231	0.183
5 Chocalán	5	0.080	5 Yali	11.64	73	0.322	0.285	0.446
6 Culiprán	5	0.087	6 Alhué	7.46	77	0.207	0.301	0.302
7 Popeta	5.9	0.102	Total	36.12	255.8	1.000	1.000	1.000
8 Yali	11.64	0.201						
9 Alhué	7.46	0.129						
Total	57.8	1.000						

1.4 Project Implementation Schedule

Agricultural development project in the objective area (irrigation project) is evaluated by CNR, and its implementation is approved by *Consejo de Riego*. Approved projects are classified into direct controlled projects of DOH (MOP) as a national project and irrigation encourage projects of CNR by the project scale (construction cost). According to the project scale, the executive bodies of the project are classified as follows;

Classification of Project	Implementation agency	Project scale	Component of project
Government ordinance No. 1123	DOH	More than 24,000 UF	Diversion weir, main canals, secondary canals
Law No. 18450	PROMM CNR	Less than 24,000 UF (*Comuna*: irrigation association) Less than 12,000 UF (private)	Tertiary canal to farm ditches

The project will be implemented by following governmental subsidy systems based on Government ordinance No. 1123 and Law No. 18450.

Laws	Ration of subsidy	Burden of beneficial farmer	Remarks
Government ordinance No. 1123	Maximum 70%	The rest	Ratio of subsidy is changed by the project components and the project scale. Low interest rate credit UF+4.5%, long term loan
Law No. 18450	Maximum 75%	The rest	Applicant applies advantageous rate for the proposal.

The irrigation facilities that are transferred from DOH after completion of the construction works are operated and maintained by beneficiaries in Culiprán-Popeta irrigation area and canal associations concerned which use the integrated diversion weir commonly. Each facility is managed by a canal association which use the facility. Especially, in the new irrigation areas in Popeta, canal association should be established. The canal association operate and maintain common irrigation facilities and own facilities, and manage water. The newly established canal associations; the integrated water management association which manages the integrated diversion weir and main canals, and the regional canal association which operates and maintains canals after the secondary canals by regional unit. Annual O&M cost is estimated at $54.4 million and $25.9 million at the integrated water management association and the regional canal association, respectively.

1.5 Development Impact and Evaluation

Evaluation of the project is made by internal rate of return of the project. The benefits are estimated by increase of agricultural production and power generation. The costs are used by allocated cost to Popeta area according to the results of the project cost estimation.

Economic net present value of the entire project and economic internal rate of return (EIRR) are estimated at $9,231.3 million and 21.1%, respectively at 12% of discount rate. Implementation of the project is expected to bring about following socio-economic impacts beside direct benefits estimated by economic evaluation.

Creation of the solidarity among inhabitants
Stable supply and diversification of agricultural products
Establishment of systematic water use
Promotion of organizing farmers
Increase of job opportunity
Increase of intention for working
Activation of socio-economic activities
Development of regional economy
Impact on the environment

Accordingly, implementation of this project is justified.

1.6 Conclusion and recommendation

(1) The project implementation benefits directly to the farmers in the project area. Especially, economic balance of the small scale farmers is improved drastically. In addition, as the proposed integrated diversion weirs of the Maipo river includes intake structures of existing irrigation systems, the project implementation contributes to establishing the system to adjust of water utilization among the users in the third section of the Maipo river. Therefore, it is recommended that the government of Chile would prepare to implement the project early based on the results of the F/S.

(2) Because Government ordinance No.1123 applies to the project, close cooperation between CNR and DOH is necessary at every stage such as adoption of the project, approval of the project, and implementation of the project. Therefore, establishment of the project promotion committee consisting of CNR and DOH is recommended.

(3) The beneficiaries of the project in new irrigation areas need to establish the project promotion organization as the local recipient organization under the guidance of OMPC. It is necessary to establish new canal associations relevant to new irrigation and the integrated diversion weir canal association which consists of existing and new canal associations relevant to the integrated diversion weir. Establishment of these new canal associations is carried out by the project promotion organization. Accordingly, it is recommended to start discussion early among the project promotion committee, *Comuna* and relevant *Unidad Vecinal* which will be a core body of the project promotion organizations.

2 Agricultural Development Plan in Mallarauco Area

2.1 The Present Situation of the Objective Area

(1) Society

Mallarauco area which belongs to *Comuna* Melipilla consists of 4 *Unidad Vecinal*. According to the Census '92, population of the objective area is 8,145 persons.

Unidad Vecinal forms administrative districts and regional society as an unity of *Junta de Vecino* which is the minimum unit of regional society. Communities in the area are extended into both sides of main roads, and shape so-called "row community." In case of row community, it is difficult to form the center of a community. The place where public facilities such as churches and schools are located is the center of a community at present.

(2) Geology

Mallarauco area consists of a plain where old riverbed deposit and terrace deposit of Quaternary age cover the valley formed by impervious base rock. However, the surface layer is a tableland composed by Alluvial pumice volcanic ash. The rivers flow and erode the tableland at present. Diluvium aquifers is overlain by the volcanic ash deposit, and development of alluvial deposit along the existing river is poor.

(3) Climate

The objective area categorizes in the Mediterranean climate, The division of winter and summer seasons is clear. While most of annual rainfall is concentrated in winter season, dry and fair weather continues in summer season. General climatic condition is as follows.

Annual rainfall	400 mm	Annual average temperature	14.8℃
Annual average maximum temperature	28.0℃	Annual minimum temperature	3.3℃
Annual average relative humidity	69.7%	Annual average wind velocity	1003.6km/month
Annual average sunshine hours per day	6.9 hr	Annual average evaporation	1,212 mm

(4) Soil and land use

According to agricultural landholding survey (REA : *Rol Extracto Agrícola*) in 1995, land use of the objective area is presented in the table below.

Unit: ha

Area	UV		Total area	Farmland	Others
Mallarauco	UV1	Bollenar	2,369.9	1,777.4	592.5
	UV2	Mallarauquito	2,952.6	1,535.4	1,417.2
	UV3	Pahuilma	5,379.4	1,882.8	3,496.7
	UV4	Mallarauco	9,622.4	4,041.4	5,581.0
		Total	20,324.4	9,237.0	11,087.4

For soil and land classification of the objective area, the data of REA and the orthophoto which obtained from CIREN are used. Land productivity classification of the area is summarized as follows.

	Land productivity classification	Area by REA (ha)
I	(No limitation for cultivation)	0.0
II	(A little limitation)	134.2
III	(Necessary to select crops)	593.3
IV	(Serious limitation for cultivation)	315.0
V	(Difficult for farmland)	0.0
VI	(Impossible excluding pasture land)	0.0
VII	(Impossible for farmland)	0.0
VIII	(Impossible for whole land use)	0.0
	Total	1,042.5

(5) Water resource

Irrigation water for the farming plot in the Mallarauco area is conducted through the Canal Mallarauco. Water rights in the Mallarauco irrigation system are settled on 920 *Accións* at intake point. Available irrigation water of 1 *Acción* varies from 4.5 lit./s to 8.0 lit./s. Based on the maximum available irrigation water of 8.0 lit./s and water right, total water requirement amount at headrace of canal is 7.36 m^3/s. Water requirement amount for peak demand period of irrigation can be assured in comparison with the actual intake water amount.

According to the well registration of DGA, 2 wells for agriculture are registered. The irrigation area by using groundwater is estimated 60 ha from the average irrigation area (30 ha/well). Both confined and free groundwater in Mallarauco basin show a tendency to lower the water level.

(6) Agriculture

The results of classification of farmers in the objective area by farming scale is presented in the table below.

Farming Size (ha)	No. of Farmers	Holding Area (ha)	Irrigation Area (ha)	Average Farming Area (ha)	Average Irrigation Area (ha)	Non-Irrigation Area (ha)
0.1 – 15	84	782.9	782.9	9.3	9.3	0
15.1 – 100	7	166.9	104.4	23.8	14.9	62.9
Over 100.1	3	791.1	155.2	263.8	50.9	638.3
Total	94	1740.9	1,042.5			701.2

Average scale of farmers' landholding in the project area is 9.4ha for small scale farmers and 25.3ha for large and medium scale farmers. Among beneficiaries of the project, 89% of the beneficiaries is small scale farmers and 11% of them is a large and medium scale farmers. The beneficiaries who hold land outside of the beneficial area for water quality improvement are only large and medium scale farmers. Most of their land is unirrigated area.

Small scale farmers in Mallarauco area have very wide farming experience and agricultural technology, compared with small scale farmers in the other areas. When export melons were produced in the area in the past, small scale farmers also cultivated them. Small scale farmers started to engage in milk production after quitting melon cultivation by the virus infection and the regulation on vegetable cultivation by contaminated irrigation water. Some of them produce quite high quality milk. Because the milk price decreased, small farmers had to quit milk production. Farming alternative for them is fruits growing but most of them cannot invest enough and remain small scale and low productivity farming.

Present cultivation crops in the objective area are as follows.

Crop	Grains			Vegetable *	Forage	Fruit Trees			Sub total	Forage &	Total
	Maize	Wheat	Total		Crops	Avocado	Lemon	Total		Others	
Area (ha)	164.7	22	186.7	99.1	225.2	31.3	20.9	52.2	563.2	479.8	1043
%	15.8	2.1	17.9	9.5	21.6	3.0	2.0	5.0	54.0	46.0	100

Note * : Basically indicate Pumpkin, Melon, Watermelon, zucchini and potato

Cultivation crops by farming scale are shown in the table below.

Crops	Grain Crops			Vegetables			Forage Crops	Fruits Trees			Sub total	Pasture & Others	Total
	Wheat	Maize	Sub total	Pumpkin	Watermelon	Sub total	Alfalfa	Avocado	Lemon	Sub total			
Small scale (9.4 ha)	0.28	1.2	1.48	0.4	0.41	0.81	1.83	0.06	0.12	0.18	4.3	5.1	9.4
(%)	2.7	13.0	15.7	4.2	4.4	8.6	19.5	0.67	1.16	1.9	45.7	54.3	100.0
Total Area (ha)	22	102.4	124.4	33.6	34.5	68.1	154.2	5.3	9.2	14.5	361.2	428.8	790.0

Crops	Grain Crops	Vegetables	Forage Crops	Fruits Trees			Subtotal	Pasture & Others	Total
	Maize	Melons	Alfalfa	Avocado	Lemon	Subtotal			
Large / Medium Scale (25.3ha)	6.2	3.1	7.1	2.6	1.2	3.8	20.2	5.1	25.3
(%)	24.5	12.3	28.1	10.3	4.6	14.9	79.8	20.2	100.0
Total Area (ha)	62.3	31.0	71.0	26.0	11.7	37.7	202.0	51.0	253.0

The table below shows agro-processing factories operating near the objective area, María Pinto and Peñaflo. Melipilla, Talagante and Culacaví are located within 10km, 30km and 25 km from the objective area, respectively. Buin, Paine, Linderos and Santiago are located within 60 km from the objective area. Accordingly, it is possible for the objective area to access easily all kinds of agro-processing facilities.

Type of Processing Facilities	No. of Facilities	Capacity
Nuts Processing Facility	1	45,000 kg/ day
Fruits Dehydration Facility	2	10,000 kg/day
Raw Milk Processing	3	N/A
Vegetable Freezing Facility	5	29,500 m^3
Packing Facility	16	135,500 kg/ day
Sterilizing Facility	3	31,000 kg/ day

(7) Agricultural support and farmers' organization

All of agricultural support services in the study area are provided through INDAP-Melipilla. As farmers' organizations in the objective Area, there are three types of organizations; canal association, milk collecting cooperative and citrus group.

As water users' association, there is only one, Mallarauco canal association. This association distributes irrigation water fairly, and maintains canals in the area as a whole. The association can utilize INDAP service systems for improvement and construction of facilities, and also applies for and materializes the project.

Milk collecting cooperative and citrus group are producers' organizations and both of them are organized by INDAP services. The milk collecting cooperative is managed by 15 dairy farms. Its base is a milk collection center, which equipped with a fixed temperature storage by INDAP services. Based on the centers, the cooperative controls animal raising, feed and milking of each farm. Citrus group (Groupo Citricola) is organized by 17 small scale farmers through utilizing SAL program of INDAP. The group intends to increase productivity and control quality of lemons and oranges. This results in establishment of the productions' status in a market and maintenance of quality.

Although there are a few producers' organizations in the area as mentioned above, they have been achieved steadily the results and contribute largely to improvement of small scale farmers' status and stability of regional society. The ratio of forming organization is still very low. The constraints on organizing small scale farmers are vigorous feeling for self-independence of themselves and mutual distrusts among them. On the other hand, there are lack of public relation on the support system, of basic motivation to form organizations. There is also lack of support organizations for implementing them.

(8) Agricultural marketing

Marketing of farm products in the objective area is divided into two; (a) individual, in which the producer sells his/her products to an intermediary without a contract, generally obtaining low prices, and (b) group marketing, or through a trade association of the producers themselves, which not only improves marketing by replacing intermediaries, but permits access to credit and technical assistance. The marketing channels of small producers are intermediaries, direct sale from producers to consumers, a market of agricultural products, and contract production, generally involving agro-industry or packing plants. Small collective milk marketing centers in the objective area include Codigua, Culiprán, Popeta, Puerta and Colorada.

(9) Farm income

Results from the questionnaire survey on economic balance of farm households in the objective area is shown in the table below.

	Small scale farmer				Medium scale farmer			
Item	Area (ha)	Income ($)	Expenses ($)	Result ($)	Area (ha)	Income ($)	Expenses ($)	Result ($)
Farm Area	8.14				18.5			
Used Area	4.39				17.0			
Gross Farm Income		3,164,032				12,133,456		
General Expenses			412,458				1,003,200	
Net Farm Income				2,751,574				11,130,256
Family Labor		75,000						
Off-farm Income		156,000						
Family Expenses			988,625				760,000	
Household Income				1,993,949				10,370,256

The economic results presented above indicate that the small farm is in a difficult situation, requiring off-farm income to make the farm viable.

(10) Agricultural infrastructure

Mallarauco area extends over 7,000ha of farmland and is irrigated by contaminated rive flow of the Mapocho river by urban sewerage. The irrigation water is divided into seven irrigation systems (irrigation areas) in *Comuna* Mallarauco. The details on number of water rights (*Acción*) and users (*Acciónistas*) are as follows.

Irrigation System	User	Water-Right	Discharge (m^3/sec)
1. Pervin	35	140.000	1.120 – 0.630
2. Norte	53	261.160	2.089 – 1.175
3. Sur	91	167.924	1.343 – 0.755
4. Higuerillas	95	193.890	1.551 – 0.872
5. Santa Ana	60	98.916	0.791 – 0.445
6. Italiano	61	107.364	0.858 – 0.483
7. Reforma	78	76.971	0.615 – 0.346
8. Retamo	21	8.000	0.064 – 0.036
Total	494	1,054.225	8.433 – 4.744

Note: Discharge is calculated from water right's discharge (1 *Acción*: 8~4.5 l/sec/ water right)

Although number of water right at the intake points is 920 in the area as a whole, there is also *Acción* at the water source which uses return flow in the downstream basin. Sum of them is 1,054.225. Intake water volume is varied by season, the volume per *Acción* is changed between 8.0 and 4.5lit./sec and distributed. Irrigation method in the area is mostly furrow irrigation in the flat land including orchard. A drip irrigation method by pumping up is applied in the orchard of the sloped land.

The mountains locate in the north and the south of the Mallarauco area and the Higuerillas river flows from the east to the west in the low flat of the center in the area. This river plays a role of a drain that collects rain and excess water of irrigation. However, the flow of river is dammed up at the downstream reach and utilized for irrigation. The river has a function as both irrigation and drainage canals.

Irrigation water of Mallarauco area is taken from the Mapocho river. Water of the Mapocho river is already contaminated by the urban sewage at the intake point of the Mallarauco canal. Thus, the farmers must use contaminated water as irrigation water in the entire area. Accordingly, the problem of contaminated irrigation water is not solved in the area, otherwise sewage is treated in the Santiago city.

Mallarauco canal association manages irrigation facilities from intake facilities to the secondary canals. Maintenance cost is paid according to number of water right (*Acción*) by a holder. The holders of water right are 494 and the maintenance cost per *Acción* is $63,000 annually. Main work of maintenance is canal repair, and the repair schedule is prepared every year. The management cost of the main canal is paid by users of the entire area. After the secondary, the management cost is paid by users concerned. The burden of canal repair cost is large in the canal system which passes through the slope of mountains. Mallarauco canal association manages water and distributes *Acción* flow fairly at each diversion point according to intake water amount.

(11) Rural infrastructure

The present situation of basic infrastructure in the objective area is shown in the table below.

Unit: %

Area		*UV*	Electricity	Water Supply	Sewage System
Mallarauco	UV1	Bollenar	84.9	89.6	10.9
	UV2	Mallarauquito	87.2	90.0	9.2
	UV3	Pahuilma	85.8	90.4	26.7
	UV4	Mallarauco	78.5	82.5	14.4
	Total		83.3	87.6	15.4

On the basic infrastructure in the objective area, installation of electricity and water supply is almost completed. Electricity is supplied by the electric supply company and will be supplied to all households, soon. All drinking water is taken from groundwater. The water supply system is renewing in the entire area by the support of EMOS at present. All households will be able to obtain tap water by the water supply system. Accordingly, installation of electricity and water supply does not have problems at all. On the other hand, installation of sewage systems has almost not proceeded, and there are no sewerage treatment facilities even in the communities where water supply facilities have already installed. Excreta is treated in the septic tank of individual houses and domestic sewage is directly discharged into drain canals. Therefore, contamination of agricultural water and river flows by domestic sewage is getting noticeable in some places. Mallarauco area extends into the valley and the structure of communities is relatively gathered. Therefore, there are a few constraints on installation of a rural sewage system. It is necessary to promote installation of a rural sewerage system from the aspect of living and production environmental conservation for inhabitants.

(12) Environment

There is no designated area, such as natural park, in Mallarauco. The results of water quality analysis for irrigation around intake structures are presented in the table below.

Date		7/22	8/11	12/8	12/11	Chilean standard	Chilean standard	Standard for
Item	Unit	St.20	St.20	St.20	C11	for Irrigation	for Recreation	growing specified
pH	-	7.4	7.1	7.7	7.4	5.5-9.0	6.5-8.3	
BOD	mg/l	96.0	59.0	38.0	110.0			
No. of Coliform Group	mg/l	9.2E+06	1.1E+08	1.7E+05	9.2E+08			
No. of Fecal Coliform Group	mg/l	1.7E+06	2.4E+07	3.5E+03	1.1E+07		1000	1000
Cu^{2+}	mg/l	0.003	0.044	0.020	0.069	0.20		
SO_4^{2-}	mg/l	405.0	381.0	324.0	326.0	250.00		
Cl^-	mg/l	257.0	275.1	204.4	224.2	200		

St.20:Rio Mapocho en Canal Mallarauco C11:Canal Mallarauco(en salida del tunel)

Compared to the standard value shown in the table above, both points in all seasons meet the standard requirement of water for agricultural use as to pH and Cu^{2+}, while both points in all seasons exceed the standard as to $SO4^{2-}$ and Cl^-. Concerning fecal coliform, both points in all seasons exceed the standard value of water for recreation use and water for growing the specified vegetables. Accordingly, water contamination in the area is a serious problem.

(13) Problems and development approach in the objective area

Examining the present situation of Mallarauco area, the problems of the area are summarized as contamination of irrigation water, decrepit irrigation facilities, and unstable farming base of small scale farmers. Based on the present problems in Mallarauco area, the measurements to solve these problems and to enjoy its advantage as a food supply base near the metropolitan area are recognized that improvement of production and living environment by improving quality of irrigation water, decrease of O & M cost and alleviation of water shortage at the terminal point by rehabilitation of the existing irrigation facilities. Crop diversification which is resulted from water quality improvement brings about stabilization of farming base by more intensive agriculture and at the same time, the quality improvement of water contributes largely to maintaining favorable health and sanitary condition of farmers.

2.2 Agricultural Development Plan

(1) Basic concept

Mallarauco area was formed by the Higuera river which is a branch of the Puangue river and flows in Melipilla Province. Irrigation water in the area is taken from the Mapocho river after the Zanjon de la Aguada canal, which sewage of Santiago city is concentrated in the Talagante province, joined the Mapocho river. Contamination level of irrigation water taken from the Mapocho river shows extremely high, over 10^5MPN/100ml of coliform groups. However, water of the Mapocho river contaminated by urban wastes must be used continuously as irrigation water under the present situation of Mallarauco area where is no alternative water sources in and out of the area.

Contamination of water quality is to be reduced by step-by-step improvement of sewage treatment plants of EMOS, gradually. Nevertheless, it will take about 25 years until good irrigation water can be taken from the rivers by completing the plants.

Positive measures for water quality improvement from agricultural sector are required to establish sound agricultural production environment and recover the function as the base of perishable food supply which utilizes the characteristics of suburban agricultural area. These measures will also contribute to establishment of agricultural production environment which satisfies the demand of markets and achievement of sound health and sanitary environment for farmers who engage in agricultural production. On the other hand, irrigation facilities in Mallarauco are well managed by canal associations, however the majority of facilities was constructed in 1800s. They have been repaired, repeatedly and used until now. The decrepit facilities has increased the maintenance cost and work. It is time to rehabilitate the entire irrigation system.

The plan for water quality improvement and rehabilitation of the existing irrigation facilities intends to have applicable contents to the other areas as a model project on improvement of deteriorated agriculture environment which metropolitan agriculture is facing at present.

(2) Improvement area of irrigation water quality

Improvement area of irrigation water quality that F/S is to be implemented is selected according to the following standards which focus on appearing improvement effect, considering characteristics of water quality improvement project as a model.

1) Areas are independent on their irrigation and drainage systems
2) Easy diversification of crops by water quality improvement
3) Large number of beneficiaries including small scale farmers

According to the standards mentioned above, three of five areas where are independent on their irrigation and drainage systems are selected because those three areas satisfies the other standards.

Area	Irrigation Area	Area (ha)	No. of Farm household				Crop
			Large Scale	Medium Scale	Small Scale	Total	
Los Carrera	Sur	196	-	-	24	24	Annual
Reforma	Reforma	716	-	3	35	38	Annual
Santa Ana	Mansano	531	3	4	25	32	Annual

(3) Agricultural production plan

Main purpose of water quality improvement plan in the objective area is that producers, especially small scale producers can gain higher income from their farming through making intensive cropping system and crop diversification possible. The second important point in the plan is influence derived from the construction of sewage treatment plants. That is to say, as a result of sewage treatment plants' construction, introduction of technical irrigation systems such as drip irrigation and sprinkler irrigation can realize because water distribution is made by pressure conveyance method using pump facilities. Crop diversification, in reality, boosts vegetable cultivation of prohibited kinds by using contaminated water mainly from the Mapocho river. Introduction of mechanized irrigation system is predominantly reflected in increase of orchards. This result enables small scale farmers to introduce high level intensive cultivation and highly profitable crops (vegetables which are prohibited to grow at present) as well as medium and large scale producers.

Considering distribution of water improvement areas and the purpose of the plan, expected effects of the plan must be important for small scale farmers, and proposed crop cultivation mainly focuses on expansion and diversification of vegetable cultivation. This is because vegetable would be the most profitable crop for small scale producers if water quality improvement is possible. Fruit tree growing requires capital and production scale which small scale farmers cannot afford. Actual prices of milk products cannot make high profit under management scale and technical level of small scale farmers. Based on the consideration above, a proposed cropping system for small scale farmers is shown in the table below.

Crop	Cereal	Traditional	Vegetable					Forage	Fruits Tree			Pasture		
	Wheat	Potato	Swiss chard	Onion	Cabbage Melon	Broccoli Cauliflower	Total	Alfalfa	Avocado	Lemon	Total	Subtotal	& Others	Total
Small Scale Farmer (ha)	0.5	0.5	1	1	1	1	4 (6)	2	0.2	0.2	0.4	7.4	2.0	9.4 (11.4)
%	5.3 (4.6)	5.3 (4.4)	10.6	10.6	10.6	10.6	42.4 (52.6)	21.2 (17.5)	2.2	2.2	4.3 (3.5)	78.6	21.4	100

Among proposed vegetables, three of them, Swiss chard, cabbage and cauliflower, are prohibited to cultivate under the present situation but have highly marketability. The other three vegetables and potato are indirectly affected by water quality. On vegetable selection for Reforma area, there is a constraint against vegetable cultivation that drainage is relatively poor, compared with the other areas. Alfalfa is important in the meaning of that it can be included in land rotation and is a rational and highly profitable crop. Cereal crops which are represented in wheat is also important crop for completing the crop rotation and self-consumption for small scale farmers. Fruit growing has an effect mainly as a kitchen orchard.

In case of average medium and large scale farmers in irrigation areas, orchards are given priority on water use, considering advantage of improved water quality. The proposed cropping system for medium and large scale farmers is described in the table below.

Crop	Cereal	Vegetable	Fruits tree			Seed production	Sub total	Pasture & Other	Total
	Maize	Melon	Avocado	Lemon	Total				
Large/ Medium Scale Farmers (ha)	2.0	3.0	9.0	7.0	16.0	2.3	23.3	2.0	25.3
%	7.9	11.9	35.5	27.7	63.2	9.0	92.1	7.9	100

Gross income in the cropping plan by farming scale is presented in the table below.

Small scale farmers (Average farming area; 9.4ha)	$	9,710,500
Large and medium scale farmers (Average farming scale; 25.3ha)	$	29,600,000

(4) Agricultural support

In order to promote socio-economic self-independence of the area, forming organizations of farmers, who are beneficiaries, is indispensable. The core for regional agricultural development is established by realizing diversification of agricultural production through improvement of water quality for irrigation. The irrigation water is improved by implementing water quality improvement project through organizing farmers in the area. Establishment of the organization system of beneficiaries, who are the recipients of the project, is indispensable to promote the project implementation in the objective area and effective use of irrigation water whose quality is improved. Based on the mutual consensus on the improvement of the present situation, following two organizations are to be established as basic systems of beneficiaries.

- Organization for water quality improvement

  In Mallarauco area, because whole irrigated area is managed by *Asc. Canalista Mallarauco*, it does not need to establish new organization to promote the project. This canal association is utilized as the organization to promote the project. Nevertheless, as for operation and maintenance of water quality improvement facilities, an independent organization in the canal association is established for smooth operation of facilities.

- Organization for effective use of facilities

  Technical and financial support services for producers' groups on utilization of improved irrigation water at the field level are provided by using the INDAP's service system. Various producers' groups are expected to be organized due to diversification of crops by water quality improvement. An advisor is to be employed through OMPC's arrangement for organizing producer's groups. On the promotion of the INDAP's project implementation , SAL, SAP or SAE is to be applied according to the level of organization for highly-advanced production cooperatives.

Moreover, Communication Center for *Unidad Vecinal* (CECUV: *Centro de Communicación para Unidad Vecinal*) is constructed in each *Unidad Vecinal* as the core facility of activities to vitalize *Unidad Vecinal* and promote smooth communication among regional inhabitants and support activities for farmers. Among agricultural support activities, promotion of uniting, enlightenment and technical guidance of agricultural support activities are undertaken by advisors organized by OMPC through cooperation with external support organizations (INIA, universities, private consultants and NGOs). CECUV is constructed in two sites in the area.

(5) Agricultural infrastructure improvement plan

Three areas, Los Carrera, Reforma and Santa Ana, are selected as the agricultural development areas by water quality improvement, and the rehabilitation of existing irrigation facilities will also be planned along with the water quality improvement. Irrigation area, duty of water and irrigation methods of the proposed areas are as follows.

Area	Irrigation Area (ha)	Water-Right		Irrigation Method
		No. of *Acción*	Water requirement (l/sec)	
Los Carrera	135.2	15.6488	125.19	Furrow
Reforma	488.5	67.9325	543.46	Furrow
Santa Ana	418.7	53.7163	429.73	Furrow
Total	1,042.5	137.2976	1,098.38	

Note: Irrigation Area is measured from 1/10,000, Water requirement is based on 8 l/sec/Right

Reforma area takes water by damming-up the Higuerillas canal, which is the drainage canal of Mallarauco irrigation system and distributed irrigation water by three canals, Norte, Centro and Sur of the irrigation area. Among these, a confluent section of the Sur canal is not included in the proposed area for water quality improvement because it joins with the other water system in the downstream reaches.

Sewage treatment plants to improve water quality are basically to be constructed around the present intake structures. Because the canals in Los Carrera and Santa Ana areas are located in higher position than the proposed irrigation area, the plant sites are selected according to the plan of treated water distribution by gravity method. In both Reforma and Santa Ana areas, because the canals are located in the lower portion and irrigation areas are flat land, treated water needs to be conveyed to the existing canals by pumping up.

Treatment capacity of the plant is determined by treatment capability. Thus, the planned treatment capacity is set the discharge of water right mentioned above. Up to the burden of inflow discharge, it is adjustable to a certain level of discharge change by selecting number of treatment tanks.

Intake facilities from the existing main canals are planned to be rehabilitated with the construction of new sewage treatment plants including increase of intake capability. Treated water at the sewage treatment plant is distributed through a regulation reservoirs to canals (pipeline) for adjustment of time-lag between treatment and irrigation. Drip and micro-sprinkler can be used in the field level because 1.0 kg/m^2 pressure water from tap of the pipeline can be obtained.

(6) Rural infrastructure improvement plan

Rural infrastructure development plan promotes from the point of permanent rural settlement through agricultural promotion, soundness and safety of inhabitants in the area. Accordingly, infrastructure whose installation is behind; connecting roads (6 routes, 26.2km), water supply facilities (4 sites), rural sewage treatment facilities (8 sites), and meeting facilities (2 sites), is planned to be improved based on the analysis of the present situation.

(7) Environmental conservation plan

According to the construction plan of the sewage treatment plants in Santiago city by EMOS, three plants will be completed along the Mapocho river in 2024 and then the treated water of approximately 25 m^3/sec will be discharged into the Mapocho river. Consequently, water quality of the Maipo river joining the Mapocho river will be greatly improved. However, according to the predicted quality of water for irrigation in the priority project area in the target year of the project (2010), water quality of the Mapocho river will be more improved than the present, the BOD value predicted by EMOS will exceed 20mg/l in 2010 with the exception at the time of minimum discharge, despite the fact that a part of the construction of the treatment plants will be completed at that time.

The purpose of the water quality improvement project in Mallarauco is to improve the contaminated water for irrigation by means of the sewage treatment plants and to create the model area for agricultural development by improvement of the rural environment and diversification of crops. It is preferable to ameliorate water in the BOD and SS values, both of which are the index of water contamination, up to the lowest value as possible, and to discharge the water. The present project, however, the object values of BOD and SS are set as 20mg/l and 30mg/l respectively, both of which are the same as the planned values in the sewage treatment plant over the Metropolitan Region. The object group number of fecal Coliform is set at 1000MPN/100ml as the domestic standard, though in this project, it is set at 23MPN/100ml which is the standard number for crops for export.

The design water quality of inflow to the treatment plant is set at 300mg/l of BOD and 300mg/l of SS. The design capacity of water to be treated is supposed to the maximum volume of water rights in the proposed area. The treatment method is designed with the conventional activated sludge method in the case where the amount of water to be treated corresponds to $0.2m^3/sec$ or more, or the sequencing batch reactor process which is suitable for the middle- or small-sized plant in the case where water volume is less than $0.2m^3/sec$. The disinfection method by chlorine or by ultraviolet rays is known as the method to disinfect coliform bacilli. In the project, adopted is the method by ultraviolet rays by which no chlorine is remained because the treated water is directly used for irrigation water. On the basis of the methods above, the sequence of sewage treatment and list of facilities are as follows:

Conventional Activated Sludge Method:	Inflow- Sand Basin- Pump Well- Primary Settling Tank- Reaction Chamber- Final Settling Tank- Disinfection Chamber- Outflow
Sequencing Batch Reactor Process:	Inflow- Sand Basin- Pump Well- Batch Reactor - Disinfection Chamber- Outflow
Design inflow quality:	BOD 300 mg/l SS 300 mg/l (1.1E+07 MPN/100 ml of fecal coliforms)
Amount of sewage treated:	0.15 m^3/sec in Los Carrera (140 ha irrigated) 0.45 m^3/sec in Santa Ana (420 ha irrigated) 0.55 m^3/sec in Reforma (490 ha irrigated)
Design treated water:	BOD 20 mg/l SS 30 mg/l (23 MPN/100 ml of fecal coliforms)
Processing method:	Conventional activated sludge method in Santa Ana and Reforma Sequencing batch reactor process in Los Carrera
Disinfection method:	Method using ultraviolet rays
Site area	Los Carreras 1.5 ha Santa Ana 2.5 ha Reforma 5.0 ha

O & M of the sewage water treatment plant is to be carried out by the Mallarauco canal association.

After the construction of the plants proposed in this project, those plants will be managed by the canal association. However, at the points where canals pass through communities, it may be considered that the canals will be damaged and irrigation water contaminated by wastes, domestic sewage, and stock-farming wastes. In this project, a campaign for enlightenment and public relations are planned on the-community-basis with respect to the environmental conservation to keep high quality of water. The promotion campaign of environmental education is also planned by recommending a member of the youth group of *UV* or other groups, and farmer's groups to have a qualification to be engaged in the environmental conservation.

In order to prevent environmental pollution by agriculture due to expansion of fertilizer and pesticide use and to promote the sustainable farming, skill guidance and technology transfer to farmers concerning the reduction of fertilizer and pesticide use are executed by the public organizations such as INIA. These activities are carried out on the farmers' organizations formed to obtain the agricultural support services from INDAP.

EIA System in Chile provides the object to be assessed from the environmental view. The related items in the system to the EIA System selected as the priority project for development in Mallarauco is "in case of the sewage treatment plant construction." Environmental assessment with regard to the EIA System is conducted by the Chile side when the implementation of this project is determined definitely.

2.3 Project Cost

The construction period of the project is to be 7 years including detailed design, preparation of contract and tender documents, tendering procedure, and construction works. The project cost is estimated at the prices level as of December, 1998 based on the results of field survey on costs of labor, construction materials and equipment. Construction works are executed by contractors under contract. Summary of the project cost is estimated at \$26.4 billion as presented in the table below.

Unit: Thousand Pesos.

Component	F.C	L.C	Total
1. Preparation cost	590,845	360,008	950,853
2. Water quality improvement / Irrigation facility improvement cost			
Sewage treatment plant facilities	11,114,356	7,123,208	18,237,564
Irrigation facility improvement	692,540	276,956	969,496
3. Rural infrastructure and Agricultural support facility development cost	624,530	838,323	1,462,853
4. Land acquisition and compensation cost		15,442	15,442
5. Engineering and administration cost	861,169	1,416,907	2,278,047
6. O&M equipment cost	121,577	45,000	166,577
7. Physical contingency (10%)	1,391,470	1,007,279	2,398,743
8. Total	15,306,167	11,080,070	26,386,171

2.4 Project Implementation Schedule

The Plan is defined as the project which farmers apply for. The project is executed within government subsidy law system for irrigation project. Therefore, the project executive organizations are divided into two based on the project scale. Water quality improvement project is executed by DOH in accordance with Government ordinance No.1123 and the irrigation facility improvement project is executed by CNR in accordance with Law No.18450. Regarding construction of sewage treatment plant, proposed standard of water quality and structure, and water quality examination after completing the construction are managed and implemented under the guidance of CONAMA. Among these projects, in case of sewage treatment facility construction, maximum 70% of the project cost is paid by national government subsidy under Government ordinance No. 1123 and the rest of it is paid by beneficiaries. Nevertheless, according to the financial analysis of farm households, the project cost needs to be subsidized at least 90%. On the burden the project cost, the burden of Santiago City which is a polluter and also the nation should be examined.

O & M of canals and water management are carried out by Mallarauco canal association. The present works and roles of Mallarauco canal association are management of canal facilities and diversion, but O & M of the plant facilities and water quality management mentioned above are added. Annual O & M cost is estimated at $360 million.

2.5 Development Impact and Evaluation

The project evaluation is made by internal rate of return of the project. The benefits are estimated by increase of agricultural products and impact of BOD reduction. The costs for evaluation are used by the results of the project cost estimation.

Economic net present value of the entire project and economic internal rate of eturn (EIRR) are estimated at $8,030.6 million and 20.5%, respectively at 12% of discount rate. Implementation of the project is expected to bring about following socio-economic impacts beside direct benefits estimated by economic evaluation.

Creation of the solidarity among inhabitants
Diversification of agricultural products
Impact of water quality improvement
Increase of job opportunity
Increase of intention for working
Activation of socio-economic activities
Development of regional economy
Impact on the environment

Accordingly, implementation of the project is justified.

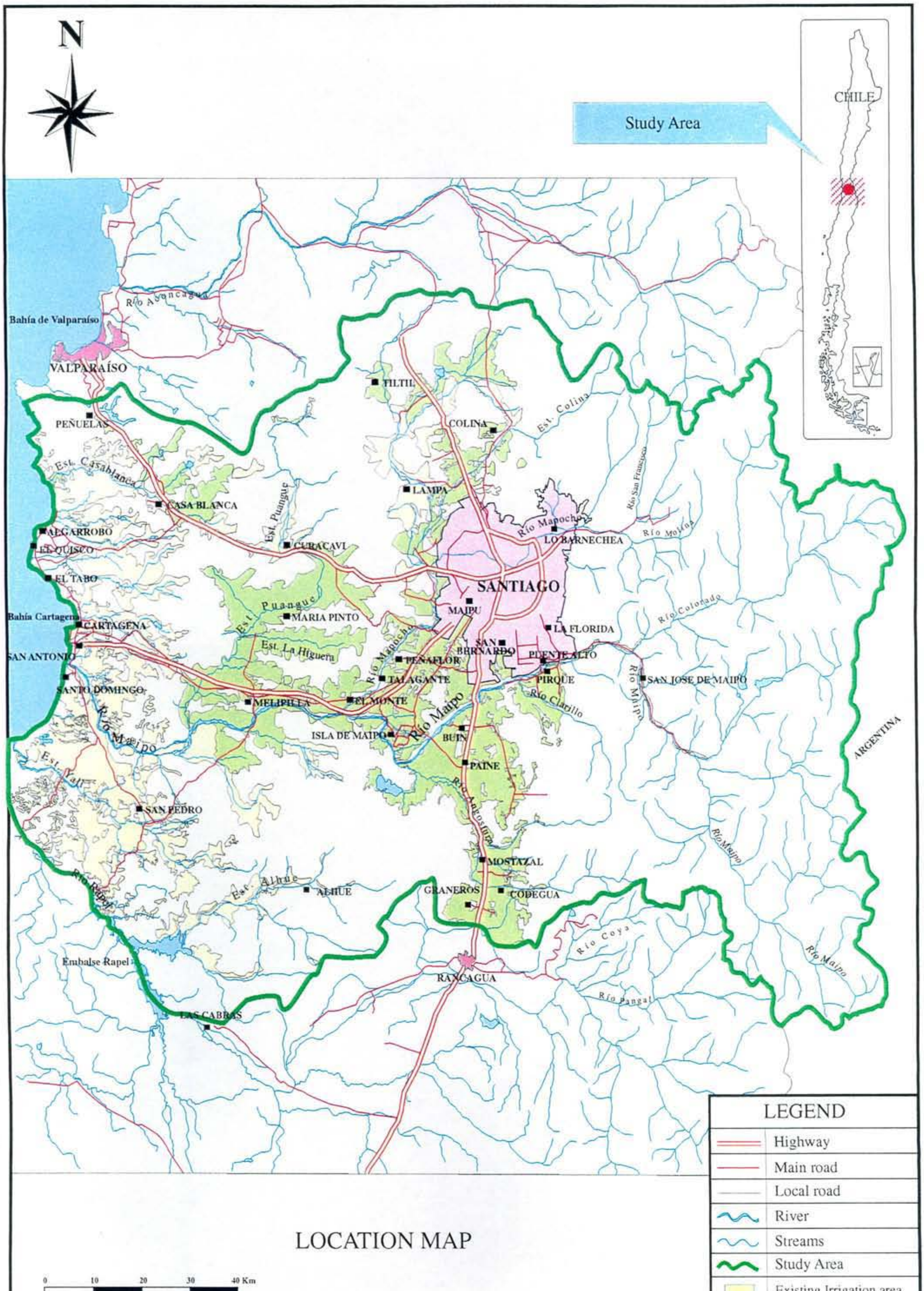
2.6 Conclusion and Recommendation

(1) The project implementation benefits directly to the improvement on farming and farming condition of the farmers in the projected area. Because the sanitary environment surrounding production of perishable food has become international interest, infrastructure improvement for agricultural production is an urgent problem in order to expand agricultural export. The water quality improvement project is recommended as a pilot project based on the understanding stated above. On the other hand, required cost of water quality improvement is large and it is hard to be established as the project in the range of direct benefit which usually can be measured. From the results of financial analysis of farmers, subsidy of 90% on investment costs is required to promote the project execution. Taking these condition into account, the burden of Santiago City, which is the cause of pollution and also the nation, should also be examined. Accordingly, it is recommended for early implementation of the project that subsidy methods for initial investment should be established in the frame of existing or new subsidy system of government, considering the project advantage.

(2) As Government ordinance No.1123 is applied to the Project under the frame of the present project support system, close cooperation between CNR and DOH is necessary at each stage such as adoption of the project by DOH, approval of the project and execution of the project. Guidance of CONAMA is required at the stage of the project promotion because the project includes water quality improvement relevant to environmental issues. Therefore, it is recommended that a project promotion committee which consists of CNR, DOH, and CONAMA should be established.

(3) The beneficiary of the project is the existing canal association, Mallarauco canal association. As O & M of sewage water facilities handed by the association, it is proposed that the section of O & M for sewage treatment facilities should be established in the present Mallarauco canal association.

Part I Master Plan



LOCATION MAP

AGRICULTURAL DEVELOPMENT AND WATER MANEGEMENT IN METROPOLITAN AREA

MASTER PLAN STUDY

Table of Contents

Page

5 PLAN OF THE AGRICULTURAL DEVELOPMENT AND WATER MANAGEMENT IN METROPOLITAN AREA

6 CONCLUSION AND RECOMMENDATION

List of Tables

List of Figures

CHAPTER 1

INTRODUCTION

1 INTRODUCTION

1.1 Authority

This Draft Final Report (the Report) is prepared according to the Scope of Work for the Study on "Agricultural Development and Water Management in Metropolitan Area, Chile" (the Project) agreed upon between the National Irrigation Commission of the Republic of Chile and Japan International Cooperation Agency (JICA) in November, 1997.

The study of the Project was conducted in two steps; Phase I and II. During the Phase I study from June to October in 1998, the Master Plan of the agricultural development of the entire study area was formulated on the basis of the field survey and study results of the present situation on the study area, then, priority project areas were subsequently identified. The Phase II study was executed from November 1998 to March in 1999 and development plan of the priority areas was formulated through the feasibility study on the priority areas.

The Report consists of the Main Report and Annexes. The Main Report comprises development plan formulated, results of detailed analysis and survey through the field and home office works carried out Phase I and Phase II studies. The Annexes describe the results of study and analysis on present situation of each field and of the formulation on the development plan in detail.

1.2 Background

In the late 19th century, the Republic of Chile stood above the other South American countries in economic field through the production of silver, copper, and niter, and the industrial development thanks to these mineral resources. Yet, the process of economic and social modernization in Chile was not easy after the era above. There was intensive political transition which depicts the demand of Chilean people for the social and economic development. There is the accumulation of much experience on these developments through the transition.

In the beginning of the 20th century, deterioration of Chilean economy started with the crisis that led by the attempt on producing niter artificially during the World War I . Then, the World Depression in 1929 hit the national economy, and made it worse. After the severe depression in the 1930s, the government promoted the import-substitution industrialization strategy. However, since 1973, the government has evolved to take the free economy and open-market policies. The Chilean economy has been making smooth progress through overcoming "Oil Shock" twice and the Debt Crisis in the late 1980s which hit the other Latin American countries as well. The Free Cabinet has made effort to facilitate economic development based on social equality and to overcome poverty founded on the political and economic stability achieved by the former Aylwin Cabinet. In Chile, agricultural sector occupies 6% of GDP, 14% of total employment, and 10% of total value of export in 1997. Thus, the agricultural sector takes the second position, which is next to mining industry, in the national economy. Agricultural development policy of the government toward 2000 puts stress on improvement of irrigation system so as to increase the productivity. The improvement of irrigation system assumes to lead the increase of agricultural production for domestic demand and export. The policy also aims at the balanced development of agriculture through assistance and strengthening of medium and small scale farmers. The government intends to give supports and subsidies on irrigation and processed agricultural product, and to extend the farming technique such as countermeasures against the disease and insect pest.

Since the late 1970s, the metropolitan economic block has been expanded drastically with population growth and industrial development in the capital city of Santiago. This resulted in the disappearance of suburban farmland which forms the particular urban scenery. At the same time, the water demand for domestic water supply, electric generation, and industrial uses has boosted. Thus, water utilization has become tighten. Moreover, the contaminated river flow which is running through the metropolitan area has become noticeable. Accordingly, sanitary condition has been deteriorating and the kinds of crop cultivation are partly limited.

Various water demand in the metropolitan area depends on surface runoff and groundwater in the Maipo river basin originated in the Andes mountains. According to the situation mentioned above, the evaluation of available water resources, optimum allocation of water, and the conservation of the basin environment have been recognized their necessities.

Reflecting these situations, the government of Chile has been started the study on "Maipo Project" in 1979 by the National Irrigation Commission as the competent authorities. Major objectives of the project were the water source development for the new irrigation scheme, the overall basin irrigation study contributing to the coordination and the management of the present water utilization on the Maipo river basin. The study consisted of four stages; to grasp the natural condition of the basin, to grasp the water demand of the basin, to establish the water utilization plan of the basin and evaluate the project. The first stage had been completed, however, the study had been suspended by the domestic affairs. Review of the first stage study results and the execution of the further stages are the urgent issues

The Government of Chile requested the Government of Japan to undertake a study on "Agricultural Development and Water Management in Metropolitan Area, Chile" in July 1996. The study aims mainly to formulate a master plan for agricultural development and water management reflecting upon environmental conditions in metropolitan area, Chile and to conduct a feasibility study for the agricultural development plan(s) in the priority project area(s). The study forms a part of the "Maipo Project" and covers 3,200 km^2 of farm land located in outskirts of Santiago metropolitan area. In response to the request, the Government of Japan dispatched the Preparatory Study Team from November 3, 1997 to November 21, 1997 through JICA, and agreed on the Scope of Work for the Study.

1.3 Objectives of the Study

The objectives of the study are;

(1) To formulate a master plan for agricultural development and water management reflecting upon environmental conditions in metropolitan area, Chile.
(2) To conduct a feasibility study for the agricultural development plan(s) in the priority project area(s).
(3) To carry out technology transfer to the Chilean counterpart personnel through on-the-job training in the course of the study.

1.4 Study Area

The study covers metropolitan areas comprising the Metropolitan Region located in the center of Chile and the part of V and VI Regions. Total area for the master plan is about 3,200 square kilometers which consists of actual and potential irrigated areas.

1.5 Scope of the Study

The Study consists of two phases, Phase I and Phase II. Scope of the Study in each phase is summarized as follows;

Phase I (Master Plan Study)
- Collection and analysis of data and information and field survey,
- Review of development plan at national and sector levels,
- Analysis on the project executing system,
- Analysis on potential water resources, regarding with surface runoffs and groundwater,
- Execution of initial environment assessment,
- Formulation of water supply and demand plan,
- Formulation of agricultural development plan,
- Selection of priority area/projects,
- Conclusion and recommendation.
Phase II (Feasibility Study)
- Collection of additional data and information, and field survey,
- Formulation of agricultural development plan in the priority area considering the environmental conservation,
- Environmental conservation plan,
- Preliminary design on major structures,
- O & M plan on infrastructures,
- Project implementation plan,
- Estimation of the project cost and benefit,
- Project evaluation,
- Conclusion and recommendation.

CHAPTER 2

NATIONAL BACKGROUND

2 NATIONAL BACKGROUND

2.1 Land and Population

The Republic of Chile is located along with the Pacific shore, and stretches about 4,300 km from south to north. The Andes mountains are the east borders. Land area is 756,000 km^2 and divided into 13 Regions including the Metropolitan Region. According to the Census in 1992, total population of Chile is about 13.5 million. The population growth rate is 1.64% in national annual average from the last census in 1982 to the current census in 1992. Estimated population in 1997 from the census in 1992 is 14.6 million. The area and population of each Region are shown in the table below.

	Region	Area (km^2)	Population (1,000 persons)	
			1992	1997
I	Tarapacá	58,698.1	339.6	379.7
II	Antofagasta	126,443.9	410.7	449.8
III	Atacama	75,573.3	230.9	259.8
IV	Coquimbo	40,656.3	504.4	553.4
V	Valparaíso	16,396.1	1,384.3	1,507.1
VI	Libertador General Bernardo O'Higgins	16,341.4	696.4	758.4
VII	Maule	30,325.3	836.1	889.8
VIII	Biobío	36,929.3	1,734.3	1,874.1
IX	La Araucanía	31,842.3	781.2	846.0
X	Los Lagos	67,013.1	948.8	1,028.2
XI	Aisén del General Carlos Ibáñez del Campo	108,494.9	80.5	90.8
XII	Magallanes y de la Antártica Chilena	132,033.5	143.2	154.0
R.M.	Región Metropolitana de Santiago	15,348.8	5,257.9	5,831.3
	Total	756,096.3	13,348.4	14,622.4

The 1992 population census resulted in a total population of 13,348,401, of which 6,553,254 male and 6,795,147 female. Women of childbearing age (14 to 49 years) had an average of 4.09 children in 1967, but dropped to 2.39 in 1992. With the declining birthrate and no significant increase in immigration, much of the growth in the Chilean population resulted from a decline in infant mortality (119.5 per 1,000 live births in 1960 to 11.8 per 1,000 in 1995). Infant mortality rate in Chile is one of the lowest in Latin America, reflecting the success of health-care programs for expectant mothers and infants implemented since the late 1960s. Slightly less than half of Chileans are estimated to be under 21 years old, indicating a young population structure.

In racial structures, Mestizo (native American mixed with European), European ancestry, Native American, and other ethnic groups occupies 66%, 25%, 7%, and 2% respectively. Official language is Spanish.

2.2 Current Situation of Socio-economy

2.2.1 Social Aspects

(1) Education and Literacy

Primary education lasts 8 years and secondary education 4 years, the school year being from March to December. According to MIDEPLAN-CASEN96, gross school enrollment was 98.2% at the primary level, 85.9% at the secondary level, and 26.3% at the tertiary level. Adult literacy rate was estimated at 95.1%, with an average schooling of 6.7 years in population over 15 years old.

(2) Health

Heavy investments in social programs helped lower infant mortality rates and raise life expectancy, giving Chile a relatively high human development index (HDI) used by the United Nations.

		Chile	Latin America
Crude birth rate per 1,000 (1995)	:	19.8	26.0
Crude mortality rate per 1,000 (1995)	:	5.7	8.0
Total fertility rate per woman (1995)	:	2.3	3.3
Life expectancy at birth (1995)	:	74.8 years	69 years
Infant mortality rate per 1,000 live births (1995)	:	11.8	38.0

2.2.2 Outline of the Politics

(1) Government

The 1980 Constitution, amended in 1989, establishes Chile as a democratic republic with three branches of government: Executive, Legislative, and Judicial.

The Executive power is vested on the President of the Republic, who is directly elected, having to win a majority or face a runoff election. The President is elected for a six-year term, and successive reelection is not allowed. President Eduardo Frei Ruiz-Tagle was elected on December 11, 1993 and took power on March 11, 1994.

The Legislative branch, a bicameral National Congress located in Valparaíso, consists of the Senate where 2 members are elected for each "senatorial circumscriptions" in addition to non-elected members who serve eight-year terms, and the Chamber of Deputies with 120 members who serve four-year terms.

The Judicial branch consists of the Courts, including the Supreme Court (21 ministers), appellate courts, and military courts.

(2) Administrative Subdivision

Administratively, the country is divided into Regions, consisting of the Metropolitan Region and 12 Regions numbered from North to South. The 13 Regions are subdivided into 51 Provinces, and these Provinces into 541 Communes. Each Region is headed by an Intendant, each Province by a Governor, and each Commune by a Mayor.

According to the 1980 Constitution, Intendants and Mayors would be appointed directly by the President of the Republic, although Mayors of smaller towns would be designated by Regional Councils created to advise the Intendants. Members of Regional Councils would be employees of government agencies in the locality, military officers, and representatives of interest groups with no party affiliation. This conception of regional government is extended to the municipal level with similar Local Councils.

(3) Political Parties

Article 19 point 15 of the Constitution guarantees political pluralism, but clarifies that against the Constitution are political parties striving for totalitarian regimes, or resort to violence. Political parties span the spectrum from left to right, from the Communist Party of Chile (PCCh), to the ruling Coalition of Parties for Democracy (CPD) dominated by the Christian Democratic Party (PDC), to the right wing National Renewal (RN) and Independent Democratic Union (UDI).

2.2.3 Outline of the Economy

(1) Overview

For the past decade, the Chilean economy has grown rapidly fueled by steadily rising domestic savings and foreign investment. It is a market-based economic system in which the private sector is the engine of growth, while the public sector plays only a guiding and supportive role by setting the ground rules, compensating for major imbalances, and maintaining macroeconomic stability. Copper remains Chile's most important product, accounting for about 40% of export earnings. However, exports of fish, forestry and manufactured products, and especially fresh fruit are of growing importance.

The governments of former President Patricio Aylwin (1990-1994) and current President Eduardo Frei have emphasized the need to maintain macroeconomic stability and the export orientation of the economy. The independent Central Bank has gradually loosened foreign exchange restrictions on capital outflows. The government remains concerned about the exchange rate effects of rapid foreign capital inflows. Although privatization has slowed down in recent years, some regional water and sewage companies are getting ready to be privatized starting at the end of 1998.

The Central Bank monetary policy adjusts interest rates as a means to affect domestic spending. One goal is to keep inflation under control while maintaining the economy on a path of steady growth. Another goal is to stabilize the exchange rate by buying or selling dollars in the official inter-bank market, in order to keep the short-term exchange rate fluctuations within a 10% band on either side of the reference data, which changes daily. A legal parallel market operates with rates similar to the inter-bank rate.

The government rarely sets specific prices, except for urban public transportation, some public utilities and port charges. An 18% value added tax (VAT) applies to all sales transactions, and brings in over 40% of total tax revenues. Government regulation affects a few sectors such as utilities, banking, securities market, and pension funds.

Chile's strong economic growth and careful debt management over the past decade meant that foreign debt is not a major problem. As of late 1996, Chile's public and private foreign debt was about US$20 billion, equivalent to around 27% of GDP. Since the mid-1980s, public sector foreign debt has declined steadily, but private sector debt has risen as firms have borrowed abroad to finance investments.

On most imports there is an 11% tariff, but a proposal was made in the second half of 1998 to lower tariff levels. Chile has free trade agreements with Mexico, Venezuela, Colombia, Ecuador and Canada, providing for duty-free trade in most products by the late 1990s. In 1996, Chile signed a trade liberalization agreement with MERCOSUR (Argentina, Brazil, Paraguay and Uruguay). Tariffs are also lower than 11% for certain products from member countries of the Latin American Integration Association (ALADI). Chile's most important non-tariff barrier is the import price band system for certain agricultural commodities: wheat, wheat flour, vegetable oil and sugar. Under this system, when import prices are below a set threshold, surtaxes are levied on top of the 11% tariff in order to bring import prices up to an average of international prices.

(2) Gross Domestic Product (GDP)

Table 2.2.1(1) shows that Chile's GDP between 1995 and 1997 increased from 6,800,000 Million to 7,800,000 Million in 1986 Chilean $, implying strong annual growth rates of 10.6% in 1995, 7.4% in 1996 and 7.1% in 1997. IDB estimates the 1997 Chilean per capita GDP at around US$3,700 (in value of the US$ in 1990), having grown at 5.3% per year between 1988 and 1997. The exchange rate of the Chilean $ in terms of US$ fluctuated from 407.1 $ in 1995, to 425.0 $ in 1996 and 439.8 $ in 1997. The value of the US$ in 1998 was around 450 $ in June and 470$ in September

Economic activities comprising GDP show that the tertiary sector is dominant, followed by the secondary sector. Agriculture, livestock, and forestry together comprise less than 7% of GDP and show a declining trend over the past 3 years, reportedly due to irregular climate consisting of too little or too much rain. This is reflected in the year to year growth rate which has been declining, being the only economic activity that showed a negative growth rate in 1997 (-2.1%). In contrast, fishery has been increasing its share in the GDP, even though its year to year growth rate also declined over the past 3 years. Major crops are grapes, apples, plums, potatoes, sugar beet, and forest products. The main agricultural export is fruit, while leading agricultural imports are banana, coffee, cotton, soybean, sugar, tea, and wheat.

Mining accounts for around 8% of GDP, and showed a strong growth rate between 1995 and 1997. Copper is the most important mining product, but Chile produces 24 non-metallic minerals that are exported. Manufacturing accounts for around 16% of GDP, showing a moderate growth rate between 1995 and 1997. Construction accounts for around 5% of GDP, showing a strong growth rate from 1995 to 1997.

Services account for about half of GDP, showing strong growth rates between 1995 and 1997. Main services are Commerce, Hotel and Restaurant accounting for about 17% of GDP, and Financial Services for about 13% of GDP. Tourism is one key service industry, with around 1.5 million visitors, half of whom from Argentina, who spend about US$900 million.

(3) Employment

Table 2.2.2(2) shows employment trend by economic activity between 1995 and 1997. It can be seen that the tertiary sector accounts for more than half of employment, the most important being Personal, Communal & Social Services with around 26%, followed by Commerce with about 18%, Transport & Communications with around 7%, and Financial Services with about 7%.

Manufacturing accounts for around 16% of total employment, Construction for around 8%, and Mining & Quarry for less than 2% of employment. Employment in Agriculture & Fishing declined continuously in the past 3 years, from 16% in 1995 to 15% in 1996 and 14% in 1997.

(4) Inflation

According to the Central Bank of Chile, the consumer price index (CPI) was double digit up to 1994, and single digit afterwards, declining year by year as shown below.

Year	1993	1994	1995	1996	1997
CPI (%)	12.7	11.4	8.2	7.4	6.1

(5) Foreign Trade

Table 2.2.3(3) and Table 2.2.4(4) show that Chile in 1997 exported around US$17,0000 million and imported nearly US$19,000 million. Copper is still the most important single export product, accounting for around 40% of export values between

1995 and 1997. Agriculture accounts for about 10% of export values, mostly fresh fruit with around 8% of export values. Export of manufactured products accounts for about 40% of total values, the most important items being food (16%), chemicals and plastics (6%), paper (6%), and wood furniture (5%). Main destinations of exports in 1997 were the US (16%), Japan (16%), UK (6%), South Korea (6%), Brazil (6%), Argentina (5%), but Chile exports to some 60 countries worldwide.

Of the imported items, Intermediate Goods comprise around 50% of total import values, Capital Goods around 27%, and Consumption Goods around 18%. Within each of these categories, the share of Agriculture is minimal, the most important being around 2% of total import values under Intermediate Goods. Manufactured Products comprise the highest import values as Consumption Goods and Intermediate Goods, with 18% and 40% of import values, respectively. Machinery and Equipment are the most important Consumption Good, while Chemicals and Oil are the most important Intermediate Good. On the other hand, Machinery, Equipment and Transportation Materials are the most important Capital Goods with around 27% of import values. Main origins of import products are the US (23%), Argentina (10%), Brazil (7%), Mexico (6%), Japan (6%), Germany (4%), Italy (4%), but Chile imports from some 60 countries worldwide.

2.2.4 Agriculture

(1) General situation of the study area

According to 1997 Census, 315,966 development plans of 27,115,580 ha in total in agriculture were carried out in Chile. 13,718 forest development plans of 19,937,485 ha was planed for forestry and silviculture and at least over its 90% was executed as forest development.

However, figures regarding forest development is not considered for analyzing the study on agriculture and livestock used in this report. The area of forest or forest works saying herein the report means agricultural development purposed on these aspects.

The Census mentioned above recorded 4,191 agricultural development plans which are not intermediate land on their production process but investment of capital and labor as swine and poultry productions.

Outline of land use on agricultural and livestock development is shown as follows;

Land use	Area (x ,000 ha)	%
Total Agriculture and Livestock	27,115.6	100.0
A. Cultivation land	2,293.4	8.5
- Annual and perennial crop cultivation	1,398.3	5.2
- Improved grassland for permanent and rotation	452.6	1.7
- Seasonal fallow and fallow land	442.5	1.6
B. Other land	24,822.2	91.5
- Improved grassland	1,009.8	3.7
- Natural grassland	11,922.2	44.0
- Planted forest	1,098.5	4.1
- Natural forest, mountain	4,870.1	18.0
- Indirect production area	236.9	0.9
- Abandoned land or non production land	5,684.7	21.0

Crops	Area (ha)
1. Fruits	233,973.1
2. Vineyard for wine	81,256.4
3. Seedlings production	2,339.1
4. Cereal, garden crops	774,011.3
5. Processing crops	70,263.7
6. Seeds production	29,620.1
7. Vegetables and flowers	113,113.5
8. Improved grassland for permanent and rotation	452,605.7
9. Seasonal fallow and fallow land	442,504.2

Source: 1997 Census

Animals raised on livestock are as follows;

Animals	Heads
Cow	4,141,545
Sheep	3,710,459
Swine	1,722,403
Horse	415,184
Mule / Donkey	31,172
Goat	738,183
Lama	79,365
Alpaca	45,282

Source: 1997 Census

Agriculture sector is shared 6.0% of GDP and 14% of population is engaged in agriculture. Approximately half of agricultural sector in GDP is produced from livestock and the rest is from other activities.

(2) Characteristics of agriculture by areas

Agriculture in Chile is divided into four (4) major zones from north to south based on characteristics of respective production systems.

- Desert area: subtropical climate zone located from northern frontier to Copiapó valley, intensive farming of flower and fruits production in irrigable area in valley.
- Mediterranean climate zone adaptable to diverse use: the area from Copiapó to Biobío
- Transitional zone: cereal , forest and livestock production area located from Biobío to the Torten river
- Wet marine climate zone in south of the Tortén river: basically livestock and forestry and also intensive farming is adapted in surrounding of swamp area

For east- west direction of above areas to IX region could divided to dry zone in front of Andean mountains, central valley, crossing valley of Norte Chico and dry zones of inland and coastal areas.

Following table shows crops and cultivating areas for understanding outline of Chilean agriculture;

Productions	Production Areas
Fruits cultivation	- Irrigable valleys from III to V region - Cultivation in hillsides of V & metropolitan regions (Avocados & Citrus) - Irrigable area of Central valley in metropolitan and VI regions - An area from VII & IX region

Vineyard for wine	- Valley in IV region - Irrigable area of Central valley of from metropolitan and IIX region - Scattered irrigable areas between metropolitan and VII regions - Casablanca valley
Vegetable	- Irrigable area with clean water scattered in metropolitan region - Irrigable Central valley in valley in V region and between VI and VII region - Valley between II and IV regions (Flowers)
Flower	- Irrigable area in Valley of V region - Scattered irrigable area in coastal dry zone of metropolitan region
Dairy products	- Between x and metropolitan regions - Area between VII and IX regions
Poultry / Swine	- Metropolitan region - Concentrated between V and VII regions
Beef cattle	- Concentrated between V I and IIX regions - From IV and X regions and metropolitan region
Seedbed (seedling)	- Irrigable area in Central valley of metropolitan region - Irrigable area in Central valley from V to VII regions - IX and X regions
Forestry	- Coastal dry zone of metropolitan region to IIX region - From IX region to X region

2.3 Agricultural Development Policy and Development Plans

2.3.1 National Agricultural Development Policy

The national agricultural policy of Chile represents in "Strategic Agenda: 1998-2000 Objectives for Agricultural Development" by the Ministry of Agriculture.

The urgent objective toward 2000 of this "Agenda" is the agricultural "modernization." Increasing the productivity of each sub-sector (agriculture, animal husbandry, and forestry) is expected contributing to achieving this objective. In order to increase productivity, the stress for the increase will be put on middle and small scale farmers. Thus, it states that the recognition of the national support requirement for these farmers who will play a nucleus role in the improvement of the productivity.

On the basis of the concept above, the Agenda sets the basic programs which concern following 6 items on the table below and each program has some targets. Promotion of the policies and implementation of the programs are guaranteed by the national budget. The Government of Chile appropriates 344.5 million dollars for these programs in 1998. This is about 66 million dollars increase, compared to the last year's.

Programs	Targets
Improvement of irrigation systems	- Doubling of pumping irrigated area - Giving the benefit to 22,500 small scale farm households(44,500ha) - Giving priority to middle and small scale farm house-holds when applying to the Law No.18450*
Recovery of deteriorated soils	- 450,000 ha (18,000 farm households in III to X II Regions) in 4 years (1996-1999) - The targets in 1998 and 1999 are 145,000 ha and 165,000 ha respectively - Incorporating private consultants so as to implement the program

to be continued

Improvement of epidemic free resources**	- Strengthening of quarantining and monitoring animals and plants for agricultural exports including transportation means such as packing by woods - Establishing the quarantine system by cooperation bet-wen public and private sectors - Altering the area where middle and small scale farm households live into the disease and insect pest free area - Incorporating the private sector into the program activities
Promotion of technical innovation and improvement of business administration	- Establishing the business center network in Chile Foundation (Fundación Chile) - Incorporating 12 business administration centers into the network - Expanding INDAP long-term loan by competition - Doubling the covered area by FAT and PROFOS (CORFO) through the 25% increase of the subsidies against 4,000 producers - Improvement of the CRI (INIA)'s administration - Easing the access to modern technologies for small scale farmers through the cooperation between INIA and INDAP - Strengthening FIA as the fund's resource for technological innovation and expanding its activities - Applying INDAP to 35,000 producers through SAP and SAL
Development and improvement of markets	- Strengthening the institutions which concerned with adjustment of competition in domestic and international markets - Establishing the fund for the markets' distortion survey - Strengthening the monitoring system for the markets' distortion and monopolization - Considering a harvest guarantee system and income stability institutions by the private sector - Approving the regulation of labeling exporting vegetables and fruits - Extending the utilization of a promoting agricultural export fund - Implementing and expanding the agreement on animals and plants in quarantine at the relevant foreign markets
Forestry development	- Forestation for the small scale farmers' owned land (10,000 ha) - Normalizing the land ownership of 3,000 households - Strengthening the monitoring function of CONAF - Incorporating the private sector into the activities of disease and insect pest prevention and the fire monitoring - Promoting the conservation of virgin forests - Promoting the establishment of the Virgin Forest Law

Notes; * the Law No.18,450: when an irrigation project is executed under the Law of Promoting Irrigation Project, the subsidy can be obtained by the proposal system

** epidemic free animals and plants resources: the high reputation of Chilean agricultural products in the international market is the reward of efforts to prevent epidemics and maintain good sanitary conditions. Thus, this situation is called "resource" or "heritage".

2.3.2 Principles of Agricultural Development in the Metropolitan Area

The authority of the Metropolitan Region aims at sustainable agricultural development based on environmental conservation. The environmental conservation will be achieved by conservation of natural resources such as "land and water." In the policy for the population increase in the metropolitan area, it is recognized that development and promotion of suburban agricultural area are important subject to be solved.

(1) Natural resources

The agricultural production in the Metropolitan Region which occupies the important place in Chile. Particularly, it plays the main role in the production and supply of vegetables and fruits. Yet, the surroundings of land and water with the agriculture in the Metropolitan Region have been deteriorated and causes stagnating and decreasing the agricultural production.

1) Land resource

Thirty percent of the fertile farmland with irrigation among total of that in Chile is located in the Metropolitan Region. Even so, expansion of urban area has led to decreasing the area of farmland, and then aggravating the surroundings of farming. In Santiago city, the most fertile farmland with irrigation has been decreasing in the past 20 years because of expanding the urban area and industrialization. The agricultural production has been also decreasing. One of the specific reasons is that urban sprawl has been progressing in the fertile farmland because farmland has been sold as sub-divided housing lots with 0.5ha farmland mainly in Santiago suburbs. Accordingly, the legislative control of land use is the important issue to be considered from the view of protecting farmland from urban sprawl and promoting the agriculture in the metropolitan area.

2) Water resource

The authority of the Metropolitan Region manages water distribution to the agriculture, domestic use, and the other industries, and then tries to keep agricultural water. Aiming at effective water use in the metropolitan area, there are three targets; a) water source development on the Maipo river basin, b) optimum water distribution, and c) water management in overall basin. From the view of agriculture, there are two targets;

- Effective utilization of irrigation water
- Water quality conservation of irrigation water

Regarding to the water quality conservation, 85% of irrigated farmland in the Metropolitan Region is regarded as the water contamination area. EMOS had established the Master Plan on the sewerage disposal system in the Metropolitan Region, and has already started the project which intends to complete until 2024. However, vegetable cultivation with contaminated irrigation water is limited in the Metropolitan Region at present. Although the vegetable cultivation in the metropolitan area occupies 28% of that in whole country, it has been decreasing in the recent years. The Ministry of Health and Welfare recommends vegetable cultivation with groundwater or non-contaminated water. The countermeasures for water quality, which protect the agriculture are important for following about 25 years, or in the other words, until the sewerage-disposal plant is operated by EMOS.

(2) Others

The supporting policies on agricultural production activities under the guidance of INDAP are as follows;

- Cultivating technique and credit system's utilization
- Water saving irrigation
- Effective land use with cultivation in green houses
- Expanding financial support for promoting small farmers' intensive agriculture
- Providing information on marketing of agricultural production and enforcing organizations and technique

The authority of the Metropolitan Region also intends to conserve the virgin forestry (2,700 ha), distribute planting stocks to ward offices and farm households, and forestation support for small farmers to produce fire wood.

2.3.3 Agricultural Development Activities in the Study Area

(1) Irrigated agricultural development

1) Irrigation projects in the Maipo river basin

The study on the irrigation projects in the overall Maipo river basin was started in 1970 by MOP (Dirección de Riego). This was "*Estudio de los recursos hidrológicos de la hoya del río Maipo.*" The Study examined the potential of water resources in the Maipo river basin, and agricultural development in the overall Maipo river basin. Then, the basic plan of agricultural development in the Maipo river basin was presented. Afterward, MOP implemented various surveys on the irrigation projects in the Maipo river basin. Yet, after the Irrigation Law (the Law No.1123) enacted in 1981, the responsibility of the study was transferred to CNR. The water resources evaluation and the soil survey in the Maipo basin were implemented in 1981. Furthermore, the water balance study on the overall basin and the agro-climatic survey were implemented in 1984 and 1987 respectively.

2) The relevant projects by MOP

The other surveys in the objective area by MOP were as follows;

a) *Factibilidad técnica Embalse Pirque. Estudio Hidrogeológico* (1981), (MOP-DDR)
b) *Estudio de Factibilidad para Abastecer El Canal Las Mercedes Con Aguas Superficiales Reguladas y Aguas Subterráneas del Estero Puangue* (1993), (MOP-DDR)
c) *Proyecto Regadío Cuncumen* (1993), (MOP-DDR)
d) *Proyecto Regadío las Brisas de Santo Domingo* (1993), (MOP-DDR)

3) The other projects

According to the Law of Promoting Irrigation Projects No. 18450 which was established in 1985, it is possible to implement irrigation projects with the application from beneficiaries. Yet, there had been no actual results in the study area. The rehabilitation of existing facilities are implemented by beneficiaries themselves.

Table 2.2.1 Gross Domestic Product by Economic Activity (1995-1997)

Economic Activity	(Million 1986 Chilean $)			(Annual Growth Rate %)			(Sectoral Weight %)		
	1995	1996	1997	1995	1996	1997	1995	1996	1997
Agriculture, Livestock, Forestry	464,295	476,478	466,579	5.2	2.6	-2.1	6.83	6.53	5.97
Fishing	100,040	109,628	118,269	15.9	9.6	7.9	1.47	1.50	1.51
Mining	527,800	596,215	644,274	9.3	13.0	8.1	7.76	8.17	8.24
Manufacturing	1,104,750	1,143,266	1,194,017	7.5	3.5	4.4	16.24	15.66	15.27
Electricity, Gas, Water	166,945	168,971	185,023	7.6	1.2	9.5	2.45	2.31	2.37
Construction	356,179	388,372	414,827	9.9	9.0	6.8	5.24	5.32	5.31
Commerce, Hotel, Restaurant	1,133,117	1,239,255	1,340,834	14.2	9.4	8.2	16.66	16.97	17.15
Transport, Communications	518,310	572,878	646,665	14.7	10.5	12.9	7.62	7.85	8.27
Financial services	915,060	981,183	1,053,955	9.8	7.2	7.4	13.45	13.44	13.48
Housing	237,006	244,441	253,517	2.9	3.1	3.7	3.48	3.35	3.24
Personal Services	422,005	439,119	457,400	3.2	4.1	4.2	6.21	6.01	5.85
Public Administration	162,933	165,160	167,403	1.4	1.4	1.4	2.40	2.26	2.14
Subtotal	6,108,440	6,524,966	6,942,762	9.2	6.8	6.4	89.82	89.36	88.81
Less: Bank Charges	444,527	476,532	512,200	8.5	7.2	7.5	6.54	6.53	6.55
Less: IVA	616,869	673,297	717,718	10.6	9.1	6.6	9.07	9.22	9.18
Plus: Import Duties	520,170	580,238	669,386	28.5	11.5	15.4	7.65	7.95	8.56
Gross Domestic Product	6,800,952	7,301,969	7,817,666	10.6	7.4	7.1	100.00	100.00	100.00

Source: Boletin Mensual, Banco Central de Chile, No. 845, Julio 1998

Table 2.2.2 Employed Population by Economic Activity (1995-1997)

Economic Activity	(Thousand Persons)			(Sectoral Share)		
	1995	1996	1997	1995	1996	1997
Total Employment	5174.4	5298.7	5380.2	100.00	100.00	100.00
Agriculture & Fishing	841.7	816.4	775.9	16.27	15.41	14.42
Mining & Quarry	87.7	90.6	87.9	1.69	1.71	1.63
Manufacturing	830.5	859.6	860.8	16.05	16.22	16.00
Construction	396.2	417	488.8	7.66	7.87	9.09
Electricity, Gas & Water	30.3	41.7	31.1	0.59	0.79	0.58
Commerce	947.1	931.9	975.9	18.30	17.59	18.14
Financial Services	330.9	369.4	376.5	6.39	6.97	7.00
Personal, Communal & Social Services	1312.5	1377.9	1382.4	25.37	26.00	25.69
Transport & Telecommunications	395.3	393.9	401	7.64	7.43	7.45
Unspecified Activities	0.0	0.2	0.0	0.00	0.00	0.00

Source: Boletin Mensual, Banco Central de Chile, No.845, Julio 1998

Table 2.2.3 Foreign Trade of Chile: Export Value (1995-1997)

Export Products	(Million US$ FOB)			(Sectoral Share %)		
	1995	1996	1997	1995	1996	1997
AGRICULTURE	1,530.40	1673.9	1637	9.31	10.87	9.62
Agriculture	162.7	161.5	172.1	0.99	1.05	1.01
Fruit	1,161.8	1,345.8	1,291.8	7.06	8.74	7.59
Livestock	29.6	26.4	26.8	0.18	0.17	0.16
Forest Products	147.7	111.2	116.4	0.90	0.72	0.68
Fishery	28.6	29.0	29.9	0.17	0.19	0.18
MINING	7,984.1	7,101.7	8,243.1	48.55	46.13	48.42
Copper	6,646.8	5,881.0	6,975.8	40.42	38.20	40.97
Others	1,337.3	1,220.7	1,267.3	8.13	7.93	7.44
MANUFACTURING	6,876.3	6,510.7	7,050.9	41.81	42.29	41.42
Food & Feed	2,626.2	2,729.8	2,684.1	15.97	17.73	15.77
Beverage, Liquor & Tobacco	223.2	342.0	470.3	1.36	2.22	2.76
Textiles & Apparel	149.9	172.0	193.3	0.91	1.12	1.14
Hide, Leather, Shoes	32.7	26.9	33.0	0.20	0.17	0.19
Wood Furniture	734.5	729.2	838.0	4.47	4.74	4.92
Paper, Cardboard, Cellulose	1,628.5	952.9	966.3	9.90	6.19	5.68
Chemicals, Petroleum, Plastics	822.6	771.5	1,014.2	5.00	5.01	5.96
Ceramics, Glass, Non-metallic	28.3	33.0	41.9	0.17	0.21	0.25
Iron, Steel, Non-ferrous	220.8	198.3	200.3	1.34	1.29	1.18
Machinery, Equipment, Electric.	237.1	347.4	385.5	1.44	2.26	2.26
Transportation Materials	145.6	177.3	201.4	0.89	1.15	1.18
Unspecified Manufacturing	26.9	30.4	22.6	0.16	0.20	0.13
OTHERS	53.9	109.9	93.8	0.33	0.71	0.55
TOTAL	16,444.7	15,396.2	17,024.8	100.00	100.00	100.00

Source: Indicadores de Comercio Exterior, Banco Central de Chile, Abril 1998

Table 2.2.4 Foreign Trade of Chile: Import Value (1995-1997)

Import Products	(Million US$ CIF)			(Sectoral Share %)		
	1995	1996	1997	1995	1996	1997
CONSUMPTION GOODS	2,668.6	3,160.2	3,480.5	17.39	18.21	18.43
AGRICULTURE	39.1	41.0	45.3	0.25	0.24	0.24
MANUFACTURED PRODUCTS	2,629.5	3,119.2	3,435.0	17.13	17.97	18.19
Food, Beverage, Liquor, Tobacco	171.8	176.5	215.9	1.12	1.02	1.14
Textiles, Apparel, Leather Goods	450.6	602.0	647.1	2.94	3.47	3.43
Wood, Paper, Printing Goods	94.7	115.0	142.0	0.62	0.66	0.75
Chemicals, Oil Products	296.7	411.9	456.5	1.93	2.37	2.42
Non-mineral Metal Products	46.8	56.0	58.0	0.30	0.32	0.31
Metal Products, Machin. & Equip.	1,420.9	1,589.1	1,724.5	9.26	9.16	9.13
Other Manufactured Products	148.0	168.7	191.0	0.96	0.97	1.01
ART WORKS	0.0	0.0	0.2	0.00	0.00	0.00
CAPITAL GOODS	4,091.3	4,651.6	5,166.7	26.66	26.81	27.35
AGRICULTURE	0.9	1.5	1.5	0.01	0.01	0.01
MACHIN. & EQUIP., TRANSPORT	4,087.8	4,645.2	5,161.3	26.63	26.77	27.33
ART WORKS	2.6	4.9	3.9	0.02	0.03	0.02
INTERMEDIATE GOODS	8,138.2	8,992.8	9,458.0	53.02	51.82	50.07
AGRICULTURE	321.0	428.7	342.3	2.09	2.47	1.81
MINING	1,227.1	1,457.7	1,432.1	8.00	8.40	7.58
Petroleum, Carbon, Organic Min.	1,028.1	1,366.6	1,331.3	6.70	7.88	7.05
Copper, Iron, Other Minerals	199.0	91.1	100.8	1.30	0.52	0.53
MANUFACTURED PRODUCTS	6,587.8	7,104.1	7,680.7	42.92	40.94	40.66
Food, Beverage, Liquor, Tobacco	535.0	649.2	715.5	3.49	3.74	3.79
Textiles, Apparel, Leather Goods	493.5	488.9	494.3	3.22	2.82	2.62
Wood Products	44.7	63.0	84.1	0.29	0.36	0.45
Paper, Printing Products	428.8	348.1	387.9	2.79	2.01	2.05
Chemicals, Oil Products	2,353.3	2,646.7	2,757.1	15.33	15.25	14.60
Non-mineral Metal Products	156.6	194.1	219.9	1.02	1.12	1.16
Basic Metal Products	630.7	572.9	688.9	4.11	3.30	3.65
Metal Products, Machin. & Equip.	1,903.8	2,098.6	2,288.6	12.40	12.09	12.12
Other Manufactured Products	41.4	42.6	44.4	0.27	0.25	0.24
ART WORKS	2.3	2.3	2.9	0.01	0.01	0.02
OTHERS	162.5	170.4	225.5	1.06	0.98	1.19
Simplified Procedures, Postal	157.6	164.9	218.8	1.03	0.95	1.16
Remainder	4.9	5.5	6.7	0.03	0.03	0.04
Subtotal	15,060.6	16,975.0	18,330.7	98.13	97.82	97.05
Free Trade Zones	287.7	378.1	557.6	1.87	2.18	2.95
TOTAL	15,348.3	17,353.1	18,888.3	100.00	100.00	100.00

Source: Indicadores de Comercio Exterior, Banco Central de Chile, Abril 1998

CHAPTER 3

PRESENT CONDITION OF THE STUDY AREA

3 PRESENT CONDITION OF THE STUDY AREA

3.1 Rural Society and General Information

3.1.1 Area and Population

Administrative organization in Chile divide into Nation, Region (*Región*), Province (*Provincia*) and Community (*Comuna*) . Basically, community is the end-organization on the national administration. The study area consists of the Metropolitan Region and the parts of the V and VI Regions which includes 9 provinces and 64 communities. Total area of the study is about 19,500 km^2 and population is about 5.5 million in total. Details are as follows.

Region	Province	Community	Area (km^2)	Population
V Region	Valparaíso	Valparaíso(Penuelas)	120.0	639
		Casablanca	870.5	16,590
	San Antonio	San Antonio	404.5	78,158
		Cartagena	245.9	11,906
		El Tabo	98.8	4,513
		El Quisco	50.7	6,097
		Algarrobo	175.6	5,968
		Santo Domingo	536.1	6,218
VI Region	Cachapoal	Graneros	112.2	22,453
		Mostazal	522.9	18,138
		Codegua	284.6	9,600
		Las Cabras	747.1	17,738
Metropolitan	Santiago	Santiago	23.0	230,977
		Independencia	7.4	77,794
		Conchali	10.6	152,919
		Huechuraba	44.3	61,784
		Recoleta	15.0	164,767
		Providencia	14.2	111,182
		Vitacura	28.6	79,375
		Lo Bamechea	1,029.5	50,062
		Las Condes	98.5	208,063
		Nunoa	16.3	172,575
		La Reina	23.3	92,410
		Macul	12.3	120,708
		Penalolen	54.9	179,781
		La Florida	70.2	328,881
		San Joaquin	9.9	114,017
		La Granja	10.0	133,285
		La Pintana	30.3	169,640
		San Ramon	6.6	100,817
		San Miguel	9.5	82,869
		La Cisterna	10.0	94,712
		El Bosque	13.9	172,854
		Pedro Aguirre Cerda	8.8	130,441
		Lo Espejo	8.1	120,075
		Estacion central	14.3	140,896
		Cerrillos	19.0	72,649
		Maipu	133.0	256,550
		Quinta Normal	11.6	116,349
		Lo Prado	6.6	110,933
		Pudahuel	196.5	137,940
		Cerro Navia	11.0	155,735
		Renca	22.8	128,972
		Quilicura	56.6	41,121
	Chacabuco	Colina	966.8	52,769
		Lampa	449.4	25,033
		Tiltil	650.0	12,838
	Cordillera	Puerlte Alto	87.8	254,673
		San Josede Maipo	4,977.9	11,646
		Pirque	441.2	11,368

To be continued

Region	Province	Community	Area (km²)	Population
	Maipo	San Bemardo	154.8	190,857
		Buin	212.3	52,792
		Paine	675.6	37,529
		Calerade Tango	73.2	11,843
	Melipilla	Melipilla	1,338.9	80,255
		Maria Pinto	393.5	8,735
		Curacavi	691.2	19,053
		Alhué	840.6	4,013
		San Pedro	788.5	6,746
	Talagante	Talagante	124.4	44,908
		Penaflor	68.8	50,148
		Isla de Maipo	189.1	20,344
		El Monte	117.6	21,882
		Padre Hurtado	80.8	29,372
TOTAL			19,517.9	5,455,955

Based on the Census in 1992 carried out by INE, the population in the study area was 5,455,955. The population according to the resident registration in 1996 is 5,922,046 and annual population growth rate is 1.7%. While about 96% of the total population lives in urban areas, 230,000 or 4% of those in rural areas, according to the Census in 1992. The transition of the population in the study area is as follows;

Item	Population			% of Rural
	Total	Urban	Rural	
Census 70	3,285,542	3,046,056	239,486	7.29
Census 82	4,458,995	4,254,958	204,037	4.58
Census 92	5,455,955	4,255,907	228,135	4.18
92/70	1.66	1.66	0.95	0.58

Transition of the population in the Census has been increasing because the study area involves the capital city of Santiago. Compared the Census in 1970 with that in 1992, the increase is mainly due to concentration of the population in the urban areas. The rural population has been slightly decreasing. However, compared three censuses in 1970, 1982, and 1992, even though the rural population had decreased drastically in 1982, the population in many communities (*Comuna*) increased in 1992. This means that the rural population tends to go back to the level of 1970 in recent years.

Compared the Census in 1970 with the Census in 1992, 12 communities in rural areas show decrease of the population. Among them, 6 communities, Puente Alto, Huechuraba, La Florida, Quilicura, Penaflor, and El Tabo, depicts more than 50 % decrease. On the other hand, 23 communities show population increase. Among them, 2 communities, Colina, Tiltil, show more than 50% increase.

The reasons why some communities show the population decrease might be migration of persons who quit agriculture and of young generations to the urban areas. This is particular in communities located in mountainous areas. On the other hand, the communities which show the population increase are located mainly around the metropolitan area of Santiago and the surroundings of local cities. Especially, the communities which show more than 50 % increase of population are the areas which involve sub-divided housing lot with farm land.

3.1.2 Rural Society

(1) Structure

Rural society in Chile was drastically changed from the simple structure, which there are the owners of large plantations and their labor farmers, by enforcing Agrarian Reform Law (*Ley de Reforma Agraria*) in 1962. The Agrarian Reform was proceeded under Agrarian Reform Corporation (CORA: *Corporación de Reforma Agraria*) and small scale owner farmers who held about 8.5ha irrigation farmland (BIH: Basic Irrigated Hectares) were created. Allen Administration (1970~1973) combined large scale farmers with state farms and cooperative farms. However, military administration in 1974 redistributed these state farms and cooperative farms as private land and approved the land ownership of about 110,000 small scale owner farmers. Agrarian Reform was finished in 1978. Accordingly, rural communities consist of large number of these small scale farmers and their families, and small number of medium and large scale agricultural enterprises (most of them is business type agricultural management).

As mentioned above, the present rural society is a newly created society which consists of new and old landholders. Therefore, forming communal society as an unity of inhabitants has been not matured yet. The field of community as unit itself is vague. Take an example, so as to determine the community as an unity of inhabitants, "*Distrito*" which is the survey division of the Census for indicating a fundamental community, or the classification by population scale; *Ciudad* (city), *Pueblo* (town), and *Aldea* (village) has been used. They do not represent the community as a social unit but are just classifications in statistics. However, this does not mean that no social unit is formed. The living field of inhabitants is formed by setting churches and schools as the center. Moreover, *Juntas de Vecinos* (JJVV) have been formed as territorially related inhabitants' groups by man and women who are older than 18 year old .

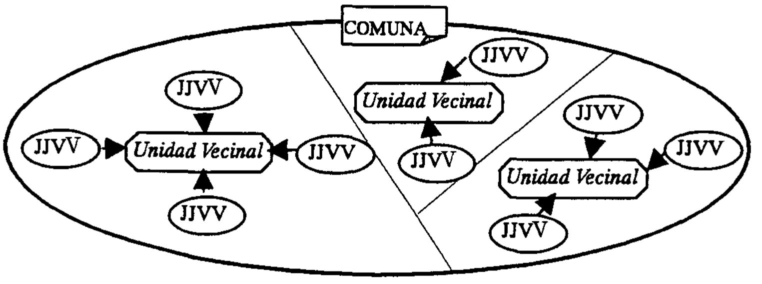
On the other hand, after transferring to civil administration in 1990, restoration of local election in 1992 induced active promotion of decentralization such as expanding local government finance. Corresponding with this, social policy extended into the fields of education, welfare, dwellings, labor, the administration of justice, and so on. In the administrative organizations of Chile, principally *Comuna* is the terminal of national administrative organizations. So as to promote decentralization, *Comuna* is divided into some blocks. This classification was primarily the living field based in order to promote the operation of *Comuna* effectively based on participation of inhabitants. This administration block is called *Unidad Vecinal* (UV).

UV is the unity whose constituents are JJVV that are territorially related self-governing communities. Therefore, it can be said that JJVV are the terminal organizations of administration and they are equal to so-called fundamental communities. So as to promote decentralization, the right of self-government was established for JJVV and its integrated unit, UV legally by Ley No.19,483 (*D.O., 30 de Noviembere de 1996*).

The summary of UV and JJVV is shown in the table below.

Unidad Vecinal (UV)	*Juntas de Vecinos* (JJVV)	*Vecinos*
Organization which tends un-concentration of operating *Comuna* and promotion of participation of inhabitants. It has the right of juridical person who does not seek profit-making for its development and benefit.	Community organization which represents inhabitants in UV. It cooperates with the nation and local government concerned to promote regional development, and protect inhabitants' benefit and right.	Individual inhabitants who settle in UV. The members of JJVV are inhabitants who are older than 18 years old and they have to register JJVV.

Relation between UV and JJVV in *Comuna* is shown in the figure below. In *Comuna*, there are some UVs.



However, some *Comunas* use the survey divisions (*Distrito*) for the Census as administrative divisions. The administrative classification is not well organized yet because the concept of UV is relatively new. In many cases, UV does not correspond with *Distrito*. Because *Distritos* have the characteristics of the survey divisions which divided by roads and rivers. On the contrary, UV which consist of JJVVs are based on territorially related connection. Thus , the gaps between UV and *Distritos* can be often seen.

(2) Human resources

In rural areas in the study area, about 95% of inhabitants engage in agriculture. According to the landholding scale of farmers, about 75%, 19% and 6% of total farmers are small scale farmers, medium scale farmers, and large scale farmers, respectively. Among them, large scale farmers mostly carry out business enterprise type farming and do not live in rural areas. On medium scale farmers, only about 50% of them live there. Therefore, most constituents of rural society are small scale farmers, and rural society is managed and operated by small scale farmers.

Although small scale farmers include tenants of large plantations and the second or the third sons of farm households, most of them are entrants into agriculture. Therefore, standard of agricultural technology is generally low, and they cannot develop farming eagerly. As a result, many farmers had to quit agriculture or leave communities. Accordingly, so as to establish stable farm management, public relations and extension of support services against farmers and the support system for guidance and training to change the present situation are indispensable, and the national government intends to strengthen the support system through INDAP and INIA as policy. Nevertheless, the support services have not so penetrated farmers that the methods of expanding the support services to all farmers are big problems. Moreover, overcoming this problem brings about development of human resource in rural areas.

Age composition of population in the study area represents almost same shape with national average one. Yet, the ratio of economically inactive population (0-15 years old and older than 65 years old) is higher, 32% while the main population of economic production activities (from 31 to 50 years old) is lower than national average ones. This might be caused by following reasons; the principal industry in the area is agriculture and the area is a pure farm village area where most of inhabitants engage in agriculture; a part of economically active population demand job opportunities out of regions' cities and its surroundings because it is relatively close to the metropolitan area of Santiago. Therefore, it is indispensable to obtain human resources for promoting regional industries and regions. Decreasing of young and middle aged generations is a problem of obtaining the successors for next generation.

In order to obtain human resources, securing job opportunities is important for the part of rural permanent settlement. In the strawberries' cultivation and its processing system in *Comuna* San Pedro, creating special products and obtaining job opportunities are combined. This system can be considered the model for regional permanent settlement in the future.

(3) Communities

The smallest unit as a group in the study area is JJVV as mentioned above. Because JJVV is formed through territorially related connection, it can be regarded as an unit community. Thus, hereafter, when the report says "community," it refers to JJVV. The communities in the study area are extended into both sides of main roads and shape row communities. There are few concentrated communities and dense communities. This is because farmland was divided at right angle along with roads and distributed with long and narrow shaped. So, farm households constructed their houses along with roads, and then this shape was formed. Consequently, farmland and houses are located in the same sections.

It is hard to form the centers of communities because each community shapes this kind of row communities but the places where public facilities such as churches and schools are located are regarded as the centers of the communities. Distance between communities is ranged approximately from 1km to 4km.

The communities are operated by mainly JJVVs. Ratio of those who join in the organizations is from about 50% to 70%. At present, integrated general opinions have not been achieved, yet.

(4) Rural organizations

As the organizations which form rural society, there are a fundamental organization which is an integrated self-governing body, UV, JJVV which is a self-governing body of communities, Center of Mother (*Centro de Madres*) which is the organization for improving women's education, Sports Club (*Clubes Deportivos*), Aid Committee (*Comités Allegados*) which is the organization for supporting poor households, Juveniles Group (*Grupos Juveniles*) which is the activity group of young generation, Culture Club (*Centros Culturales*) which is the club for fostering general education and so on. The activities of these organizations promote self-governmental activities with deepening mutual help and relationship among inhabitants in the study area.

The fundamental of each organization is JJVV, and its integrated unit is UV. So, basically each organization is formed JJVV. Forming JJVV, the mother bodies are often territorially related groups. The membership is the inhabitant who is older than 18 years old. President, director general, and secretary are selected by mutual vote. JJVV have to submit a members' list to *Comuna*, hold general meeting, and make an annual report. Each JJVV holds monthly meetings and discusses the present facing problems, the direction of regional operation, project plans, and so on.

On the other hand, there are producers' organizations by farmers and canal organizations by water right holders. They are not limited by UV and *Comuna* but formed as wide-ranged organizations which specialize their objectives and functions. The organizations are operated with general opinions of the members, democratically. Particularly, producers' organizations are formed fundamentally by medium and small scale farmers. When they are formed, support institutions such as INDAP provide support services.

(5) Gender

According to the data of MIDEPLAN-CASEN 96 (Socio-economic Characterization Survey), the effect of economic growth and social policy is shown, for example, the percentage of poor and extremely poor households got about halved, compared with 1987. Nevertheless, income disparity has not shrunken but relatively expanded. The same data also determines the extreme poverty lines (*Indigente*) by the cost of food baskets (sum of the food prices to satisfy the nutritious level for subsistence and non-food prices for subsistence) ; $17,136/month in urban areas, and less than $13,204/month in rural areas and that the poverty lines (*Pobre No Indigente*) are $34,272/month in urban areas and less than $23,108/month in rural areas.

Changes of population ratio of the poor (%) in Chile is as follows;

	1987	1990	1992	1994	1996
The extremely poor	17.4	12.9	8.8	7.6	5.8
Not extremely poor	27.7	25.7	23.8	19.9	17.4
The poor	45.1	38.6	32.6	27.5	23.2

The present administration sets poverty eradication as the important problem of policy, and implements various projects through Fund for Solidarity and Social Investment (FOSIS), and so on. These projects are not just distribution of subsidies and welfare but implemented with the aim at independence of the social vulnerable and participation of the poor in the process of development through expanding primary and vocational education, measurements for women and young generation, and support for middle and small enterprises.

On the poverty situation in the study area, the situation of *Comuna* Melipilla which is a typical rural area is summarized as the table below based on CASEN 96.

	Comuna Melipilla	Metropolitan Area	Nation
Extremely poor	3.4	2.7	5.8
Not extremely poor	13.3	12.1	17.4
Total	16.7	14.8	23.2

According to the table above, both the extremely poor and the poor are smaller than the national average, but both of them are higher than those of the Metropolitan Region as a whole. Improving poverty in rural areas is a objective. Thus, it is important to promote economic self-independence of small scale farmers.

On the other hand, education plays a big role to alleviate poverty. Improvement of educational environment has been implemented, actively. This results in drastic improvement of illiteracy rate. The change of illiteracy rate is shown in the table below.

	1990	1991	1992	1993	1994	1995	1996	1997
Illiteracy rate	6.3	6.1	5.7	5.2	4.9	4.9	4.8	4.7

According to CASEN 96, illiteracy rate by region in the study area is as follows;

	Urban areas			Rural areas			Total		
	Man	Woman	Total	Man	Woman	Total	Man	Woman	Total
Vth Region	2.2	3.2	2.7	9.5	7.4	8.5	3.0	3.6	3.3
VIth Region	4.9	4.8	4.8	13.9	14.6	14.2	8.2	8.0	8.1
MR	1.8	3.0	2.4	9.6	7.1	8.4	2.1	3.1	2.7
Chile	2.6	3.8	3.2	12.9	14.3	13.6	4.4	5.3	4.8

In the study area, the illiteracy rate of the VIth Region is extremely high, and it shows more than twice as much as the national average. The illiteracy rate in rural areas is about five times as much as that in urban areas. There is a big gap between urban and rural areas. Therefore, improvement of educational environment in rural areas will be the problem to be solved in the future.

Social advance of women in Chile started with acceptance of girls' students to elementary schools in 1810. Association for women's right is established in 1933, and women's right of vote established legally in 1949. In 1971, Recommendation on Equality of Job Opportunity Between Men and Women by ILO ratified. As a result, advance of women to various fields such as public officers, teachers, health and sanitary, and institutions has been activated, but this is not a situation in rural areas.

In many cases, women's share of works in rural areas is limited to housework and bringing up children. The concept that men work outside and women protect houses takes root. Therefore, women are isolated from the activities of JJVV and economic activities. The reason of this situation is that there are not enough training and education of skills for economic independence and of organized activities for women. At present, advance of women in various fields is active, but is not penetrated enough in rural areas. Dealing with this, INDAP promotes the support program for rural women's independence (PRODEMU) with National Service of Women, SERNAM. PRODEMU promotes participation of women on the field of green house cultivation and agricultural processing as the main activity. Not so many, but there are some organizations which are working with acquisition of skills for economic independence through forming producers' organizations by women. Accordingly, the activities for improving rural women's status are taking root, gradually. So as to establish this tendency more effectively, forming organizations of women in community level is needed. For this, improvement and construction of the base facilities for interchange among rural women and the support system for forming organization are indispensable.

3.1.3 Sub-basin Division

To grasp the basin characteristics in regional-wise, the study area is divided into 12 sub-basins based on administrative and basin boundaries. The sub-basins are as follows;

	Sub-basin	Communities(*Comuna*)		
1	Río Maipo Alto	Puente Alto	San Jose de Maipo	
2	Río Clarillo	Pirque		
3	Río Mapocho Alto	Santiago	Independencia	Conchali
		Huechuraba	Recoleta	Providencia
		Vitacura	Lo Barnecha	Las Condes
		Nunoa	La Reina	Macul
		Penalolen	La Florida	San Joaquin
		La Granja	La Pintana	San Ramon
		San Miguel	La Cisterna	El Boaque
		Lo Espejo	Pedro Aguire Cerda	Cerrillo
		Maipu	Estacion Central	Quinta Normal
		Lo Prado	Pudahuel	Cerro Navia
		Renca	Quilicura	
4	Est. Lampa	Colina	Lampa	Tiltil
5	Río Mapocho Bajo	San Bernardo	Calera de Tango	Talagante
		Penaflor	El Monte	Padre Hurtado
6	Río Angostura	Graeros	Mostazal	Codegua
		Buin	Paine	Isla de Maipo
7	Est. Alhué	Las Cabras	Ahué	
8	Cue. Melipilla	Melipilla		
9	Est. Puangue	Maria Pinto	Curacavi	
10	Est. Yali	Santo Domingo	San Pedro	
11	Cue. San Antonio	San Antonio	Cartagena	El Tabo
12	Est. Casablanca	Casablanca	El Quisco	Algarrobo
		Penuelas		

Distribution of communities and sub-basin division are shown in Fig.3.1.1 and Fig.3.1.2 respectively.

The population of each sub-basin is as follows;

	Population Census 92			Urban			Rural			%Rural population		
	Total	Urban	Rural	82/70	92/82	92/70	82/70	92/82	92/70	70	82	92
1. Río Maipo Alto	266,319	262,038	4,281	1.67	2.22	3.71	0.36	0.78	0.28	17.70	4.44	1.61
2. Río Clarillo	11,368	2,640	8,728	1.09	8.71	1.43	1.24	1.04	1.29	84.63	96.50	76.78
3. Río Mapocho Alto	4,311,133	4,298,240	12,893	1.36	1.18	1.60	0.59	0.71	0.42	1.13	0.49	0.30
4. Est. Lampa	90,640	60,910	29,730	1.96	1.56	3.07	0.91	1.64	1.50	50.03	31.73	32.80
5. Río Mapocho Bajo	349,010	313,459	35,551	1.75	1.46	2.57	0.98	0.96	0.94	23.63	14.75	10.19
6. Río Angostura	160,856	108,199	52,657	1.82	1.36	2.47	0.89	1.06	0.95	55.89	38.39	32.74
7. Est. Alhué	21,751	6,116	15,635	1.49	0.82	1.23	0.87	1.43	1.24	71.68	59.55	71.88
8. Cue. Melipilla	80,255	51,306	28,949	1.28	1.23	1.60	0.96	1.28	1.22	47.32	35.26	36.07
9. Río Puangue	27,788	12,999	14,789	1.56	1.25	1.95	1.01	1.32	1.33	62.48	51.83	53.22
10. Est. Yali	12,964	2,081	10,883	2.96	0.96	2.85	0.91	1.23	1.13	92.97	80.35	83.95
11. Cue. San Antonio	94,577	89,268	5,309	1.34	1.18	1.59	0.70	1.17	0.82	10.28	5.64	5.61
12. Est. Casablanca	29,294	20,564	8,730	1.59	1.31	2.08	0.89	1.06	0.95	48.25	34.45	29.80
Total	5,455,955	5,227,820	228,135	1.36	1.23	1.66	0.85	1.12	0.95	7.29	4.58	4.18

3.2 Natural Resources

3.2.1 Geology

Chile locates the part of volcanic and seismic zones in the Pacific Rim. The downgoing plate from the Pacific Ocean to the South American Continent forms the upheaval of the Andes mountains and volcanic and seismic zones exist in the country. To explain outline of geology in the study area, the area can be divided into 5 zones; the Andes mountains, the front part of the Andes mountains, the central basin, the coastal mountains, and the coastal plain.

(1) The Andes mountains

The Andes mountainous zone consists of sedimentary and volcanic rocks which deposited from the Mesozoic Jurassic period to the Mesozoic Cretaceous period. These rocks are folded drastically by orogenic movement or are displaced by faults. These axes of the fold and the fault lines are stretched from almost north to south not only in the study area but also in overall Chile. This orogenic movement was active from the Tertiary to the beginning of the Quaternary periods. One of the movements was intrusion of granodiorite during the Miocene of the Tertiary period. The size of this rock is about 2 to 20 km, and exposes many places such as in the main stream of the Maipo river. Furthermore, this orogenic movement has continued during the Quaternary period . One of the movements has been volcanic activity since the end of the Tertiary period. The andesite series, which has extruded from the Mesozoic deposit, are stretched as high mountains. The volcanoes which had been active during the Tertiary period became dormant volcanoes. On the other hand, the volcanoes which started their activities after the Quaternary period are still active volcanoes. There are three active volcanoes in the upstream of the Maipo river's tributary, the Volcán river. One of them, Mt. San Jose (Volcán San Jose, 5856m above the sea level) erupted violently in 1960.

(2) The front part of the Andes mountains

Geological structure of the front part of the Andes mountains consists of the upper part of the Mesozoic Cretaceous sedimentary rocks and the volcanic rocks which has erupted from the Tertiary Miocene to Pliocene. There is no new volcano. An axis of fold and a fault line stretch from north to south as same as the Andes mountains.

(3) The central basin

Base rock series of the central basin consist of almost the upper part of the

Mesozoic Cretaceous sedimentary rocks. Developed fault in the eastern part of the central basin depicts that the western part of that has sunk. There is no developed fault (zone), and no noticeable topographical change. There is no information to specify the starting era of the basin's depression, but it is estimated that the depression had been occurred in the beginning of the Diluvial epoch. The height of the depression is more than 450m. After forming the basin on the base rock, gravel flew into the central basin through rivers, and then alluvial fans were formed. The sediments of the alluvial funs include some stratums of pumiceous pyroclastic materials. Each river forms large or small alluvial fans, and also compound alluvial fans. After forming the alluvial fans, the Andes mountains and the front part of the Andes mountains still continues to be uphove. Thus, the surface of the alluvial funs has formed terrace by erosion. The top of the alluvial fans, which is from 25 to 30 m, has become terrace. Alluvial gravel bed has developed in the present river bed.

(4) The coastal mountains

The coastal mountains consist of the area which formed by the Mesozoic Cretaceous sedimentary rocks and volcanic rock series. The area was intruded by the granite series from the late Cretaceous period to the beginning of the Tertiary period. This coastal mountains are also uphove, but Alluvial and Diluvial deposits are developed widely because the large upheaval of the coastal terrace than the coastal mountains interrupt the rivers originating the coastal mountains..

(5) The coastal plain

The coastal plain consists of coastal terrace which is from 150 to 200m in relative height. The base rock is formed by the granite series which intruded in the Palaeozoic. The coastal terrace is covered by the Diluvial gravel deposit, but is divided by rivers. Poor alluvial deposit is spread along the present river bed.

Regarding the relationship between the water resources and geology, it should be considered that the dam site locates in the area which is not only orogen but also volcanic and seismic zones. Regarding the groundwater resources development, the sediments of the alluvial fans, which deposited on the depressed central basin in the process of the orogenic movement, can be considered as the main aquifer.

The summary of the geology in the study area is as follows. Moreover, Fig. 3.2.1 shows the geological map including the study area.

Period	Kinds of rock	Distributed area	Relationship with the water resources development
Alluvial age of the Quaternary period	sand・clay・gravel	The central basin, the present river bed・flooding area	Groundwater resources development
Diluvial age of the Tertiary period	sand・clay・gravel	Alluvial fans・terrace, the central basin・the coastal terrace	Groundwater resources development
The Miocene of the Tertiary period	Sedimentary rock series	The Andes mountains, the front part of the Andes mountains	Groundwater resources development
The Mesozoic period	Sedimentary rock series	The base rock in the central basin	Dam sites
The Tertiary period	Granodiorite	The Andes mountains	Dam sites
The Mesozoic period	Granodiorite	The coastal mountains	Dam sites
The Palaeozoic period	Granodiorite	The coastal terrace	Dam sites

3.2.2 Climate

Atmospheric dynamics in Chilean country is governed by the Pacific high pressure, a cold air mass from the South Pole, the Humboldt ocean current and the existence of the Andes Mountains. Climate in Chile can be classified into four from the north to south, arid, semi-arid, semi-humidity and humidity zones. The study area categorizes in semi- humidity zone and called the Mediterranean climate.

Most of the observatories, continuous observation is being carried out regarding the temperature, rainfall, evaporation and wind velocity though many lack of records can be found. The table below summaries major features of climatic condition within and near the study area. Cerro Calan may be considered representative of the basin situated between coastal mountains and the Andean Mountains, and Melipilla of the areas related to the coastal mountain areas.

Cerro Calan

Item	Jan.	Feb.	Mar	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Temperatura (ºC)													
Max.	34,6	34,2	33,2	30,5	26,7	24,0	24,5	26,4	28.2	29,9	32,7	34,2	29,9
Min.	10,2	9,8	7,9	5,5	3,2	1,0	0,6	1,0	1,9	3,4	5,4	8,1	4,8
Mean	22,2	21,8	20,1	16,6	13,2	11,1	10,5	11,3	12,6	15,3	18,2	20,8	16,1
Precipitación (mm)													
	0,9	2,3	5,6	25,2	65,0	85,6	105,9	66,5	42,2	20,6	11,3	7,4	438,1
Evaporación (mm)													
	189,6	155,9	125.4	61,6	31,4	18,5	20,8	33,4	53,0	102,6	137,3	181,0	1110,7
Humedad Relativa (%)													
	59,3	63,0	65,4	70,1	75,1	77,6	76,1	75,7	73,9	68,1	62,9	58,4	68,8
Horas de Sol (Hr)													
	11,4	10,6	8,6	6,4	4,4	3,6	4,0	4,9	5,6	8,0	9,7	10,7	7,3
Viento (km/month)													
	1156,4	815,5	721,0	441,3	294,8	286,1	404,7	437.4	598,0	780,1	955,6	1212,6	675,3

Melipilla

Item	Jan.	Feb.	Mar	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Temperatura (ºC)													
Max.	32,2	32,4	31,1	29,0	25,2	21,8	21,9	23,8	26,8	28,4	31,1	32,5	28,0
Min.	7,4	7,2	5,3	2,9	1,2	0,4	0,0	0,2	1,4	2,7	4,4	6,3	3.3
Mean	19,1	18,9	17,7	15,1	12,6	10,7	10,1	11,0	12,6	14,5	16,5	18,4	14,8
Precipitación (mm)													
	0,1	0,2	3,0	17,8	76,1	94,7	107,4	57,6	25,4	10,9	6,0	1,3	400,6
Evaporación (mm)													
	206,3	165,9	124,9	70,7	34,9	20,1	21,8	36,2	62,2	112,5	154,8	202,0	1212,4
Humedad Relativa (%)													
	60,1	62,5	66,3	70,9	77,5	80,7	80,1	77,1	72,9	67,2	62,5	58,7	69,7
Horas de Sol (Hr)													
	10,5	9,6	7,7	6,1	4,2	3,4	3,6	5,0	5,8	8,0	8,9	9,9	6,9
Viento (km/month)													
	1599,5	1158,1	877,9	508,1	526,5	693,6	845,6	751,2	900,3	1158,6	1381,8	1641,8	1003,6

(1) Rainfall

For estimation of average annual rainfall in the study area except the Andes Mountain areas, twelve (12) meteorological observatories were selected taking the location of observatories into account. Furthermore, to grasp the basin characteristics in regional-wise, the study area is divided into 12 sub-basins based on administrative and basin boundaries. Average monthly rainfall at each sub-basin is as follows taking the basin ratio estimated by the Theissen Polygon and the rainfall record at each meteorological station into account.

Unit : mm

No.	Station	Annual Average	85% Probability	No.	Station	Annual Average	85% Probability
1	Embalse Ruange	426,5	185,1	9	Las Melosas	904,5	554,1
2	Cerro Calan	438,1	252,7	10	Laguna Aculeo	625,5	280,6
3	Los Panguiles	357,5	182,8	11	Casablanca	366,1	206,8
5	Bocatoma Central la Ermita	501,8	185,2	12	Colliguay	596,5	317,3
6	Pirque	505,6	269,2	13	Rapel	486,8	292,6
8	Melipilla	400,6	212,6	14	Graneros	529,2	303,2

Unit: Area - km^2, Ratio - %, Rainfall - mm

Sub-Basin	Basin Area	Area Ratio	Annual Average		85% Probability	
			Sub-basin Rainfall	Areal Rainfall	Sub-basin Rainfall	Areal Rainfall
1 Río Maipo Alt	213	0,0158	503,6	7,9	225.0	3,5
2 Río Clarillo	441	0,0326	543,5	17,7	294.6	9,6
3 Río Mapocho Alt	1110	0,0821	432,6	35,5	238.8	19,6
4 Estero Lampa	1831	0,1355	434,7	58,9	246.3	33,3
5 Río Mapocho Bajo	620	0,0459	474,1	21,8	240.4	11,0
6 Río Angostura	1997	0,1478	598,1	88,4	315.0	46,5
7 Estero Alhué	1588	0,1175	562,9	66,1	288.8	33,9
8 Melipilla	1339	0,0991	428,1	42,4	219.7	21,7
9 Estero Puange	1085	0,0803	403,2	32,4	210.9	16,9
10 Estero Yali	1325	0,0980	470,0	46,1	277.0	27,1
11 San Antonio	749	0,0554	388,7	21,5	211.9	11,7
12 Estero Casablanca	1217	0,0900	373,1	33,6	210.2	18,9
	13515	1,0000		472,4		254,1

With above-mentioned average annual rainfall in the sub-basin, average annual rainfall in the study area can be estimated at 472 mm. Also annual rainfall under the condition of 85% exceedance probability is at 254 mm.

(2) Other meteorological items

The maximum air temperature in the study area except the Andes Mountains occurs in the mid of summer, December to February, and the minimum is the mid of winter, June to August. Annual average air temperature ranges 14 to 16 ºC, while summer shows 17 to 19 ºC and 10 to 13 ºC in winter. Daily difference of air temperature counts around 20 to 25 ºC through the year.

Annual average relative humidity shows 53 to 69 % in the study area except the Andes Mountains. Those values count 60 to 80 % in summer and 48 to 70 % in winter. On the other hand, annual average evaporation ranges 1100 to 1400 mm. During the summer, those values count over 100 to 250 mm though less than 100 mm shows in winter.

3.2.3 Soil and Land Use

(1) Present land use

Land use by basins in the study area is described as follows;

Zone	Farmland '97 Census	Farmland (ha)				Grassland (ha)	Forest (ha)	Urban (ha)	River etc. (ha)	Total (ha)
		Vegetable	Fruit	Cereals	Total					
1 .Río Maipo Alto	3,489	1,226	1,159	1,936	4,322	553	33	4,310	497,352	506,570
2. Río Clarillo	7,105	3,030	4,658	814	8,501	651	123	471	34,374	44,120
3. Río Mapocho Alto	9,795	8,422	2,073	3,189	13,683	5,150	450	51,746	131,632	202,660
4 Est. Lampa	19,482	10,521	5,534	5,432	21,486	13,321	401	25,164	146,247	206,620
5 Río Mapocho Bajo	28,111	11,753	15,657	4,586	31,996	2,076	30	11,583	16,276	61,960
6. Río Angostra	56,325	12,092	29,132	19,224	60,448	6,562	13,130	6,464	113,066	199,670
7 Est. Alhue	15,404	2,389,	2,500	5,385	10,274	3,752	725	288	143,735	158,774
8 Cue. Melipilla	30,492	9,070	10,706	17,547	37,323	8,635	522	2,133	82,278	133,890

To be continued

Zone	Farmland '97 Census	Farmland (ha)				Grassland (ha)	Forest (ha)	Urban (ha)	River etc. (ha)	Total (ha)
		Vegetable	Fruit	Cereals	Total					
9 Río Pangue	13,235	8,738,	2,394	6,711	17,842	5,549	290	1,649	83,139	108,470
10 .Est. Yali	17,884	311	7	30,313	30,632	20,687	25,977	1,373	53,791	132,460
11 Cue. San Antonio	16,177	214	26	23,787	24,027	5,303	15,931	3,493	26,166	74,920
12 Est. Casablanca	17,084	605	2,362	29,165	32,132	16,882	37,802	4,623	30,241	121,794
Total	234,585	68,370	76,206	148,089	292,666	89,121	95,414	113,295	1,361,298	1,951,794

Trend of land use in Santiago metropolitan area and local cities is that agricultural land is rapidly diverted to use for residential and commercial purposes. On the other hand, land in grassland and forestland are purchased by large-scale farmers for large scale orchard development. Information of SEREMI-MINVU is described an expansion of Santiago metropolitan area by invading to farmland summarized as follows;.

Year	Population (x ,000)	Area (ha)	Density (/ha)
1940	952.1	11,340	84.0
1952	1,354.4	15,570	86.9
1960	1,907.4	22,880	83.4
1970	2,779.5	29,480	94.3
1982	3,937.3	38,364	102.6
1992	4,676.9	46,179	101.3

Expansion of Santiago metropolitan area in 1992 is four times of 1940 and its trend is continuing more after then. Especially in Chacabuco province (Colina, Lampa, Tiltil) is urbanized rapidly. Therefore, SEREMI-MINVU has an intention to develop in disciplinary by establishment a urban plan including Chacabuco area in 1995. However, basic infrastructure development as potable water and sewerage seemed to be delayed. On the other hand as effects on agriculture, involvement of residential areas in the farmland is being caused environmental aggravation and confusion on agricultural production.

According to 1997 Census, 16,285 agriculture and livestock development plans were executed in the Study area and their total development area is 1,465,265 ha, however 465,215 ha (32%) of the area is not cultivated land and the rest was arable direct or indirect for production. 231,493 ha (approximately 15.8% of total development area) of arable land direct and indirect for production is under cultivation as shown below. 417,604 ha (Approximately 28.5% of total area) is natural and improved grassland, 321,187 ha (Approximately 21.9% of total area) is under forest mainly virgin forest, and 29,675 ha (Approximately 2.0% of total area) is indirectly concerned in production as canals, road, facilities, lakes and marshes.

Region	Total developed area (ha)	Cultivated Land*	Natural Grassland**	Forest, Canal	Indirect Use	No Arable land***
Metropolitan	1,139,180	162,293	278,887	231,215	24,121	442,665
V	207,119	35,495	92,562	69,674	2,473	6,915
VI	118,966	33,706	46,155	20,298	3,172	15,635
Total	1,465,265	231,493	417,604	321,187	29,765	465,215

* : Including improved grassland (30,879 ha), seasonal fallow and fallow land (43,384 ha)
** : Including natural grassland, improved grassland (improved grassland is 14,193 ha)
*** : Approximately 82% of no arable land is in San Jose de Maipo

It is for demonstrates significant relation of irrigated area and cultivated area. Irrigated area and the ratio of irrigable area to total development and total cultivated areas are shown below. Availability of irrigation is critical factor in order to determine benefit level of cultivation of non-irrigable land, it is particularly significant in majority of Metropolitan Region and V Region excluding Casablanca. V Region, on the other hand, cultivation in non-irrigable land is highly possible though 50% of farmland is grassland and fallow land.

Region	Total developed area (ha)	Irrigated area (ha)	Ratio of Irri. area/ Developed area	Ratio of Irri. area/ cultivated area
Metropolitan	1,139,180	143,671.0	12.6%	88.5%
V	207,119	6,664.6	3.2%	18.8%
VI	118,966	28,624.9	24.0%	84.9%
Total	1,465,265	178,960.5	12.2%	

Land use information of cultivated land in agricultural and livestock development in the study area is summarized in Table 3.2.1 based on 1997 Census. From the table, it is understand that intensive cultivation possible to high productivity per unit area is carried out around 43% of farmland in the study area. Fruits cultivation occupies 55,304 ha equivalent to 24% of total cultivated areas in the study area. Following fruits cultivation, vegetable cultivation shows 12% of 27,955 ha and grapes for wine counts 3.7% of 8,702 ha. In other crops, intensive cultivation is prevailed for seed, seedling and flower cultivation. A lot of profitable crop cultivation shows the fact that the study area has favorable characteristics for crop cultivation in view of soil and climate.

(2) New potential irrigation area

The classification of land productivity (REA) used by the office of Internal Tax Services (Servicio de Impuestos Internos) is obtained at CIREN for the study area in order to evaluate land productivity and of new irrigation development area. However the classification is involving problem such as indicate irrigated area if there is canal in an area and on accuracy and overestimation due to purpose mainly for evaluate farmland, however, it is an advantage on available of information by individual community and of information relatively close to reality. It is only information on potential and ration of land use because it is classified land potential by with and without irrigation classification

Information by each community of 12 sub-basin in the study area described in Table 3.2.2 based on the data obtained REA. The table is shown only community holding large farmland area and completely subdivided communities as Wechuraba and Lo Barunechea are not included. Total irrigated area in the Study area reaches 1,767,332 ha by REA and it is approximately 300,000 ha more than 1997 Census. The difference is occurred that REA is including the area of forest development and the Census is not. Land use classification in REA for Class VI and VII is 1,224,892 ha in total, it is correspond to 786,402 ha of the land not utilized for agriculture and the natural forest in the figure of Census.

Total irrigated area in the study area by REA is 217,093 ha which is excess 39,000 ha in the '97 Census's 178,960 ha. The figures in REA is relatively close to the official figures of 206,000 ha for actual irrigated area at present in the study area by CNR. The area where canals are developed in the study area is 231,00 ha. The '97 Census is seemed to be responded to actual irrigated area and the area was probably little underestimated during the '96-'97. Therefore, the difference between REA and the Census on irrigated area is depend upon include or exclude an area where insufficient water supply in canals are equipped.

Non irrigated farmland belong to the first priority of classes I, II, III and the second priority of class IV of classification of potential land productivity by respective sub-basins and communities was studied in order to specify high potential irrigation development area. Classes I to III are identified as an arable land with certain limitation and class IV is arable but with considerable limitation. Class VI which is mainly slope land without irrigation classified as non-arable was considered as potential arable land utilizing slope in case of favorable climate and no limitation of slope. Irrigable areas in sub-basin bases according to above mentioned priorities are shown below;

Sub-basin	Potential Classification of land Productivity (ha)		
	I - III	IV	VI
Est. Yali	10,474	15,528	35,206
Est. Casablanca	9,961	15,818	20,962
Cue. San Antonio	4,727	12,012	20,536
Est. Alhue	4,240	14,944	10,178
Est. Lampa	4,143	16,545	21,817
Est. Puangue	2,611	7,023	17,041
Cue. Melipilla	1,673	8,710	27,324

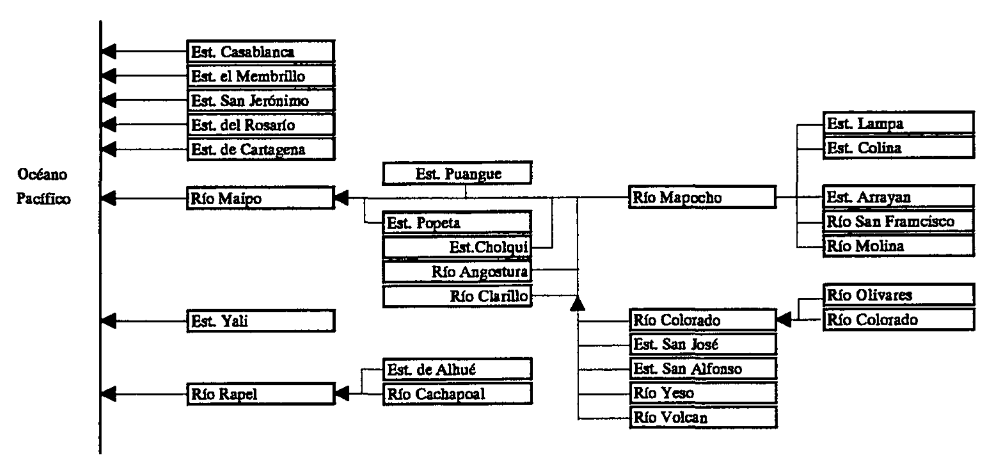
In case of San Antonio sub-basin, considerable part has become the area for expansion of neighboring resort and water diversion to this area is difficult due to high altitude. Santo Domingo of Est. Yali sub-basin is also similar and resort area is expanding into the majority land of 5,357 ha of classes I and III. However, the rest of land in Santo Domingo and San Pedro are far from resort area and remain 6,000 ha of classes I and III and 30,000 ha of class IV. Est. Lampa sub-basin has large irrigable land, however, holding special situation. Chacabuco province has 35,000 ha of arable land according to SEREMI de Agriculture and 49,000 ha of land is divided for sale as lots for villa residence. High potential irrigation development areas are Est. of Yali, Casablanca, Alhue, Puangue, Lampa and Melipilla according to REA information of arable land without irrigation.

Fig.3.2.2 shows soil map, classification of potential land productivity in Fig. 3.2.3, and present land use in Fig.3.2.4.

3.2.4 Water Resources

(1) Surface runoff

Rio Maipo, main stream and its tributaries, composes the river system in the study area. As for the other rivers, Rio Rapel located the southern part of the study area and small rivers originated in the coastal mountains flow down separately with Rio Maipo into the Pacific Ocean. River diagram regarding the major rivers and streams related to the study area is as follows;



Concerning the water utilization in the study area, surface runoff in each sub-basin is estimated to clarify the available surface runoff under the condition of average and 85% exceedance probability. Runoff from each sub-basin is calculated with the following procedures;

- Estimation of runoff in each sub-basin divides into two manners, one is runoff from the Andes Mountains and other is runoff from the areas except the Andes Mountains. Observation record is employed as the runoff from the Andes Mountains and areal rainfall is used for estimation of runoff in other areas.
- Following three sub-basins are involved with runoff from the Andes Mountains. Observatories used for the estimation are also shown in the table.

Sub-basin	River	Observatory
Río Maipo Alto	Río Maipo	Río Maipo en el Manzano
		Río Yeso en Embalse el Yeso
Río Mapocho Alto	Río Mapocho	Estero Arrayan en La Montosa
		Río Mapocho en los Almendros
Est. Lampa	Est. Colina	Colina en Compuerta Vargas

- Runoff from areas except the Andes Mountains is estimated by using areal rainfall in each sub-basin. Runoff coefficient is used for conversion from the rainfall amount to the runoff volume. Runoff coefficient is employed at 0.276 with the discharge record at Quilamuta (Est. de Alhué) and Boqueron (Est. Puangue) observatories, and areal rainfall of its river basins.

Observatory	Basin Area km^2	Annual runoff (1) MCM	Annual Rainfall (2) MCM	Runoff (1) / (2)
Quilamuta	779	133,8	470,9	0,284
Boqueron	137	21,9	81,7	0,268

Estimated results of surface runoff in each sub-basin are as follows with procedures mentioned above. Estimation is made on average year and 85% exceedance probability year conditions.

Sub-Basin	Basin -area (km^2)	Annual Average (MCM)	85% Probability (MCM)
1 Río Maipo Alt	213	3,743.21	2,337.25
2 Río Clarillo	441	66.16	35.86
3 Río Mapocho Alt	1110	448.65	183.32
4 Estero Lampa	1831	250.11	138.81
5 Río Mapocho Bajo	620	81.13	41.13
6 Río Angostura	1997	329.68	173.61
7 Estero Alhué	1588	246.72	126.59
8 Melipilla	1339	158.19	81.21
9 Estero Puange	1085	120.73	63.16
10 Estero Yali	1325	171.86	101.29
11 San Antonio	749	80.36	43.81
12 Estero Casablanca	1217	125.32	70.59
Total	1,3515	5,822.1	3,396.6

With these estimation results, surface runoff of annual basis in the study area can be summarized as follows;

Item	Annual Average (MMC)	85% Probability (MMC)
Total annual runoff	5,822.1	3,396.6
Oct. to Mar.	2,989.6	1,756.0
Apr. to Sep.	2,832.5	1,640.6
Runoff from the Andean Mountains	4,060.2	2,448.5
Oct. to Mar.	2,867.7	1,689.1
Apr. to Sep.	1,192.5	759.4
Runoff from areas except the Andean Mountains	1,761.9	948.1
Oct, a Mar,	121.9	66.9
Apr. to Sep.	1,640.0	881.2

Surface runoff in the study area can be estimated around 58 MCM in the average year. 70% of total surface runoff is supplied by thaw in the Andes Mountains, furthermore, 70% of runoff from the Andes Mountains concentrates upon summer, from October to March. Runoff from areas except the Andes Mountains is estimated around 17.6 MCM and 90% of total runoff generates by precipitation falling in winter from April to September.

(2) Groundwater

The potential yield of groundwater in the study area is estimated based on following assumptions.

- So as to estimate potential yield of groundwater in the study area, groundwater units are settled based on hydrogeological structure in the study area. Twelve (12) groundwater units are settled in the study area on the basis of existing data compiled by the hydrogeological survey results.
- The area of aquifer distribution in each groundwater unit refers to the figures in "*Proyecto Maipo – Estudio Hidrologico e Hidorogeologico y Album de planos, CNR, 1984.*" For the units having no area data, unit area is estimated by the topographical map.
- The depth of water holding stratum is settled referring to the depth of existing wells and the hydrogeological profile.
- The ratio on depth of aquifer is estimated through dividing the total depth of aquifer and semi-aquifer, which shown in the hydrogeological profile, by drilling depth of well.
- The capacity of aquifer is estimated through multiplying the area of aquifer, the depth of water holding stratum, and the ratio on the depth of aquifer.
- Effective porosity is employed the value shown in the above reference data. The value is applied to each aquifer; unconfined, confined, and semi-confined aquifers.

According to the assumptions above, estimated potential yields of groundwater in each unit are as follows;

Groundwater unit	Area of aquifer distribution (km^2)	Depth of water holding stratum (m)	Ratio on depth of aquifer (%)	Capacity of aquifer (MCM)	Effective porosity (%)	Potential yield (MCM)
Maipo - Mapocho Superior	40.0	50	59	1,180	15	177
Maipo - Mapocho U	1,635.6	100	59	96,500	15	14,475
Maipo - Mapocho L	1,308.5	200	59	154,403	5	7,720
Maipo - Inferior	625.1	180	50	56,259	0.3	169
Til Til - Lampa	64.6	150	53	5,136	20	1,027
Chacabuco - Polpaico U	168.5	100	46	7,751	6	466
Chacabuco - Polpaico L	134.8	50	46	3,100	0.2	6
Colina - Batuco U	477.8	100	32	15,290	0.4	61
Colina – Batuco L	382.2	150	32	18,346	0.4	73
Angostura u/s	203.8	50	34	3,465	0.4	17
Angostura d/s	72.0	100	34	2,448	0.3	7
Puangue u/s	51.3	100	34	1,744	5	87
Puangue d/s	483.3	150	37	26,823	4	1,073
Casablanca U	162.5	50	39	3,169	13	412
Casablanca L	130.0	150	39	7,605	0.3	23
San Geronimo	15.9	50	81	644	8	52
Del Rosario	31.8	50	47	747	6	45
Cartagena	7.0	100	51	357	5	18
Yali	192.9	100	52	10,031	0.2	20
Alhué	237.7	100	52	12,360	0.6	74
Total	6,425.3			427.358		26,002

U, L, u/s and d/s accompanied with the groundwater units in the above table show qualitative division for the area of aquifer, based on the hydrogeological structure of each unit.

- U: The area of aquifer distributed in the alluvial and diluvial deposits within the groundwater units.
- L: The area of aquifer distribution which extracted the area of shallow base rock, and 80% of the groundwater unit area is employed for the area.
- u/s: The area of aquifer distribution located in the upstream reach of rivers.
- d/s: The area of aquifer distribution located in the downstream reach of rivers.

According to the table above, the potential yield of groundwater in the study area counts around 26,000 MCM, but Maipo-Mapocho groundwater unit occupies more than half of it, 22,000 MCM.

3.3 Economy

3.3.1 Regional Economy

Table 3.3.1 shows the gross regional product (GRP) of each administrative Region of Chile, in relation to the gross domestic product (GDP). The three Regions comprising the Study area, namely, Region V, Metropolitan Region and Region VI, together account for around 53% of GDP (39% Metropolitan Region, 9% Region V, and 5% Region VI). However, since only small areas of Region V and Region VI are included in the Study area, the gross regional product of the Study area can be estimated as 45% of GDP. Still, inclusion of Metropolitan Area makes the study area a dominant element in the national economy.

Table 3.3.2 shows gross regional products of Region V, Metropolitan Region and Region VI, respectively, by economic activity. In Region V, Manufacturing is the most important component of GRP comprising more than 20%, while in the Metropolitan Region the service sector such as Commerce and Financial Services comprise the overwhelming majority, and in Region VI Mining is the most important GRP component with around 30%.

Agriculture and Forestry as a component of GRP comprise the highest proportion in Region VI and the lowest in Metropolitan Region. Interestingly, however, Agriculture and Forestry of Metropolitan Region make the highest contribution, among the three Regions, to the Agriculture component of GDP. In other words, Agriculture and Forestry in Metropolitan Region comprise around 3% of GRP, but about 16% of GDP. On the other hand, Agriculture and Forestry in Region V comprise around 10% of GRP and 11% of GDP, while in Region VI the corresponding figures are about 25% of GRP and 15% of GDP. The dominant weight of Agriculture and Forestry of Metropolitan Region can be attributed to the large size of its GRP, and to the high value of the agricultural outputs produced in the Metropolitan Region.

3.3.2 Water Utilization in the Economic Sector

Water utilization in the study area is broadly divided into three categories, irrigation water use over 179.000 ha of farmland, drinking water supply for 5.5 million residents including Santiago city and industrial water utilization.

(1) Irrigation water use

Present water utilization for irrigation is estimated on the basis of the irrigation area shown in the Census in 1997 carried out by INE and the water requirement of crops with the sub-basin wise. Present irrigation area with the sub-basin and crop wise is summarized as follows;

Unit : ha

	Sub-basin	Trigo	Maiz	Cebolla	Alfalfa	Vid	Vinas	Total
1	Río Maipo Alt	136,4	59,0	302,4	744,9	560,5	449,9	2253,0
2	Río Clarillo	705,5	28,5	292,2	1624,9	1724,7	591,5	4967,3
3	Río Mapocho Alt	1146,0	539,3	3428,5	2542,5	1338,7	423,7	9418,8
4	Estero Lampa	880,8	161,8	7261,7	3594,9	5284,5	107,8	17291,5
5	Río Mapocho Bajo	3818,7	1002,1	5254,1	5714,5	9939,4	839,6	26568,2
6	Río Angostura	10709,7	1153,4	8732,5	3844,5	21913,7	4174,0	50527,9
7	Estero Alhué	5808,3	1319,5	693,7	1278,6	2815,7	435,3	12351,2
8	Melipilla	7961,3	1123,2	5318,5	9546,9	7399,7	462,5	31812,1
9	Río Puange	3009,4	1678,6	3493,4	4068,0	2253,3	362,9	14865,7
10	Estero Yali	88,2	197,5	171,3	1864,0	544,9	11,2	2877,1
11	San Antonio	23,5	88,2	266,2	209,1	151,1	9,0	747,1
12	Estero Casablanca	220,6	19,0	465,7	2757,8	509,2	1308,4	5280,7
	Total	34508,5	7370,0	35680,2	37790,6	54435,4	9175,9	178960,5

Crop water requirement is estimated considering the potential evapo-transpiration (ETo), crop coefficient, effective rainfall and prevailing irrigation method in the study area.

Meteorological data at Melipilla and Cerro Calan are employed for the estimation taking the meteorological conditions into account. Data at Melipilla is applied for the areas located from coastal mountains to the coast and Cerro Calan for the areas central basin in the study area. Potential evapotranspiration of crop and diversion water requirement by crops at field level are as follows;

Item	Unit	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Cerro Calan														
ETo	mm/day	6,45	5,72	4,13	2,72	1,79	1,39	1,45	1,89	2,56	3,73	5,01	6,26	mm
	mm/month	200,0	177,3	123,9	84,3	53,7	43,1	45,0	52,9	79,4	111,9	155,3	187,8	1314,5
Melipilla														
ETo	mm/day	5,99	5,17	3,83	2,49	1,53	1,15	1,24	1,78	2,68	3,98	5,05	5,9	mm
	mm/month	185,7	160,3	114,9	77,2	45,9	35,7	38,4	49,8	83,1	119,4	156,6	177,0	1243,9

Crops	Application Efficiency	Unit	Unit Water Requirement Cerro Calan	Melipilla
Trigo	0,3	mm	1390	1416
Maiz	0,45	mm	1869	1770
Alfalfa	0,3	mm	3207	3110
	0,9	mm	-	1037
Cebolla	0,45	mm	1588	1541
	0,9	mm	-	770
Vid	0,45	mm	2453	2115
	0,9	mm	973	1058
Vinas	0,45	mm	1962	1692
	0,9	mm	-	846

Based on the crop water requirement and irrigation area in sub-basin wise, irrigation water amount can be summarized as follows;

Sub-basin	Irrigation Area (ha) Total	Surface Flow	Groundwater	Irrigation Demand (MCM) Surface Flow	Groundwater
1. Río Maipo Alt	2252,9	2153,2	99,7	64,78	1,02
2. Río Clarillo	4967,3	4439,4	527,9	135,07	5,41
3. Río Mapocho Alt	9418,8	8871,0	547,8	237,15	5,61
4. Estero Lampa	17291,5	13381,8	3889,7	352,78	39,84
5. Río Mapocho Bajo	26568,2	25423,6	1144,6	713,40	11,72

To be continue

6. Río Angostura	50527,9	45105,7	5422,2	1148,49	55,53
7. Estero Alhué	12351,2	11070,8	1280,4	244,87	14,25
8. Melipilla	31812,1	28690,6	3121,5	762,22	34,75
9. Estero Puangue	14865,7	13412,3	1453,4	344,65	16,18
10. Estero Yali	2877,1	488,5	2388,6	13,81	25,68
11. San Antonio	747,1	455,3	291,8	10,39	3,23
12. Estero Casablanca	5280,7	3026,0	2254,7	103,50	22,09
Total	178960,5	156518,2	22422,3	4131,12	235,32

With the table shown above, required irrigation water amount in the study area counts around 4,370 MCM. Out of which, 4,130 MCM depends on surface runoff and 240 MCM on the groundwater.

(2) Drinking water utilization

Following public and/or private corporations perform drinking water supply in the study area.

Region	Corporation	Commanding Area	Related Sub-basin of the Study
Metropolitan	Empresa Metropolitana de Obras Sanitarias S. A. (EMOS)	Gran Santiago, Agua Potable Rural	Río Maipo Alt, Río Mapocho Alt, Río Mapocho Bajo, Est. Lampa, Melipilla, Río Angostura, Est. Puangue
	Servicio Municipal de Agua Potable y Alcantarillado de Maipú (SMAPA)	Maipú	Río Mapocho Alt
	Empresa Agua Potable Manquehue (EAPM)	Manquehue, La Dehesa Huechuraba, Chicureo	Río Mapocho Alt
	Aguas Cordillera S. A. (AC)	Las Condes, Vitacura	Río Mapocho Alt
	Servi*Comunal* S.A. (SC)	Colina, Lampa	Est. Lampa
V	Empresa de Obras Sanitarias de Valparaíso (ESVAL)	Gran Valparaíso	Casablanca
	Aguas Quinta S.A. (AQ)	San Antonio	San Antonio, Casablanca
VI	Empresa de Servicios Sanitarias del Libertador (ESSEL)		Río Angostura

Based on the information regarding the annual production value of drinking water and forecasted production value obtained from each corporation, present and future drinking water supply of each sub-basin in the study area can be summarized as follows. Some figures are compensated by the report such as "*Análisis Uso Actual y Futuro de los Recursos Hídricos de Chile - IPLA Ltda*" and "*Modelo de Simulación Hidrológico Operacional Cuencas de los Ríos Maipo y Mapocho - Informe Etapa II Demandas de Agua - AC Ingenieros Consultores Ltda.*"

Sub-basin	Major Cities	Supply	Present Water Supply			Forecasted Water Supply		
			1997	Water Source		2010	Water Source	
			Production	Surface flow	Groundwater	Production	Surface flow	Groundwater
1. Río Maipo Alt	San Gabriel	EMOS	0,09	-	0,09	0,12	-	0,12
	San José de Maipo	EMOS	1,05	-	1,05	1,36	-	1,36
	El Canelo-Las Vertientes	EMOS	2,05	-	2,05	2,65	-	2,65
	Total		3,19	-	3,19	4,13	-	4,13
2. Río Clarillo	Pirque		0,62	-	0,62	0,78	-	0,78
3. Río Mapocho Alt	Gran Santiago	EMOS	442,21	385,61	56,60	462,30	392,03	70,27
	Maipú	SMAPA	53,19	-	53,19	68,82	-	68,82
	Manquehue	EAPM	3,77	-	3,77	7,68	-	7,68
	Las Condes	AC	69,90	52,42	17,48	107,21	80,41	26,80
	Total		569,07	438,03	131,04	646,01	472,44	173,57
4. Estero Lampa	Lampa, Colina	SC	4,07	-	4,07	13,59	-	13,59
	Til Til	EMOS	0,44	-	0,44	0,57	-	0,57
	Total		4,51	-	4,51	14,16	-	14,16
5. Río Mapocho Bajo	Talagante	EMOS	4,30	-	4,30	5,56	-	5,56
	El Monte	EMOS	1,69	-	1,69	2,19	-	2,19
	Padre Hurtado	EMOS	3,44	-	3,44	4,45	-	4,45
	Malloco Peñaflor	EMOS	5,40	-	5,40	6,99	-	6,99
	Total		14,83	-	14,83	19,19	-	19,19

6. Río Angostura	Isla de Maipo	EMOS	0,68	-	0,68	0,88	-	0,88
	Valdivia de Paine	EMOS	0,14	-	0,14	0,18	-	0,18
	Buin-Paine-Linderos	EMOS	6,98	-	6,98	9,03	-	9,03
	Graneros	ESSEL	1,38	-	1,38	1,78	-	1,78
	Total		9,18	-	9,18	11,87	-	11,87
7. Estero Alhué	Villa Alhué		0,15	-	0,15	0,19	-	0,19
	Las Cabras	ESSEL	0,43	-	0,43	0,56	-	0,56
	Total		0,58	-	0,58	0,75	-	0,75
8. Melipilla	Melipilla	EMOS	3,21	-	3,21	4,15	-	4,15
	Pomaire	EMOS	1,56	-	1,56	2,02	-	2,02
	Total		4,77	-	4,77	6,17	-	6,17
9. Estero Puangue	Curacaví	EMOS	1,35	-	1,35	1,75	-	1,75
10. Estero Yali			0,69	-	0,69	0,89	-	0,89
11. San Antonio	San Antonio	AQ	7,30	4,74	2,56	9,04	5,85	3,19
	Cartagena	AQ	2,08	1,35	0,73	2,51	1,63	0,88
	El Taba	AQ	1,41	0,92	0,49	2,48	1,61	0,87
	Total		10,79	7,01	3,78	14,03	9,09	4,94
12. Estero Casablanca	Casablanca	ESVAL	0,82	-	0,82	1,07	-	1,07
	El Quisco	AQ	1,81	1,18	0,63	2,37	1,54	0,83
	Algarrobo	AQ	1,31	0,85	0,46	2,12	1,38	0.74
	Total		3,94	2,03	1,91	5,56	2,92	2,64
Grand Total			623,52	447,07	176,45	725,29	484,45	240,84

With the table shown above, drinking water supply at present situation in the study area counts around 623 MCM. Out of which, 447 MCM depends on surface flow and 176 MCM on the groundwater. In future, those drinking water supply are estimated to increase around 102 MCM.

(3) Industrial and mining water use

Industrial and mining water use in the study area depends entirely on the groundwater. Most of the factories locates in the Río Mapocho basin, and others in the Estero Lampa and Río Angostura basins. Basic data for present and future water utilization in those economic sectors are extracted from the report "*Análisis Uso Actual y Futuro de los Recursos Hídricos de Chile - IPLA Ltda*".

	Industrial (MCM)		Mining (MCM)		Total (MCM)	
	1997	2010	1997	2010	1997	2010
1. Río Maipo Alt	-	-	-	-	-	-
2. Río Clarillo	-	-	-	-	-	-
3. Río Mapocho Alt	224,87	382,93	10,37	13,62	235,24	396,55
4. Estero Lampa	33,96	57,83	-	-	33,96	57,83
5. Río Mapocho Bajo	13,26	22,57	-	-	13,26	22,57
6. Río Angostura	0,55	0,93	-	-	0,55	0,93
7. Estero Alhué	-	-	-	-	-	-
8. Melipilla	0,40	0,68	-	-	0,40	0,68
9. Estero Puangue	-	-	-	-	-	-
10. Estero Yali	-	-	-	-	-	-
11. San Antonio	-	-	-	-	-	-
12. Estero Casablanca	6,91	9,73	-	-	6,91	9,73
Total	279,95	474,67	10,37	13,62	290,32	488,29

With the table shown above, industrial and mining water use in the study area estimate around 290 MCM. In year 2010, it is estimated that those water use increase around 70% as it was.

(4) Summary of the water utilization

Present water utilization of the economic sector in the study area can be summed up 5,280 MCM in total as follows. Out of which, 4,580 MCM depends on surface runoff and 700 MCM on groundwater.

Unit: MCM

Water Source	Irrigation Use	Drinking Water Use	Industrial Use	Total
Surface runoff	4,131.12	447.07	-	4,578.19
Groundwater	235.32	176.45	290.32	702.09
Total	4,366.44	623.52	290.32	5,280.28

(5) Water balance

The model for the water balance study is constructed to clarify the water utilization in the study area. The model consists of twelve (12) basin-blocks and those basin-block equivalent to sub-basin division of the study. Expression of the balance on demand and supply of water in the sub-basin is made with inflow and outflow of the sub-basin as variables. Calibration of the model is made by the monthly basis precipitation and runoff records of three years, from 1993 to 1995. Verification between measured and estimated discharges is made at points, Río Mapocho Rinconada de Maipú, Río Angostura en Valdivia de Paine and Río Maipo en Cabimbao.

Water shortage on irrigation and other water utilization can be summarized as follows using the simulated results in average and 85% exceedance probability on precipitation and runoff.

Sub-basin	Demand (a) (MCM)		Average		85% probability	
	Irrigation	Others	Deficit (b) (MCM)	Ratio (b/a) %	Deficit (b) (MCM)	Ratio (b/a) %
1. Río Maipo Alt	65.798	3.190	0.000	0.00	0.000	0.00
2. Río Clarillo	140.478	0.620	0.000	0.00	3.048	0.02
3. Río Mapocho Alt	242.758	804.310	0.000	0.00	0.000	0.00
4. Estero Lampa	392.614	38.470	158.857	0.37	194.815	0.45
5. Río Mapocho Bajo	725.123	28.085	0.000	0.00	62.610	0.08
6. Río Angostura	1204.022	9.726	508.621	0.42	594.097	0.49
7. Estero Alhué	259.128	0.580	199.570	0.77	214.339	0.83
8. Melipilla	796.971	5.168	549.590	0.69	564.292	0.70
9. Estero Puangue	360.834	1.350	126.089	0.35	131.278	0.36
10. Estero Yali	39.495	0.690	5.746	0.14	7.315	0.18
11. San Antonio	13.625	7.010	7.855	0.38	8.774	0.43
12. Estero Casablanca	125.595	8.939	48.650	0.36	54.470	0.40
Total	4366.440	908.138	1604.978		1835.038	

Following can be pointed out regarding the present water utilization in the study area;

- Irrigation water use occupies over 80% among the water demand in the study area,

- Water shortage shown in the above table arises in irrigation use. Irrigation demand is estimated on the basis of theoretical crop water requirement, therefore, ratio of deficit for irrigation can be considered as the sufficiency ratio against the theoretical crop water requirement.

- Water shortage arises in the most of the sub-basins except the sub-basin can easily be used runoff from the upstream reach of Río Maipo.

3.4 Present Agricultural Situation

3.4.1 Land Classification by Land-holding Scale and Degree of Modernization on Farm Management

(1) Land-holding scale

The classification on land-holding scale in Chile has following legislative and institutional aspects.

1) Equivalent area or Basic Irrigation Area (HRB)

All land is regarded as being converted in and equivalent to basic irrigation area. Basic Irrigation Area (HRB) is evaluated to estimate of all land by equivalence of basic irrigation area. This concept is come up so as to establish the common estimation criteria for farmland by tax office and the criteria for land expropriation by scale on the process of agricultural reform. At present, this concept is applied to various laws such as the Law No. 18450 which formulated on the base of land estimation and the Agricultural Reform Law.

2) Landholding by household unit

About 8 HRB land, which can be used stably without someone's help and with which one family can live. The size was determined with concerned technical level in the time when the Agricultural Reform Law became effective (1968),.

3) Large scale landholding

In the Agricultural Reform Law, "large scale landholding" refers to over 80 HRB landholding. This criterion was determined in order to promote efficient middle scale farming by household unit. In the Agricultural Reform law, efficient landholders can hold until 320 HRB land, exceptionally.

4) Small scale landholding

In the INDAP Basic Law, "small landholder" refers to those who have the land of smaller than 12 HRB. All plans for small scale farm households by INDAP and other public institutions have been established on the base of this category. The support services for small scale farm households under the Law No. 18450 are based on this category. Moreover, a definition of small scale farm households of INDAP describes two points which land holder lives mainly by agriculture and property to be succeeded is within a certain limits

5) Landholding except agricultural use in rural area

The Law 3516 which approves division of local farmland by up to 5,000m^2 unit resulted in promotion of diverting local farmland into land for cottage building or housing lot. They are scattered in traditional small scale farmland.

6) Information on the '97 Census

The most current information on landholding classification is the Census in 1997. In the Census, no distinction is made on irrigated or non-irrigated farmlands on land holding classification. Also, no reference is mentioned on the characteristics of each farmlands.

According to these conditions and the purpose of the study, landholding scale of each farm household in the study area is classified into following three types.

- 0.5 - 15.0 ha :
  Small scale landholding. Most of small landholders in the central valley are in irrigated area, and it is considered that the scale of most irrigated land in the Maipo river basin is about 1.0 HRB. This classification assumes the landholders who hold 0.5 - 12.0 HRB.
- 15 - 100 ha
  Middle scale landholding. Almost the same criterion with small landholders is applied to middle scale landholders. This classification assumes the landholders who hold 12 - 80 HRB.

- Larger than 100 ha
  Large scale landholding. This criterion assumes over 80 HRB landholding, but most of such scale's land does not have irrigation facilities.

Under 0.5 ha land is excepted from the land classification because most of them are not farmland. The Census in 1997 did not care under 0.5 ha landholding as the subject of the agricultural development. In the study area, 1,251 landholdings were assured and their total area is 371.1 ha. Thus, it does not affect to the study. Under 0.5 ha landholding occupies less than 0.2 % of total area in all sub-basins, and the number of farm households does not excess 12.2 % of total ones. This scale's farm households occupy 6.0% in the whole study area.

The table below shows the summary on number of farm households, total area, average area by three classifications described above and sub-basin wise based on the Census in 1997.

Sub-basin	< 0.5ha			0.5 ～ 15.0ha			15.0 ～ 100.0ha			100.0 ha<		
	No. of farm H/H	Total area	Average area	No. of farm H/H	Total area	Average area	No. of farm H/H	Total area	Average area	No. of farm H/H	Total area	Average area
Maipo Alto	10	3	0.30	191	705.2	3.69	51	2041.4	40.0	29	490363.6	16909.0
Clarillo	46	12.3	0.27	341	1423.8	4.18	95	3328.5	35.0	19	20242.4	1065.0
Mapocho Alt.	39	11.6	0.30	841	3041.0	3.62	171	5839.9	34.2	45	31850.2	708.0
Est.Lampa	45	14.2	0.32	1331	6524.3	4.90	320	10967.7	34.3	133	115375.4	868.0
Mapocho Ba.	125	38.6	0.31	1814	7566.9	4.17	508	17798.3	35.0	73	16565	227.0
Angostura	649	186.7	0.29	3658	14063.3	3.84	859	32527.7	38.0	157	97229.9	619.0
Rapel	73	21.8	0.30	1187	5119.9	4.31	273	10028.2	38.0	104	113188	1088.0
Melipilla	155	50.4	0.33	2184	8218.2	3.76	537	18646.2	35.0	200	81881.8	409.0
Puangue	50	14.2	0.28	1018	4935.6	4.85	206	6900.4	33.5	65	53513.3	823.0
Yali	24	8.3	0.35	1023	4170.6	4.08	510	23514.3	46.1	234	100257.9	429.0
San Antonio	11	3.4	0.31	489	1940.5	3.97	198	7989.3	40.4	95	56971.3	600.0
Casablanca	24	6.6	0.28	500	2620.3	5.24	324	12628.3	39.0	130	74884	576.0
TOTAL	1251	371.1	0.30	14577	60329.6	4.14	4.052	152210.2	37.6	1284	1252323	21095.0

Note; No.: Number, H/H: Household

The number of small scale farm households occupies 68% in the whole study area, or 14,577 households, and total occupied area is 60,348 ha or under 4.1% of the whole study area. Average landholding in area is 4.14 ha, but most of average area by each sub-basin ranges from 3.62 ha in Maipo Alto to 5.24 ha in Casablanca. Among total small scale households, 5 - 10 ha landholding and 10 - 15 ha landholding occupy about 25 % and about 10.7 % respectively.

The number of small scale farm households concentrates in the sub-basins of Angostura, Mapocho Bajo, and Mapocho Alto. These areas have large irrigated farmland and small non-irrigated farmland, and occupies about 43.3% of total number of farm households and holds about 40.9% of total farmland. This is because small farm households intend to be concentrated in irrigable area. The sub-basins of Melipilla, Alhué, Yali, and Puangue which have large non-irrigated farmland occupy about 37.3% of total small farm households, and about 37.2% of total landholding. This figures show the second largest concentration in these sub-basins. Among these sub-basins, Melipilla and Puangue have large irrigated farmland, and Lampa has slightly smaller irrigated farmland than average one, and occupies about 9.1 % of total small farm households, and about 10.8 5 of landholdings. The sum of Casablanca and San Antonio sub-basins occupy 6.8% of total small landholders, and 7.5% of landholding area. The sub-basins of Maipo Alto and Clarillo in the highest elevated area have a few small farm households, and occupy 3.6% of number of that and landholding.

The number of middle scale farm households is 4,025 and occupy 19.2% of total households and 152,210 ha or 10.4 % of the study area. Average area of total middle scale farm households is 37.6 ha, but mostly ranges from 33.5 ha of Puangue to 46.1 ha of Yali. As for the area of farmland, there is no big difference among middle scale farm households. The number of middle scale farm households in sub-basins of Angostura, Mapocho Bajo, and Mapocho Alto occupies 37.7%. The sum of the number of middle scale small farm households in sub-basins of Mapocho Bajo, Mapocho Alto, Melipilla, Yali, Alhué, and Puangue is 38%. In the sub-basin of Lampa, the middle scale farm households are fewer than the small scale farm households, 7.9%. In the sub-basins of Casablanca and San Antonio, the former is more than the latter, 10.4%. Moreover, in the sub-basins of Maipo Alto and Clarillo, the former is same as the latter, 3.6%.

Total number of large scale farm households is 1,284, and total cultivated area by them in the study area is 1,252,322 ha. The total holding area by large scale farm households is 490,363 ha, if 29 large scale farm households who hold land without irrigation in the sub-basin of Maipo Alto is subtracted from total held area by the large scale farm households. Likely, average area decreases from 975 ha to 607 ha, if 29 households mentioned above is subtracted from the total area. Average area ranges from 227 ha in Mapocho Bajo to 16,909 ha in Mapocho Alto. In the sub-basins of Maipo Alto and Lampa, the large farm households are the majority within the sub- basins; 39%, 490,363 ha and about 9.2 %, 115,375 ha respectively.

(2) Level of modernization on farm management

To classify the farm households, degree of ability for the introduction of new technology, efficient farming, participation to the market and response on the new requirements can be considered as the criteria other than the land holding size. These are the level of modernization on farm management in each farm household.

In case of new irrigation projects, many improvement factors on prevailing farm management exist in compliance with the changing from the extensive agriculture in the non-irrigated farmland to the intensive agriculture with irrigation. Therefore, it is required to put stress on the importance of improvement for the farmers living in the new irrigation area. Empresa Agraria sets framework on the index for the improvement of existing farm management and many variables tie with the farming scale and the level of modernization on farm management. On the contrary, in the Census in 1997, farming scale variable is only usable as the index of this study. Finally, it is appropriate to divide the farmers into following two groups in view of productivity of the crop cultivation.

Small-scale farm households
: Holding 0.5 to 15 ha of farmlands and performing the agricultural production by traditional farming method.

Medium and large scale farm households
: Holding over 15 ha of farmlands and performing the agricultural production by modernized method.

There are farmers who manage modernized farming even though their landholding classify into small-scale. Similarly, there are farmers who manage extremely traditional farming though their landholding classify into medium and/or large scale. However, certain trend on the farm management can be recognized for each farm households and that trend should be reflected to settle the framework on the future projects.

Present crop cultivation on small, medium and large scale farm households of each sub-basin is shown in Table 3.4.1 and 3.4.2. The table shows difference of production activity on both farmers group. In case of small-scale farmers, around 42% of cultivated areas used for low productivity or indirect (natural glass-land, fallow-land, etc.) productive activities though only 19%is occupies in case of medium and large scale farmers. Further, 42 % of farm-land is used for intensive agriculture (fruits, vegetables, grapes, seed, etc.) in case of medium and large scale farmers, however, those utilization are limited only 28% in case of small-scale farmers.

3.4.2 Crops and Cultivation

A comparison of land use in the study area based on 1997 Census and the Census carried out during 1975 to 1976 is shown below.

Crops	'75-'76 Census (ha)	'97 Census (ha)
Cereals, Processing crops	67,391	31,748
Vegetable, Flower	23,686	25,885
Fruits	28,411	43,506
Vineyard	2,985	6,703
Seed sand seedlings	N.A.	5,898
Forage	28,979	30,619
Total	151,452	144,359

Source: Domestic agriculture and livestock, Recent trend and forecast, , CORFO, 1998

From the table, sector of intensive cultivation such as fruits, vegetables, grapes for wine, seed production is significantly increased. On the contrary, cultivation of cereals and *chacras* is decreased over 50% at present. This phenomenon can be considered as the process of intention on agricultural production in Metropolitan Region or in the study area. These movements on intention are recent trend relating to the process on open market economy.

Present situation of crops and its cultivation in the study area is as follows;

(1) Cereals and traditional crops

Cultivated area for these crops is approximately 36,000 ha and it is decreased by over 50% in 20 years from previous Census to the last Census. Crop production in metropolitan region is above the national average in any crops except potato by the same Census. Result of basic survey for agriculture and livestock (EMA) of INE from 1990 described that cultivated area of these crops decreased over 25,000 ha in the last 10 years and trend of decrease significant comparing 11,000 ha from 1976 to the beginning of the survey. Trend of decrease of cultivation area is for entire crop except potato, which was not decrease during 1990 to 1997.

(2) Fruits

Fruits is cultivated in 24% of orchard area in the study area which is equivalent to 55,304 ha. 40% of fruit cultivation, 22,452 ha, are concentrated in Angostura and followed by 7,000 ha in Melipilla and 6,000 ha in Est. Lampa sub-basins. Change of cultivation area of major fruits in 1994 and 1997 is shown below;

Crops	1994 (ha)	1997 (ha)	Fluctuation (%)
Almond	2,172	2,653	18
Cherry	343	302	-12
European Plum	1,842	2,159	17
Japanese Plum	2,625	2,669	2
Apricot	838	817	12
Peach	2,319	1,495	-36
Peach for Preservation	1,690	1,331	-27
Nectarine	3,047	2,504	-15
Lemon	2,803	2,926	20
Red Apple	451	608	35
Green Apple	193	169	-12
Quince	100	105	5
Orange	1,602	1,713	23
Olive	197	285	45
Pear	3,114	1,622	-48
Table grape	12,679	9,251	-25
Kiwi	1,356	1,005	-26
Walnut	3,419	3,542	4
Avocado	2,803	3,672	31
Total	44,038	39,778	-9.7

Source: Land registration of fruit cultivation 1994 & 1998, CIREN

Rate of cultivation area and area of table grapes and pears has been decreased significantly. Table grapes decreased approximately 25% of area that is 3,428 ha and pears decreased approximately 48% that is 1,492 ha. Peaches, nectarine and kiwi are also decreased. Avocado, in the other hand, has increased most at 31% that is equivalent to 869 ha and followed by plum of 317 ha (17%). Lemon, orange, almond and walnut are expanded cultivation areas.

As the reason of decrease on cultivation area of fruits, it is noted that orchard situated in the suburbs of Santiago competes its conditions of location with development and subdivision of the housing lot, high payroll costs in the outskirts of Santiago, and effects for profitability on fruits cultivation due to continuos decreasing of exchange rate in recent 5 years.

Base on the data of CIREN, cultivation area of fruits is not decrease in totally, provinces located in the outskirts of Metropolitan area are rather decrease but increase in the areas far from the Metropolitan area. The reason that decrease of areas for fruits production in the study areas is already described in the previous paragraph. On the other hand, expanded areas of fruits cultivation locates in the Melipilla province having the areas for new irrigation development.

(3) Vegetable

Vegetable cultivation is characterized as intensive cultivation with relatively high technique and cultivation is total 27,955 ha share of 12% of cultivated area. Vegetable is cultivated in all the sub-basin. Vegetable cultivation area in metropolitan region by Census of 1975 to '96 and 1997 and the data of 1990 to 1991 and 1994 to 1995 of ODEPA are compared below;

Item	Census	ODEPA		Census
	1975 - 76	1990 - 91	1994 - 95	1996 - 97
National total	103,835	119,268	120,268	113,113
Metropolitan region total	23,686	40,327	32,260	25,641
Metropolitan/National	22.8%	33.8%	26.8%	22.6%

Source: 1975-76 Census, 1997 Census INE, Outline of local agriculture 1991, 1997 2nd half agriculture report ODEPA

Vegetable cultivation in metropolitan region in 1990 to 1991 has shared approximately 33.8% of entire nation, however, fell to 22.6% in 1997 Census.

Following factors are considered on decrease of vegetable cultivation in metropolitan region.

- Vegetable cultivation using sewage for irrigation in metropolitan region decreased considerably by outbreak of cholera in early nineties.
- Urbanization has rushed into traditional vegetable cultivation area as Chiccureo in Santiago. It is considered that vegetable cultivation particularly affected by urbanization recently.
- Vegetable cultivation tends to move to the other area due to increment of labor cost in metropolitan region, particularly as Lamp and Collina.
- Facility and purchasing point of food Processing industry, as of tomatoes, tend to move out from metropolitan region.
- Effect of draught in 1996- 97 according to 1977 Census is raised as a reason
- Vegetable prohivited the cultivation by using contaminated irrigation water is as follows;

Cabbage	Chicory	Radish	Celery	Srrawberry
Spinach	Chard	Carrot	Cauliflower	Halian Parsley
Coriander	Turnip	Water cress		

(4) Grapes for wine production

Regarding fruit cultivation, grape for wine production is raised as successful contribution on exportation. Trend of metropolitan region and national on wine grape cultivation is shown below;

Unit: (ha)

	SAG					Census
	1975	1980	1985	1990	1996	1997
Metropolitan region	9,425	9,280	3,410	3,027	5,904	6,703
National	104,599	102,690	62,152	54,267	55,894	81,256

Source: SAG& INE, Agriculture and livestock sector, Recent trend and forecast, CORFO, 1998

Cultivation area of grape for wine production in the study area is 8,702 ha and its over 90% is located in irrigated area. It is 10.7% of cultivated area of the country and 17.7% of irrigated grape cultivation. 20% of good quality wine grape cultivation is in the study area and most of large-scale producers are located in the area.

National wine consumption in the last 30 years is taken its place by pisco and beer from 53lit./head to 20 lit./head. Traditional brands as “Concha y Toro” and “Undurraga” and others have shifted largely their business to exportation. Success of export raised necessity of new cultivation method for high quality product and competitive quality by drastic improvement of wine brewing technology.

(5) Seed production

Seeds are produced in large area in the study area. Multiplication of pure line and commercial seeds of cereals, vegetable and processing crops as corn, wheat, mervil-of -Peru (*Mirabilis jalapa*) and potatoes are produced.

Area of seed production in the study area is 7,970 ha and its 44% is located in Angostura sub-basin and over 10% in Lampa, Puangue and Melipilla sub-basins respectively. The study area has shared seed production area approximately 27% of the country according to 1997 Census.

Seed production is normally carrying on by contract bases. Expansion of this business by assigning various functions to the enterprises is possible. Chile has long experience of business in this field. Specialized farmers are available and selection for training is also possible. Chile situated seasonal lag with Northern Hemisphere, which is seed large consumer and less damages of diseases and pests by geographical isolation, therefore, seed production in Chile is considered large advantage under its advanced legal systems and favorable climate and soil condition.

(6) Forage crops and livestock

Forage crop cultivation occupies 18.3% of the total cultivated areas and aims at important role of the cultivation crops in the study area. A part of produced forage crop are sold in Metropolitan region and its outskirts, and consumed by the producers for their livestock.

Livestock is not major industry in Maipo river basin, however, high potentiality of livestock in the outskirts of Santiago shows due to high demands on dairy milk, beef, chicken, pork and eggs.

Head of animals and share in the country of the study area according to 1997 Census are shown below. Many head of swine is realized by modernized technique for raising and making possible to raise near the markets and produced area of the forage crops. Maize which is basic forage crop is mainly produced in VI region but Metropolitan region is also produced. Presently, market of the forage crops is Santiago however export market is being considered making the best use of location on near the port for export.

Animals	Head		%
	Metropolitan Region	National	
Cow	229,531	4,141,545	5.5
Sheep	60,544	3,710,549	1.6
Swine	643,066	1,722,403	37.3
Horse	40,016	415,184	9.6
Goat	21,005	738,183	2.8

Source: 1997 Census

Metropolitan region occupy 12.3% of milk supply to the daily products factories in 1997. This trend has been continued from the last decade and reflects close relation between milk production and Metropolitan region and its outskirts. Milk production in Metropolitan region is supported by the high technique of production and profitability. Recently, many small-scale farmers participate to the milk production but occupy less than 3 % of the total production value due to low technique of production.

Data of dairy products is shown below. Factory in metropolitan region emphasizes on fresh products as milk, natural cheese and yogurt. Highly reservable products as powdered milk and cheese are not produced.

	Metropolitan Region	National	Rate (%)
Received milk at factory (lit.)	188,246,789	1,525,693,711	12.3
Price at factory ($/lit.)	108.78	98.13	--
Milk production (lit.)	123,422,357	270,662,130	45.6
Powdered milk (kg)	0.0	65,726,445	0.0
Natural cheese (kg)	6,771,886	7,106,429	95.3
Yogurt (lit.)	66,942,114	79,422,500	84.3

Source: Publication of Milk products 1997, ODEPA

Indicators of meat production, broiler and egg is shown below. Beef and pork productions as well as broiler have a tendency to concentrate to large fresh food consumption area of Santiago. As for the pork and broiler, production is concentrated in VI region other than Metropolitan region because those areas produce forage crops for food.

	Metropolitan Region	National	Rate (%)
Beef production (ton)	120,351	262,105	45.9
Lamb production (ton)	684	9,811	7.0
Pork production (ton)	96,695	208,703	46.3

Source: Slaughterhouse survey, INE, ODEPA. Livestock report March 1998 ODEPA

	Metropolitan Region	National	Rate (%)
Broiler (thousand ton)	57,322	136,673	41.9
Egg (pieces)	1,002,707	1,852,760	54.1

Source: Poultry farm survey, IV to IIX region, INE, ODEPA. Livestock report March 1998 ODEPA

3.4.3 Yield

The 1997 Census is available to observe present yields per unit of the study area. Yields of cereals, minor cereals and major crops for processing in the Census is shown in Table 3.4.3. Yield per unit area is shown for each crops on irrigated area and non-irrigated area, and number of farmer using irrigation or not, because the Census is not describe yield with and without irrigation. For small scale farmers, it was prepared based on 1986 EMA data and summary is shown below;

Unit: qq/ha

Crops	Irrigated			Non Irrigated		
	Small scale	Middle/large Scale	Variant (%)	Small scale	Middle/large Scale	Variant (%)
Wheat	31.9	37.2	16.7	14.8	23.1	-56
Oats				8.7	25.2	-189.1
Corn	62.0	86.5	-39.5	46.0	51.3	-11.6
Beans (domestic)	9.4	12.4	-31.5	5.3	8.0	-51.4
Beans (export)	11.7	12.9	-10.6			
Lentil				4.0	5.1	-26.9
Chick pea				8.4	10.6	-25.6
Potato	96.0	158.9	-65.5	42.7	91.0	-113.0
Mervel-of-Peru	20.7	24.3	-17.5	14.1	34.0	-140.9
Tobacco	29.5	30.7	-4.1			

Source: Prepared by Agraria based on ENA '86-'87, Echenique J. & Rolando N., Small scale farming

Yield of fruits is referred a study carried out by the Catorica University because it is not available in 1997 Census. The data are described by age of tree and domestic and export purposes. Technical levels were set on capable to supply continuously for export market. Table below is summary of yield of fruits;

Crops	For Domestic (kg/ha)	For Export
European Plum	27,000	
Japanese Plum	19,881	2,250 box/ha
Apricot	10,880	1,280 box/ha
Peach (late variety)	28,800	6,300 box/ha
Kiwi	24,000	6,300 box/ha
Gala Apple	60,000	2,526 box/ha
Nectarine (late variety)	28,800	3,063 box/ha
Serr. Walnut	4,000	4,000 kg/ha
Hass Avocado	10,000	6,000 kg/ha
Pakham's Pear	40,000	1,680 box/ha
Thompson S. ha Table Grape	20,300	2,070 box/ha

Source: Yield of fruits per unit area, J.L. Dominguez & other. Economic prospect of agriculture, No.100, Feb. 1995

3.4.4 Agro-processing

Agro-processing activity in the study area occupies the most important position in the nation. A lot of number and kinds of processing facilities can be found in the study area and its production capacity is high compared with other areas. Outline of the processing facilities in the study area is as follows;

Kind of Agro-processing	Nos.	Productive Capacity	
Fine powder processing	16	800,000	ton / year
Winery for export	37	120000	lit. /year
Dairy product processing	4	200000	lit. / year
Dry fruits factory	30	795	ton / day
Dry vegetable factory	4	178	ton / hour
Frozen fruits and vegetable	8	276,850	ton / hour
Fruits juice processing	6	300,000	ton / year
Canning factory	4	223,100	kg / day
Preserved fruits	3	303,000	kg / day
Jam	6	21,100	kg / day
Tomate processing	4	800	ton / day
Dry fruits processing	24	147,781	kg / day
Pickles	10	14	ton / day
Freezing facility	111	1,100,000	(area) m^2
Packing facility	444	8,533	ton / day
Disinfection facility	38	1,091	ton / day
Slaughterhouse	4	-	

3.4.5 Farmers Income

Farmers income by agricultural activities is estimated in each sub-basin basis in accordance with the farming type of small, medium and large scale farmers. Average land use by sub-basin basis shown in 1997 Census is employed as the basic conditions of farming type for estimation.

Farming type of small-scale farmers shown in the Census is employed as it is because those farming scale correspond to the average value of each sub-basin. Meanwhile, farming type of 100 ha is employed to reflect the average land holding size in case of medium and large scale farmers. Farming size of these types is not expressed with certain accuracy since many farm lands which no farming activities is made at present include in the data of Census.

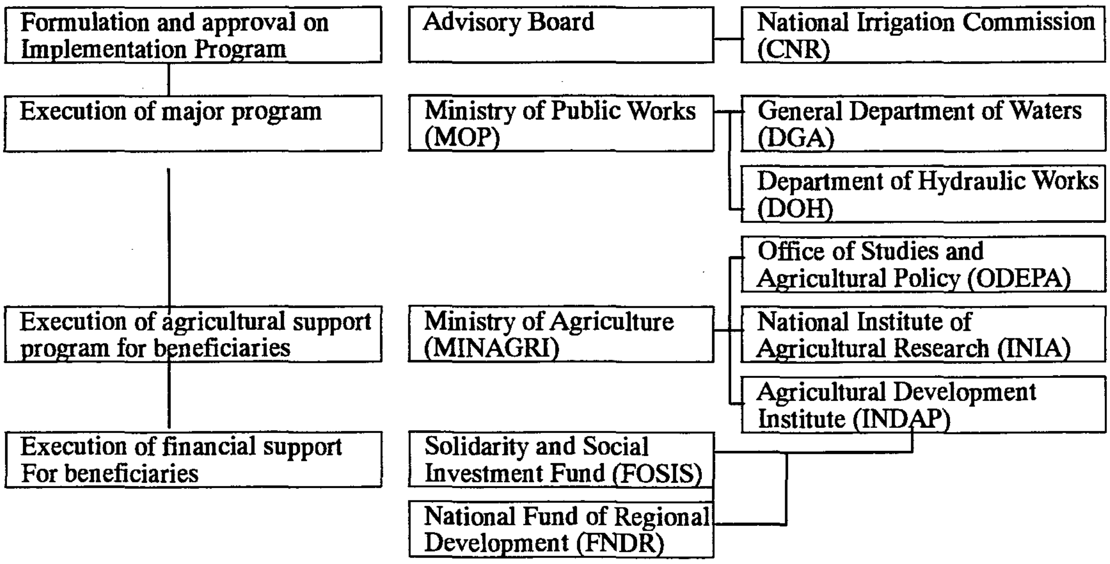
Table 3.4.4 and 3.4.5 show cropping pattern, gross income by cultivated crops and areas in accordance with the farming type of each sub-basin. The lowest, highest and average gross income of small-scale farmers come to \$ 822,000 of Casablanca, \$ 3,370,000 of Lampa and 1,854,000 of whole sub-basin, respectively. Many small-scale farmers engage vegetable cultivation in Lampa therefore their income show the highest value among the sub-basin.

In case of medium and large scale farmers, gross income varies from \$ 45,334,000 of San Antonio to \$ 161,120,000 of Angostura. Agricultural development program is being carried out intensively in Angostura thus income value shows high compared with other sub-basins. Average gross income of medium and large scale farmers accounts more than \$ 108,000,000 and over \$ 100,000,000 is shown at 8 sub-basins out of 12 sub-basins.

3.5 Agricultural Support System

3.5.1 Governmental Institutions for Agricultural Support

Agricultural support in Chile is dealt with various measures depending on the purpose of assistance. Institutions related to the agricultural support extends over the several governmental organizations. Basic procedures on agricultural support can be summarized as follows;



Related organizations for the agricultural support are dispersed among the ministries with purpose of assistance as shown below. However, formulation and execution of the support program are entrusted to the regional administration body which know the actual situation of local society well and in view of the promotion of decentralizations. Also, those procedures are being made with the participation of the beneficiaries.

MIDPLAN (Ministry of Planning and Coordination)	FOSIS(Solidarity and Social Investment Fund) FNDR(National Fund of Regional Development)
MOP (Ministry of Public Works)	DGA (General Department of Waters)) DOH(Department of Hydraulic Works) INH (National Institute of Hydraulics)
MINAGRI (Ministry of Agriculture)	SEREMI (Ministerial Regional Secretariat) ODEPA (Office of Studies and Agricultural Policy) INDAP (Agricultural Development Institute) SAG (Agriculture and Livestock Service) INIA (National Institute of Agricultural Research) CONAF (National Forest Corporation)
MEFR (Ministry of Economic Promotion and Reconstruction)	CNR (National Irrigation Commission) CORFO (Production Development Corporation) INE (National Statistics Institute) CIREN (Center of Natural Resources Information)

3.5.2 Agricultural Support Organizations

Share of social policy expense (the policy for fields such as education, welfare, dwellings, labor, jurisdiction) occupied 58.1% of national budget in 1988, but 65.7% in 1997. While national budget in 1997 is 4.9 times as much as that in 1988, social policy expense in 1997 is 5.5 times as much as that in 1988. Growth rate of social policy expense has increased more than that of national budget.

Within social policy expense, the budgets relevant to agricultural support directly are INDAP project expense and FOSIS project expense. All INDAP project expense is the budget for agricultural support. FOSIS project expense covers not only agricultural field but also all fields relevant to independence of the social vulnerable. With increasing social policy expense, expense of INDAP services has increased. This was 8,431 million pesos (1.0% of social policy expenses) in 1988, but there was a big growth and it increased by 8.7 times or 73,343 million pesos (1.6% of social policy expenses) in 1997.

On the other hand, FOSIS services started in 1991, and the budget was 3,643 million pesos at that time (0.2% of social policy expense), but it was steadily grown and increased by 5.7 times or 20,913 million pesos (0.5% of social policy expense) in 1997.

Unit : million pesos

Item	1988	1991	1994	1997
National Budget	1,415,671	2,620,030	4,615,392	6,909976
Social policy expense	822,032	1,583,526	2,953,402	4,538,828
of FOSIS	-	3,643	15,032	20,913
of INDAP	8,431	15,412	37,429	73,343

Social support system in Chile extends into various ministries and agencies. Therefore, it was hard to understand and utilize the system. Due to this, the manual (*Manual de Consulta Sobre Proyectos de Inversión Local*) which contains the results of social support system is published by MIDEPLAN-BID in 1995. It intends to strengthen solidarity of whole social policy and to increase efficiency of that. According to the manual, main programs implemented as agricultural support are summarized in following table.

Section	Program	Executives	Subject
Enlightenment	· Agricultural information support plan	MINAGRI	the whole
	· Agricultural organization development plan	MINAGRI	the whole
	· Irrigation law promotion plan	CNR	the whole
	· Basic activities for resource development plan	INDAP	small farmers
	· Farmers with irrigation development plan	CNR-INDAP-	small farmers
	· Economical forestry promotion plan	ODEPA	the whole
	· Agricultural market development	INFOR ODEPA	the whole
Forming organization	· Forming farmers' organization plan	FOSIS-INDAP	small farmers
	· Promotion of rural job opportunity plan	FOSIS-INDAP	small farmers
	· Support for small producers' organization establishment plan	FOSIS-INDAP	small farmers
	· Middle and small irrigation promotion plan (PROMM)	DOH-INDAP	small farmers
Technology transfer	· Agricultural technology transfer plan	INDAP	small farmers
	· Agricultural technology promoting organization plan	GTT	large and middle scale farmers
	· Consulting for farmers plan	INIA、U-Ch	the whole
Credit	· Small farmers' support fund	INDAP	small farmers
	· Forming farmers' organization fund	FOSIS	small farmers
	· Promoting middle and small irrigation plan (PROMM)	DOH-INDAP	small farmers

Source: Manual de Consulta Sobre Proyectos de Inversion Local, MIDEPLAN-BID

Basic condition for receiving the support from these organizations is holding water right. The preconditions of participating INDAP services which are the main part of agricultural support are that those who hold from 0.5ha to 12ha irrigated land and water right, beneficiaries have already organized, the project plan concerned has already established, and so on. In short, the support policy by the national government is not just distribution of subsidies or projects but also proceeds to promote independence and participation of inhabitants to the development process. Therefore, achieving agreement on the support project by beneficiaries is indispensable.

At present, agricultural support services are implemented mainly by INDAP in Chile. According to INDAP-RM, the number or the percentage of farm households which participate in INDAP services was 2,458 households or about 17% of total small scale farmers and 4,525 households or 31% of that in the field of credit support and technological support, respectively. These numbers include those who received both types of support. In sum, only about 20% of total small scale farmers are benefited by INDAP services except the overlapped persons. As mentioned above, the support system has not expanded to general beneficiaries because basic conditions are that beneficiaries have to form an organization and establish a project plan, and the service systems were not enlightened enough.

INDAP service budget by Region

	1996	(%)	1997	(%)	97/96
INDAP total	64,476,732	100	68,595,544	100	1.064
V^th^ Region	2,713,976	4.21	3,541,937	5.02	1.301
VI^th^ Region	6,453,688	10.00	7,382,146	10.47	1.144
Metropolitan Region	2,611,512	4.05	2,998,564	4.26	1.148

Source; The budget includes only portion of local currency. MEMORIA 1997, INDAP

Composition of INDAP services in RM

Item of Service	1996		1997	
	Beneficiaries	Service cost (%)	Beneficiaries	Service cost (%)
Credit (Financiero)	1,355	69.9	2,458	72.8
Technological development (Desarrollo Tecnológico)	2,081	14.8	2,447	13.1
Organization development (Desarrollo Organizaciones)	1,072	2.6	1,050	3.0
Agricultural marketing (Agronegocios)	900	2.5	340	2.7
Small scale irrigation (Riego Campesino)	817	10.2	688	8.4

Source : MEMORIA 1997, INDAP

Under this situation, INDAP established "New technological support services for innovation and transformation of productivity (*Nuevos servicios de asesorá técnica para la innovación y transformación productiva*)" for that beneficiaries can receive the support step by step. This program consists of "Local Support Services (SAL: *Servicio Assesoría Local*)," "Project Support Services (SAP: *Servicio de Asesría a Proyectos*)" and "Specialization Support Services (SAE: *Servicio de Asesoría Especializada*)." The beneficiaries can receive from the first step's service, SAL and then higher steps of support service gradually. The points of each support service are shown in the table below.

Item	Local Support Service (SAL)	Project Support Service (SAP)	Specialization Support Service (SAE)
Step	The 1st step	The 2nd step	The 3rd step
Supporting period	Maximum 2 years	Maximum 5 years	No limitation
Purpose of the service	Promoting small farmers' cooperation, strengthening organizations, support of farming technology, increase of productivity through strengthening farming	Value added products and improvement of production technology and business operating	Making cooperative business enterprises which is operated by small scale farmers highly-advanced
Basic condition	· Small scale producers · Groups of more than 20 persons · 7～10% burden of total cost	· Small scale producers · Groups of more than 10 persons · 10～30% burden of total cost	· Small scale producers · Cooperative business organization which has already reached a certain level · 25～35% burden of total cost

As mentioned above, the steps are systematized for that beneficiaries themselves can participate in the process of development step by step. Nevertheless, the problems with forming organization at the beginning and how farmers establish the project plan are not solved yet.

INDAP establishes a local office in each Region, and intends to promote agricultural support. Yet, INDAP has not penetrated into farmers because it does not cover all *Comunas*. Therefore, close relationship with SECPLAC is required to broad the base of farmers' support and promote farmers' independence. Local offices of

INDAP and the related *Comuna* are as follows;

Region	INDAP local offices	*Comuna*
V	Casablanca	Casablanca, El Quisco, Algarrobo
	San Antonio	San Antonio, Cartagena, El Tabo, Santo Domingo
VI	Rancagua	Graneros, Mostazal, Codegua
	Las Cabras	Las Cabras
RM	Melipilla	Melipilla, Mariá Pinto, Alhué, San Pedro
	San Bernardo	San Bernardo, Buin, Paine, Calera de Tango
	Talagante	Talagante, Peñaflor, Isla de Maipo, El Monte
	Norte	Colina, Lampa, Tiltil, Curacaví

Based on the structure of agricultural support system as mentioned above, the process that small scale farmers receive the support services is as follows.

(1) Forming producers' organization by small scale farmers themselves
(2) Employment of a private consultant by the producers' organization
(3) Making the project plan under the guidance of the private consultant (the purpose of the project, necessity, detail design of the project to be received the support, fund plan, basic information on the members such as water right and scale of irrigation farmland, and the project agreement sheet)
(4) Submission of the plan to the local INDAP and a preliminary survey
(5) Screening the plan at the head quarter of INDAP and appraisal
(6) If the project passes the screening, the local INDAP office would start technological and financial support. If the project plan is not approved, the plan is reviewed and applied again. All application expense is paid by farmers, and subsidies for the application are not provided.

As mentioned above, small farmers have to form organization for application till to establish the plan. Moreover, there is no guarantee for approval of the plan, and the system is not easy to be dealt with. Because of lack of the system on this basic part, the support services for small scale farmers after this is not connected with farmers' realities. Thus, it is hard to penetrate every measurement to farmers.

On the other hand, Communal Secretary of Planning and Cooperation (SECPLAC: *Secretario Comunal de Planificación y Coodinación*) is formed in each *Comuna* as an organization which takes promotion of decentralization. Social policy has been pushed forward through participation of inhabitants by SECPLAC. SECPLAC can be said a public organization which has close relationship with local areas. However, it does not extend into farmers' support because its implementing policy is strongly partial to social infrastructure improvement. Therefore, its cooperation with INDAP is not close.

SECPLAC in each *Comuna* is stationed under SERPLAC (*Secretario Regional de Planificación y Coodrinación*) at the Region level, administratively. SERPLAC collects regional information and distribute subsidies.

On the other hand, farmers who hold less than 0.5ha irrigated land had the support system for implementing an improvement project of irrigation facilities, and so on by PROMN. This system was carried out from 1993 to 1998 by the fund of World Bank. According to the appraisal of the project effect, it is discussed if it continues or new support system is created. There is no support systems for small scale farmers who hold less than 0.5ha at present. So as to promote independence of small scale farmers, continuous PROMM type support system is needed.

3.5.3 Farmers' Credit

Financial support is implemented by financial institutions (private or public banks) which known well generally, and also governmental institutions concerned such as INDAP and PROMM. Small scaled farm households do not have enough mortgage to receive credit from commercial banks. The financial support by PROMM usually involves irrigation projects. It consists of subsidies for irrigation facilities and for field irrigation at farm lot. Moreover, the financial support by PROMM involves technical support for the benefits of beneficiaries to be obtained and making the financial support effective. INDAP has different financial support systems from that mentioned above. They are the long credit system for investment and the short credit system for annual cultivation. In addition, INDAP has a technical support system for the producers who want to. Regional distribution of commercial financial institutions is shown in the table below.

Region/Country	1995		1996	
	Institutions	Branch offices	Institutions	Branch offices
R. Metroplitana	34	508	34	537
V	19	133	19	136
VI	15	50	15	51
Chile	34	1,214	34	1,251

Source: Compendio Estadísticas Regionales, MIDEPLAN, Noviembre 1997

3.5.4 Farmers' Organization

Farmers' organizations in the study area are canal associations by water users, an integrated canal association for controlling the canal associations, farmers' organizations, producers' organizations, but there is not a comprehensive organization like a cooperative organization which includes economic and guidance sections, and so on.

Most of farmers' organizations are formed by small scale farmers who hold less than 15ha by purpose of production. They work as producers' associations (*Asociación Gremial de Pequeño Agricultores*). The government concerned such as INDAP, FOSIS, PROMM, ODEPA, and INIA gives technological and financial support especially to these small scale farmers. INDAP plays a main role in this field. It gives advice to water right holders for highly-advanced farming. It also gives advice for obtaining water right, forming farmers' organizations, and provides credit to the farmers who do not hold water right.

So as to form organizations, INDAP do not instruct farmers directly, but they have to try to form an organization by themselves and to submit an establishment plan to INDAP. Only afterward, INDAP starts to give the support for activities. In short, the farmers who can receive its support indicate the farmers whose subsistence is agriculture, who have ability and motivation to improve the present situation. The structure is that INDAP gives support to the organizations and the groups which have already formulated agreement on the service through participation of these farmers.

On the other hand, there is National Solidarity of Agriculture (SNA; *Sociedad Nacional de Agricultura*) as a business enterprise type farmers' organization for large and medium scale farmers. This organization is that of business enterprise type farmers, and plays a big role in Chilean economy.

(1) Canal associations

The canal associations are established for securing the right of water users, distributing water appropriately, operate and manage of facilities. The executives are selected through election by members. The project plans are determined at general meeting of the organizations. The organizations are operated by organizations fees which the members pay by amount of water right. The scale of the canal associations are ranged between a few from hundreds members, but the organizations are operated by direct participation of members. Large organizations hire private consultants as advisers to operate the organization and operate and manage the facilities appropriately. Nevertheless, many of irrigation facilities have been decrepit. Thus, it is the time for many organizations to improve the facilities. It becomes a big problem how to restrain the cost for operation and management of the facilities.

As an integrated organization of canal association, these is Confederation of Chilean Canal (*Confederación de Canalistas de Chile*). The confederation secures the right of canal associations, raises the status of them, controls canal association's information comprehensively, and gives advice for operation of unit organization. The joint of the confederation is voluntary, thus some canal associations are not the members. Yet, the percentage of the members is about 80% of all canal associations.

Distribution of canal associations in the basins of the rivers is summarized as follows. Distribution of beneficiaries is beyond *Comuna* and extends widely.

Basin	River	Organization	Canal association
RIO MAIPO	1 Estero Tiltil	Asoc.	1
	2 Estero Colina	Asoc.	1
	3 Estero Lampa	Asoc.	8
	4 Estero Arrayan	J.V.	1
	5 Estero Arrayan	Asoc.	6
	6 Rio Mapocho	Asoc.	40
	7 Quebrada de Macul Mapocho	J.V.	6
	8 Estero Agua Fria	J.V.	1
	9 Estero Agua Fria	Asoc.	6
	10 Rio Maipo	J.V.	1
	11 Rio Maipo	Asoc.	3
	12 Rio Maipo 1ª Seccion	Asoc.	8
	13 Rio Maipo 2ª Seccion	Asoc.	15
	14 Estero Puangue	J.V.	1
	15 Estero Puangue	Asoc.	10
	16 Estero Paine	Asoc.	3
	17 Estero Codegua	J.V.	1
	18 Estero Codegua	Asoc.	7
	19 Estero Angostura	Com.	4
	20 Estero Peuco	J.V.	1
RIO RAPEL	1 Estero Alhue	Asoc.	3
	2 Estero Polulo	Asoc.	3
	3 Estero Las Palmas	Asoc.	2
	4 Estero Caren	Asoc.	2

(2) Farmers' association / Producers' organizations

Farmers' association in Chile consists of agricultural labors and small scale farmers and started to form the association in large scale so as to improve socio-economic condition of farmers in 1967. Afterward, it became a larger political pressure with 300,000 members in 1972. During military administration period, the activities of farmers' association was restrained because its social demand was regarded as illegal activity. Then, the association was disbanded. In 1987, the association was reorganized but its activities are stagnant.

On the other hand, as farmers' organizations, there are producers' organizations for increase of agricultural productivity and stabilization of farming. The producers' organizations are formed by production, and they are not comprehensive cooperative organizations. The producers' organizations are the bases for receiving the support services by INDAP and plays an important role for stabilization and improvement of regional agriculture.

The number of the producers' organizations formed by instructions of INDAP is 45 mainly in the Metropolitan Region and its distribution is as follows;

Comuna	No. of organizations	*Comuna*	No. of organizations
Alhué	1	Paine	1
Buin	2	Pirque	1
Colina	2	San Bernardo	4
Curacavi	1	San Pedro	1
Lampa	2	Santiago	16
Maria Pinto	4	Talagante	4
Melipilla	6		

Source: INDAP Region Metropolitana, 1998

Classifying these organizations by products, Centers of Collecting Milk (CAL: *Centros de Acopio de Leche*) by small scale livestock farmers is the majority. Most of them are organized by the project of small scale milk collection (PMR: *Proyecto Microregional Lechro*). Most of CALs adopt the method of collecting milk which producers bring to milk collecting plants and then selling it together to processors. However, some organizations whose projects are well under way plan to process dairy food and to sell the milk directly to the central market through utilizing the project systems provided by SAP and SAE.

Through utilizing PRODEMU which is the women support project of INDAP for improvement of rural women's status and their independence, some organizations are formed for organic vegetable cultivation, making folk crafts and handicrafts, and produce special products of regions.

Establishment of producers' organizations is not only for improvement of productivity and stabilization of farming, but also influence regional society and economy directly. The producers' organizations play a very important role for economic independence of region and promotion for rural permanent settlement. There is bid demand for forming organizations among producers, but many of them have troubles with the method of forming an organization, individual information of producers, obtaining fund and so on. This is because the base of forming organizations is dependent on farmers themselves. The necessity of advisers for forming organizations and introducing institutions becomes a big problem.

3.5.5 NGOs

The main activities of NGOs were supports for the urban poor and protection for fundamental human right. However, the field of the activities has been expanded. NGOs are active in various fields and there are about 800 groups in all parts of the country.

According to Directory of Institution without profit purpose (*Directorio de Instituciones Privadas Sin Fines de Lucro*) by MIDEPLEAN-CDI or MIDEPLAN-Cooperation of International Development (*Corporación de Desarrollo Internacional*), the activities of NGOs in the study area are summarized as a following table, and 450 groups are working. The number of working groups in each region is as follows. Among them, only 3 groups implement the activities related to agriculture. One group is in the Vth Region, and two groups are in the Metropolitan Region. Main activity fields are small scale credit, regional development, health and sanitation, social development , and environmental education.

Item	The V[th] Region	The VI[th] Region	The Metropolitan Region
Assistance (*Asistenciales*)	26	11	95
Communication and Culture (*Comunicación y Cultura*)	1	1	45
Development of Natives (*Desarrollo Indígna*)	-	-	-
Rural Development (*Desarrollo Rural*)	4	4	26
Human right (*Derechos Humanos*)	3	1	26
Local Development (*Desarrollo Local*)	7	6	66
Education (*Educación*)	8	4	42
Infancy and adolescence (*Infancia Adolescencia*)	11	5	60
Environment (*Medio Ambiente*)	11	3	25
Micro credit (*Microempresas*)	14	3	22
Women (*Mujeres*)	10	-	25
Health (*Salud*)	3	2	40
Dwelling (*Vivienda*)	-	-	9

SODEM (*Corporación Solidaridad y Desarrollo*) which provides agricultural support has its base in Maipú city and implements the programs for small scale farmers' independence by organic farming. In the study area, it constructed the field for training in *Comuna* San Pedoro, Loica area, in the study area. It extends the technology or strawberries' organic cultivation and achieved the results that strawberries come to stay a special product in *Comuna* San Pedoro. OCAC (*Fundación Oficina Coordinadora de Asistencia Campsina*) is a large scale group which has its base in Santiago. It works for modernization of rural areas and improvement of farmers' status through especially financial support for farmers' organizations. Although the activities of agricultural support by NGOs are small scaled and not enough, the field of activities has been expanded steadily. The recognition of farmers has been increasing. Therefore, it is required to construct cooperation methods with NGOs because the importance of NGOs will increase in the field of farming support, forming farmers' organizations, and rural improvement from now on.

On the other hand, as mentioned above, it is fatal for small scale farmers to receive the INDAP service that the support system lacks for forming organizations such as a producers' organization at the initial stage. If the support activities of NGOs engage in this field, a part of the problem could be solved.

3.6 Agricultural Economics and Marketing

3.6.1 Market System and Organization

The Metropolitan Region is the main center for marketing, industrialization, and consumption of agricultural products in the country. Major economic agents involved in these activities are wholesale markets, supermarkets, exporters, agroindustry and mills. Vertical integration is observed in pork and chicken production, while beef production is more horizontal and based mainly on cattle fairs and Lo Valledor slaughterhouse. Small producers of the region market their products mainly through intermediaries, traditional wholesale markets, and cattle fairs. Small producers also sell their outputs to a diversity of industrial plants processing agricultural products, and less frequently, to exporters and supermarkets.

(1) Wholesale markets

a) Vega Central
This is an old market located in a congested area in downtown Santiago, which has ceased to be a good location for a wholesale market, and the infrastructure does not meet the required sanitary conditions.

b) Lo Valledor
It is located in the south of the capital city, being the destination of most vegetable and fruit produced in the country, especially by small producers. Lo Valledor market has an estimated area of 25,000 m^2 for sale stalls, storage and parking.

In recent years, traditional wholesale markets have lost ground to other buyers (supermarkets, agroindustry, exporters), due to the following factors:

- Predominance of informal transactions, and lack of transparency
- Unclassified products, thereby penalizing high quality products
- Limited capacity in relation to regional production and marketing needs
- Deficient security measures

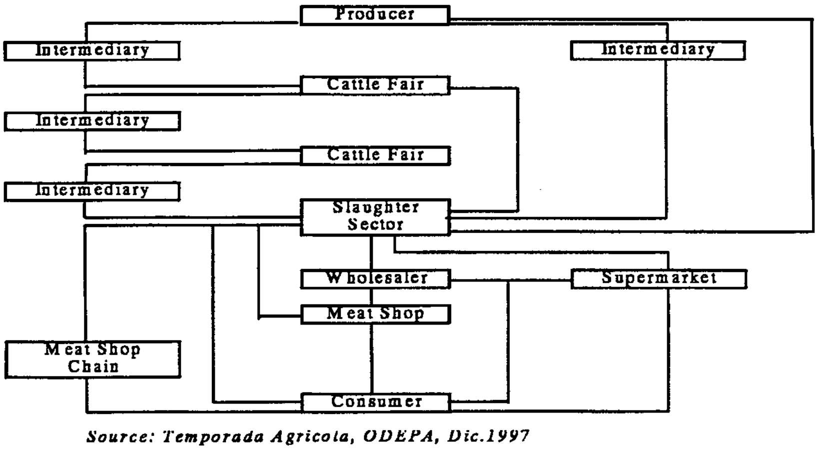
The above mentioned negative factors induced proposals to set up two new wholesale markets for fresh fruit and vegetable, as well as other consumption items like meat, dairy, fish and groceries. These two new wholesale markets seek to regain the confidence and preference of producers and consumers through transparent transactions, lower cost and increased profits to producers by reducing the role of intermediaries, and improved relationship between producers, intermediaries and distributors. The two new markets are:

c) Wholesale market of Santiago (MERSAN)
It is located in the industrial district of Lo Espejo, with the target total market area of 50 ha and 350 shops. The idea is for shops to be operated by producer's groups, so that these producers can sell directly to consumers.

d) Model market of Santiago
The target total market area is 30 ha and 1,600 shops. The idea is for producers to buy a plot to become an associate of the market, or to rent the space they need.

(2) Marketing of beef and livestock products

A study by ODEPA shows the flow chart below as fresh beef marketing channel from producer to consumer. In addition, there is a second beef market involving firms that process beef products, such as dry or canned beef factories, restaurants and food service companies. These firms are usually supplied by slaughterhouses, beef wholesalers, or beef importers, and are estimated to account for 40-45% of the beef market.



Source: Temporada Agricola, ODEPA, Dic.1997

Agents participating in fresh beef marketing are: brokers, fairs, slaughterhouses, meat shops, and supermarkets.

a) Cattle brokers
Cattle Brokers are intermediaries between demand and supply, charging 0.5% of the transaction value. Some brokers may actually buy and sell cattle in an attempt to increase their profit margin.

b) Livestock fairs
Livestock Fairs are physical spaces where cattle sellers bring their livestock to be auctioned off by buyers. Fairs charge 3% to sellers and buyers alike. As communication means improve, the role of brokers and fairs has decreased, from an estimated 50% in the 1970s to 30% of cattle marketing at present.

c) Slaughterhouses
Slaughterhouses supply beef to wholesalers and retailers. Rather than the traditional supply of carcass, the recent trend is to supply beef cuts, which have increased from the original 8 to the present 52 cuts. The supply of beef as cuts, rather than as carcass in half or quarter animal, has the advantage of facilitating specific demand satisfaction at each retailer outlet (meat shop, supermarket), and lowering transportation costs (cuts are free of unnecessary bones and fat). Slaughterhouses operate at the commercial level and at the family consumption level, and their locations are as follows.

Region	Slaughterhouse	
	Commercial	Family Consumption
Region V	12	0
Metropolitan Region	12	0
Region VI	11	6
Chile	112	52

The slaughterhouse in Lo Valledor, Metropolitan Region, accounted for 13.4% of beef production in 1995. Not a single slaughterhouse in Chile, however, is permitted to export beef to the US, Japan, Canada and the European Union.

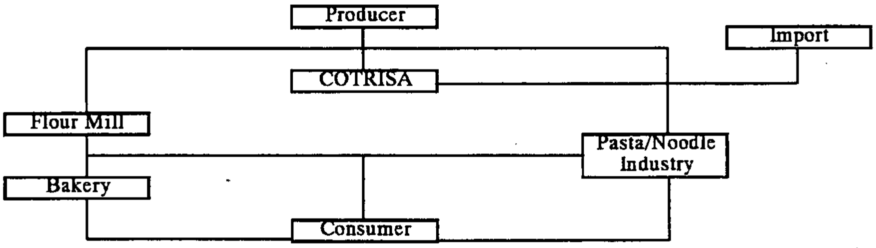
d) Milk marketing
In the study area, a well developed marketing scheme is collective milk marketing by a group of small producers (*"centro de acopio de leche"*). This is a very interesting scheme that gives bargaining power to small producers, in their negotiation with other milk buyers or with milk processing plants. Some of these groups of small milk producers, however, do not consider milk industrialization, alleging that quality control of milk production is extremely difficult under rudimentary and unsanitary conditions prevalent among small producers.

(3) Marketing of farm products

In the marketing of farm products, the concern is always with small producers who lack bargaining power to sell their products. Theoretically, bringing these small producers together, to induce collective marketing of their products, should increase their bargaining power, and should benefit everyone in the group with better prices from their products. This scheme, however, is difficult to put into practice, due to the quality differential in their products, whereby high quality producers are penalized by the price averaging with lower quality products. The quality differential problem can be overcome, as in the case of milk, since collective marketing of milk ("centro de acopio de leche") in the study area is fairly well developed.

a) Cereal marketing

Cereal species may require milling and processing prior to consumption (e.g. wheat), or may require just milling (e.g. rice), or can be marketed as such even without milling (e.g. corn). The marketing channel can be schematically represented as follows;



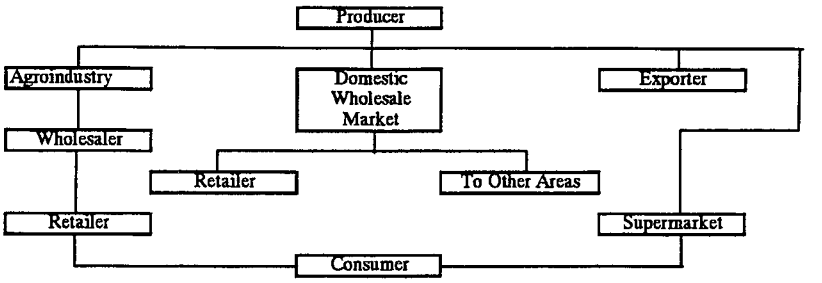
b) Vegetable and fruit marketing

Freshly consumed vegetable and fruit are usually produced near consumption centers. Since Santiago Metropolitan Area concentrates around one-third of Chilean population, vegetable/fruit production and marketing take place predominantly near this major consumption center. Wholesale markets serving the Santiago Metropolitan Area were already described above. Within the study area, the coastal cities of Valparaiso and Viña del Mar are also important consumption centers.

All these consumption centers and production areas are served by the best road network of the country. These are very favorable circumstances for agricultural marketing, opening up diverse options to producers. Selling to intermediaries who come to the farm is obviously an option, but it is usually the least attractive due to the low price paid by intermediaries. A second option for farmers is to sell their products in popular fairs or roadside stalls. Yet another option is to take their products to a "*concesionario*" or broker, paying him between 2% and 7% commission on sales value. Another option is to take their products to be auctioned off among wholesalers.

When a vegetable or fruit farmer earns a reputation as a producer of quality products, wholesalers or supermarkets or brokers may place direct orders with the said producer, implying better prices for less cost to the farmer, who can save transportation cost to the market. A producer who has an advantage, like clean groundwater instead of polluted river water for irrigation, may receive direct order or contract production for supermarkets or exporters. Exporters and agroindustry are buyers whose importance have grown in the recent past.

The marketing channel of fresh fruit and vegetable can be schematically represented as follows;



3.6.2 Agricultural Commodities

The study area is recognized to be the most important fruit producing area of the country, due to the proximity of the main consumption center, processing plants and export facilities. By the same reasons, vegetable production in the study area is favorable, hindered only by the polluted irrigation water.

Agricultural commodities under consideration in this section are basically staple food, and those produced in the study area are summarized in Table 3.6.1.

It is clarified that meat production refers to slaughterhouse carcass meat, and not to livestock production. Therefore, the share of the study area is high, since slaughter occurs near consumption centers, and the study area is the main consumption center of the country. The Metropolitan Region accounts for around 50% of beef and pork carcass meat production of the country.

In cereal production, the study area is important only in terms of wheat and corn. Wheat production in the Metropolitan Area accounts for around 7% of the country, while corn production accounts for about 10%.

The study area has very little weight in terms of legume production, be it beans, lentils, garbanzo or peas. Likewise, the Metropolitan Region accounts for only around 5% of potato production of the country.

3.6.3 Prices and Quality

(1) Prices

Government support for agricultural marketing consists of measures to improve and stabilize prices, to open up new markets, and to make updated price information available to interested parties. Specific measures supporting agricultural marketing include the following.

- COTRISA (Wheat Marketing Company): price regulation and purchase of wheat, to eventually include corn and rice in the future
- Price band to avoid violent price fluctuations in wheat, wheat flour, sugar and vegetable oil
- PROCHILE, an office of the Ministry of Foreign Affairs, promotes Chilean agriculture and forestry products in foreign markets
- Suppliers Development Program, of CORFO, gives support to improve relationships between agroindustry and farmers
- ODEPA provides updated price information by fax or by Internet

ODEPA provides price information concerning farm, livestock, forestry and agroindustry products, as well as prices of agricultural inputs, on daily basis or as monthly and yearly averages, for the domestic as well as for the international markets. Examples of price information provided by ODEPA are shown in Table 3.6.2.

(2) Quality

Quality in agriculture involves the establishment of criteria to determine quality classification, and the practical application of these criteria. Obviously, quality criteria are established by specific products, like cereals (humidity content, broken grain, foreign matter), milk (fat content, foreign matter), fresh vegetable (physical appearance), etc. In the case of milk, field work observation within the study area revealed that quality control was implemented upon receipt of each batch of milk, and it is probably this quality control applied to each individual producer what makes collective milk marketing possible.

3.6.4 Household Income

A 1996 household income survey by type of economic activity shows that the rich-poor gap, measured as the ratio between the average incomes of the top 20% and the bottom 20%, is widest in agriculture at 11 times, as detailed below.

Type of Economic Activity	Bottom 20%	Top 20%	Income Gap
Agriculture, Fish., Forest., Hunt.	53.696	590.794	11,00
Mining	82.264	687.335	8,36
Manufacturing	72.809	553.181	7,60
Electricity & Water	85.913	498.373	5,80
Construction	74.865	686.853	9,17
Commerce, Restaurant	64.559	458.189	7,10
Transport, Communic., Storage	73.116	559.989	7,66
Financial, Insurance, Real Estate	76.858	713.131	9,28
Services	57.635	427.242	7,41
Unspecified	71.684	540.674	7,54
Total	62.954	530.132	8,42

Source: CASEN 1996, MIDEPLAN, January 1998

The average household income of the bottom 20% in agriculture is absolutely the lowest of all economic activities, but the average household income of the top 20% in agriculture is higher than in six categories (manufacturing, electricity / water, transportation / communications / storage, commerce / restaurant, services, and unspecified).

Unfortunately, the household income differential by type of activity is not reported by geographic region. Instead, the gap between the average incomes of the top 20% and the bottom 20% by geographic region is specified in terms of earned income and monetary subsidies, as detailed below.

Geographic Region	Income Gap: Top 20%/Bottom 20%		
	Earned Income	Subsidies	Total Income
Metropolitan Region	13.92	0,0837	13,25
Region V	9,78	0,1094	9,11
Region VI	12,32	0,1573	11,17
Chile	14,84	0,1117	13,63

Source: CASEN 1996, MIDEPLAN, January 1998

The Metropolitan Region shows a wider income gap than Regions V and VI, but shows also a smaller ratio of subsidies to earned income.

3.7 Agricultural Infrastructure

3.7.1 Existing Irrigation and Drainage System

Historically, irrigation has been applied to the study area through the utilization of water from Río Maipo and Río Mapocho. In the beginning of the 19th century, diversion works were built around the upstream of Río Maipo, La Obra. The alignment of Canal San Carlos led to the beginning of large irrigation projects. Afterward, irrigation development through utilizing surface runoffs has been carried out in the basins along with both river banks. Until the 20th century, large irrigation projects have been implemented such as San Carlos, Canal de Maipo, Pirque, and Buin with Río Maipo, and Mercedes and Mallarauco with Río Mapocho. These works have been done by private sector. Until around 1950, construction of most existing irrigation systems has implemented. Santiago locates in alluvial fan, and thus groundwater is plentiful. Since 1950, it has been used as irrigation water in the area where has been no available surface runoff, and as drinking water in urban areas. According to the Census in 1997, the irrigated area in the study area is 178,960ha, which is the sum of surface runoff and groundwater irrigated area. Figure 3.7.1 shows the existing irrigation canal networks.

3.7.2 Level of Facilities in the Existing Irrigation System

Based on the survey results on the existing irrigation facilities in the study area, structural level of the existing irrigation facilities are as follows;

(1) Diversion weirs

Irrigation system starts from the diversion works at rivers or reservoirs. Then, the irrigation water flow through the settling basin, main canals, branch canals, and then to fields. Existing diversion works differ in its structural level. The diversion works having large commanding areas, such as Las Vertientes, Obra, Eyzaguirre, Clarillo, and Mercedes, are made of concrete. Thus, intake efficiencies are high. On the other hand, small intake facilities are made of gabion and earth levees. The structure of them is damaged so easily by flood. O & M such as rehabilitation has been carried out every year. The cost for rehabilitation of damaged facilities by flood is high and this burdens farming cost. Moreover, insufficient capacity of settling basins causes the inflow of various materials into the canals. Except the weirs managed individually, Asociación de Canales, which also manages canals, is responsible for the management of weirs.

(2) Canals

Both main and branch canals in the study area are unlined. Reinforcement by concrete and/or masonry lining is made at the places, sliding of canal slopes, canal route running hillside, and geologically weaken points. Percolation loss is large because of unlined canals and O & M has been carried out every year. Even though the lining by concrete or masonry might be effective against the leakage from canals, it is hard to facilitate at the moment because beneficiaries have to bear the cost for the rehabilitation works. Lining of canal sections will bring low leakage of water, however, fostering volume to the groundwater will also become smaller. These phenomenon affect to the downstream areas where return flow is used as the irrigation water. An incentive to change the present structural condition of canals comes low, because irrigation is made counting the return flow from the upstream areas. The ratio of water loss of main canals can be considered as 10 to 15 % taking the discharge measurement results of the *Associación de Mallalauco*. The maintenance activities of canals are the small scale rehabilitation works, removal of deposits and weeding during winter or no cropping season.

(3) Division structures and its management

Most division structures of the canals are applied to dividing wall distributors because off-take amount is decided by the size of water right. The canals whose canal slope is enough steep to take fall are divided by lateral intakes. The division structures are important to distribute irrigation water on the base of water right. Associación de Canales manages up to the secondary canals as well as weirs.

(4) Irrigation at the field level

The method of most irrigation in the areas where river runoff is used, is furrow irrigation. However, the areas where suffered from irrigation water shortage applies water saving irrigation such as Californian Method and drip irrigation to the field level. After the severe drought in 1968, technique of water saving irrigation has been gradually expanded, and then during 1980s, was expanded drastically. Many of farm households started to irrigate reclaimed farm land with the surplus water, which brought by introduction of water saving irrigation. Most of the areas, where groundwater is used for irrigation, adopt pumping irrigation.

3.7.3 O & M of Irrigation Facilities

(1) Canal association

O & M of irrigation facilities is implemented by canal associations. Many of canal associations have the system of enterprises and are managed just as enterprises. Legally, the canal associations are regarded as enterprises and keep the facilities as their property. Farmers or users have water right and the association is managed by the collected tariff for canal management from the users. The association will be approved legally through the procedure of application to the DGA and approval of the DGA for establishment of the association. Some directors (5-6 directors) are selected in each association. They organize the board of directors, and manage the association. Large canal associations hire engineers as technical advisers for canal management, establish the authorities, and carry out canal management and rehabilitation projects. O & M cost in these associations is paid by the users as water tariff. The associations that are not approved legally will take disadvantage. For example, the Law No. 18450 is inapplicable to them when they carry out rehabilitation works.

(2) O & M cost

O & M costs consist of rehabilitation cost (rehabilitation of collapsed portion of canal, removal of earth and rocks from the canal and intake structure, etc.) and management cost of canal association. O & M costs of each canal association changes due to the management conditions (maintenance works and its extent, and collecting method of water tariff), condition of the intake structure and canals.

In the case that a power station involves in canal network, sometimes the power generation sector pays the management cost to the canal associations. Yet, all canal associations were established by users individually, and O & M cost is paid according to the *Accións*. The tariff of one *Acción* is from 40,000 peso to 400,000 peso and such amount can not neglect as the farming cost for some farmers. Water users in Melipilla, Puangue and Angostura are being paid high water tariff other than the canal associations because structural level of irrigation facilities on those areas is lower than other areas. In either case, deterioration of existing irrigation facilities is now in progress and annual O & M cost has a tendency to increase.

(3) The present condition of water utilization

1) Water utilization and water right

Water right stipulated in the low (Codigo de Aguas) are divided into three categories depending on the condition of water source and the form of utilization. They are permanent or eventual water rights, consumptive or no consumptive water rights and continuous or discontinuous water rights. An application of water right is made to the DGA. Confirmation on the water right, which it applies for, is made by the DGA regarding the intension of existent water right owners by public notice and available water amount by water balance study. The settlement of water right is permitted when procedures of confirmation shows without inconvenience. The settlement of water right for the rivers in the study area is made by division of three sections in Rió Maipo, five sections in Rió Mapocho and one section from the up to down streams in other rivers.

Transision of existent water right is carried out at the water market (Mercado del Agua) which is assured legally. In the river section which water demand is abundant in, there is a form that water right is kept by the purchase and sale not for the actual water utilization but for speculation purpose. These water rights unused are brought about un-necessity for irrigation use by retirement from agriculture, project hasn't started though water right was acquired, amout of actual water utilization is less than the amount of water right, reserved water right for future project, etc. Present water utilization in the study area from the view of water rights is as follows;

- 8,133 of water rights has been settled in the first section of Río Maipo which consenrates over 60% of annual runoff in the study area and the section is maintained the major water utilization in the metropolitan area. Among the water rights settled in the first section of Río Maipo, 82% is occupied by 10 irrigation systems and 16% is by EMOS. Remaining 2% exists as the water right which is not identified or utilized. Transision of existent water right at the water market is carried out mainly in the first section of Río Maipo and it is scarce in other sections and rivers.
- Because water utilization by gravity system is limited in the second and third sections of Río Maipo, reserved and/or unused water rights exist in the sections due to suspension of project execution and/or provision for the future projects. Since intake structures of the existing canal system in the sections are constructed independently, intake amount is regulated by the canal capacity and/or the river discharge at the time of intake.
- Water rights cover the whole runoff of river on the first, second and third sections in the Río Mapocho. They are maily irrigation purpose. In the fourth and fifth sections of the Río Mapocho, regulation of water utilization is being made by the Junta de Vigilancia as well as the sections in the upper streams. However, stabilized water utilization is being carried out compared with the upper stream sections due to inflow of the drainage water from the upper basin and of groundwater flow.
- Rivers and streams which thaw water is not available have limitation such as water volume and time to use on its river runoff. Water rights are set out for the whole runoff of the rivers and/or streams.
- No steady flow type but longitudinal separation devices is normally used as the diversion devices in the canal system. Therefore diversion over the regulated amount is practiced when there exists unused water rights.

As mentioned in the above, water rights registered for the river surface flow in the study area reached its limits. Difficulties to set out the new water rights and recent increased water demand in the metropolitan area are focused on the actual status of the existent water rights. Also, efficient utilization measures of water resources including taxation measures for the unused water rights is now being discussed in the national assembly and the mass communication. These discussions concerning the efficient utilization of the unused water rights stand that the obligations occur in the right use though water can be used on the basis on the water rights as the private property, in other words, recognition that water is the social overhead capitals is being required.

2) Irrigation use

Reflecting the historical background such as landlords constructed diversion weirs in conformity with the expansion of farmland and present water right system, irrigation water distribution in Chile has not depended on the commanding farm land. River discharge is divided by Acción based on river management sections (*Sección*). Within a section, there can be taken 100% of river flow at the time water shortage. The consent among those who have water right is required when the water is tried to be transferred to other places. The water right is not involved with the farm land. They can be sold freely, and the purpose of their utilization is not fixed. The facilities are recognized legally as individual property of private sector (personnel, canal association). The owners are responsible for rehabilitation of their facilities, principally. Under this condition, there is low incentive for improving canal facilities to save water in the areas where have plenty of water. In the area where the improvement of the facilities is needed, only rehabilitation of the parts that needed to be used is executed.

3.8 Rural Infrastructure

3.8.1 General Condition

According to the statistics of municipalities, present condition of the basic infrastructures in the study area is as follows;

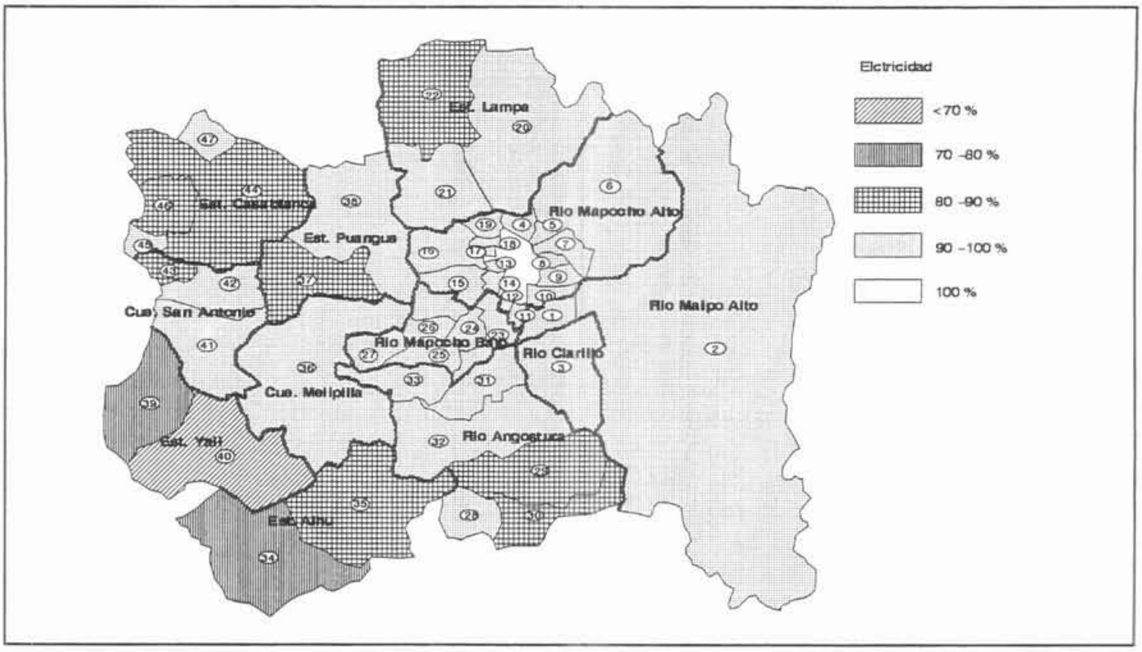
Sub-basin	No. of Households	Electricity %	Water supply %	Drainage %
1.Rio Maipo Alto	68,416	98.6	98.0	87.7
2.Rio Clarillo	2,949	94.6	48.6	38.8
3.Rio Mapocho Alto	1,056,176	99.4	99.2	89.3
4.Est. Lampa	21,595	92.3	76.9	45.2
5.Rio Mapocho Bajo	79,805	97.7	94.6	72.5
6.Rio Angostura	38,530	92.6	80.0	46.6
7.Est. Alhué	6,891	76.0	46.7	27.3
8.Cue. Melipilla	20,297	94.5	81.1	52.0
9.Rio Puangue	7,552	90.4	76.0	39.1
10.Est. Yali	4,775	70.5	30.5	28.7
11.Cue. San Antonio	39,424	95.3	91.1	71.0
12.Est. Casablanca	18,515	88.6	62.6	51.3
Total	1,364,925	98.5	96.8	84.4

Installation ratio of basic infrastructure is generally high in the study area. It is particularly high in the sub-basins which involves urban areas. Yet, the installation ratios of water supply and sewage system are low in rural areas, especially, in the sub-basins which involve mountainous areas.

3.8.2 Installation Condition of Basic Infrastructures

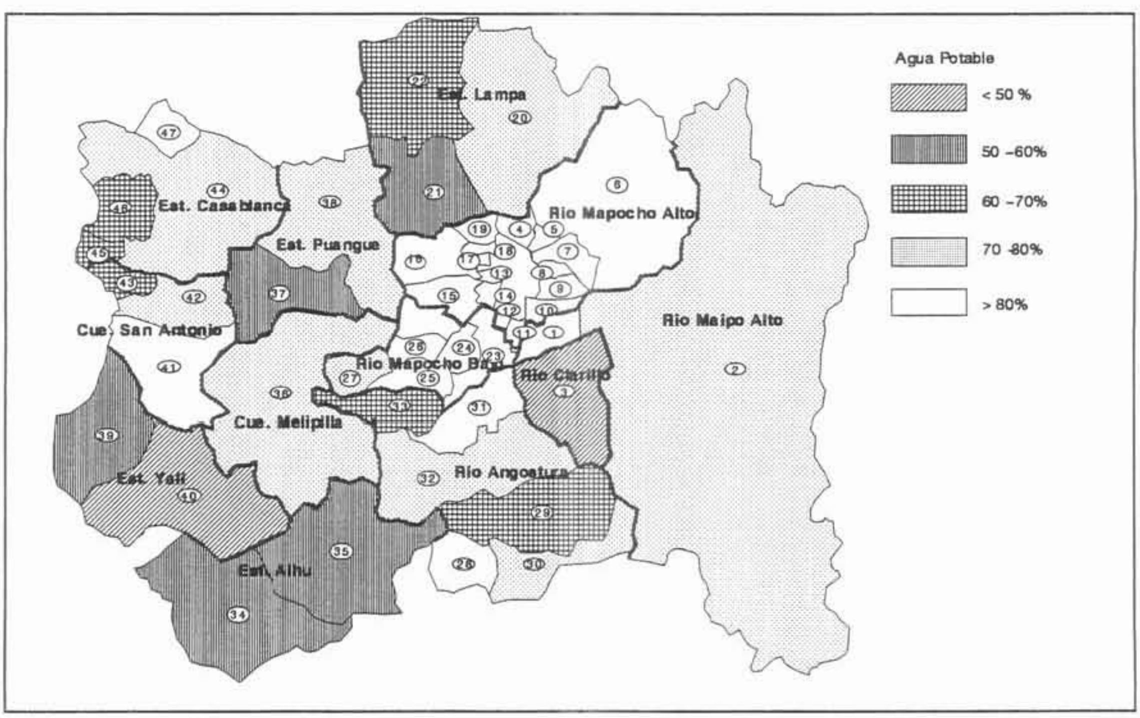
(1) Electricity

Installation of electricity supply facilities is proceeding, but electric uninstalled communities can be seen in mountainous areas. The installation ratio in most communities is over 80%.



(2) Water supply

The installation of waterworks is almost completed in rural areas located in flat plain. In those areas, domestic water is supplied through water pipe networks. On the contrary, in the mountainous areas, domestic water supply depends on small scaled waterworks by groundwater. The Metropolitan Region has the waterworks installed by EMOS. While, most of mountainous communities have own water supply system.

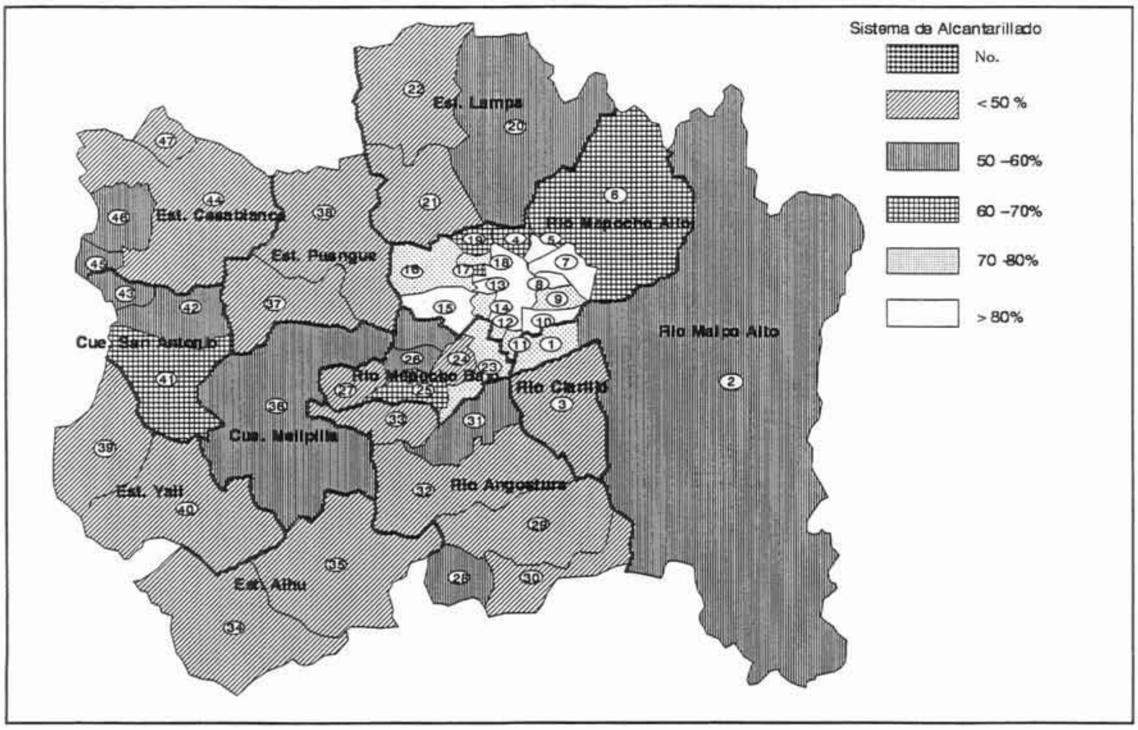


Installation of waterworks is retarded in sub-basins of Río Clarillo, Est. Alhué, Est. Yali, and Est. Casablanca.

(3) Sewerage system

Sewerage systems are installed mainly in the central areas of each community. Although the sewerage systems have already installed, final sewerage disposal systems have not installed yet in most areas. Thus, indisposed domestic miscellaneous waste water is discharged into rivers directly. This causes deterioration of water quality on irrigation and rivers, and environmental aggravation of sanitary aspect. Indisposed waste water discharges especially into basins of the Maipo river and the Mapocho river which involve the urban area of Santiago city. The areas whose agricultural water sources are these rivers have cultivation limits by regulations. Thus, agricultural producing is aggravated. Moreover, water quality of rivers is deteriorated by inflow of waste water in local cities. Agricultural producing and living environment are also degraded.

Installation condition of sewerage systems in each community is shown in the figure on the following.



Installation of the sewerage system is retarded in sub-basins of Río Clarillo, Est. Lampa, Río Angostura, Est. Alhué, Melipilla, Río Puangue, and Est. Casablanca.

A plan on sewerage disposal in Santiago city aimed at 2024 has been established by EMOS. The planning area consists of three disposal sections. Construction of a sewerage-disposal plant has already started in the first disposal section. The disposal service will be available from 2001. Then, improvement of water quality can be achieved.

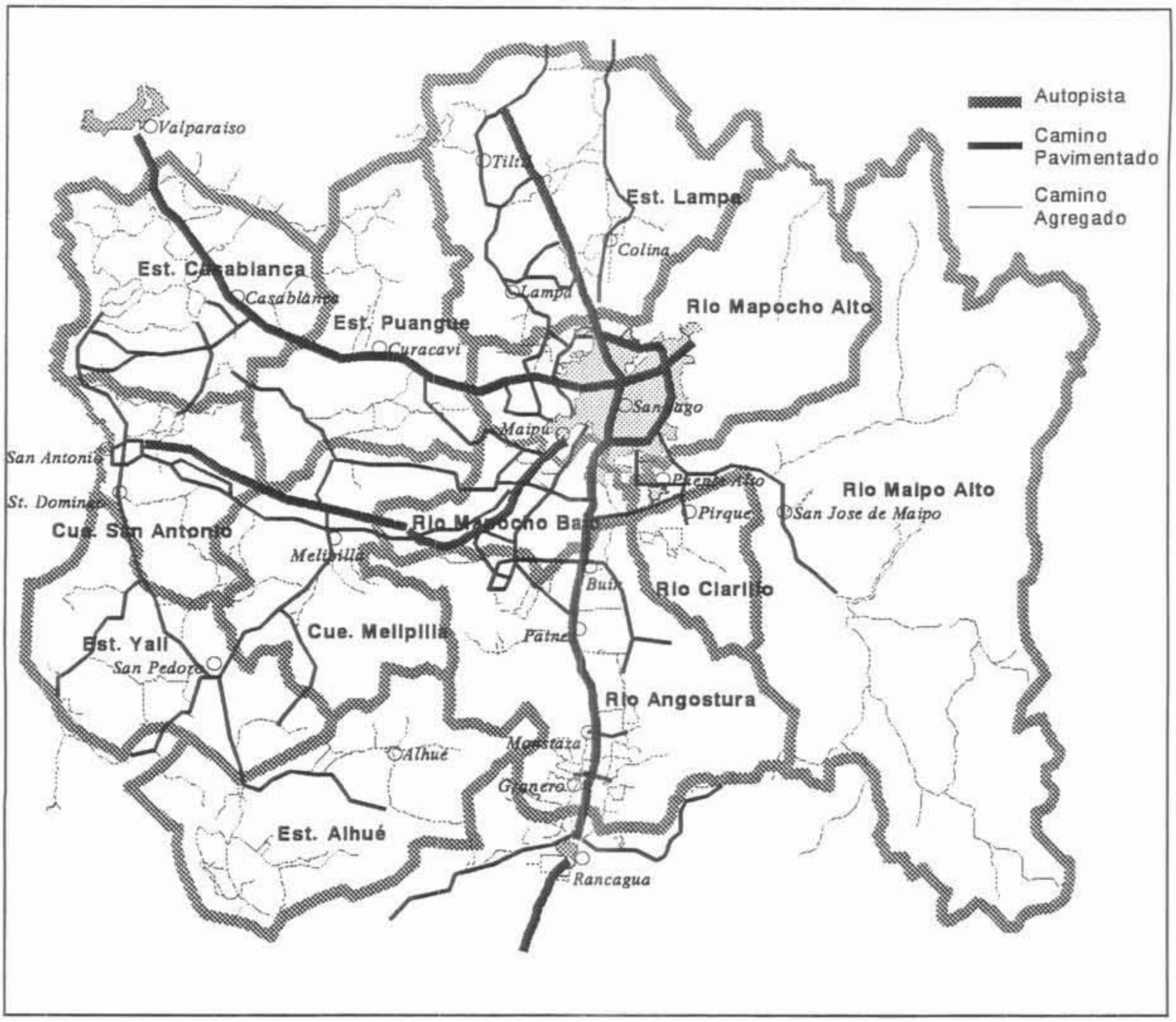
(4) Education and medical service

Generally, installation of educational and medical facilities are completed in the study area. However, both facilities are not well installed in rural communities.

As for educational facilities, long-distance school commuting and dormitory system are common in mountainous areas. Some measurements need to be taken for this situation. As for medical facilities, rural communities have only health centers.

(5) Roads

Roads as far as the levels of national and regional highways are completely paved. Road network which covers wide area has been established, and it becomes a main artery for physical distribution. Most of provincial highways which managed by community offices are unpaved. Yet, there is no hindrance for the passage of cars. As a general transportation system, the buses run in as far as the smallest units of each community. All community have access to national and regional highways, but there is not enough connected roads among or between community.

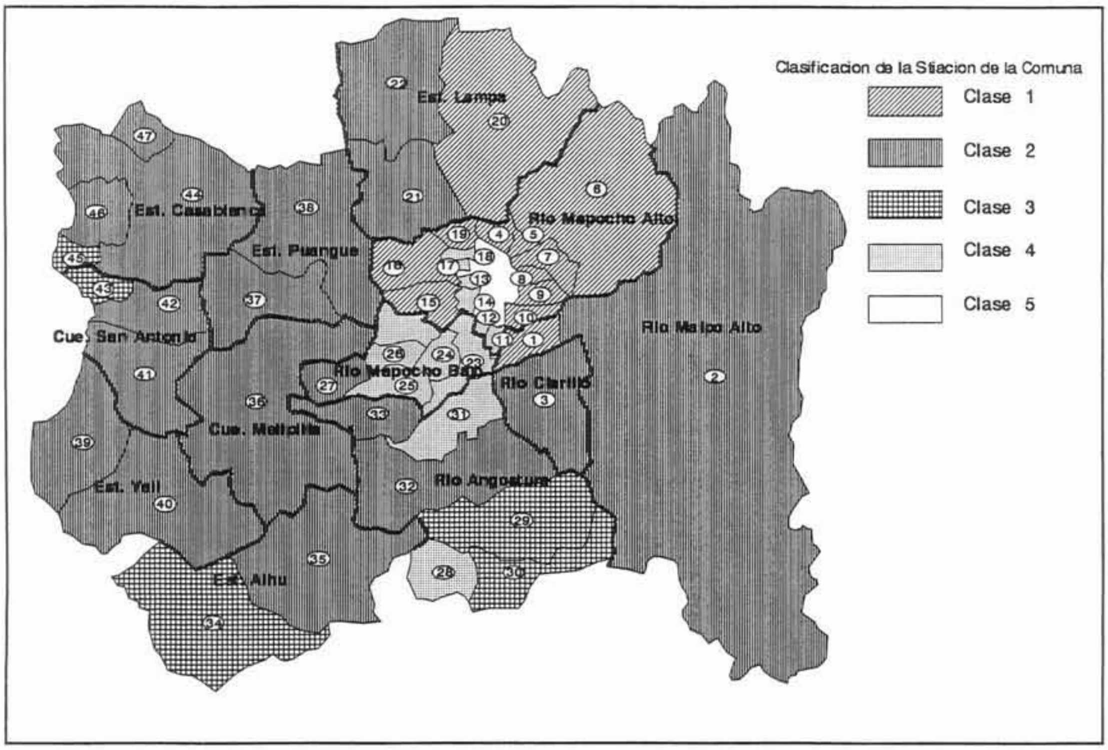


(6) Classification of community

To clarify the characteristics of each community, cluster analysis is made with five indicators such as employment ratio on primary industry, electrification ratio, covering ratio of water works and sewerage. Community in the study area divided into five classes based on the results of cluster analysis. Characteristics of each class are as follows;

Class	Characteristics
1	Insufficient basic infrastructure and low engagement ratio on agriculture Rapidly urbanization area
2	Insufficient basic infrastructure and high dependence on agriculture Typical agricultural area
3	Low facilitation of basic infrastructure and dependence on agriculture Agricultural area in a remote region
4	High facilitation of basic infrastructure and dependence on agriculture Agricultural area in outskirts of urban area
5	Urbanized area

For the classification of community in study area, fundamental structures can be seen such as behind of basic infrastructure in the rural area and sprawl by rapid urbanization in outskirts of Santiago. About 65% of community belongs to Class 2 and upgrade of basic infrastructure relating to the production and living is indispensable for activation and stabilized development of regional society. Classification of community is as follows based on the level of basic infrastructure in the study area.



3.9 Environmental Situation

The environment in the urban area is consisted in a correlation between the impermeable land including human habitations, roads and buildings, and the permeable land involving farmland, forest, meadow and water. In other words, it is the human-centered system into which such elements as air, water, soil, plants, animals, and micro-organisms are integrated: Ecosystem in the urban area.

The metropolitan region where deciduous-tree-fruits such as grapes have been produced for a long time and where a city area and farmland are closely involved, is characterized by its original ecological view. However, the recent increase in population in the city area is leading the region to an expansion, which seems to have a great influence on the ecosystem in the urban area.

3.9.1 Environmental Administration

The promulgation of the Fundamental Law of Environment (Law No. 19,000) in March 1994 and establishment of CONAMA led the environmental administration in Chile to the new stage. Meanwhile, the environment assessment system was more systematically established by the Law. In an agriculture field, the Ministry of Agriculture takes the lead to preserve soil for agricultural use, limit the use of agrochemical, and promote the preservation of forest and ecosystem.

Eleven objects for work are under consideration in the Assessment System of Environment approved in April 1997. Works related to water among them are works that have a great influence on waterworks, dams, drainage, the natural water system, and environmental improvement facilities. The following objects are included in the object with respect to the present project: the construction of a dam equal to or higher than 5 meters, or equal to or longer than 15 meters; an object in which the area influenced by draining water from natural lakes and marshes is equal to 20 hectares; the construction of a sewage disposal plant; and works or activities in the national parks. The assessment is conducted by the public organization having the authority for environment, which is coordinated by CONAMA. The public organization considers the necessity of DIA or EIA in accordance with the contents of works planned together with EIA section of CONAMA.

The assessment of the investment projects has been voluntarily carried out from 1993 until the establishment of guidelines for the assessment of environment in 1997. It takes 180 days as the whole period for EIA from the submission of reports to CONAMA until the decision of approval or rejection. The period may be prolonged, provided there is an observation on EIA. EIA system of projects is under control of COREMA. The offices in Santiago, Valparaiso, and Rancagua are in charge of the assessment of projects over the metropolitan region, the fifth province, and sixth province respectively. Projects over two or more provinces are assessed by CONAMA Headquarter.

There are provided regulations concerning water quality according to the purpose of use; a standard for water for agricultural use, drinking water, water for marine industrial use, water for recreation use, factory effluent and others. The standard value for water for agricultural use includes 27 standard values mainly composed of heavy metals. These regulations, however, have no binding force such as the penal regulations.

In discharging factory effluent into a sewer, on the basis of the law promulgated in July 1998, the effluent is first dealt by the plant, which each factory has the legal obligation to install, and then discharged into a sewer in the regulated standard value for discharging. In directly discharging factory effluent into rivers, there is provided the provisional regulations of 1992, giving a grace period for installing the plant to the existing factories, but not observed so far.

3.9.2 Natural Environment

(1) Designated area for protection

Designated areas within the object region such as the national parks are shown in the table below, which are managed by the Natural Forestry of Agricultural Department.

Type of Designation	Name of Areas	Size	Place (Basin)
National Park	No area designated	-	-
National Reserve	RIO CLARILLO	10,185ha	Rio Clarillo
	ROBLERIA DEL COBRE DE LONCHA	5,870ha	Est. Alhue
	LAGO PENUELAS	9,094ha	Est. Casablanca
	ESTERO EL YALI	520ha	Est. Yali
Natural Monument	EL MORADO	3,000ha	Rio Maipo U.
Natural Sanctuary	YERBA LOCA	11,575ha	Rio Mapoch U.
	LOS NOGALES	11,025ha	Rio Mapocho U.
	CASCADA DE LAS ANIMAS	3,600ha	Rio Maipo U.

Estero el Yali was registered as the marsh of the Ramsar Convention in December 1996,whose size was 520ha including the mouth of the Yali River and three lakes around the marsh. The marsh is also a bait and rest area for migratory birds. SECTOR BATUCO (Protection Zone (Priority III)) is to be entered on the list of the Convention. Fig. 3.9.1 shows areas for environmental preservation.

The number of animals and plants, and species has been rapidly decreasing recently over the metropolitan region compared to other provinces. Such factors are considered to be the cause of the phenomenon as water, soil, and air pollution, forest fire, the indiscriminate hunting, capture of animals for pets, and loss of soil because of human activities including industry, mining industry, housing, and agriculture (*Memoria del "Diagnostico ambiental para el Plan Regional de Desarrollo Urbano 1998-1999 Comision Ambiental del Plan Regional de Desarrollo Urbano, 1998*). Countermeasures against these factors are conducted by CONAF, CONAMA, and SNAPSE such as guarding against poaching, foiling an attempt to smuggle animals for pets, preventing forest fire, expanding the no-hunting area, and preserving the vegetation. Although there are organizations for environmental preservation, the watching activities are not carried out thoroughly.

One of the purposes of the Fundamental law of Environment Ley 19.300 is to preserve the diversities of animals and plants. In the Law, the conduct of the EIA is prescribed. Also prescribed in the Law are the EIA and actions in consideration for environment such as decrease in influence on environment or recovery of environment in the case where there is a great influence on the recyclable resources or there are resources or preservation areas around the project site.

The table below shows a distribution of the economic forest in every province in Chile, showing that few economic forests are distributed in the northern area of and around the metropolitan region, while 98.22% of the forests in the southern of the seventh province.

Province	Artificial Forest (ha)	Natural Forest (ha)	Total (ha)	Ratio (%)
I ~ IV	1,457	4,000	5,457	0.06
V	43,703	0	43,703	0.49
VI	59,589	41,200	100,789	1.14
MR	4,851	2,700	7,551	0.09
VII~XII	1,108,305	7,568,600	8,676,905	98.22
Total	1,217,905	7,616,500	8,834,405	100.00

Source: Report for Support of Planning the Preservation of Environment in Developing Countries – Republic of Chile-, Overseas Environment Cooperation Center Co. Ltd., March 1995.

The table below shows the condition of plants to be preserved and of vertebrate animals on land or in water. Numbers in brackets show the numbers of vertebrate animals over the metropolitan region.

Category	Tree	Succulent *1	Cryptophyte	Pteridophyte	Total
Extinct	-	1	1	-	2
Endangered	11	36	6	8	61
Vulnerable	26	105	40	8	177
Rare	32	19	31	23	105
Insufficiently Known	-	13	34	7	54
Total	69	173 *3	111 *3	44	397 *3

*1 Cactaceae and Ananas Comosus, *2 Total includes two species belonging to two categories.,
*3 Extinct species are excluded. *Source: Benoit, 1989.(PRICA, 1995)*

Category	Mammal	Bird	Reptile	Amphibia	Fish	Total
Extinct	1(1)	1(0)	0(0)	0(0)	0(0)	2(1)
Endangered	15(3)	10(4)	1(2)	6(2)	18(0)	50(11)
Vulnerable	15(4)	32(4)	13(5)	9(1)	23(0)	92(14)
Rare	12(2)	12(11)	18(1)	10(0)	1(0)	53(14)
Indetermination	2(1)	0(0)	0(0)	0(0)	0(0)	2(1)
Insufficiently Known	7(4)	18(6)	13(0)	6(2)	2(0)	46(12)
Total	51(14)	72(25)	45(8)	31(5)	44(0)	243(52) *1

*1 Extinct species are excluded. *Source: Libro Rojo de los Vertebrados Terrestres de Chile, CONAF, 1988.*

(2) Present condition of pollution

Within the metropolitan region, water pollution in the urban area including 34 communes and 4.7 million people in 1992 is most remarkable. The amount of living sewage and factory effluent accounts for 90% of the whole state. The sewage network spreads out in Santiago, the total length of which in the urban area reaches, according to EMOS, 6,500 km as of 1997. However, there is no sewage disposal plant so that filthy water in 13 m3/sec on the average of stream amount brought together from that area is directly discharged without disposed from 40 points of the Mapocho River, Zanjon de la Aguada Canal, and Maipo River. Such discharging brings about terrible water pollution of the rivers to be discharged, causing damage on nature and living surroundings. Water quality of the middle of the Maipo River, which has considered relatively good, is getting seriously worse recently because of the expansion of the urban area.

In the agricultural area where water for irrigation has been taken from the rivers polluted, the agricultural activity is seriously influenced by the water such as the limitation of crops to grow, fall of value as merchandise, and consumer's avoidance of the crops. Farmers considering difficulty of maintaining agriculture decide to give up farming and sell their farmland for housing those results in the disordered and unplanned expansion of the urban area.

The group number of coliform bacilli included in water for agricultural use taken from those rivers and canal is distributed within a range from 1,000 MPN/100ml or more to 105 MPN/100ml or more (cited from "Chile Managing Environmental Problems: Economic Analysis of Selected Issues", The World Bank, 1994). The former number corresponds to that of coliform bacilli in water taken mainly from the middle and lower part of the Maipo River and upper part of the Mapocho River, while the latter corresponds to that of coliform bacilli taken from Zanjon de la Aguada Canal and the middle and lower part of the Mapocho River.

In order to grasp the present condition of water quality surveys on water quality of river irrigation canals, and wells were carried out by an entrusted local consultant in July, August, and December 1998. 13 objects, water temperature, pH, EC, SS, DO, BOD, the group number of coliform bacilli, NO3-N, Ca2+, Mg2+, Cu2+, SO42- and Cl-, were analyzed, mainly based on bacteria broken out by living sewage. In the third survey in December, the survey points of the upper of the Maipo River and the Mapocho river where water quality was found relatively clear in the first and second surveys were not re-surveyed, while survey points were increased on canals instead. Figs. 3.9.2 and 3.9.3 show the survey points of water quality and the condition of water pollution respectively. Respective tables 3.9.1 to 3.9.3 show the analysis result of water quality.

The present survey particularly shows, compared to the past one carried out by the Chile organization, that the group number of coliform bacilli taken from the middle of the Maipo River has remarkably increased. Evaluation of fecal coliforms is shown in Table 3.9.2. Of the group number of fecal coliforms taken from rivers, 1,000 MPN/100ml or more accounts for about two third, around a quarter of which is 100 million MPN/100ml or more corresponding to the number of coliform bacilli taken from the lower part of the Mapocho River. The number of coliform bacilli taken from most of the excess points was 1000 MPN/100ml or more, though the numbers from the Lampa River and Puangue River were 0.1 mil. MPN/100ml or so. Of the number of canals, the value of 8 canals taken from Zanjon de la Aguada, the middle and lower of the Mapocho River are 100 million MPN/100ml or more. Of well water, no group number of 100 MPN/100ml or more was found.

	Evaluation of fecal coliforms (number of excess point/number of survey point)					
The number of fecal coliforms	1,000 MPN/100ml or more			100 mil. MPN/100ml or more		
Place	River	Canal	Well	River	Canal	Well
First Survey	18/26	2/3	0/7	5/26	1/3	0/7
Second Survey	17/29	1/2	0/7	8/29	1/2	0/7
Third Survey	14/23	15/16	0/7	2/23	9/16	0/7

The table below shows the evaluation of BOD, which is the index of river pollution. Rivers passing through the urban area and canals from which water is taken shows BOD 10mg/l or more because of city sewage. Survey points of Zanjon de la Aguada and confluence with the Mapocho River shows BOD 200mg/l or more.

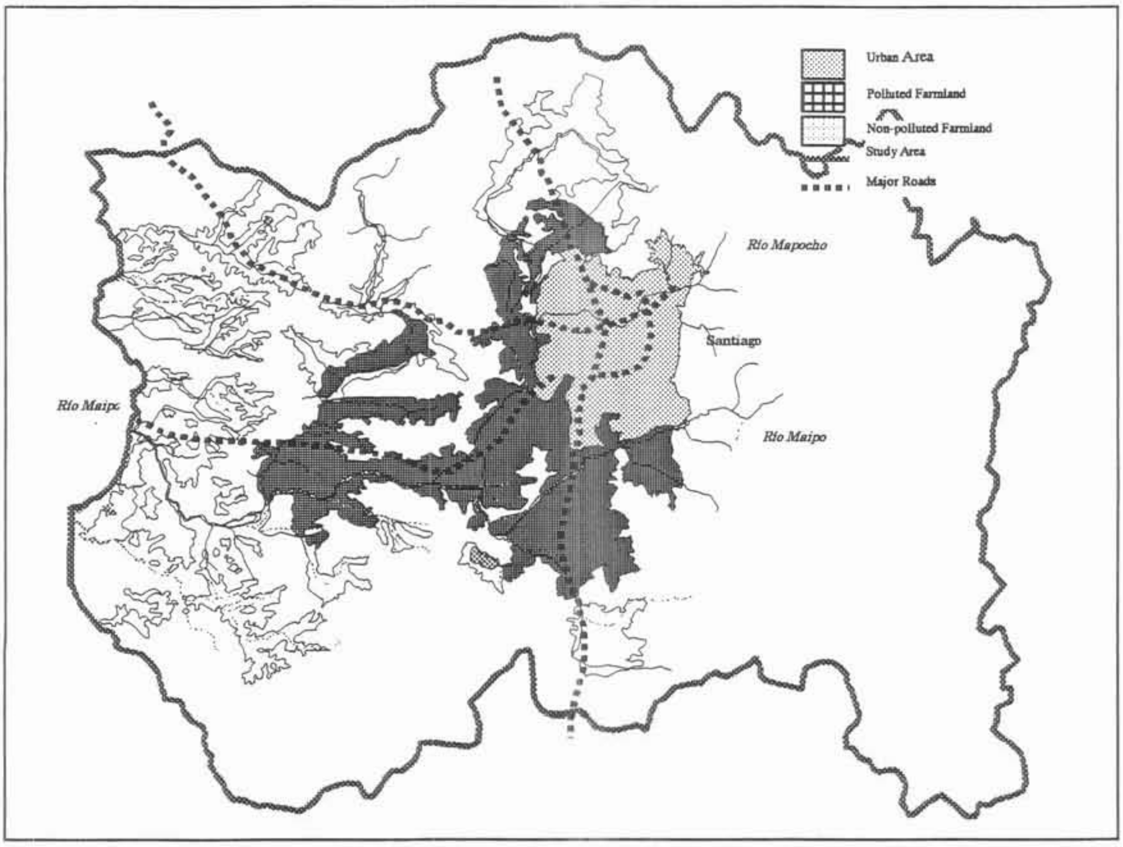
	Evaluation of BOD (number of excess point/number of survey point)					
Concentration	10 mg/l or more		100 mg/l or more		200mg/l or more	
Place	River	Canal	River	Canal	River	Canal
First Survey	16/26	3/3	1/26	1/3	0/26	1/3
Second Survey	13/29	1/2	1/29	1/2	1/29	1/2
Third Survey	22/23	15/16	2/23	6/16	0/23	0/16

The table below shows the comparison of copper ion (Cu) in water for agricultural use. The concentration value over the Chile standard one was found at one point of the upper of the Mapocho River. 13 survey points of 23 shows 0.02 mg/l or more. Particularly, all points of the Mapocho River until those of the confluence with the Maipo River show 0.02 mg/l or more. 14 points of 16 surveyed on canals and 2 of 7 on wells show 0.02 mg/l or more.

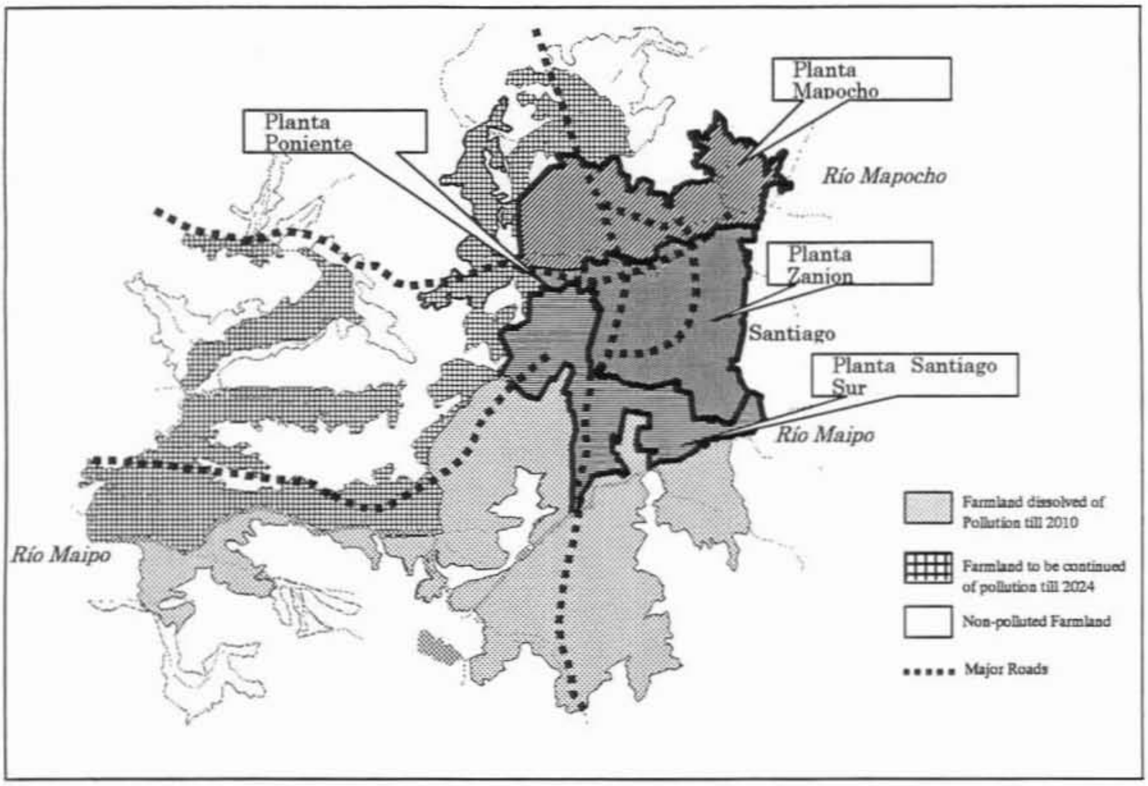
	The Comparison of Copper Ion (Cu) in Water for Agricultural Use (number of excess point/number of survey point)					
Concentration	0.20mg/l (Chile Standard) or more			0.02mg/l (Japanese Standard) or more		
Place	River	Canal	Well	River	Canal	Well
First Survey	0/26	0/3	0/7	1/26	0/3	0/7
Second Survey	1/29	0/2	0/7	5/29	1/2	0/7
Third Survey	1/23	0/16	0/7	13/23	4/16	2/7

The construction of a sewage treatment plant has been planned by EMOS since 1995 in order to improve such condition of water quality. According to the plan, Santiago City is divided into three sections for treatment, the South, Central, and North Section. A part of operation is to start in the South section in 2001 (from 3.5 m3/s in the beginning to 6.4 m3/s in the end), and in the North in 2009 (from 6.1 m3/s to 8.2 m3/s). It is not until 2024 that the plant will be completely constructed because the dealing amount of water to be treated will be escalated in every section in the plan. Sewage disposal population and the average amount of discharged water will be estimated at 8.7 million and 25 m3/sec respectively in 2024, the last stage of the plan. The sewage treatment plant in operation now is only the Poniente Pilot Plant built in 1993 whose dealing amount is only 0.2m3/sec. Fig. 3.9.4 shows the plan of sewage treatment in Santiago.

The installation of interceptor collectors and construction to change the drain point of rivers have been carried out in order to prevent sewage from flowing into water for agricultural use. These constructions cause, however, another water pollution by discharging sewage into the lower part of rivers. Following is the irrigation area that water for irrigation has been taken from the Mapocho and Maipo rivers and sewerage is incoming to those rivers.



Distribution of the area to be avoided the contamination of irrigation water with the sewage treatment plan of EMOS is as follows;



3.9.3 Social Environment

The outbreak of cholera in 1991 brought about such problems as the influence of sewage in the metropolitan region on agriculture and the necessity of disposing of the sewage. Economic loss because of the outbreak of typhoid and hepatitis caused by the worse public health and distribution of polluted agricultural products was roughly calculated and estimated to be about $2.63 million as of May 1993 (cited from the publication, The World Bank, 1994). Raising the specified vegetables such as lettuce with surface water is still prohibited in the whole metropolitan region, but not prohibited in the other regions. When growing the specified vegetables with ground water in the metropolitan region, the permission of the supervising organization, SAG, is necessary, which is given on condition that the group number of fecal coliforms in underground water is no more than 1,000 MPN/100ml.

The number of the outbreak of typhoid per 100,000 people in the metropolitan region from 1985 to 1996 is shown in the table below, indicating that the number had been less than 100 until 1991 but has remained less than 10 since 1992.

Year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Number	86	78	54	56	76	46	49	8	6	6	6	5

Source: "Indicatdores de atencíon de salud," Ministerio de Salud, 1996

Further, the total number of the outbreak of typhoid in1996 within the whole metropolitan region, and each amounted number of six areas consisting of the region are shown in the table below, indicating that the total within the whole region accounts for 305 in which 180 comes from SUR zone and the other zones are within a range from 18 to 36.

Zone	Whole Region	ORIENTE	CENTRAL	SUR	NORTE	OCCIDENTE	SUR ORIENTE
Number	305	24	20	180	27	36	18
Per 0.1mil.	5.32	2.24	2.76	16.67	4.37	3.40	1.52

Source: "Indicadores de atencíin de salud," Ministerio de Salud, 1996

The amount of solid waste in every province of Chile in 1988 is shown in the table below, indicating that the most amount discharged from the Santiago metropolitan region accounts for 120,000 ton/month, about 60 % of the total.

Region	Population (1.000 persons)	Production per month (1.000 ton)	%
I～IV	1.183	14	7,0
V	1.180	21	10,5
VI	366	7	3,5
MR	4.831	120	60,0
VII～XII	2.793	38	19,0
Total	10.353	200	100,0

Source: Ximena Alegría., "Residuos Sólidos",Insituto de Ingenieros 1990.

As to general waste, every community contracts individually to private companies to dump in the landfill for general waste. Lo Errazuriz was completely closed in December 1995 so that waste generated from 36 municipal over the metropolitan region was to be distributed to the other two landfills with initiative of SESMA. The amount of solid waste in 1998 was 120,000 tons/month, which accounted for 60 % of the total amount in all areas of Chile.

At the site where the irrigation facilities such as canals for irrigation passing through the living area, there have been problems recently such as inflow of domestic sewage into canals, deterioration of water quality because of dumping waste into canals, and decrease in area of canals. The present situation is that there is no activity for amelioration of environment by residents at the site and that a guild of canal association is dealing with those problems by itself on the other.

3.10 Constraints and Development Potentials on Agricultural Development

3.10.1 Present Problems and Future Prospects

To grasp the basin characteristics in regional-wise, the study area is divided into 12 sub-basins based on administrative and basin boundaries. According to the results of the study on the present condition, major index of each sub-basin concerning nature, social and agriculture can be summarized as shown Table 3.10.1. Also the problems on the agriculture in the study area can be summarized in following four points.

(1) Present problems

1) Disparity caused by landholding scale

The landholding structure in the study area is distorted. 6% of landowners who hold more than 100ha farmland occupy 86% of total farm land in the study area and more than 80% of landowners who hold less than 15ha occupy only 5% of that. Large and middle scale farmers have established their bases for farming (management scale, labor force, irrigation, and agricultural machinery) and of management (access to distribution and markets, fund, and credit access). They farm as enterprises and industry. On the other hand, small scale farmers have not established stable farming and management bases because of small farming scale and traditional agricultural technology. Thus, extended reproduction of agriculture is difficult for them. In addition, migration of these small scale farmers from rural to urban areas has been increased in these years. The increase of the migration has been caused by that installation of BHN infrastructure has been behind in rural areas compared to in urban areas besides low income structure of small scale agriculture.

2) Tightness and competition of water use

Almost whole water use depends on the runoff from upstream of Maipo river (Andes mountains) in the study area at present. Irrigation use dominates its water use, but utilization for water supply, mining and manufacturing industries, and electric generation has been increased with expansion of capital city, Santiago. Both surface and ground water uses are controlled by water right system. However, from the point of established water right, its water amount has already reached its limit, and it is almost impossible to establish new water right.

3) Contamination of agricultural water

Irrigation systems, which intake water from the rivers which run near the metropolitan area of Santiago, uses contaminated water by waste water from the metropolitan area as agricultural water. At present, the cultivation of designated vegetables such as lettuce by contaminated irrigation water is prohibited. On the other hand, treatment of urban waste water is planned to be improved gradually by EMOS and its target year is 2024. Nevertheless, it will take about 25 years for the irrigation systems to obtain purity irrigation water from rivers.

4) Decrease of farmland

Based on the expanding metropolitan economy, abandonment of agricultural land use from agricultural sector in the suburb of the metropolitan area has proceeded due to demand of expanding urban land use from the urban side and decreasing sustainability of agricultural land use in the farmland The farmland which alter to urban land is the superior farmland which consisted of proper soil for crop cultivation and for irrigation water use.

The future tendency on each problem can be prospected as follows.

(2) Future prospects

1) Disparity caused by landholding scale

The problem of disparity caused by landholding scale is, in the other words, the problem of small scale agriculture. There is no indication that technological and financial problems on the small scale agriculture can be improved at present. If the situation remains as it is, small scale farmers who are the main executives of the small scale agriculture would be left alone in competitive society and gradually be ignored, and then would have to abandon their farmland. The farmland will be combined with large and middle scale farmland or be not used as farmland. In this case, the first point to notice is the existence of job opportunity. When quitting agriculture directly means unemployment, rural or urban areas will hold new social and economic problems. The other one is the role which small scale farmers have been playing in rural areas. They have relationship with surrounded nature through agriculture which is their subsistence. The ecology system is formed and sustained through activity system of agriculture. The fact that total small scale farmers dominate 80% in whole Study Area depicts that small scale farmers are main constituents of rural society. Therefore, decrease or disappearance of small scale agriculture means structural disruption of rural area. This will cause serious social problems.

2) Tightness and competition of water use

The water use in the metropolitan area has already reached its limit. Thus, it is difficult to settle new water right through the easy methods such as use of river surface runoff. New water utilization will be promoted through the use of small scale ground water development, obtaining the established water right in the market, utilization of unused water right, rationalization of water use so far, storage of flood runoff, and so on. In the existing irrigation system, the frequency of water shortage has been increased at the terminal of the system with superannuating facilities.

3) Contamination of agricultural water

Chilean agricultural product for export achieved good reputation internationally by its quality and price, and maintains it until now. The reputation also needs to be sustained from now on. It will be brought through that Chile can produce not only high quality products with competitive power by technology but also low agricultural chemical products under isolation condition which resulted by peculiar weather and nature. This natural environment is precious property for Chile.

The competition in an agricultural market is very severe. Examples of competitive power loss, which resulted from something contained in or mixed with the products by accident, have been frequently heard. In addition, it can never be ignored that bad rumor on the products damage the dealings in the market even if the fact is not so bad. The fact in Chile is the use of contaminated irrigation water for crop cultivation. Even if the regulation on epidemics such as Cholera concerned with sanitation, contaminated water flow and bad smell which can be felt in cultivation areas would damage the image against the agricultural products in case that this spreads as rumor, once. This will obviously damage agricultural processing food and perishable food such as fruits and vegetables which have been expanded in Chie and will also influence low agricultural chemical products which mentioned above.

4) Decrease of farmland

Decrease of farmland in the metropolitan area and its suburb result from the trend of expanding urban areas and the gap on senses of value between present value of farmland for agricultural use and that for multiple use. The other causes are promotion for farmland transfer under current system, restriction of crop cultivation by contaminated irrigation water and so on. However, urban planning was established in Santiago city and other main cities. Through the planing, areas are clarified by land use and change of land use tends to be limited within designated framework from now on. On the other hand, development of subtropical fruit cultivation has been promoted through utilizing micro climate condition and ground water. The farmland for this use has increased. According to the demand in the market, the development of this type's fruit cultivation areas tends to continue for the time. Nevertheless, this restricts to particular fruit cultivation and cannot satisfy the demand for various crop cultivation. Thus, development of new farmland is required.

3.10.2 Constraints and Potentials

Based on the present problems and their future prospects, the constraints and development potentials for examining effective use of resources, agricultural promotion, and environmental conservation as the countermeasures to solve the problems in the study area are recognized as follows.

(1) Constraints

- Limited support system for small scale farmers

Supporting activities for small scale farmers are implemented by governmental institutions such as INDAP, but in order to use this program, farmers are required to establish the utility plan of the supporting system and to operate a supported program after its approval. It is not easy for small scale farmers to receive the support under such a system which requires a formed organization by the beneficiaries and their ability of establishing the plan. The basic condition for receiving the farming support from government and strengthening power of negotiation is to form small scale farmers' organizations. Nevertheless, following reasons prevent forming small farmers' organizations at present; small farmers do not know the existence of the supporting program, there is no farmers who can be a leader even if they know it, and individualistic living custom and so on. On the background of this situation, the "small scale farmer" is historically new class which emerged after agricultural reform.

- Superannuated infrastructure and facilities' environment

Most part of the cultivated land located along main stream and tributaries of the Maipo river is equipped with irrigation facilities. Most of these facilities were built before 1950 and are superannuated. Thus, O & M cost of them has been increased annually. In addition, problems such as deterioration of water quality and shrinking cross-sectional area of flow due to inflow of gray water and thrown away garbage into canals have been recently emerged at the points which the canals pass through.

- Little amount of rainfall and imbalanced rainfall distribution

Annual rainfall is about 400mm. This amount of rainfall is not enough to crop cultivation. Moreover, most rainfall is concentrated in winter from May to September. Therefore, irrigation is indispensable for stable farming.

- Difficulty of obtaining new water right

Present water use is dominated by irrigation use, but urban use such as water supply service has been increasing. Present settled water right relevant to surface and ground water in metropolitan area has reached the limit of available amount of water source. Therefore, methods which do not influence settled water right such as dam construction for water storage are needed in order to obtain a certain amount of water and stable new water right.

- Discharge of untreated waste water

Most of waste water from urban areas is discharged into the Mapocho river without treatment in the end because the Mapocho river which flows along the edge of southwest functions as a drain due to topography of the city area of Santiago. Step-by-step construction of waste water treatment plants are planned relevant to amount of treated water, and costs of facility and operating. Thus, present discharge of untreated waste water into the river will continue for time being.

- Demand of urban land use

In the capital city of Santiago and local cities, land demand for housing, factories, and offices due to population concentration has been satisfied with altering land use of surrounding farmland. It is promoted to alter farmland use to multiple land use through deteriorating farming environment by urbanization, abandoning farming resulted from economic motivation led by increasing land price, subdividing farmland approved as the system, and so on.

(2) Development potentials

- Existence of a large market

The Study Area is located in the suburbs of Santiago city which is the largest domestic agricultural market. It is possible for even small scale producers to sell products under the better condition than the present one by forming organizations and developing a new channel of self-sale. Not only domestic agricultural market but also export markets of fruits, vegetables, and seeds have been established through making use of the inverse season of the northern hemisphere. Because ODEPA provides the market price information service to farmers, the basic condition is prepared to improve the present sale condition by controlling the period of shipment.

- Farmers' high intention for improvement of farming

In the study area, some small scale farmers achieved the power of price negotiation in the market and sold their products under favorable condition for them through forming producers' organizations for specific crops and standardizing requirements and quality of products, and intending stable shipment in these years. This kind of examples suggests the possibility of forming farmers' organizations in other areas. There is the possibility of promoting forming organizations with assembling forms which suit to each area, strengthening their negotiation power in the markets, and accelerating receipt of agricultural support.

- Meteorological and topographical condition which suit for cultivation

The Study Area is belonging to the Mediterranean climate zone and also has advantage on protecting against epidemics because of its topographical condition which makes the area isolate from other areas. Thus, if only irrigation condition is satisfied, this would mean the area has meteorological condition that can develop various types of agriculture such as fruits and vegetables.

- Possibility of utilizing water by reservoir

Irrigation water which used in summer when crop cultivation reaches its peak is snowmelt runoff from the Andes mountains which emerged in rivers with going up temperature. In the areas where snowmelt water cannot be used, water whose origin is ground water is used as irrigation water. On the other hand, in winter when no-irrigation period and simultaneously flood runoff occurs by rainfall, most of river runoff is not used. So, there is the possibility to expand water use through storing the runoff and leveling water use. In addition, some established water rights are unused and only held or are sold in a water right market. These is also possibility of new water use by utilizing these water rights.

- Existence of suitable farmland for development

Mainly in coastal mountain area, extensive farming is operated by using rainfall in winter because there is no available water source near farmland. Under this situation, unirrigated farmland and uncultivated land that suit for irrigation are estimated about 110,000ha in the study area. From the point of land resource, there is large possibility to develop irrigated agriculture.

- The sense of crisis against contaminated agricultural water

Farmers think it is unreasonable that they have to deal with water quality's improvement by themselves because quality of irrigation water has been deteriorated by urban waste water in the metropolitan area. On the other hand, so as to keep up the boom of agricultural export stably, it is recognized that water quality as infrastructure should be considered, at present. The farmers and inhabitants around farmland have high sense of crisis on their health and sanitary.

3.10.3 Direction for the Development

Based on the results of site survey on current agriculture in the metropolitan area, its problems are summarized as follows;

- Disparity caused by landholding scale
- Competition of land and water resources between agricultural and urban uses
- Deterioration of living and producing environment that represent discharge of untreated waste water into rivers

The direction of countermeasures to solve these problems are summarized in a following figure based on future prospects of each problem, constraints on agricultural development, and development potentials mentioned before.

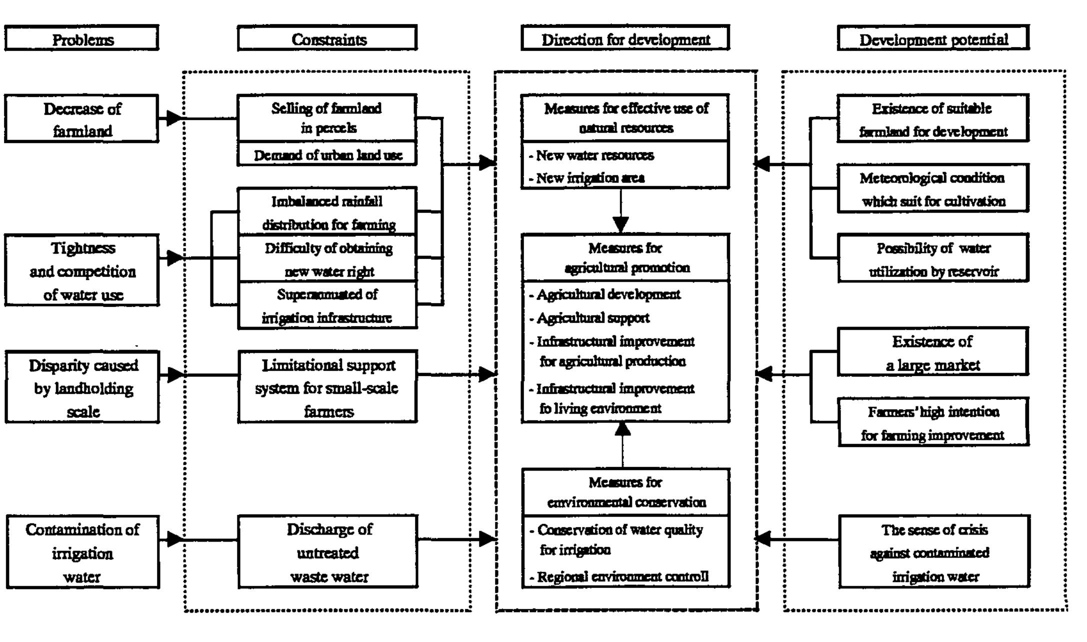


Table 3.2.1 Area by Cultivated Crop

Sub-basin	Province	Total farm-land (ha)	Planted Area (ha)	Cereal (ha)	Chacras * (ha)	Industrial crops (ha)	Horticultural Crops (ha)	Flowers (ha)	Forage crops (ha)	Fruits (ha)	Grapes (wine&table) (ha)	Nursery bed (ha)	Seed Production** (ha)	Forested area (ha)
1. Río Maipo Alto (sub-total)	Cordillera	493,094.30	3,489.10	129.5	56.6	0	224.7	49.2	704.4	531	424.7	0.5	13	1,355.50
2. Río Clarillo (sub-total)	Cordillera	24,852.00	7,104.90	703.4	31.7	0.4	179.6	22.3	1,618.70	1,718.40	584.8	5.1	90.7	2,149.70
3. Río Mapocho Alto (sub-total)	Santiago	40,408.10	9,795.20	1,164.00	523.3	28.5	3,008.30	28.7	2,589.70	1,360.50	380.1	44.9	449	218.1
4. Est. Lampa (sub-total)	Chacabuco	132,163.70	19,482.40	961.8	161.5	24	6,783.00	11.4	3,890.60	5,719.30	93.5	20.4	1,081.10	734.80
5. Río Mapocho Bajo (sub-total)	Talagante Maipo	41,108.00	28,110.90	3,960.60	1,040.20	5	4,674.80	78.6	5,919.10	10,322.90	755.9	99.7	689.1	564.9
6. Río Angostura (sub-total)	Talagante Maipo Cachapoal	142,979.80	56,324.70	10,981.50	1,147.30	83.3	5,390.40	48.5	3,917.20	22,452.50	3,951.10	332.7	3,489.00	4,523.80
7. Est. Alhué (sub-total)	Cachapoal Melipilla	128,210.50	15,404.10	6,579.80	1,501.10	0.3	674.7	0	1,441.80	3,183.30	458	27	100.6	1,437.50
8. Cue. Melipilla (sub-total)	Melipilla	108,447.70	30,492.40	7,363.50	1,039.60	1.7	3,828.10	6.7	8,821.40	6,837.10	410.7	35.9	1,037.80	1,089.90
9. Est. Puangue (sub-total)	Melipilla	65,283.00	13,235.20	2,633.90	1,473.10	1	2,209.20	1.6	3,563.80	1,974.40	314.6	0.5	851.4	211.7
10. Est. Yali (sub-total)	Melipilla San Antonio	127,798.00	17,884.60	6,429.90	679.5	0	281.2	3.3	2,226.00	544.9	11.2	4.1	139.8	7564.7
11. Cue. San Antonio (sub-total)	San Antonio	66,563.50	16,177.30	2,852.70	77.6	0	250.1	0.1	2,465.80	151.1	9	0.8	16	10,354.10
12. Est. Casablanca (sub-total)	Valaparaiso	89,923.80	17,084.20	956.3	256.5	0.1	451.6	1.2	5,838.40	509.2	1,308.40	7.9	12.9	7,741.60
Total		1,460,832.40	234,585.00	44,716.90	7,988.00	144.3	27,955.70	251.6	42,996.90	55,304.60	8,702.00	579.5	7,970.40	37,946.30

Source: Censo Nacional Agropecuario 1997

* Chacras (Traditional Crop) : Main crops which farmers cultivated in the land where was provided instead of salary during the plantation era (Potato, Maize, Beans, Melon and etc.) .

** Seed Production: Seed for export and domestic consumption (Vegetable, Maize, Wheat and etc.).

Note: Total farmland area does not include fallow land (4,432.3ha).

Table 3.2.2 Area by Land Productivity

Sub-basin	Community	Total Area	With irrigation					Without irrigation									Province	Community
	(Comuna)	(Ha)	I	II	III	IV	Total	I	II	III	IV	V	VI	VII	VIII	Total	(Provincia)	(Comuna)
1. Río Maipo Alto	PUENTE ALTO	5,545.85	513.65	789.04	2,004.08	347.70	3,654.47	0.00	2.70	13.64	11.41	5.99	603.35	703.40	550.89	1,891.38	CORDILLERA	PUENTE ALTO
	SAN JOSE DE MAIPO	492,697.64	1.50	22.37	586.76	739.83	1,350.46	45.72	0.00	320.06	242.34	0.94	5,669.47	82,430.39	402,638.26	491,347.18	CORDILLERA	SAN JOSE DE MAIPO
	subtotal	498,243.49	515.15	811.41	2,590.84	1,087.53	5,004.93	45.72	2.70	333.70	253.75	6.93	6,272.82	83,133.79	403,189.15	493,238.56		
2. Río Clarillo	PIRQUE	44,230.14	625.47	3,630.74	2,267.27	1,085.33	7,608.81	1.80	54.00	335.18	480.13	3,350.65	3,756.01	11,744.19	16,899.37	36,621.33	CORDILLERA	PIRQUE
	subtotal	44,230.14	625.47	3,630.74	2,267.27	1,085.33	7,608.81	1.80	54.00	335.18	480.13	3,350.65	3,756.01	11,744.19	16,899.37	36,621.33	CORDILLERA	
3. Río Mapocho Alto	PUDAHUEL	17,669.76	202.12	660.75	2,575.88	1,377.76	4,816.51	0.00	154.10	184.08	2,613.32	0.00	4,066.72	4,786.54	1,048.49	12,853.25	SANTIAGO	PUDAHUEL
	MAIPU	11,055.05	863.05	2,161.75	2,736.44	626.15	6,387.39	200.86	92.20	0.00	616.73	66.80	1,505.62	1,723.47	461.98	4,667.66	SANTIAGO	MAIPU
	QUILICURA	5,496.71	795.41	398.22	1,110.63	858.26	3,162.52	0.00	0.00	0.43	384.10	44.90	750.00	911.15	243.61	2,334.19	SANTIAGO	QUILICURA
	subtotal	34,221.52	1,860.58	3,220.72	6,422.95	2,862.17	14,366.42	200.86	246.30	184.51	3,614.15	111.70	6,322.34	7,421.16	1,754.08	19,855.10		
4. Est. Lampa	COLINA	115,060.08	346.38	2,646.16	5,998.39	2,748.32	11,739.25	8.01	446.72	989.42	6,214.18	17.40	9,464.46	48,373.51	37,807.13	103,320.83	CHACABUCO	COLINA
	LAMPA	42,967.73	102.55	330.83	2,485.21	2,961.24	5,879.83	1.06	283.89	1,012.47	4,824.23	107.85	6,730.24	20,650.84	3,477.32	37,087.90	CHACABUCO	LAMPA
	TILTIL	66,097.12	6.20	592.30	1,183.43	1,617.97	3,399.90	61.00	579.13	762.47	5,506.77	2.50	5,622.53	35,691.93	14,470.89	62,697.22	CHACABUCO	TILTIL
	subtotal	224,124.93	455.13	3,569.29	9,667.03	7,327.53	21,018.98	70.07	1,309.74	2,764.36	16,545.18	127.75	21,817.23	104,716.28	55,755.34	203,105.95		
5. Río Mapocho Bajo	SAN BERNARDO	11,956.60	608.58	5,617.56	2,381.57	224.32	8,832.03	0.00	3.50	1.80	20.69	0.10	269.50	1,651.31	1,177.67	3,124.57	MAIPO	SAN BERNARDO
	CALERA DE TANGO	7,051.45	84.18	4,123.79	1,698.62	52.35	5,958.94	0.00	17.81	22.40	0.00	0.00	80.92	333.10	638.28	1,092.51	MAIPO	CALERA DE TANGO
	TALAGANTE	10,912.65	29.05	4,085.97	3,516.26	1,098.09	8,729.37	75.56	9.08	72.00	120.70	4.42	27.32	1,556.32	317.88	2,183.28	TALAGANTE	TALAGANTE
	PENAFLOR	14,030.50	298.31	3,433.63	3,852.82	1,230.07	8,814.83	17.22	38.60	248.79	92.93	118.18	564.04	3,551.15	584.76	5,215.67	TALAGANTE	PENAFLOR
	EL MONTE	10,783.98	26.82	2,536.19	2,636.75	964.17	6,163.93	0.50	84.70	0.00	204.65	8.50	410.52	3,718.95	192.23	4,620.05	TALAGANTE	EL MONTE
	subtotal	54,735.18	1,046.94	19,797.14	14,086.02	3,569.00	38,499.10	93.28	153.69	344.99	438.97	131.20	1,352.30	10,810.83	2,910.82	16,236.08		
6. Río Angostura	BUIN	18,909.21	5,341.53	6,336.83	2,780.22	1,146.83	15,605.41	38.19	0.00	39.38	34.08	41.25	102.20	2,508.58	540.12	3,303.80	MAIPO	BUIN
	PAINE	72,832.47	1,369.26	5,930.04	8,496.29	3,235.50	19,031.09	24.01	85.94	620.11	605.13	501.87	3,021.23	35,838.83	13,104.26	53,801.38	MAIPO	PAINE
	ISLA DE MAIPO	18,041.03	289.15	1,457.93	4,311.91	1,379.33	7,438.32	3.53	56.50	269.90	246.60	26.90	768.88	6,795.44	2,434.96	10,602.71	TALAGANTE	ISLA DE MAIPO
	GRANEROS	10,668.90	1,919.94	3,182.51	1,347.33	218.49	6,668.27	7.50	2.20	35.32	6.10	0.00	716.76	2,345.55	887.20	4,000.63	CACHAPOAL	GRANEROS
	MOSTAZAL	43,649.76	5.60	2,073.41	3,245.84	1,681.02	7,005.87	0.00	9.80	135.85	715.70	147.65	2,705.88	13,619.43	19,309.58	36,643.89	CACHAPOAL	SAN FRANCISCO DE MOSTAZAL
	CODEGUA	18,044.43	799.84	3,147.79	2,892.17	973.94	7,813.74	0.00	0.00	2.70	90.50	13.53	827.99	7,226.17	2,069.80	10,230.69	CACHAPOAL	CODEGUA
	subtotal	182,145.80	9,725.32	22,128.51	23,073.76	8,635.11	63,562.70	73.23	154.44	1,103.26	1,698.11	731.20	8,142.94	68,334.00	38,345.92	118,583.10		
7. Est. Alhué	LAS CABRAS	68,242.12	23.11	2,101.16	5,840.35	3,027.58	10,992.20	377.91	623.47	1,284.80	5,774.27	371.85	7,043.88	38,925.74	2,848.00	57,249.92	CACHAPOAL	LAS CABRAS
	ALHUE	94,145.26	4.50	71.04	483.29	476.15	1,034.98	0.00	314.66	1,640.42	9,168.47	25.20	3,134.55	61,385.30	17,441.68	93,110.28	MELIPILLA	ALHUE
	subtotal	162,387.38	27.61	2,172.20	6,323.64	3,503.73	12,027.18	377.91	938.13	2,925.22	14,942.74	397.05	10,178.43	100,311.04	20,289.68	150,360.20		
8. Cue. Melipilla	MELIPILLA	136,825.45	275.58	9,349.70	13,922.07	10,982.19	34,529.54	46.30	644.80	983.16	8,708.74	491.56	27,324.25	55,984.95	8,112.15	102,295.91	MELIPILLA	MELIPILLA
	subtotal	136,825.45	275.58	9,349.70	13,922.07	10,982.19	34,529.54	46.30	644.80	983.16	8,708.74	491.56	27,324.25	55,984.95	8,112.15	102,295.91		
9. Est. Puangue	MARIA PINTO	40,747.85	290.34	1,908.80	3,773.99	2,773.00	8,746.13	3.80	485.18	1,043.37	3,635.40	105.85	9,600.31	15,717.55	1,410.26	32,001.72	MELIPILLA	MARIA PINTO
	CURACAVI	71,460.34	216.98	1,528.37	3,056.13	1,357.22	6,158.70	15.00	34.54	1,029.66	3,384.05	155.92	7,440.71	43,724.66	9,517.10	65,301.64	MELIPILLA	CURACAVI
	subtotal	112,208.19	507.32	3,437.17	6,830.12	4,130.22	14,904.83	18.80	519.72	2,073.03	7,019.45	261.77	17,041.02	59,442.21	10,927.36	97,303.36		
10. Est. Yali	SAN PEDRO	69,699.02	0.00	0.00	241.41	86.20	327.61	37.50	199.30	4,879.80	11,271.69	442.60	20,481.66	30,855.20	1,203.66	69,371.41	MELIPILLA	SAN PEDRO
	SANTO DOMINGO	47,358.57	0.00	195.67	141.32	22.85	359.84	0.00	73.64	5,284.44	4,255.63	369.62	14,725.32	19,472.85	2,817.23	46,998.73	SAN ANTONIO	SANTO DOMINGO
	subtotal	117,057.59	0.00	195.67	382.73	109.05	687.45	37.50	272.94	10,164.24	15,527.32	812.22	35,206.98	50,328.05	4,020.89	116,370.14		
11. Cue. San Antonio	SAN ANTONIO	37,685.04	0.00	188.49	413.32	224.87	826.68	26.25	184.60	2,047.88	8,763.97	584.10	13,868.50	10,765.70	617.36	36,858.36	SAN ANTONIO	SAN ANTONIO
	CARTAGENA	24,485.58	0.00	52.00	5.20	4.60	61.80	19.28	0.00	2,315.33	2,471.81	0.00	3,629.70	15,485.56	502.10	24,423.78	SAN ANTONIO	CARTAGENA
	EL TABO	10,827.80	0.00	0.00	0.00	7.00	7.00	0.00	0.00	135.60	776.56	0.00	3,038.50	6,583.73	286.41	10,820.80	SAN ANTONIO	EL TABO
	subtotal	72,998.42	0.00	240.49	418.52	236.47	895.48	45.53	184.60	4,498.81	12,012.34	584.10	20,536.70	32,834.99	1,405.87	72,102.94		
12. Est. Casablanca	CASABLANCA	105,858.54	10.90	976.40	2,319.02	562.29	3,868.61	422.02	402.33	8,831.86	10,524.17	83.70	13,507.60	66,548.02	1,670.23	101,989.93	VALPARAISO	CASABLANCA
	EL QUISCO	4,481.18	1.90	0.00	0.00	3.00	4.90	4.00	0.00	71.31	666.55	0.00	1,278.96	2,444.09	11.37	4,476.28	SAN ANTONIO	EL QUISCO
	ALGARROBO	16,705.51	0.00	0.00	116.43	0.00	116.43	0.00	0.00	230.42	4,627.69	8.00	6,175.57	5,321.20	226.20	16,589.08	SAN ANTONIO	ALGARROBO
	subtotal	127,045.23	12.80	976.40	2,435.45	565.29	3,989.94	426.02	402.33	9,133.59	15,818.41	91.70	20,962.13	74,313.31	1,907.80	123,055.29		
	Total study area	1,766,223.32	15,051.90	69,529.44	88,420.40	44,093.62	217,095.36	1,437.02	4,883.39	34,844.05	97,059.29	7,097.83	178,913.15	659,374.80	565,518.43	1,549,127.96		Total study area

Table 3.3.1 Gross Regional Product (GRP) (1990-1992)

Region	(Million 1986 $)			(Regional Weight %)		
	1990	1991	1992	1990	1991	1992
I	124,828	131,198	141,620	2.81	2.79	2.73
II	271,778	289,155	303,012	6.13	6.15	5.84
III	61,161	70,939	79,994	1.38	1.51	1.54
IV	102,791	108,367	115,996	2.32	2.30	2.24
V	380,935	397,111	423,096	8.59	8.44	8.15
R.M.	1,736,198	1,853,863	2,080,761	39.14	39.40	40.10
VI	204,748	207,054	228,128	4.62	4.40	4.40
VII	161,150	185,353	211,066	3.63	3.94	4.07
VIII	409,815	429,243	457,223	9.24	9.12	8.81
IX	94,790	99,083	103,825	2.14	2.11	2.00
X	161,988	164,561	171,461	3.65	3.50	3.30
XI	19,171	20,974	21,792	0.43	0.45	0.42
XII	117,493	116,391	114,999	2.65	2.47	2.22
GRP	3,846,846	4,073,292	4,452,973	86.72	86.57	85.82
VAT, Import Duty, Others	589,196	631,781	735,738	13.28	13.43	14.18
GDP	4,436,042	4,705,073	5,188,711	100.00	100.00	100.00

Source: Compendio Estadisticas Regionales, MIDEPLAN, Noviembre 1997

Table 3.3.2 (1) Region V: Gross Regional Product by Economic Activity (1989-1990)

	(Million 1986 $)			(Sectoral Share %)			(Share in GDP %)		
	1988	1989	1990	1988	1989	1990	1988	1989	1990
Agriculture, Forestry	37,496	33,189	41,470	10.91	8.82	10.89	11.99	10.35	11.92
Fishery	5,286	6,387	6,577	1.54	1.70	1.73	11.71	12.60	13.68
Mining	38,771	47,937	46,235	11.28	12.73	12.14	10.52	11.87	11.67
Manufacturing	82,405	88,748	78,565	23.97	23.57	20.62	11.77	11.43	10.06
Electricity, Gas, Water	11,207	14,450	14,554	3.26	3.84	3.82	10.96	14.54	14.91
Construction	17,057	21,800	21,358	4.96	5.79	5.61	8.80	9.60	9.00
Commerce	35,231	38,114	38,026	10.25	10.12	9.98	6.25	6.00	5.70
Transport, Communication	38,384	46,345	50,021	11.17	12.31	13.13	14.85	15.80	16.02
Financial Services	21,575	23,750	24,530	6.28	6.31	6.44	4.38	4.23	4.22
Housing	18,431	18,712	19,160	5.36	4.97	5.03	9.23	9.21	9.19
Personal Services	29,662	30,329	31,465	8.63	8.06	8.26	9.17	9.07	9.13
Public Administration	18,862	18,000	19,663	5.49	4.78	5.16	13.52	12.97	13.94
Minus: Bank Charges	-10,647	-11,310	-10,689	-3.10	-3.00	-2.81	3.90	3.65	3.39
GRP	343,720	376,451	380,935	100.00	100.00	100.00	8.79	8.74	8.59

Source: Compendio Estadisticas Regionales, MIDEPLAN, Noviembre 1997

Table 3.3.2 (2) Metropolitan Region: Gross Regional Product by Economic Activity (1988-1990)

	(Million 1986 $)			(Sectoral Share %)			(Share in GDP %)		
	1988	1989	1990	1988	1989	1990	1988	1989	1990
Agriculture, Forestry	48,589	52,085	58,757	3.25	3.14	3.38	15.54	16.24	16.89
Fishery	117	151	195	0.01	0.01	0.01	0.26	0.30	0.41
Mining	15,098	14,738	15,142	1.01	0.89	0.87	4.10	3.65	3.82
Manufacturing	329,607	371,317	381,769	22.02	22.36	21.99	47.10	47.82	48.90
Electricity, Gas, Water	24,158	27,308	27,913	1.61	1.64	1.61	23.63	27.48	28.59
Construction	80,631	89,926	95,395	5.39	5.42	5.49	41.60	39.60	40.20
Commerce	372,134	427,879	451,672	24.86	25.77	26.02	66.00	67.40	67.70
Transport, Communication	128,189	143,900	154,314	8.56	8.67	8.89	49.58	49.05	49.41
Financial Services	392,192	447,261	462,146	26.20	26.94	26.62	79.55	79.65	79.55
Housing	99,900	101,929	104,884	6.67	6.14	6.04	50.01	50.18	50.32
Personal Services	176,064	183,903	189,045	11.76	11.08	10.89	54.45	54.97	54.85
Public Administration	59,277	59,756	60,285	3.96	3.60	3.47	42.49	43.05	42.75
Minus: Bank Charges	-228,768	-259,711	-265,319	-15.28	-15.64	-15.28	83.71	83.75	84.08
GRP	1,497,188	1,660,442	1,736,198	100.00	100.00	100.00	38.28	38.54	39.14

Source: Compendio Estadisticas Regionales, MIDEPLAN, Noviembre 1997

Table 3.3.2 (3) Region VI: Gross Regional Product by Economic Activity (1988-1990)

	(Million 1986 $)			(Sectoral Share %)			(Share in GDP %)		
	1988	1989	1990	1988	1989	1990	1988	1989	1990
Agriculture, Forestry	45,448	49,052	55,527	23.36	24.71	27.12	14.53	15.29	15.96
Fishery	126	126	134	0.06	0.06	0.07	0.28	0.25	0.28
Mining	69,015	62,530	57,021	35.47	31.50	27.85	18.73	15.48	14.39
Manufacturing	16,931	19,394	19,177	8.70	9.77	9.37	2.42	2.50	2.46
Electricity, Gas, Water	6,463	6,875	5,961	3.32	3.46	2.91	6.32	6.92	6.10
Construction	14,343	14,988	18,035	7.37	7.55	8.81	7.40	6.60	7.60
Commerce	13,943	15,840	17,798	7.17	7.98	8.69	2.47	2.50	2.67
Transport, Communication	5,540	6,137	6,386	2.85	3.09	3.12	2.14	2.09	2.04
Financial Services	7,542	8,575	8,938	3.88	4.32	4.37	1.53	1.53	1.54
Housing	6,556	6,632	6,764	3.37	3.34	3.30	3.28	3.26	3.25
Personal Services	9,139	9,326	9,731	4.70	4.70	4.75	2.83	2.79	2.82
Public Administration	3,214	3,202	3,156	1.65	1.61	1.54	2.30	2.31	2.24
Minus: Bank Charges	-3,691	-4,153	-3,880	-1.90	-2.09	-1.90	1.35	1.34	1.23
GRP	194,569	198,524	204,748	100.00	100.00	100.00	4.97	4.61	4.62

Source: Compendio Estadisticas Regionales, MIDEPLAN, Noviembre 1997

Table 3.4.1 Small Scale Farmers' Farming by Sub-basin

Crop \ Sub-Basin		1. Río Maipo Alto	2. Río Clarillo	3. Río Mapocho Alto	4. Est. Lampa	5. Río Mapocho Bajo	6. Río Angostura		7. Est. Alhué		8. Cue. Melipilla	9. Est. Puangue	10. Est. Yali	11. Cue. San Antonio	12. Est. Casablanca	Total
							RM	Cachapoal	RM	Cachapoal						
1. Fruits	ha	71.9	145.2	264.7	117.4	794.5	1,410.1	394.6	-	562.3	591.7	355.4	-	-	31.4	4,739.3
	%	10.2	10.2	8.7	1.8	10.5	13.3	11.4	-	12.1	7.2	7.2	-	-	1.2	7.9
2. Grapes for Wine Productio	ha	10.6	21.4	-	-	196.7	-	-	-	-	-	-	-	-	-	228.7
	%	1.5	1.5	-	-	2.6	-	-	-	-	-	-	-	-	-	0.4
3. Vegetables and Flowers	ha	112.3	226.4	860.6	3,262.2	1,990.1	1,950.8	394.6	-	139.4	1,955.9	1,174.7	-	188.2	31.4	12,286.6
	%	15.9	15.9	28.3	50.0	26.3	18.4	11.4	-	3.0	23.8	23.8	-	9.7	1.2	20.4
4. Cereals	ha	215.8	435.7	468.3	1,122.2	1,339.3	2,290.1	1,145.6	231.2	613.4	1,331.4	799.6	1,626.5	-	-	11,619.1
	%	30.6	30.6	15.4	17.2	17.7	21.6	33.1	49.0	13.2	16.2	16.2	39.0	-	-	19.3
5. Field Crops	ha	26.8	54.1	21.3	163.1	401.1	137.8	138.4	65.1	41.8	427.4	256.7	575.5	126.1	94.3	2,529.6
	%	3.8	3.8	0.7	2.5	5.3	1.3	4.0	13.8	0.9	5.2	5.2	13.8	6.5	3.6	4.2
6. Industrial Crops	ha	13.4	27.1	-	-	60.5	84.8	100.4	-	51.1	-	-	-	-	-	337.3
	%	1.9	1.9	-	-	0.8	0.8	2.9	-	1.1	-	-	-	-	-	0.6
7. Forage Crops	ha	81.6	165.2	130.8	117.4	597.8	275.7	100.4	-	-	394.5	236.9	-	500.7	-	2,600.8
	%	11.6	11.6	4.3	1.8	7.9	2.6	2.9	-	-	4.8	4.8	-	25.8	-	4.3
8. Forage	ha	111.4	225.0	1,094.8	815.5	1,392.3	3,901.6	1,086.8	29.3	3,169.3	2,342.2	1,406.7	258.6	937.3	2,463.1	19,233.7
	%	15.8	15.8	36.0	12.5	18.4	36.8	31.4	6.2	68.2	28.5	28.5	6.2	48.3	94.0	31.9
9. Fallow	ha	61.4	123.9	200.7	926.5	794.5	551.3	100.4	146.3	69.7	1,175.2	705.8	1,710.0	188.2	-	6,753.7
	%	8.7	8.7	6.6	14.2	10.5	5.2	2.9	31.0	1.5	14.3	14.3	41.0	9.7	-	11.2
Total	ha	705.2	1,423.8	3,041.1	6,524.3	7,566.9	10,602.3	3,461.0	471.9	4,647.1	8,218.2	4,935.6	4,170.6	1,940.5	2,620.3	60,328.8
No. of Small Farmers	No.	191.0	341.0	841.0	1,331.0	1,814.0		901.0		1,187.0	2,184.0	1,018.0	1,023.0	489.0	500.0	14,577.0
Farming Area	ha	705.2	1,423.8	3,041.0	6,524.3	7,566.9	10,602.3	3,461.0	471.9	4,647.1	8,218.2	4,935.6	4,170.6	1,940.5	2,620.3	60,329.6
Average Farming Area	ha	3.69	4.18	3.62	4.90	4.17		3.84		3.91	3.76	4.85	4.08	3.97	5.24	4.1

Table 3.4.2 Medium and Large Scale Farmers' Faming by Sub-basin

Sub-basin / Crop / Region		1. Río Maipo Alto	2. Río Clarillo	3. Río Mapocho Bajo	4. Est. Lampa	5. Río Mapocho Bajo	6. Río Angostura	7. Est. Alhué	8. Cue. Melipilla	9. Est. Puangue	10. Est. Yali	11. Cue. San Antonio	12. Est. Casablanca	Total
		Cordillera	Cordillera	Santiago	Chacabuco	Maipo Talagante	Talagante Maipo Cachapoal	Cachapoal	Melipilla	Melipilla	Melipilla San Antonio	San Antonio	Valparaíso	
Fruits	(ha)	459.1	1,573.2	1,095.8	5,601.9	9,528.4	20,647.8	2,621.0	6,245.4	1,619.0	544.9	151.1	477.8	50,565.4
	%	15.0	25.7	13.6	37.7	41.8	43.0	19.1	24.3	15.5	4.0	1.0	2.8	25.5
Grapes	(ha)	414.2	563.4	380.1	93.5	559.2	3,951.1	458.0	410.7	314.6	11.2	9.0	1,308.4	8,473.4
	%	13.6	9.2	4.7	0.6	2.5	8.2	3.3	1.6	3.0	0.1	0.1	7.7	4.3
Vegetables	(ha)	112.4	0.0	2,147.7	3,520.9	2,684.7	3,045.0	535.3	1,872.2	1,034.5	281.2	61.9	420.2	15,715.9
	%	3.7	0.0	26.7	23.7	11.8	6.3	3.9	7.3	9.9	2.1	0.4	2.5	7.9
Flowers	(ha)	49.2	22.3	28.7	11.4	78.6	48.5	0.0	6.7	1.6	3.3	0.1	1.2	251.6
	%	1.6	0.4	0.4	0.1	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Cereals	(ha)	0.0	267.7	695.7	0.0	2,621.3	7,545.4	5,735.2	6,032.2	1,834.3	4,803.4	2,852.7	956.3	33,344.1
	%	0.0	4.4	8.6	0.0	11.5	15.8	41.7	23.4	17.6	35.7	18.5	5.6	16.8
Field Crops	(ha)	29.8	0.0	502.0	0.0	639.2	871.0	1,394.2	612.2	1,216.5	104.1	0.0	162.2	5,531.1
	%	1.0	0.0	6.2	0.0	2.8	1.8	10.1	2.4	11.7	0.8	0.0	1.0	2.8
Industrial Crops	(ha)	0.0	0.0	28.5	24.0	0.0	0.0	0.0	1.7	1.0	0.0	0.0	0.1	55.3
	%	0.0	0.0	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Forage Crops	(ha)	622.8	1,453.5	2,458.9	3,773.2	5,321.3	3,541.0	1,441.8	8,426.9	3,326.9	12.0	1,965.2	5,838.4	38,181.9
	%	20.4	23.7	30.5	25.4	23.4	7.4	10.5	32.7	32.1	0.1	12.8	34.5	19.2
Seedling	(ha)	0.5	5.1	44.9	20.4	99.7	332.7	27.0	35.9	0.5	4.1	0.8	7.9	579.5
	%	0.0	0.1	0.6	0.1	0.4	0.7	0.2	0.1	0.0	0.0	0.0	0.0	0.3
Seeds	(ha)	13.0	90.7	449.0	1,081.1	689.1	3,489.0	100.6	1,037.8	851.4	139.8	16.0	12.9	7,970.4
	%	0.4	1.5	5.6	7.3	3.0	7.3	0.7	4.0	8.2	1.0	0.1	0.1	4.0
Forest Products	(ha)	1,355.5	2,149.7	218.1	734.8	564.9	4,523.8	1,437.5	1,089.9	211.7	7,564.7	10,354.1	7,741.6	37,946.3
	%	44.3	35.0	2.7	4.9	2.5	9.4	10.5	4.2	2.0	56.2	67.1	45.8	19.1
Total	ha	3,056.5	6,125.6	8,049.5	14,861.2	22,786.3	47,995.3	13,750.5	25,771.6	10,412.0	13,468.7	15,410.8	16,926.9	198,614.8

Source; Agriculture and Forestry Census 1997

Table 3.4.3 Average Yield of Main Crops by Province

Province	Crops	Irrigated Area (ha)	Unirrigated Area (ha)	No. of Agricultural households with irrigated land (H/H)	No. of Agricultural households without irrigated land (H/H)	Yield (qq/ha)
San Antonio	Avena (grano seco)	1.0	487.1	1.0	27.0	10.6
	Cebada forrajera	0.0	162.2	0.0	20.0	18.8
	Garbanzo	0.0	512.0	0.0	112.0	6.6
	Maiz (grano seco)	135.4	9.0	23.0	9.0	48.4
	Papa	86.1	11.2	114.0	19.0	107.4
	Poroto consumo	23.5	4.1	36.0	9.0	9.6
	Trigo blanco	74.7	6,157.2	4.0	301.0	33.3
	Trigo Candea	37.0	110.0	3.0	2.0	37.3
Cachapoal	Arveja (grano seco)	29.7	8.4	31.0	4.0	9.4
	Maíz (grano seco)	34,081.4	19.1	6,457.0	4.0	101.2
	Papa	2,660.5	15.5	2,243.0	2.0	131.8
	Poroto consumo	511.4	0.1	546.0	1.0	12.8
	Poroto exportación	75.3	0.0	35.0	0.0	18.9
	Trigo blanco	3,337.8	477.4	435.0	51.0	53.4
	Trigo Candeal	5,949.4	108.9	549.0	13.0	62.8
	Curagulla	89.0	0.0	51.0	0.0	13.8
	Maní	86.2	0.0	87.0	0.0	17.7
	Maravilla	82.7	0.0	18.0	0.0	25.2
	Remolacha	399.4	0.0	64.0	0.0	535.0
	Tabaco	188.7	0.0	36.0	0.0	28.0
Valparaiso	Avena (grano seco)	80.7	12.5	7.0	5.0	6.6
	Papa	200.1	6.2	184.0	8.0	82.2
	Trigo blanco	153.1	365.9	14.0	37.0	32.4
	Poroto consumo	56.6	0.1	76.0	1.0	10.3
	Arveja	2.9	19.1	4.0	13.0	3.0
Santiago	Maíz (grano seco)	146.0	0.0	23.0	0.0	93.7
	Papa	481.3	0.0	146.0	0.0	135.3
	Trigo blanco	282.1	0.0	15.0	0.0	48.2
	Trigo candeal	735.7	0.0	27.0	0.0	55.7
Chacabuco	Maíz (grano seco)	78.8	0.0	26.0	0.0	46.6
	Papa	120.3	0.0	61.0	0.0	141.6
	Trigo Blanco	315.0	0.0	12.0	0.0	29.0
	Trigo Candeal	568.0	0.0	19.0	0.0	49.5
		18.0	0.0	18.0	0.0	2.0
Cordillera	Maíz (grano seco)	221.2	0.0	32.0	0.0	109.4
	Papa	61.9	0.0	67.0	0.0	80.8
	Trigo blanco	120.0	0.0	8.0	0.0	44.3
	Trigo candeal	478.2	0.0	30.0	0.0	50.4
	Menta	4.0	0.0	1.0	0.0	
Maipo	Maíz (grano seco)	1,832.3	0.0	426.0	0.0	94.3
	Papa	990.9	0.0	352.0	0.0	174.7
	Poroto consumo	129.4	0.0	101.0	0.0	11.1
	Trigo blanco	1,097.6	35.0	156.0	1.0	53.6
	Trigo candeal	3,415.2	11.5	342.0	2.0	60.8
	cáñamo	3.0	0.0	1.0	0.0	150.0
Melipilla	Garbanzo	0.0	54.0	0.0	16.0	3.3
	Maíz (grano seco)	5,934.8	0.0	764.0	0.0	109.1
	Papa	2,460.7	0.0	1,026.0	0.0	153.1
	Poroto consumo	117.0	0.0	85.0	0.0	16.5
	Trigo blanco	1,390.7	2,180.0	164.0	276.0	35.5
	Trigo candeal	3,480.5	55.0	224.0	4.0	60.7
	Soya	37.0	0.0	1.0	0.0	20.0
Talagante	Maíz (grano seco)	1,205.7	0.0	198.0	0.0	107.0
	Papa	758.7	0.0	485.0	0.0	117.9
	Poroto consumo	114.9	0.0	95.0	0.0	12.2
	Trigo Blanco	457.6	0.0	47.0	0.0	49.4
	Trigo Candeal	1,810.0	0.0	133.0	0.0	59.5

Source:Censo Nacional Agropecuario 97

Table 3.4.4 Gross Income by Cropping Pattern of Each Farming Type, Crops and Area (Small Scale Farmers)

Sub-basin		Fruits & Grape vines	Vegetables & Flowers	Cereal & Traditional Crops+	Forage crops & Improved Glassland	Natural Glassland	Seasonal Fallow & Fallow Land	Total
	Benefit$/ha ($000)	1,400 1,000 * 1,800 ** 1,500 ***	1,100 1,200 *	390 360 *	360 330 *	100 60 *	0	
1.- Río Maipo Alto	Ha/Crop	0.4	0.6	1.4	0.4	-	0.9	3.7
	Benefit/crop ($000)	560	660	546	144	-	-	1,910
2.- Río Clarillo	Ha/Crop	0.5	0.7	1.5	0.6	-	0.9	4.2
	Benefit/crop	700	770	585	216	-	-	2,271
3.- Río Mapocho Alto	Ha/Crop	0.3	1.0	0.5	0.2	1.6	-	3.6
	Benefit/Crop	420	1,100	195	72	160	-	1,947
4.- Est. Lampa	Ha/Crop	-	2.4 *	1.0	-	1.0	0.5	4.9
	Benefit/Crop	-	2,880	390	-	100	-	3,370
5.- Río Mapocho Bajo	Ha/Crop	0.5	1.1 *	0.9	0.4	0.9	0.4	4.2
	Benefit/Crop	700	1,320	351	144	90	-	2,605
6.- Río Angostura	Ha/Crop	0.5	0.7	0.8	-	1.8	-	3.8
	Benefit/Crop	700	770	312	-	180	-	1,962
7.- Est. Alhué	Ha/crop	0.5 *	-	1.3 *	-	2.5 *	-	4.3
	Benefit/Crop	500	-	468	-	150	-	1,118
8.- Cue. Melipilla	Ha/crop	0.3	0.9	0.6	-	1.2	0.8	3.8
	Benefit/Crop	420	990	234	-	120	-	1,764
9.- Est. Puangue	Ha/crop	0.4	1.3	1.0	-	1.3	0.8	4.8
	Benefit/Crop	560	1,430	390	-	130	-	2,510
10.- Est. Yali	Ha/Crop	0.1 **	-	2.1	-	-	2.0	4.2
	Benefit/Crop	180	-	819	-	-	-	999
11.- Cue. San Antonio	Ha/Crop	-	0.4	-	1 *	2.0	0.6	4.0
	Benefit/Crop	-	440	-	330	200	-	970
12.- Est. Casablanca	Ha/Crop	0.1 ***	0.1 *	0.2 *	-	4.8	-	5.2
	Benefit/Crop	150	120	72	-	480	-	822

Source: Censo Nacional Agropecuario 1997

+ Traditional Crop (Chacras) : Main crops which farmers cultivated in the land where was provided instead of salary during the plantation era (Potato, Maize, Beans, Melon and etc.) .

Table 3.4.5 Gross Income by Cropping Pattern of Each Farming Type, Crops and Area (Medium and Large Scale Farmers)

		Cereale Crops	Traditional Crops+	Vegetables & Flowers	Forage Crops	Fruits	Grape Vine	Seed Production++	Planted Forset	Total
Sub-basin	Benefit$/ha ($000)	360	610	1,300	650	2,330	2,400	2,000	400	
1.- Río Maipo Alto	Ha/Crops	-	1.0	5.0	21.0	16.0	14.0	1.0	42.0	100.0
	Margen/cult ($000)	-	610	6,500	13,650	37,280	33,600	2,000	16,800	110,440
2.- Río Clarillo	Ha/cult	4.0	-	1.0	24.0	25.5	8.5	2.0	35.0	100.0
	Margen/cult	1,440	-	1,300	15,600	59,415	20,400	4,000	14,000	116,155
3.- Río Mapocho Alto	Ha/cult	9.0	6.0	27.0	31.0	14.0	4.0	6.0	3.0	100.0
	Margen/cult	3,240	3,660	35,100	20,150	32,620	9,600	12,000	1,200	117,570
4.- Est. Lampa	Ha/cult	-	-	24.0	26.0	38.0	1.0	6.0	5.0	100.0
	Margen/cult	-	-	31,200	16,900	88,540	2,400	12,000	2,000	153,040
5.- Río Mapocho Bajo	Ha/cult	12.0	3.0	12.0	23.0	42.0	3.0	3.0	2.0	100.0
	Margen/cult	4,320	1,830	15,600	14,950	97,860	7,200	6,000	800	148,560
6.- Río Angostura	Ha/cult	16.0	2.0	6.0	7.0	43.0	10.0	7.0	9.0	100.0
	Margen/cult	5,760	1,220	7,800	4,550	100,190	24,000	14,000	3,600	161,120
7.- Est. Alhué	Ha/cult	42.0	10.0	4.0	11.0	19.0	3.0	1.0	10.0	100.0
	Margen/cult	15,120	6,100	5,200	7,150	44,270	7,200	2,000	4,000	91,040
8.- Cue. Melipilla	Ha/cult	23.0	2.0	7.0	33.0	24.0	3.0	4.0	4.0	100.0
	Margen/cult	8,280	1,220	9,100	21,450	55,920	7,200	8,000	1,600	112,770
9.- Est. Puangue	Ha/cult	18.0	12.0	10.0	32.0	16.0	3.0	7.0	2.0	100.0
	Margen/cult	6,480	7,320	13,000	20,800	37,280	7,200	14,000	800	106,880
10.- Est. Yali	Ha/cult	31.0	1.0	2.0	5.0	8.0	4.0	1.0	48.0	100.0
	Margen/cult	11,160	610	2,600	3,250	18,640	9,600	2,000	19,200	67,060
11.- Cue. San Antonio	Ha/cult	18.00	-	1.0	13.0	0.8	0.1	0.1	67.0	100.0
	Margen/cult	6,480	-	1,300	8,450	1,864	240	200	26,800	45,334
12.- Est. Casablanca		6.0	1.0	2.0	34.0	-	11.0	-	46.0	100.0
		2,160	610	2,600	22,100	-	26,400	-	18,400	72,270

Source: Censo Nacional Agropecuario 1997

\+ Chacras (Traditional Crop) : Main crops which farmers cultivated in the land where was provided instead of salary during the plantation era (Potato, Maize, Beans, Melon and etc.) .

++ Seed Production: Seed for export and domestic consumption (Vegetable, Maize, Wheat and etc.).

Table 3.6.1 Production by Region (ton) (1990-1995)

Meat/Region	1990	1991	1992	1993	1994	1995
Beef						
Region V	16,888	14,701	12,848	13,720	13,925	16,505
Metropolitan Region	111,590	104,949	95,290	112,452	120,749	127,031
Region VI	8,187	7,883	7,166	7,415	8,005	9,636
Three Regions	136,665	127,533	115,304	133,587	142,679	153,172
Chile	242,452	229,791	199,972	224,099	239,615	257,792
Pork						
Region V	3,735	3,243	2,731	2,010	2,102	2,894
Metropolitan Region	59,116	63,793	68,022	70,865	79,424	85,750
Region VI	38,284	37,449	41,708	47,913	52,533	57,216
Three Regions	101,135	104,485	112,461	120,788	134,059	145,860
Chile	123,171	128,835	137,571	147,282	160,814	172,410
Lamb						
Region V	114	117	220	100	72	97
Metropolitan Region	1,893	2,048	1,697	1,602	1,182	1,022
Region VI	282	259	243	225	216	202
Three Regions	2,289	2,424	2,160	1,927	1,470	1,321
Chile	14,880	13,451	12,784	13,372	12,180	10,229
Goat Meat						
Region V	29	20	38	43	14	3
Metropolitan Region	0	1	1	2	0	0
Region VI	0	1	1	1	1	1
Three Regions	29	21	40	46	15	4
Chile	227	199	257	229	146	74
Horse Meat						
Region V	5,410	5,454	5,022	3,812	4,155	4,511
Metropolitan Region	4,187	4,609	3,122	1,643	1,890	5,218
Region VI	1	0	0	1	1	0
Three Regions	9,598	10,063	8,144	5,456	6,046	9,729
Chile	10,807	11,533	9,519	6,582	7,162	10,831

Cereal/Region	1990	1991	1992	1993	1994	1995
Wheat						
Region V	43,560	52,526	39,959	34,184		36,067
Metropolitan Region	149,886	136,146	88,524	92,427		92,751
Region VI	219,617	173,412	97,645	125,964		156,243
Three Regions	413,063	362,085	226,128	252,575	0	285,062
Chile	1,588,677	1,556,588	1,322,336	1,271,202		1,227,148
Oats						
Region V	177	1,037	36	51		1,163
Metropolitan Region	1,960	3,396				87
Region VI	796	1,901	199	627		1,500
Three Regions	2,932	6,334	235	678	0	2,750
Chile	206,684	182,699	202,435	176,434		199,627
Region V	1,571	849	1,232	184		774
Metropolitan Region	1,957	523	382	807		618
Region VI	2,567	2,989	2,804	3,306		1,879
Three Regions	6,095	4,360	4,419	4,296	0	3,271
Chile	106,959	109,089	83,970	100,289		64,103
Corn						
Region V	9,448	20,541	17,288	17,443		17,133
Metropolitan Region	121,793	119,246	106,851	97,075	0	96,922
Region VI	596,583	629,555	654,660	700,167		695,486
Three Regions	727,824	769,342	778,799	814,685	0	809,541
Chile	835,723	911,056	899,496	937,250		931,572
Rice						
Region V						
Metropolitan Region						
Region VI	19,482	23,108	32,194	29,891		33,201
Three Regions	19,482	23,108	32,194	29,891	0	33,201
Chile	117,115	133,531	130,629	133,080		152,795

Legume/Region	1990	1991	1992	1993	1994	1995
Beans						
Region V	1,329	3,829	1,755	748		651
Metropolitan Region	1,300	1,312	632	426		1,990
Region VI	11,494	12,806	7,918	4,459		8,877
Three Regions	14,123	17,947	10,304	5,633	0	11,518
Chile	116,954	90,693	54,560	53,980		65,581
Lentils						
Region V	3	372	36	18		
Metropolitan Region	14	101				
Region VI	270	327	71	44		163
Three Regions	287	799	107	62	0	163
Chile	11,883	15,782	9,796	8,911		9,697
Garbanzo						
Region V	445	1,261	495	309		253
Metropolitan Region	902	89	187	148		77
Region VI	1,451	6,114	2,012	1,835		1,856
Three Regions	2,798	7,464	2,694	2,292	0	2,185
Chile	8,778	18,638	10,767	10,090		10,073
Peas						
Region V	87	106	12	11		
Metropolitan Region	20	44		7		63
Region VI	171	662	117	36		118
Three Regions	278	812	128	54	0	181
Chile	5,346	7,784	4,906	4,120		3,295
Chickpeas						
Region V	16	232	73	165		5
Metropolitan Region	1	20	68	85		
Region VI	219	436	124	99		54
Three Regions	236	688	265	349	0	59
Chile	1,650	2,098	1,537	1,759		1,120

Potato/Region	1990	1991	1992	1993	1994	1995
Potato						
Region V	47,141	59,888	41,151	44,822		21,494
Metropolitan Region	57,244	37,246	45,137	35,985		48,588
Region VI	60,263	69,365	61,652	51,193		47,865
Three Regions	164,648	166,499	147,939	131,999	0	117,947
Chile	843,938	1,023,236	926,036	899,619		827,633

Source: Compendio Estadisticas Regionales, MIDEPLAN,Noviembre 1997

Table 3.6.2 Price Information by ODEPA

Wholesale Price in Santiago in 1997 ($/ton without VAT)

Product	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct.	Nov	Dec
Wheat	83,030	85,200	85,450	85,610	87,920	90,580	88,330	87,670	87,330	85,080	82,580	81,880
Corn	82,500	78,130	67,130	64,250	64,690	64,000	63,190	62,380	61,690	63,380	68,310	70,810
Rice	82,500	82,500	87,500	92,500	92,500	92,500	95,000	95,000	85,000	85,000	85,000	85,000
Beans	326,670	373,330	360,000	370,000	376,670	373,330	333,330	313,330	283,330	273,330	330,000	400,000
Potato	54,070	48,199	43,264	44,338	52,825	58,735	62,725	65,470	71,387	94,676	136,458	153,731
Beets	23,952	23,272	22,929	23,174	23,202	23,241	23,113	22,940	23,068	22,990	23,261	23,898
Rape Seed	109,890	109,890	111,480	111,480	112,440	112,440	112,440	112,440	112,440	111,600	111,600	111,600
Sunflower	128,520	128,520	128,520	128,520	128,520	128,520	128,520	128,520	128,520	128,520	128,520	126,520
Beef	842,500	855,000	862,500	835,000	840,000	879,000	951,000	1,065,000	1,341,500	1,131,500	910,000	917,500
Pork	540,000	540,000	600,000	645,000	730,000	845,000	845,000	725,000	780,000	688,000	665,000	700,000
Chicken	616,500	654,000	652,500	640,000	547,500	547,500	550,000	550,000	580,000	590,000	590,000	590,000
Butter	1,543,760	1,519,400	1,505,200	1,506,640	1,533,740	1,546,720	1,552,520	1,557,920	1,571,320	1,579,440	1,601,030	1,598,750
Whet Flour	137,333	128,167	127,500	134,000	131,833	133,333	133,667	132,333	130,333	128,000	127,333	124,667
Sugar	233,860	235,180	235,180	235,180	235,180	235,180	235,180	235,180	235,180	235,180	235,180	239,370
Urea	130,900	127,433	125,595	123,920	122,666	121,860	118,560	121,900	115,363	104,593	103,113	105,082
Ammonium Phos.	141,573	140,044	137,314	136,600	135,533	135,533	136,347	137,800	136,047	133,320	133,320	137,687
Fish Meal	256,330	254,330	264,000	274,250	275,630	272,600	276,800	276,800	282,280	280,360	288,760	288,760

Source: Mercados Agropecuarios,ODEPA, Ministerio de Agricultura, No. 71, Junio 1998

International Price in 1997 (US$ FOB/ton)

Product	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct.	Nov	Dec
Wheat US	167.2	165.5	172.7	180.0	172.1	155.1	142.2	152.8	153.3	152.9	149.8	146.6
Wheat Argentina	143.8	148.1	167.3	181.1	183.5	168.3	164.6	163.7	155.0	149.4	139.3	134.6
Yellow Corn US	123.5	124.8	131.4	127.1	120.1	115.0	107.8	114.5	115.7	122.5	119.6	115.7
Yellow Corn Arg.	115.7	113.3	120.5	119.4	116.9	114.7	107.8	111.0	112.3	118.4	118.0	116.4
Rice Bangkok	373.0	390.0	380.5	354.1	350.0	350.0	350.0	334.3	304.1	303.9	281.5	290.2
Sugar London	305.9	308.4	309.6	312.8	322.0	329.1	332.4	345.4	319.8	299.5	304.4	300.7
Soybeans Oil US	495.2	494.6	513.8	513.7	525.8	504.0	484.1	489.2	508.2	537.1	566.1	547.1
Soybeans Oil Arg.	510.3	510.7	515.8	514.1	526.9	525.1	518.0	521.2	542.7	588.3	630.1	622.3

Source: Mercados Agropecuarios,ODEPA, Ministerio de Agricultura, No. 71, Junio 1998

Price Band Annual Average (US$/Ton)

Product	1990	1991	1992	1993	1994	1995	1996	1997
Wheat								
Floor	187	201	190	187	183	183	210	213
Ceiling	261	252	232	240	246	234	240	251
Vegetable Oil								
Floor	592	626	604	609	625	628	699	705
Ceiling	1,114	845	719	706	740	692	778	772
Refined Sugar								
Floor	353	362	400	400	410	418	442	449
Ceiling	490	465	453	453	453	438	479	496

Source: ODEPA Internet Information

Table 3.9.1 (1) Results of water quality analysis Observation period : 20/7/1998～23/7/1998

Date		21/7	21/7	21/7	21/7	21/7	22/7	22/7	23/7	23/7	23/7	21/7	21/7	21/7
Item	Unit	St.1	St.2	St.3	St.4	St.5	St.6	St.7	St.8	St.9	St.10	St.11	St.12	St.13
Temperature	℃	7.4	8.0	13.3	7.5	8.9	10.1	12.1	10.3	12.2	11.5	4.8	3.1	11.0
pH	-	8.0	7.8	6.4	7.6	7.8	6.8	7.3	7.0	7.1	7.1	7.6	8.0	7.8
EC	μmhos/cm	600.0	1,260.0	1,330.0	1,270.0	1,290.0	970.0	1,230.0	1,200.0	1,200.	1,220.0	830.0	1,050.0	300.0
SS	mg/l	70.0	230.0	322.0	285.0	270.0	95.0	140.0	130.0	120.0	135.0	105.0	195.0	130.0
DO	mg/l	9.0	8.0	8.5	0.0	1.0	9.0	0.0	1.0	1.5	0.0	0.0	9.0	9.0
BOD	mg/l	<3.0	<3.0	14.0	38.0	28.0	<10.0	32.0	21.0	18.5	40.0	5.7	<3.0	3.9
No. of Coliform Group	MPN/100ml	5.4E+02	2.2E+03	5.4E+07	3.5E+04	1.6E+04	2.4E+04	9.2E+05	3.5E+05	3.3E+02	5.4E+03	7.9E+01	7.9E+01	2.4E+03
No. of Fecal Coliform Group	MPN/100ml	3.5E+02	4.9E+02	2.4E+07	3.5E+03	1.6E+03	3.5E+03	9.2E+04	9.2E+04	3.3E+01	1.7E+03	7.8E+00	2.7E+01	3.5E+02
NO_3-N	mg/l	5.6	5.4	4.1	3.7	5.1	3.3	3.1	6.0	5.5	7.1	4.7	3.7	6.7
Ca^{2+}	mg/l	87.6	183.1	207.0	175.1	191.0	175.1	183.1	199.0	191.0	183.0	167.2	183.1	42.2
Mg^{2+}	mg/l	25.6	41.7	22.5	88.4	41.5	37.3	37.0	27.3	64.7	51.0	11.9	37.0	14.2
Cu^{2+}	mg/l	0.003	0.003	0.003	0.003	0.001	0.003	0.003	0.002	0.003	0.003	0.003	0.002	0.003
SO_4^{2-}	mg/l	145.8	280.0	420.0	395.0	401.4	360.0	390.0	350.0	380.0	370.0	346.3	305.0	76.3
Cl^-	mg/l	105.4	238.4	265.9	256.8	284.3	183.0	220.0	192.6	201.7	220.0	87.1	165.1	19.3

Date		21/7	22/7	23/7	20/7	20/7	20/7	22/7	22/7	20/7	23/7	20/7	20/7	20/7
Item	Unit	St.14	St.15	St.16	St.17	St.18	St.19	St.20	St.21	St.22	St.23	St.24	St.25	St.26
Temperature	℃	12.0	13.2	9.2	3.2	11.1	14.5	11.0	12.0	12.0	8.4	4.5	12.5	6.1
pH	-	7.4	6.7	6.9	7.7	7.3	7.2	7.4	7.3	7.8	7.1	7.8	7.9	7.7
EC	μmhos/cm	1,000.0	230.0	1,340.0	234.0	1,140.0	1,420.0	1,350.0	1,310.0	1,520.0	1,740.0	1,800.0	1,430.0	790.0
SS	mg/l	310.0	80.0	180.0	120.0	240.0	410.0	205.0	160.0	246.0	100.0	90.0	112.0	95.0
DO	mg/l	2.0	7.0	0.0	6.5	0.0	0.0	0.0	0.0	4.5	8.0	0.0	9.0	9.0
BOD	mg/l	14.7	4.3	64.0	10.0	45.0	179.0	96.0	45.0	20.0	3.8	78.0	<10.0	<3.0
No. of Coliform Group	MPN/100ml	5.4E+04	3.3E+01	2.4E+04	<1.8	2.4E+07	2.4E+06	9.2E+06	1.6E+07	2.4E+04	3.5E+04	2.3E+01	1.6E+04	3.3E+01
No. of Fecal Coliform Group	MPN/100ml	5.4E+03	1.1E+01	2.2E+04	<1.8	1.4E+06	9.2E+05	1.7E+06	7.9E+05	9.2E+03	3.5E+03	<1.8	1.1E+03	6.8E+00
NO_3-N	mg/l	4.5	2.9	3.7	3.5	3.0	12.7	3.3	2.6	2.8	2.5	3.9	6.6	4.5
Ca^{2+}	mg/l	318.4	30.2	159.2	35.8	175.1	175.1	183.1	183.1	183.1	445.8	183.1	199.0	95.5
Mg^{2+}	mg/l	47.5	12.7	51.7	11.1	32.1	46.6	41.7	46.3	83.5	34.9	23.3	45.9	20.7
Cu^{2+}	mg/l	0.002	0.003	0.007	0.110	0.003	0.003	0.003	0.003	0.005	0.007	0.002	0.003	0.003
SO_4^{2-}	mg/l	290.0	32.2	390.0	80.3	302.6	402.3	405.0	395.0	496.7	980.0	396.8	455.0	122.5
Cl^-	mg/l	284.3	12.8	266.0	18.3	238.4	220.1	257.0	229.0	275.1	82.5	458.5	247.6	142.1

Table 3.9.1 (2) Results of water quality analysis

Date		20/7	20/7	20/7	20/7	20/7	22/7	22/7	22/7	22/7	23/7
Item	Unit	C1	C2	C3	#1	#2	#3	#4	#5	#6	#7
Temperature	℃	8.7	7.0	15.2	14.9	16.8	13.0	14.2	13.0	16.0	15.9
pH	-	7.9	8.1	7.0	8.2	7.5	7.3	6.7	7.1	6.7	7.3
EC	μmhos/cm	1,295.0	1,290.0	1,570.0	260.0	830.0	1,230.0	1,140.0	2,800.0	600.0	900.0
SS	mg/l	152.0	148.0	450.0	90.0	88.0	83.0	70.0	60.0	80.0	100.0
DO	mg/l	7.0	6.5	0.0	9.0	9.0	9.0	7.5	1.0	9.0	9.0
BOD	mg/l	10.0	15.0	645.0	<10.0	<10.0	<10.0	6.8	20.9	<10.0	<10.0
No. of Coliform Group	MPN/100ml	2.2E+05	1.6E+03	2.4E+07	3.3E+01	7.9E+01	4.9E+01	<1.8	1.1E+02	7.9E+01	1.1E+01
No. of Fecal Coliform Group	MPN/100ml	2.1E+04	3.5E+02	3.5E+06	3.3E+01	4.9E+01	<1.8	<1.8	3.3E+01	1.1E+01	<1.8
NO_3-N	mg/l	2.8	2.2	18.0	3.8	3.6	6.2	3.5	9.2	4.1	2.7
Ca^{2+}	mg/l	2,14.9	175.1	127.4	13.5	127.4	254.7	296.8	350.2	67.7	111.0
Mg^{2+}	mg/l	40.8	41.9	61.7	7.1	43.1	16.6	21.5	144.2	37.7	36.6
Cu^{2+}	mg/l	0.003	0.003	0.016	0.003	0.003	0.003	0.002	0.002	0.003	0.002
SO_4^{2-}	mg/l	384.0	405.6	420.0	30.0	255.7	410.0	350.0	560.0	127.0	410.0
Cl^-	mg/l	275.0	256.8	265.9	21.1	128.4	192.6	183.0	477.0	119.0	275.0

St.1: Río Maipo antes Río Volcan, St.2: Río Maipo en la Obra, St.3: Río Maipo en Pte. San Ramón (antes Río Clarillo)
St.4: Río Maipo en Pte. Los Morros (después Río Clarillo), St.5: Río Maipo en Viluco (Puente Ferrocarril), St.6: Río Maipo en Rosario (después Río Angostura)
St.7: Río Maipo después Río Mapocho, St.8: Río Maipo antes Estero Cholqui, St.9: Río Maipo en Cabinbao
St.10: Río Maipo en Desembocadura, St.11: Río Yeso antes Junta Río Maipo, St.12: Río Colorado antes Río Maipo
St.13: Río Angostura en Angostura, St.14: Río Angostura en Valdivia de Paine, St.15: Estero Puangue en Curacaví
St.16: Estero Puangue en camino a San Antonio, St.17: Río Mapocho en Los Almendros, St.18: Río Mapocho en canal La Punta
St.19: Río Mapocho en Canal Las Mercedes, St.20: Río Mapocho en Canal Mallarauco, St.21: Río Mapocho en El Monte
St.22: Estero Lampa después Estero Colina, St.23: Estero Alhue en Quilamuta
St.24: Río Maipo en Fdo Cruz de Piedra, St.25: Estero Las Cruces antes Estero Lampa, St.26: Río Volcán en Pte. Bolsón
C1: Canal San Carlos en Tobalba (Frente Hotel Radison), C2: Canal el Carmen en las Canteras, C3: Zanjón de La Aguada antes Río Mapocho
#1: Pozo Quilicura (Oxiquim), #2: Pozo Pudahuel (Embot. Andina Planta Renca), #3: Pozo Padre Hurtado (Camino Guanaco, Piscicultura 2)
#4: Pozo El Monte (AP El Monte), #5: Pozo Maria Pinto (18 Sept N°215), #6: Pozo Bollenar (Hostería)
#7: Pozos Tejas Verdes (P5 San Juan Aguasquinta)

Table 3.9.2 (1) Results of water quality analysis

Observation period : 8/8/1998～12/8/1998

Date		8/8	13/8	13/8	13/8	13/8	13/8	12/8	12/8	12/8	12/8	8/8	8/8	13/8
Item	Unit	St.1	St.2	St.3	St.4	St.5	St.6	St.7	St.8	St.9	St.10	St.11	St.12	St.13
Temperature	℃	9.0	7.2	11.6	4.5	8.8	11.9	9.5	8.8	11.0	11.3	7.0	5.4	12.6
pH	-	8.6	8.2	7.3	8.2	8.4	7.5	7.2	7.5	7.6	7.5	7.9	8.1	8.8
EC	μmhos/cm	5,10.0	1,300.0	1,440.0	1,370.0	1,400.0	980.0	1,330.0	1,190.0	1,220.0	1,200.0	860.0	1,250.0	320.0
SS	mg/l	328.0	482.0	518.0	542.0	448.0	460.0	305.0	390.0	365.0	262.0	340.0	350.0	540.0
DO	mg/l	8.8	9.0	0.0	8.7	3.1	9.0	0.0	1.0	5.6	6.5	9.3	9.5	9.0
BOD	mg/l	<10.0	<10.0	95.0	2.9	11.0	<10.0	65.0	35.0	9.0	16.0	<10.0	<10.0	<10.0
No. of Coliform Group	MPN/100ml	2.2E+03	3.5E+04	2.2E+06	1.7E+03	3.5E+03	1.6E+07	9.2E+06	2.8E+06	3.3E+05	3.5E+05	7.0E+01	1.3E+02	1.6E+05
No. of Fecal Coliform Group	MPN/100ml	2.2E+02	7.9E+01	3.3E+04	4.9E+02	7.9E+02	1.1E+05	2.8E+06	2.4E+04	1.7E+05	2.6E+04	4.5E+00	<1.8	1.3E+02
NO_3-N	mg/l	1.7	1.0	3.8	1.5	2.6	3.3	2.9	3.0	4.8	5.4	1.6	2.1	2.8
Ca^{2+}	mg/l	70.8	215.0	199.0	159.5	183.1	151.2	175.1	207.0	183.1	214.9	151.2	191.0	44.6
Mg^{2+}	mg/l	11.2	18.0	55.6	56.6	14.1	47.5	102.8	50.7	46.9	36.6	28.6	36.9	12.6
Cu^{2+}	mg/l	<0.001	0.007	0.005	0.007	0.006	0.006	0.019	0.012	0.008	0.002	<0.001	0.003	0.006
SO_4^{2-}	mg/l	125.5	437.0	443.0	324.0	425.0	335.0	351.0	344.0	347.0	334.0	301.0	430.0	74.5
Cl^-	mg/l	89.9	265.9	293.4	284.0	293.4	165.1	275.1	229.3	229.3	238.4	73.4	146.7	18.3

Date		13/8	12/8	12/8	10/8	11/8	11/8	11/8	11/8	11/8	12/8	10/8	11/8	8/8
Item	Unit	St.14	St.15	St.16	St.17	St.18	St.19	St.20	St.21	St.22	St.23	St.24	St.25	St.26
Temperature	℃	12.7	8.0	10.7	4.7	5.3	14.1	12.8	12.6	11.1	9.3	4.0	10.0	8.8
pH	-	7.8	7.7	7.6	7.6	7.6	7.1	7.1	7.2	8.0	7.6	8.1	8.0	8.3
EC	μmhos/cm	1,020.0	240.0	1,380.0	220.0	1,200.0	1,450.0	1,310.0	1,270.0	1,720.0	1,800.0	1,730.0	1,620.0	710.0
SS	mg/l	448.0	374.0	264.0	352.0	500.0	510.0	520.0	504.0	482.0	380.0	352.0	378.0	306.0
DO	mg/l	9.0	8.4	8.2	8.5	0.0	0.0	0.0	0.0	0.0	9.0	3.1	7.5	9.0
BOD	mg/l	<10.0	3.0	10.0	<10.0	25.0	210.0	59.0	92.0	22.0	<10.0	9.2	10.0	<10.0
No. of Coliform Group	MPN/100ml	2.2E+04	2.4E+02	9.2E+03	4.9E+01	5.4E+06	2.8E+07	1.1E+08	9.2E+08	5.4E+04	1.1E+02	5.4E+02	1.1E+04	7.9E+01
No. of Fecal Coliform Group	MPN/100ml	2.2E+03	7.9E+01	2.4E+03	2.2E+01	2.4E+06	1.3E+07	2.4E+07	2.4E+07	3.5E+04	4.9E+01	<1.8	1.1E+03	3.3E+01
NO_3-N	mg/l	3.1	3.6	4.5	3.9	2.5	9.8	6.4	4.8	3.1	2.8	1.5	2.4	1.6
Ca^{2+}	mg/l	191.0	28.6	183.1	34.2	154.2	175.1	199.0	183.1	207.0	461.6	191.0	199.0	95.5
Mg^{2+}	mg/l	46.6	13.8	74.6	10.7	70.2	41.9	64.5	74.2	82.9	16.1	92.6	41.3	30.0
Cu^{2+}	mg/l	0.003	0.005	0.008	0.254	0.018	0.072	0.044	0.052	0.007	0.006	0.001	0.008	<0.001
SO_4^{2-}	mg/l	290.0	29.3	381.0	74.5	352.0	410.0	381.0	373.0	694.0	515.0	407.0	617.0	110.5
Cl^-	mg/l	165.1	13.8	256.8	11.0	229.3	284.3	275.1	256.8	293.4	275.1	466.9	275.1	155.9

Table 3.9.2 (2) Results of water quality analysis

Date		10/8	11/8	12/8	10/8	11/8	11/8	11/8	11/8	12/8	12/8	12/8	12/8
Item	Unit	St.27	St.28	St.29	C1	C3	#1	#2	#3	#4	#5	#6	#7
Temperature	℃	6.1	12.8	7.5	7.6	14.6	14.7	17.7	13.7	14.3	11.2	14.3	15.5
pH	-	7.3	7.2	7.2	8.1	6.9	8.0	7.4	7.2	7.1	7.2	7.2	7.6
EC	μmhos/cm	250.0	1,370.0	750.0	1,400.0	1,600.0	240.0	740.0	1,250.0	1,270.0	2,800.0	770.0	820.0
SS	mg/l	346.0	590.0	360.0	422.0	598.0	450.0	432.0	358.0	256.0	294.0	254.0	354.0
DO	mg/l	8.7	0.0	9.0	7.5	0.0	8.4	8.6	9.0	9.0	8.6	9.0	9.0
BOD	mg/l	<10.0	73.0	3.9	<10.0	472.0	2.7	<10.0	<10.0	<10.0	8.0	<10.0	<10.0
No. of Coliform Group	MPN/100ml	1.7E+04	9.2E+07	5.4E+04	7.0E+02	2.2E+08	2.4E+03	3.3E+01	3.3E+01	2.0E+00	2.3E+01	1.7E+01	6.8E+00
No. of Fecal Coliform Group	MPN/100ml	1.3E+04	2.2E+06	1.1E+04	3.3E+02	3.5E+06	2.2E+02	<1.8	<1.8	<1.8	<1.8	2.0E+00	4.0E+00
NO_3-N	mg/l	3.8	8.4	4.2	3.6	20.7	3.5	5.0	7.5	4.6	9.3	9.5	2.1
Ca^{2+}	mg/l	37.4	183.5	111.4	159.2	151.2	15.1	111.0	199.0	238.8	418.0	87.6	99.5
Mg^{2+}	mg/l	7.4	83.5	39.1	37.7	79.7	4.7	29.6	59.8	40.6	152.0	21.4	25.4
Cu^{2+}	mg/l	0.009	0.061	0.009	0.004	0.106	0.009	0.007	<0.001	0.007	0.007	0.002	0.006
SO_4^{2-}	mg/l	112.5	445.0	173.5	395.0	438.0	28.4	215.0	380.0	368.0	820.0	176.0	177.0
Cl^-	mg/l	6.4	293.4	114.6	284.0	311.8	19.3	114.7	201.7	229.3	573.1	137.6	55.0

St.1: Río Maipo antes Río Volcan, St.2: Río Maipo en la Obra, St.3: Río Maipo en Pte. San Ramón (antes Río Clarillo)
St.4: Río Maipo en Pte. Los Morros (después Río Clarillo), St.5: Río Maipo en Viluco (Puente Ferrocarril), St.6: Río Maipo en Rosario (después Río Angostura)
St.7: Río Maipo después Río Mapocho, St.8: Río Maipo antes Stero Cholqui, St.9: Río Maipo en Cabinbao
St.10: Río Maipo en Desembocadura, St.11: Río Yeso antes Junta Río Maipo, St.12: Río Colorado antes Río Maipo
St.13: Río Angostura en Angostura, St.14: Río Angostura en Valdivia de Paine, St.15: Estero Puangue en Curacaví
St.16: Estero Puangue en camino a San Antonio, St.17: Río Mapocho en Los Almendros, St.18: Río Mapocho en canal La Punta
St.19: Río Mapocho en Canal Las Mercedes, St.20: Río Mapocho en Canal Mallarauco, St.21: Río Mapocho en El Monte
St.22: Estero Lampa después Estero Colina, St.23: Estero Alhue en Quilamuta
St.24: Río Maipo en Fdo Cruz de Piedra, St.25: Estero Las Cruces antes Estero Lampa, St.26: Río Volcán en Pte. Bolsón
St.27: Estero Arrayán antes Río Mapocho (Puente El Remanso), St.28: Río Mapocho aguas abajo junta Stero Lampa, St.29: Estero Puangue en canal Los Rulos
C1: Canal San Carlos en Tobalba (Frente Hotel Radison), C3: Zanjón de La Aguada antes Río Mapocho
#1: Pozo Quilicura (Oxiquim), #2: Pozo Pudahuel (Embot. Andina Planta Renca), #3: Pozo Padre Hurtado (Camino Guanaco, Piscicultura 2)
#4: Pozo El Monte (AP El Monte), #5: Pozo Maria Pinto (18 Sept N°215), #6: Pozo Bollenar (Hostería)
#7: Pozos Tejas Verdes (P5 San Juan Aguasquinta)

Table 3.9.3 (1) Results of water quality analysis Observation period : 6/12/1998~11/12/1998

Date		10/12	10/12	10/12	8/12	8/12	10/12	10/12	7/12	7/12	8/12	8/12	9/12
Item	Unit	St.2	St.3	St.4	St.5	St.6	St.7	St.8	St.9	St.10	St.13	St.14	St.15
Temperature	℃	16.1	18.8	22.4	25.5	23.8	26.9	28.3	19.6	22.7	24.2	22.4	32.6
pH	-	8.0	8.1	7.6	9.8	8.7	8.2	8.7	7.9	8.6	9.3	8.6	9.3
EC	μmhos/cm	910.0	920.0	900.0	830.0	900.0	1,060.0	1,000.0	960.0	1,100.0	340.0	950.0	270.0
SS	mg/l	100.0	115.0	80.0	184.0	152.0	93.0	90.0	154.0	136.0	138.0	96.0	100.0
DO	mg/l	3.3	3.5	5.6	5.9	5.4	4.9	5.7	4.5	6.0	3.5	7.0	3.9
BOD	mg/l	23.0	24.0	9.0	19.0	21.0	16.0	11.0	42.0	20.0	49.0	15.0	17.0
No. of Coliform Group	MPN/100ml	3.5E+02	2.6E+06	2.2E+04	3.5E+01	1.6E+04	1.6E+04	2.7E+01	7.0E+03	3.5E+02	5.4E+02	3.5E+03	4.9E+01
No. of Fecal Coliform Group	MPN/100ml	2.4E+02	2.2E+05	9.2E+03	3.9E+01	9.2E+03	3.5E+03	7.8E+00	3.5E+03	3.3E+01	7.9E+01	1.3E+03	3.3E+01
NO_3-N	mg/l	1.1	0.7	0.7	3.1	1.8	2.5	1.9	2.6	1.7	2.4	3.4	1.0
Ca^{2+}	mg/l	145.8	134.0	134.0	122.2	157.6	220.6	173.4	197.0	204.9	41.8	181.2	44.8
Mg^{2+}	mg/l	16.0	18.7	32.3	23.6	45.3	29.7	35.7	66.9	48.4	11.5	35.4	0.8
Cu^{2+}	mg/l	0.097	0.090	0.020	0.007	0.007	0.058	0.009	0.029	0.018	0.008	0.021	<0.001
SO_4^{2-}	mg/l	337.5	327.5	310.0	313.0	300.0	350.0	340.0	310.0	360.0	72.0	315.0	31.9
Cl^-	mg/l	121.4	144.8	186.0	139.4	167.2	196.1	177.5	222.0	223.0	18.6	167.2	13.1

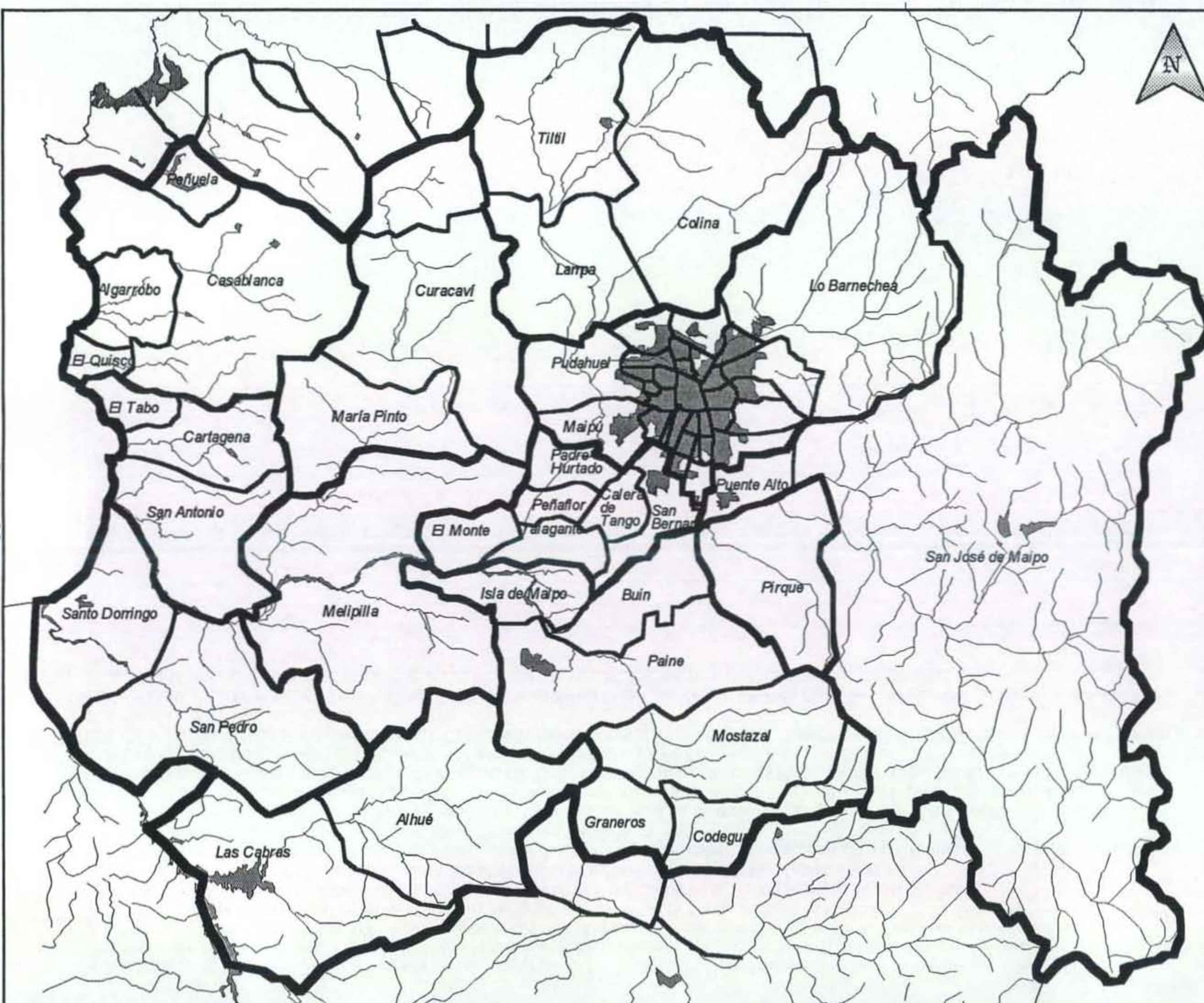
Date		7/12	10/12	9/12	6/12	8/12	10/12	9/12	7/12	9/12	9/12	8/12
Item	Unit	St.16	St.17	St.18	St.19	St.20	St.21	St.22	St.23	St.25	St.29	St.30
Temperature	℃	18.1	17.5	17.0	22.5	23.4	28.0	24.5	26.5	24.6	23.1	19.4
pH	-	7.7	6.0	7.5	7.5	7.7	7.5	8.3	7.5	7.6	7.5	7.8
EC	μmhos/cm	1,180.0	440.0	830.0	1,080.0	1,005.0	1,050.0	1,280.0	1,700.0	1,260.0	1,145.0	800.0
SS	mg/l	132.0	98.0	118.0	64.0	174.0	160.0	105.0	104.0	110.0	95.0	176.0
DO	mg/l	3.8	4.4	3.6	1.0	4.8	0.0	5.0	6.3	4.5	4.9	3.1
BOD	mg/l	35.0	17.0	45.0	140.0	38.0	150.0	32.0	25.0	32.0	33.0	45.0
No. of Coliform Group	MPN/100ml	3.5E+03	2.4E+02	1.7E+07	2.8E+08	1.7E+05	2.4E+02	1.7E+03	3.5E+03	3.5E+03	5.4E+05	9.2E+04
No. of Fecal Coliform Group	MPN/100ml	1.3E+03	1.3E+02	7.9E+06	1.7E+08	3.5E+03	1.3E+02	1.3E+03	1.4E+02	1.3E+03	1.7E+05	9.2E+04
NO_3-N	mg/l	3.0	1.0	0.8	6.5	2.2	1.4	1.7	0.8	1.9	2.4	3.4
Ca^{2+}	mg/l	189.1	76.4	122.2	173.4	181.2	173.4	165.5	614.4	173.4	165.5	157.6
Mg^{2+}	mg/l	58.0	30.5	16.7	22.0	53.7	44.8	86.1	8.3	49.4	40.5	49.9
Cu^{2+}	mg/l	0.040	3.100	0.043	0.076	0.020	0.027	0.005	0.017	0.013	0.006	0.022
SO_4^{2-}	mg/l	410.0	220.0	290.0	350.0	324.0	356.0	345.0	410.0	411.0	350.0	320.0
Cl^-	mg/l	241.5	11.2	149.4	195.1	204.4	196.1	205.5	83.6	178.0	214.8	167.2

Table 3.9.3 (2) Results of waterquality analysis

Date		10/12	9/12	10/12	11/12	11/12	11/12	11/12	11/12	11/12	10/12	11/12	12/16
Item	Unit	C1	C2	C3	C4	C5	C6	C7	C9	C11	C12	C13	C14
Temperature	℃	14.2	14.5	21.2	17.8	19.4	22.7	24.6	27.3	21.5	24.1	25.8	17.2
pH	-	8.2	8.1	7.1	7.1	7.2	7.3	7.3	7.4	7.4	8.4	7.9	7.8
EC	μmhos/cm	920.0	860.0	1,350.0	830.0	1,160.0	1,170.0	1,240.0	1,130.0	1,100.0	980.0	920.0	1,070.0
SS	mg/l	108.0	140.0	150.0	97.0	105.0	123.0	135.0	183.0	170.0	82.0	95.0	130.0
DO	mg/l	3.0	2.7	0.0	2.9	1.8	0.0	0.0	0.0	0.0	5.9	3.8	3.2
BOD	mg/l	28.0	42.0	170.0	33.0	45.0	110.0	116.0	108.0	110.0	12.0	15.0	19.0
No. of Coliform Group	MPN/100ml	5.4E+06	1.7E+04	2.2E+07	5.4E+08	5.4E+05	1.6E+09	5.4E+08	9.2E+08	9.2E+08	5.4E+08	1.7E+05	<1.8
No. of Fecal Coliform Group	MPN/100ml	1.6E+05	2.2E+03	1.3E+07	3.3E+06	1.3E+05	9.2E+08	2.8E+07	1.7E+08	1.1E+07	9.2E+06	1.3E+05	<1.8
NO_3-N	mg/l	0.7	1.8	17.6	3.7	2.9	1.8	2.1	1.7	2.3	1.6	2.0	3.4
Ca^{2+}	mg/l	134.0	130.0	149.7	118.2	157.6	157.6	165.6	165.5	173.4	204.9	173.4	181.4
Mg^{2+}	mg/l	41.5	23.1	36.4	37.4	31.6	22.5	31.4	26.8	49.4	30.1	35.7	58.2
Cu^{2+}	mg/l	0.021	0.021	0.100	0.051	0.019	0.032	0.032	0.033	0.069	0.027	0.012	0.041
SO_4^{2-}	mg/l	326.0	300.0	302.0	294.0	371.5	294.0	292.0	321.0	326.0	309.0	311.0	363.0
Cl^-	mg/l	168.1	126.1	289.5	149.4	214.8	224.2	214.8	252.2	224.2	177.5	186.8	261.5

Date		11/12	9/12	11/12	9/12	9/12	12/14	8/12	10/12	9/12	9/12	7/12
Item	Unit	C15	C17	C18	C19	#1	#2	#3	#4	#5	#6	#7
Temperature	℃	27.0	19.0	21.0	23.4	22.5	18.7	18.8	19.4	18.5	23.2	18.1
pH	-	7.8	8.4	8.1	7.3	8.4	7.7	7.4	7.2	7.2	7.2	7.8
EC	μmhos/cm	990.0	180.0	880.0	1,180.0	330.0	750.0	1,150.0	1,010.0	2,120.0	715.0	820.0
SS	mg/l	103.0	85.0	75.0	138.0	110.0	79.0	148.0	92.0	90.0	95.0	92.0
DO	mg/l	2.7	6.1	6.1	0.0	4.3	2.1	5.1	6.0	5.1	4.1	7.9
BOD	mg/l	25.0	21.0	6.2	175.0	15.0	39.0	24.0	11.0	25.0	14.0	9.0
No. of Coliform Group	MPN/100ml	1.6E+09	3.5E+03	1.7E+05	1.6E+09	<1.8	2.0E+00	1.7E+02	2.0E+00	3.3E+01	2.4E+02	4.9E+01
No. of Fecal Coliform Group	MPN/100ml	5.4E+07	2.4E+03	9.2E+03	1.6E+09	<1.8	<1.8	3.3E+01	<1.8	1.7E+01	4.9E+01	7.8E+00
NO_3-N	mg/l	1.9	1.2	2.4	8.5	2.4	2.5	4.6	2.8	9.4	9.7	0.5
Ca^{2+}	mg/l	173.4	23.6	173.4	149.7	15.8	118.2	197.0	197.0	334.9	134.0	106.4
Mg^{2+}	mg/l	35.7	5.2	35.7	27.3	5.9	37.4	44.1	53.2	229.0	0.4	24.1
Cu^{2+}	mg/l	0.027	0.006	0.013	0.045	0.003	<0.001	0.032	0.020	0.008	0.002	0.018
SO_4^{2-}	mg/l	321.0	31.0	300.0	340.0	30.0	255.0	370.0	360.0	750.0	147.0	200.0
Cl^-	mg/l	196.1	5.6	177.5	214.8	21.5	149.4	223.0	186.8	583.8	121.4	134.7

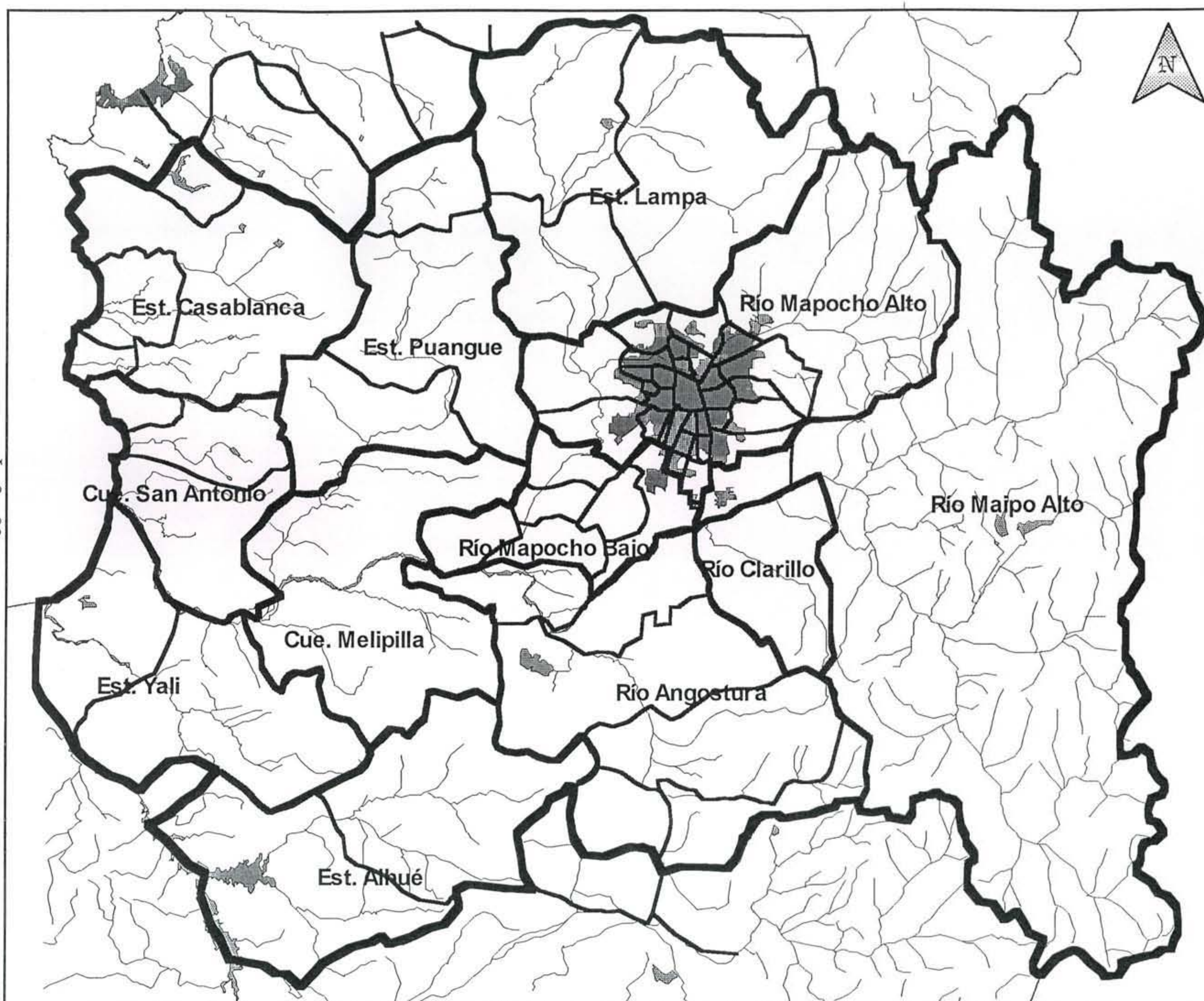
St.2: Río Maipo en la Obra, St.3: Río Maipo en Pte. San Ramón (antes Río Clarillo), St.4: Río Maipo en Pte. Los Morros (después Río Clarillo),
St.5: Río Maipo en Viluco (Puente Ferrocarril), St.6: Río Maipo en Rosario (después Río Angostura), St.7: Río Maipo después Río Mapocho (Haras Los Boldos),
St.8: Río Maipo antes Estero Cholqui (Pte. Ing. Maramblo), St.9: Río Maipo en Cabinbao (Quicanhue), St.10: Río Maipo en Desembocadura,
St.13: Río Angostura en Angostura, St.14: Río Angostura en Valdivia de Paine, St.15: Estero Puangue en Curacaví,
St.16: Estero Puangue en camino a San Antonio, St.17: Río Mapocho en Los Almendros, St.18: Río Mapocho en canal La Punta
St.19: Río Mapocho en Canal Las Mercedes, St.20: Río Mapocho en Canal Mallarauco, St.21: Río Mapocho en El Monte
St.22: Estero Lampa después Estero Colina, St.23: Estero Alhue en Quilamuta, St.25: Estero Las Cruces antes Estero Lampa,
St.29: Estero Puangue en Canal Los rulos, St.30: Estero El Gato (en Pte. Gato 1)
C1: Canal San Carlos en Tobalba (Frente Hotel Radison), C2: Canal El Carmen en las Canteras, C3: Zanjón de La Aguada antes Río Mapocho,
C4: Canal La Pólvora (frente calle Rapa-Nui), C5: Canal Casa de Pudahuel (Cam. Noviciado Alt.1300), C6: Canal Esperanza Alto (en la puntilla),
C7: Canal Esperanza Bajo (en cruce Carretera 78-Antigua), C9: Canal Castillo (Vicuña Mackenna Parad.23), C11: Canal Mallarauco (en salida del túnel),
C12: Canal El Paico (El Paico alto), C13: Canal San Miguel (en línea F.F.C.C), C14: Canal Lo Aguirre,
C15: Canal Lo Chacón (entrada Balneario Yamil), C17: Canal Esmeralda en Colina (En Esmeralda frente a Consultorio), C18: Canal Culiprán (en puntilla El Cerrillo),
C19: Canal Las Mercedes en Curacaví,
#1: Pozo Quilicura (Oxiquim), #2: Pozo Pudahuel (Embot. Andina Planta Coca Cola Renca), #3: Pozo Padre Hurtado (Camino Guanaco, Piscicultura 2)
#4: Pozo El Monte (AP EMOS El Monte), #5: Pozo Maria Pinto (18 Sept N°215), #6: Pozo Bollenar (Hostería Las lilas II),
#7: Pozos Tejas Verdes (P5 San Juan Aguasquinta)



1 Río Maipo Alto	Puente Alto San José de Maipo
2 Río Clarillo	Pirque
3 Río Mapocho Alto	Santiago, Huechuraba Vitacura, Ñuñoa Peñalolén, La Granja San Miguel, Lo Espejo Maipú ,Lo Prado Renca, Independencia Recoleta, Lo Barnecha La Reina, La Florida La Pintana ,La Cisterna Pedro Aguirre Cerda Pudahuel, Quilicura Estación Central Conchalí , Providencia Las Condes, Macul San Joaquín San Ramón, El Bosque Cerrillo, Quinta Normal Cerro Navia
4 Est. Lampa	Colina, Lampa, Tiltil
5 Río Mapocho Bajo	San Bernardo, Peñaflor Calera de Tango El Monte, Talagante Padre Hurtado
6 Río Angostura	Granros, Buin, Mostazal Paine, Codegua Isla de Maipo
7 Est. Alhué	Las Cabras, Alhué
8 Cue. Melipilla	Melipilla
9 Est. Puangue	Maria Pinto, Curacaví
10 Est. Yali	Santo Domingo San Pedro
11 Cue. San Antonio	San Antonio, Cartagena El Tabo
12 Est. Casablanca	Casablanca, Peñuelas El Quisco, Algarrobo

Fig. 3.1.1
Administrative
Boundaries

DESARROLLO AGRICOLA Y MANEJO
DE AGUAS DEL AREA METROPOLITANA
JICA - CNR



1 Río Maipo Alto	Puente Alto San José de Maipo
2 Río Clarillo	Pirque
3 Río Mapocho Alto	Santiago, Huechuraba Vitacura, Ñuñoa Peñalolén, La Granja San Miguel, Lo Espejo Maipú ,Lo Prado Renca, Independencia Recoleta, Lo Barnecha La Reina, La Florida La Pintana ,La Cisterna Pedro Aguirre Cerda Pudahuel, Quilicura Estación Central Conchali , Providencia Las Condes, Macul San Joaquin San Ramón, El Bosque Cerrillo, Quinta Normal Cerro Navia
4 Est. Lampa	Colina, Lampa, Tiltil
5 Río Mapocho Bajo	San Bernardo, Peñaflor Calera de Tango El Monte, Talagante Padre Hurtado
6 Río Angostura	Granros, Buin, Mostazal Paine, Codegua Isla de Maipo
7 Est. Alhué	Las Cabras, Alhué
8 Cue. Melipilla	Melipilla
9 Est. Puangue	Maria Pinto, Curacaví
10 Est. Yali	Santo Domingo San Pedro
11 Cue. San Antonio	San Antonio, Cartagena El Tabo
12 Est. Casablanca	Casablanca, Peñuelas El Quisco, Algarrobo

Fig. 3.1.2

Sub-Basin Division

DESARROLLO AGRICOLA Y MANEJO
DE AGUAS DEL AREA METROPOLITANA
JICA - CNR

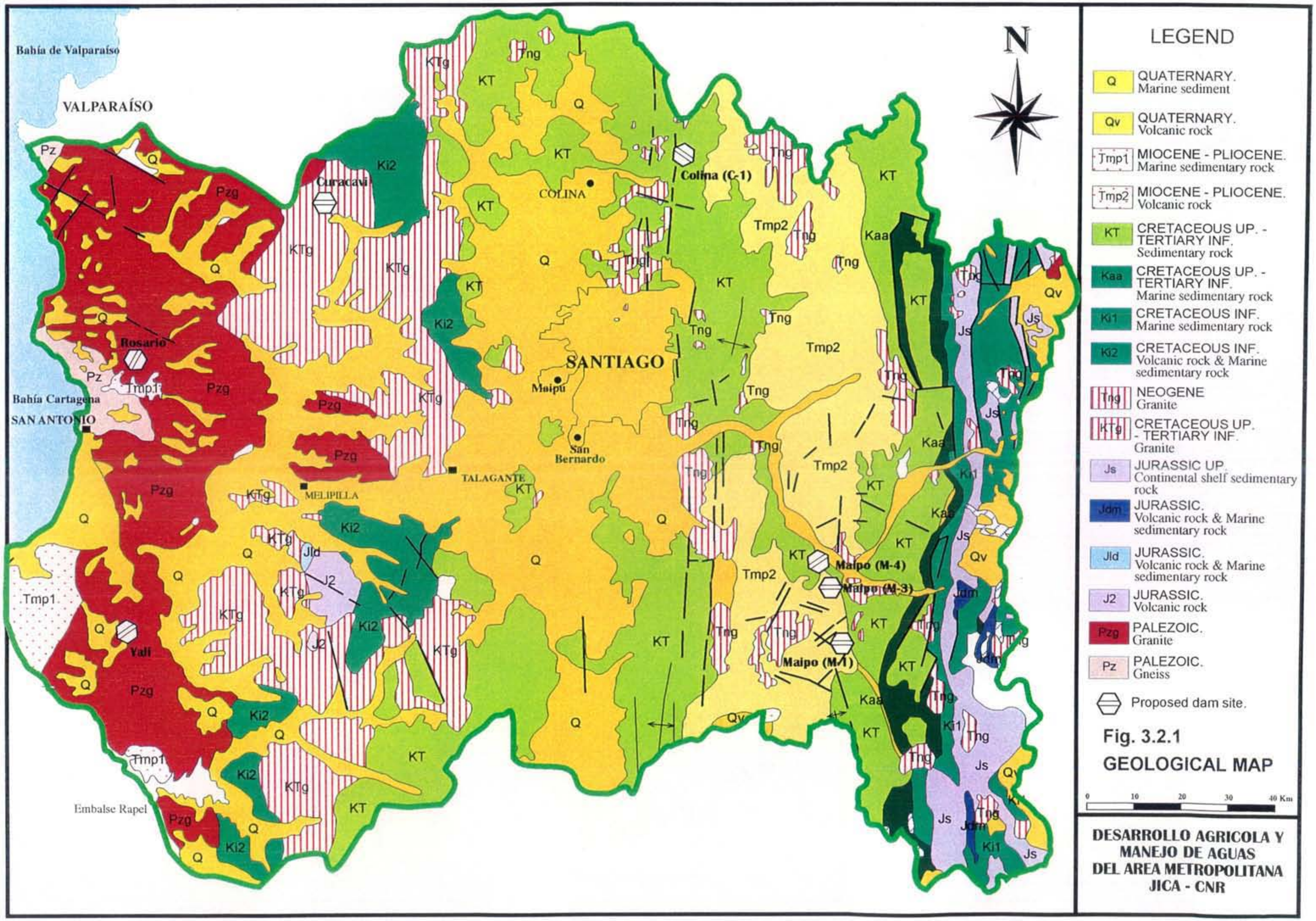


Fig. 3.2.1 GEOLOGICAL MAP

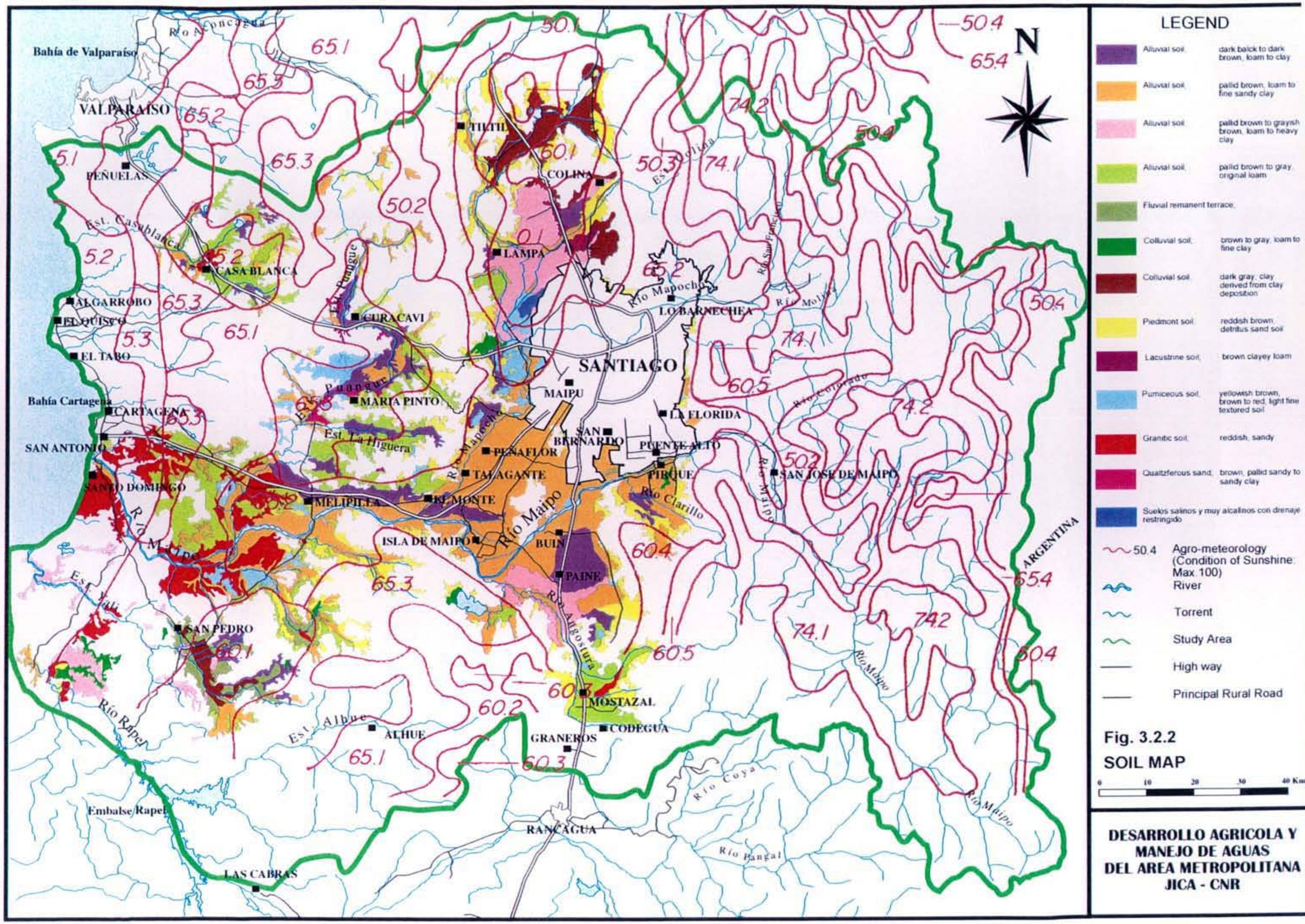


Fig. 3.2.2

SOIL MAP

DESARROLLO AGRICOLA Y MANEJO DE AGUAS DEL AREA METROPOLITANA JICA - CNR

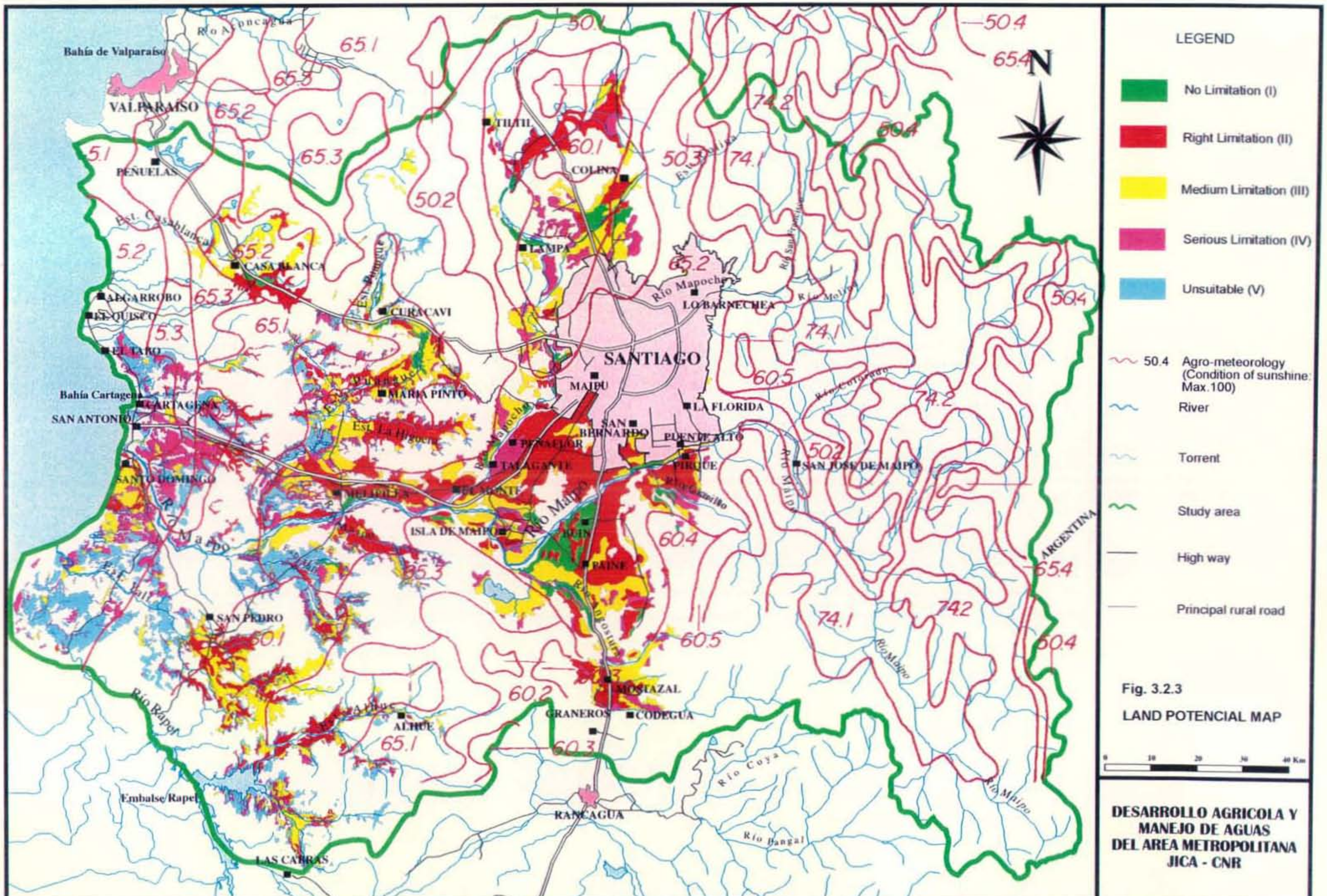


Fig. 3.2.3
LAND POTENCIAL MAP

DESARROLLO AGRICOLA Y MANEJO DE AGUAS DEL AREA METROPOLITANA JICA - CNR

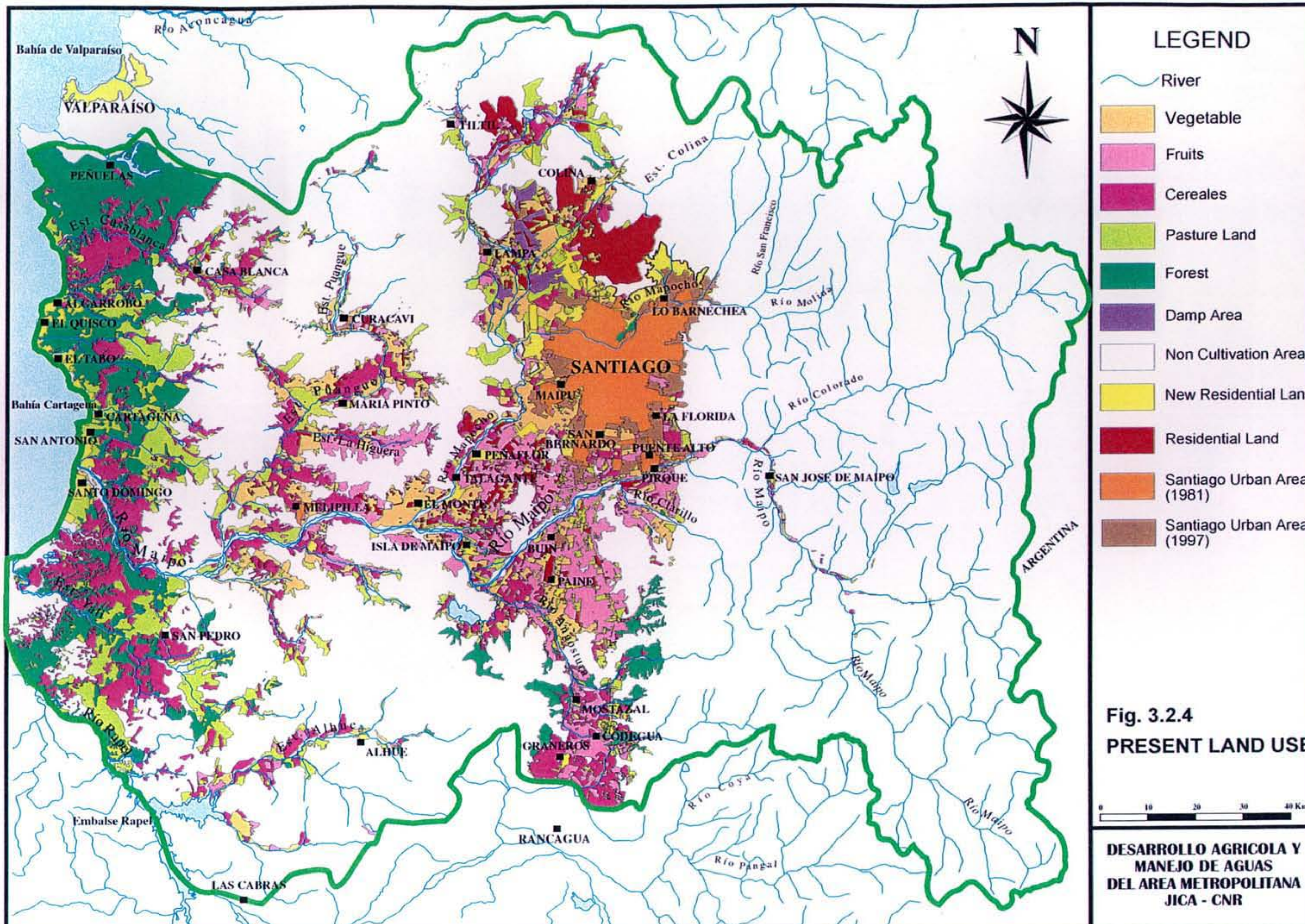
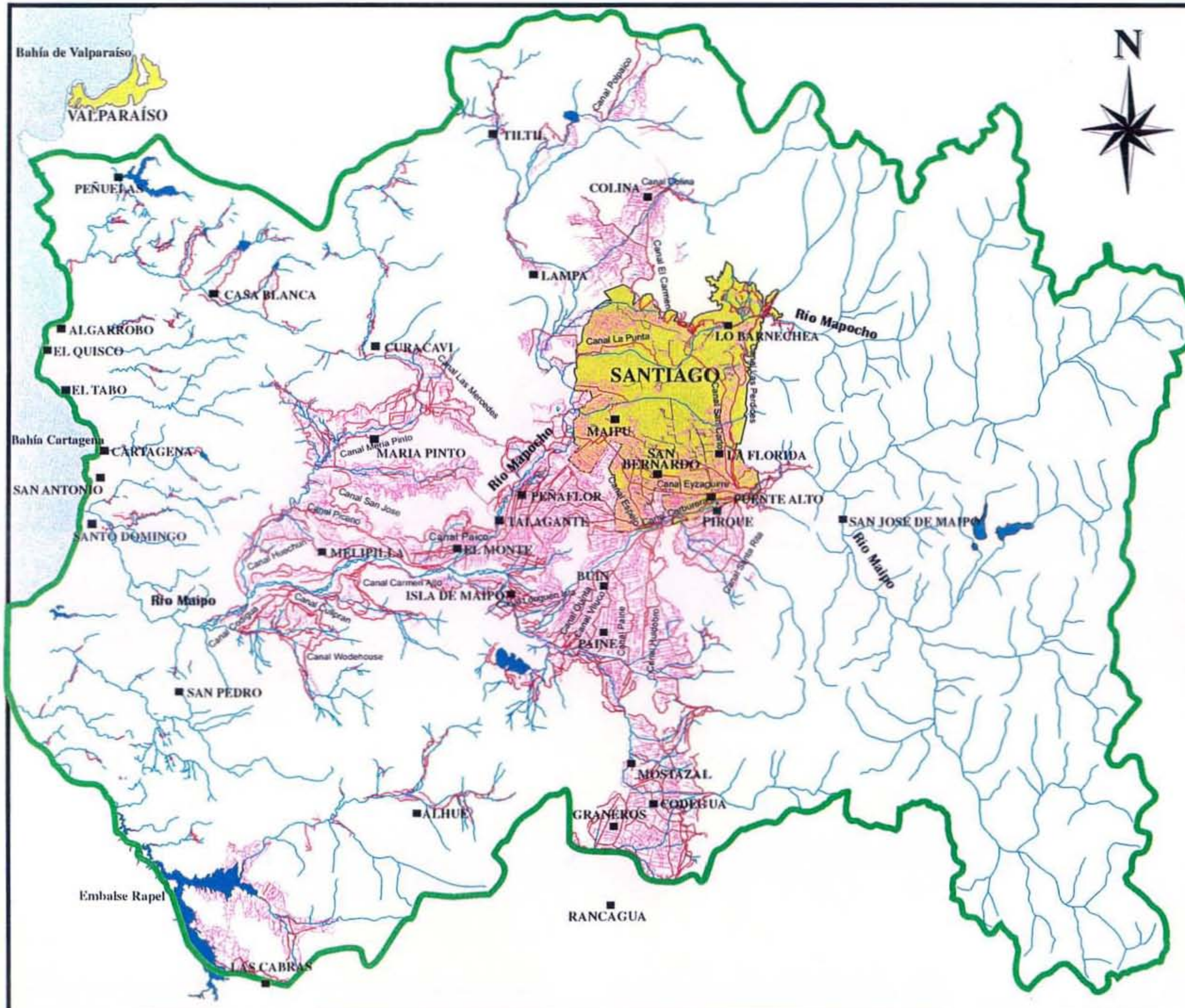


Fig. 3.2.4
PRESENT LAND USE

DESARROLLO AGRICOLA Y MANEJO DE AGUAS DEL AREA METROPOLITANA
JICA - CNR



LEGEND

River

Main Canal

Lateral Canal

Fig. 3.7.1

EXISTING IRRIGATION CANAL NETWORKS

0 10 20 30 40 Km

DESARROLLO AGRICOLA Y MANEJO DE AGUAS DEL AREA METROPOLITANA JICA - CNR

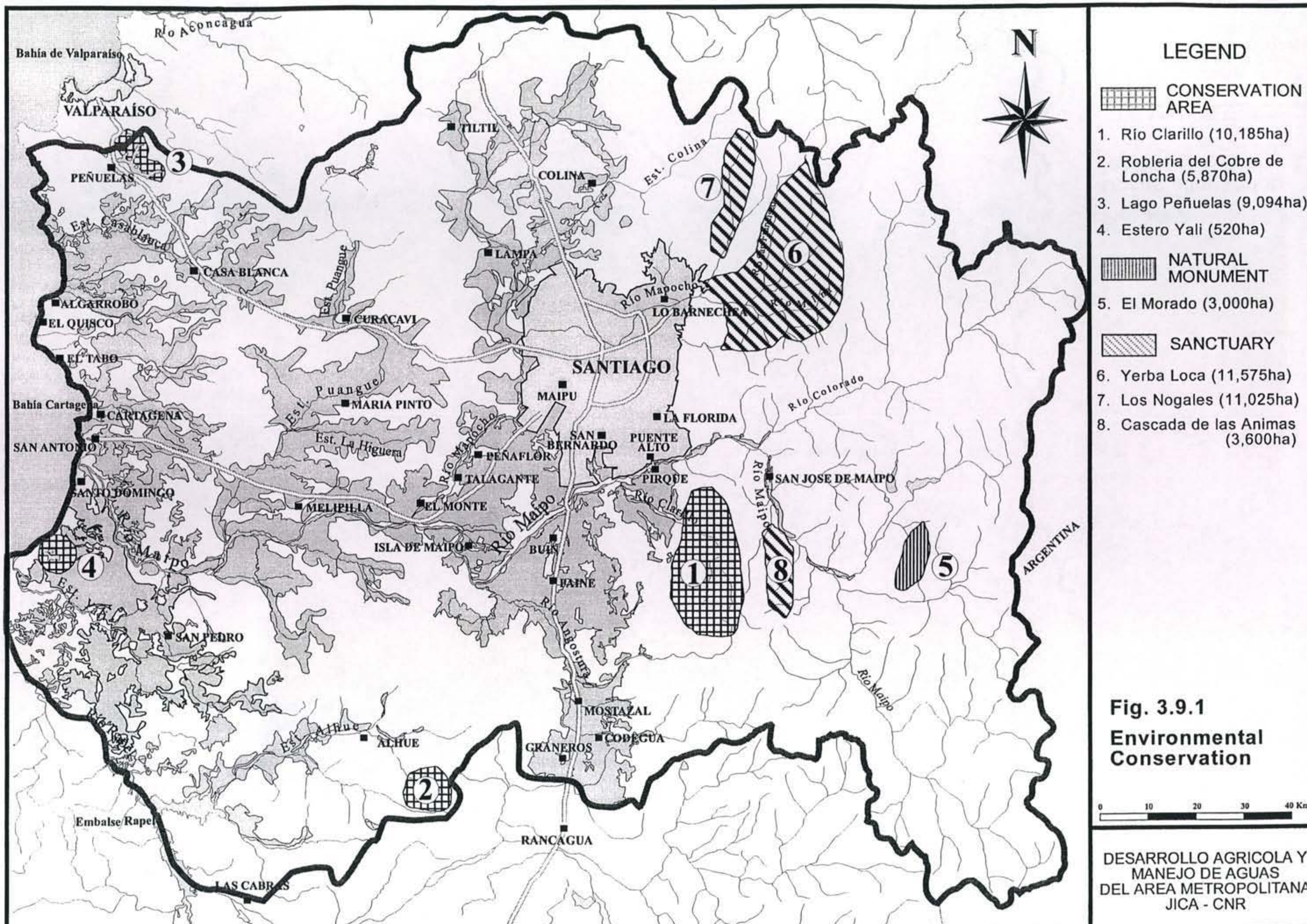
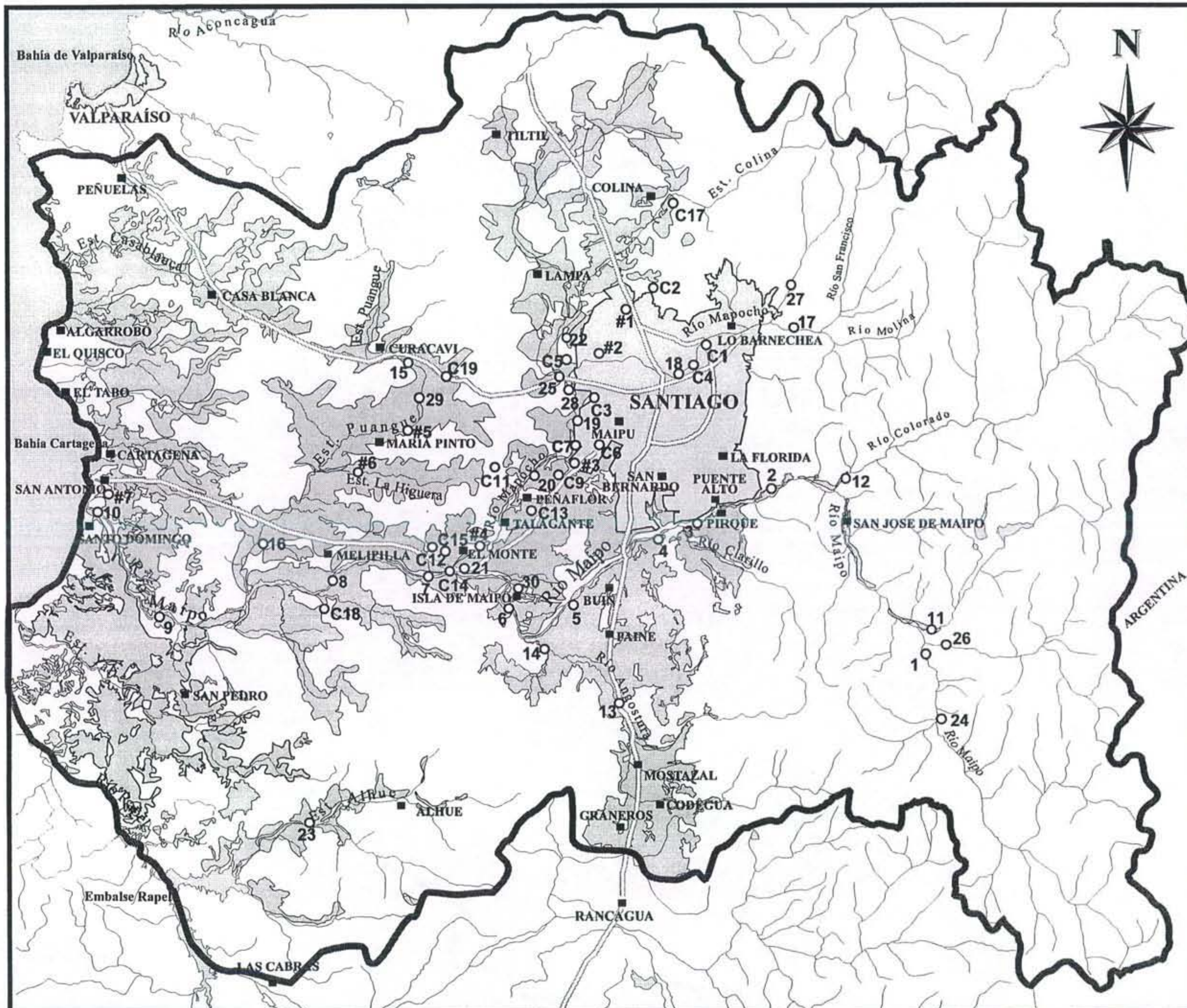


Fig. 3.9.1 Environmental Conservation

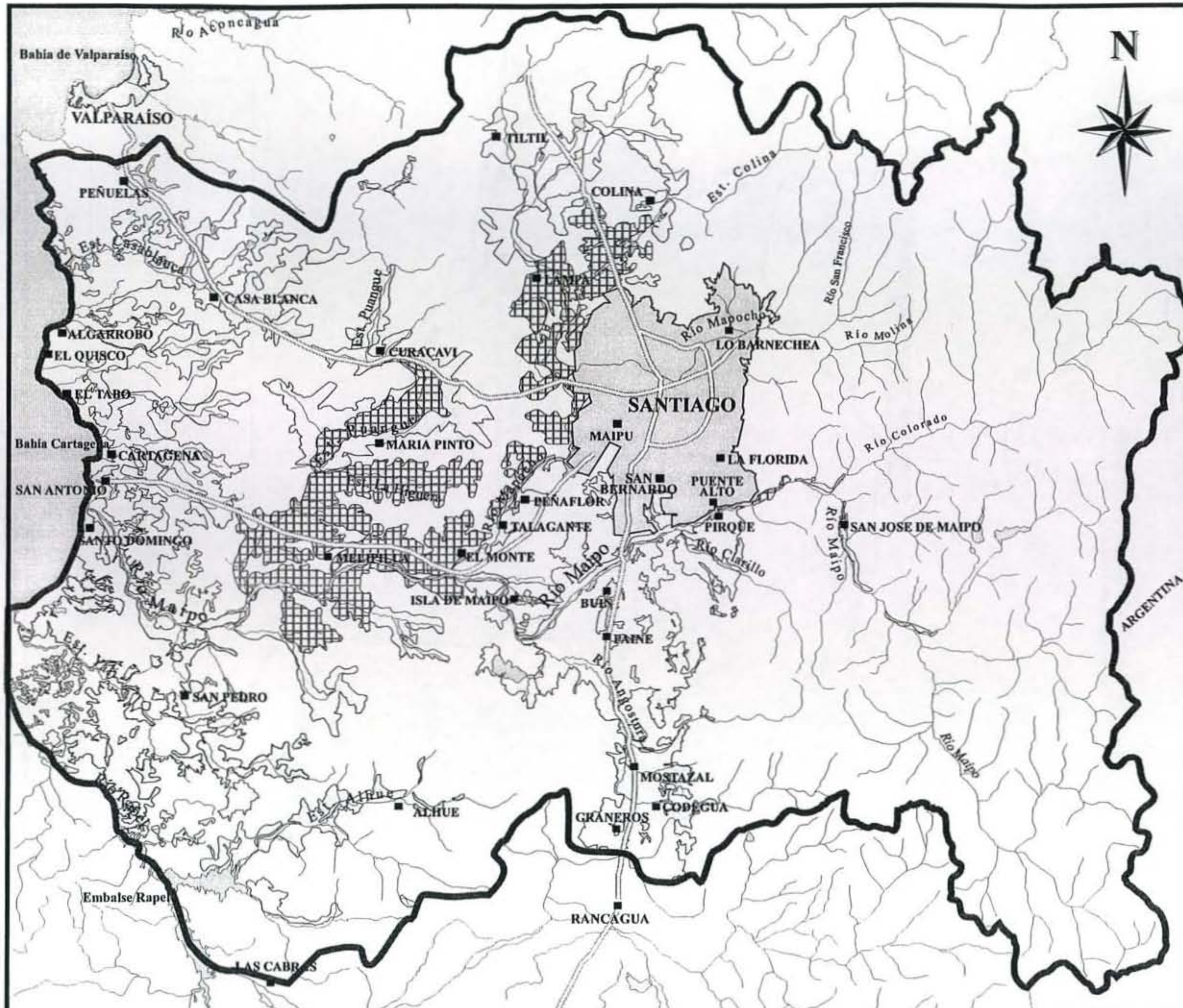


○ Observation Point

Fig. 3.9.2
Observation Point for Water Anlysis

0 10 20 30 40 Km

DESARROLLO AGRICOLA Y
MANEJO DE AGUAS
DEL AREA METROPOLITANA
JICA - CNR



LEGEND

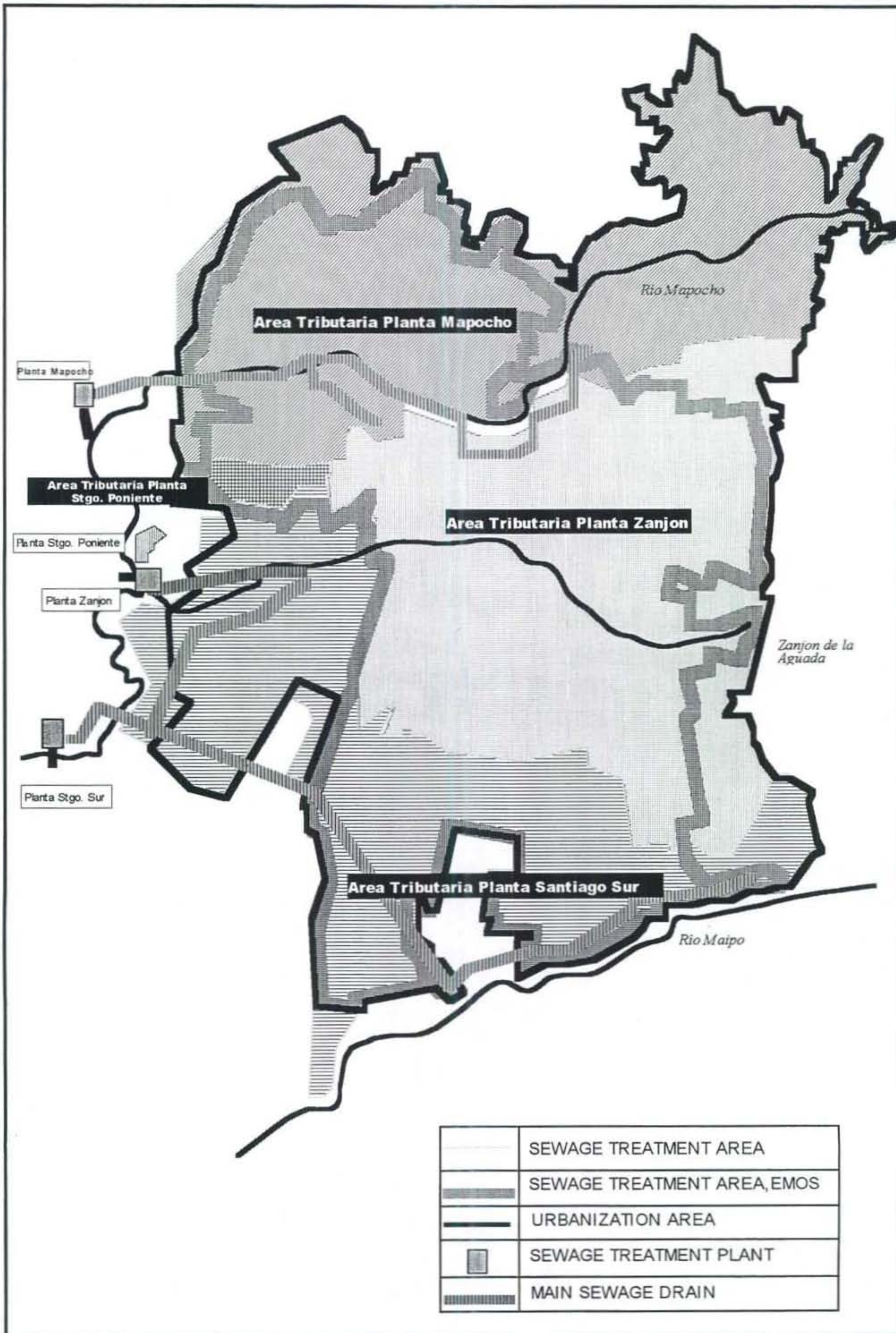
- Area where water quality needs to be improved
- Expected area where water quality would be improved by EMOS until 2010
- Farmland
- Urban Area

Fig. 3.9.3

Present Situation of Water Contamination

0 10 20 30 40 Km

DESARROLLO AGRICOLA Y
MANEJO DE AGUAS
DEL AREA METROPOLITANA
JICA - CNR



DESARROLLO AGRICOLA Y MANEJO DE AGUAS DEL AREA METROPORITANA (JICA - CNR)	**FIG. 3.9.4 SEWAGE TREATMENT PLAN**

CHAPTER 4

BASIC CONCEPT OF THE DEVELOPMENT PLAN

4 BASIC CONCEPT OF THE DEVELOPMENT PLAN

4.1 Basic Concept

The objective area for the development covers the Metropolitan Region that includes the capital city of Santiago, and part of the V and VI Regions. The population of the capital city is one third of national population (14.2 million) or 5 million. The objective area plays important role historically and presently as the main agricultural production area in Chile, especially for horticultural products (fruits and vegetables) and other agricultural products consumed in the Metropolitan area and for exportation.

The current problems of agriculture in the area are expansion of Santiago city by population growth, disappearance or decrease of farmland, contaminated irrigation water, tightness of available water and difficulties of farming management on small scale farmers.

Based on the above recognition, the development plan is to promote socio-economically well-balanced agriculture for the harmonized progress by effective use of limited sources of water and land considering environmental conservation, on agriculture affected by sprawled expansion and contaminated irrigation water due to sewage by population growth.

4.2 Approach on the Development Plan

4.2.1 Justification with the National and Provincial Policies

Agriculture policy of Chile is described in "Strategic Agenda 1998 – 2000, Target of Agricultural Development" prepared by the Ministry of Agriculture. Provincial agriculture policy is also formed an action plan within the frameworks of the national policy.

The "Strategic Agenda" intents an urgent agriculture modernization by promote export of agricultural products to international market, and is raised, as basic components for the productivity improvement, infrastructure development for production by irrigation improvement and innovation and improvement on both technology and management. Agriculture in Chile is, at the same time, required sloughs away from conventional profit-seeking commercial agriculture and alters to agriculture with new vision capable to respond demand of new age, and stressing a fostering and strengthening of middle and small-scale farmers for their promotion.

In line with the concept of "Strategic Agenda" , the development plans to be formulated intend to play a role of food production center for the Metropolitan area and to improve productivity in order to maintain its important position in the national agriculture by effective use of land and water resources, development of environmental conservation, establishment of infrastructure for production (including development to make possible to supply clean water for irrigation), and development and strengthen agricultural support system for small scale farmers.

4.2.2 Intention on the Development Plan

(1) Economic Development

The objective area is located in the Mediterranean Agriculture Zone in Agro-ecological classification of Chile and is the most developed irrigation area with fertile soil and favorable climate conditions in the country. The area is also an important position on economy as major food supply center for the Metropolitan area and agricultural production area for export products recently.

Progress and stability of the economics are one of the major elements on the national policy. It is needless to say that agriculture in the Metropolitan area is taking a leading role on the history and the traditions. Just as mentioned in "Strategic Agenda", modernization of agriculture is the major subject for achieving the target and the economical progress is to be realized as the result. In the other hand as "Agenda" pointed out, the development intention intended to avoid to concentrate only to a profit-seeking commercialism of efficiency oriented. Along the above intention, agriculture in the Metropolitan area in the plan is intended to maintain a role on economic development considering various aspects as farmers types in the aspect of manpower resource and effective use of land and water in the aspect of the natural resource.

(2) Balanced Society

Population inflow into urban area and surroundings is common phenomena in the world. These phenomena involve the risk as the cause of social and environmental problems arising in both urban and rural areas. Depopulation and devastation of rural area due to population outflow cause decline of economic activity in the agricultural production and the distortion of rural society. Moreover, Depopulation in the rural area affects seriously to the natural environment, because natural environment in the rural area is maintained through the living activities of rural habitants. In case of recent Chile, population increase is tend to occur in the capital city of Santiago as well as surrounding urban cities, on the other hand, rural population has been constant in general or no significant in case of decrease. It is considered that rural condition in Chile is still remain without significant problem even though the fact of decrease labor population is exist.

The significant difference in living condition and income level between urban and rural areas is observed. Although farmers are not giving up farming, many are selling farmland as subdivided housing lots and it is serious situation from the point of agriculture development. It is required to reform as the past situation to maintain the relation of neighboring of urban and rural and fulfill food supply for urban residents, and to reduce the gap with urban on condition of rural living, production and economics in order to play a role of food supply center of the Metropolitan area. It is the condition to maintain steadily rural area of Chile in which is still remain without serious problem. Approach in the plan will be made from three aspects of infrastructures on living and production, and agricultural support for certifying the conditions above.

4.2.3 Target Year of the Development Plan

Target year is to be 2010 in the plan.

4.2.4 Framework of the Development Plan

The framework of the development plan is recognized as follow by the basic concept of the development.

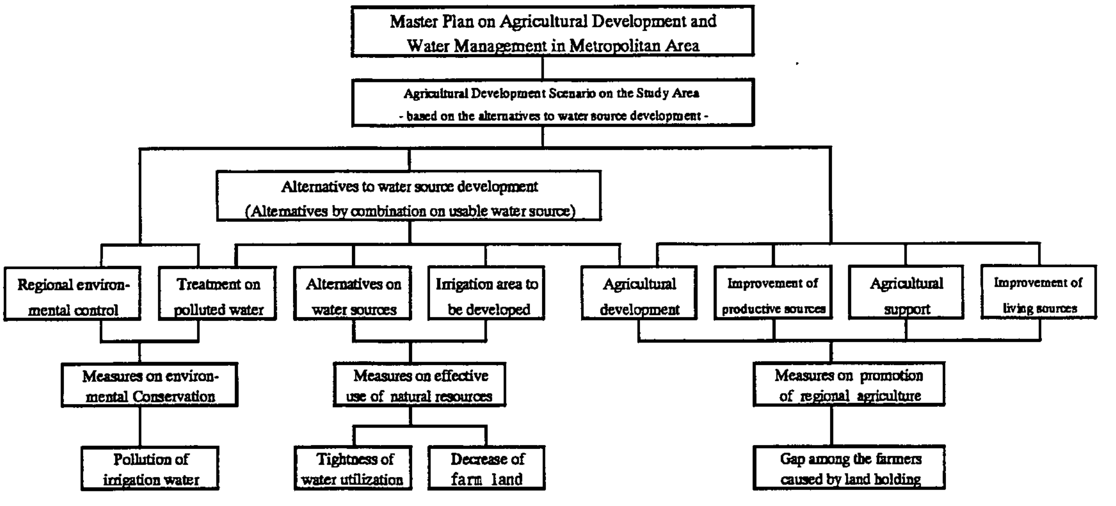
1) Effective use of water and land resources in the Project area
2) Environmental conservation in entire basin.
3) Agricultural promotion in the Metropolitan area

CHAPTER 5

PLAN OF THE AGRICULTURAL DEVELOPMENT AND WATER MANAGEMENT IN METROPOLITAN AREA

5 PLAN OF THE AGRICULTURAL DEVELOPMENT AND WATER MANAGEMENT IN METROPOLITAN AREA

Study procedures of the master plan on "Agricultural Development and Water Management in Metropolitan Area" is summarized in the flow chart below based on the present condition of the study area and the basic concepts of the development plan.



5.1 Water Resources Development Plan

5.1.1 Basic Concept on the Water Resources Development Plan

The present water utilization in the study area mostly depends on the discharge from the upstream reach of the Maipo river. Available surface runoff in the basin is 4,100 MCM in average year and 2,500 MCM in 85% exceedance probability, however, demands on irrigation, water works and other industrial uses accounts 3,370 MCM in average year and 3,150 MCM in 85% exceedance probability. Present water utilization of surface runoff in the Maipo basin reaches its upper limits of available amount.

Forecasted demands of water in 2010 are about 730 MCM for domestic water supply and about 490MCM for mining and other industries. The amount of domestic water supply depending on the surface runoff of the Maipo river is estimated to increase about 40 MCM from about 450MCM at present to 490 MCM. The countermeasures to increase of water demands are to obtain by buying existing water right, rehabilitation of the Yeso dam located in the upstream reach of the Maipo river, utilization of Laguna Negra, and storage of runoff by construction of a dam in the Maipo river. On the other hand, newly required irrigation area is estimated as about 112,000 ha. Available surface runoff, except the Maipo river downstream, has reached to its limit. Thus, most of the water source for new irrigation is to be from groundwater. However, groundwater has also become harder to obtain new water right annually because water use has been increasing. Accordingly, groundwater use can be judged also to reach to its limit in the future.

The countermeasures to the shortage of available surface runoff and groundwater to satisfy increasing demand are to decrease ineffective discharge by constructing reservoirs, save at existing irrigation area and effective use of unused water rights for reasonable water use of existing water resources. These are realistic methods for developing new water sources and expanding water use in the study area.

5.1.2 Water Resources Development

(1) Reservoir

Possibility of dam construction in 6 rivers and 14 sites are examined on the basis of topography, geology, and scale of basins. Average annual discharge, probable discharge, and available water amount in these sites are shown in the table below. Whole available water is eventual discharge (surplus discharge with 85% exceedance probability over 85 % exceedance probable runoff). Table 5.1.1 shows the runoff resume at each dam site.

Rivers	No.	Area of basin (km^2)	River bed elevation (m)	Dam height (m)	Dam crest-length (m)	Available water storage (MCM)	Average annual runoff (MCM)	85%year runoff (MCM)	Available water amount (MCM)
Maipo	M-1-1	1,378	1,510	200	850	570	855.7	348.9	145.5
	M-1-2	1,378	1,510	150	735	290	855.7	348.9	145.5
	M-2-1	1,488	1,363	165	422	780	924.0	376.8	157.1
	M-2-2	1,488	1,363	147	356	620	924.0	376.8	157.1
	M-2-3	1,488	1,363	128	296	460	924.0	376.8	157.1
	M-3	1,518	1,335	175	568	729	942.6	384.4	160.2
	M-4-1	2,785	1,159	200	895	800	2,666.7	1,705.0	431.3
	M-4-2	2,785	1,159	161	800	440	2,666.7	1,705.0	431.3
Mapocho	1	584	1,070	130	470	97	221.4	80.4	29.82
Colina	C-1	208	970	150	630	110	26.9	12.7	4.63
	C-2	235	804	150	940	150	30.4	14.3	5.24
Rosario	1	184	120	55	350	81	67.4	38.1	29.3
Yali	1	555	113	37	260	108	253.2	146.7	106.6
Curacavi	1	244	331	125	250	115	40.5	4.8	4.7

As examining each dam site from the view of water quality and natural environmental conservation, the site of Mapocho has drainage from mines in the upstream and submergence of power station, and the site of Yali has the natural environmental conservation area. Thus, both sites are eliminated from the objective site for reservoir construction. As the potential site for dam construction in the upstream of the Maipo river, the site of M-4 is to be selected, in which reaches maximum capacity of reservoir by the available water and possible storage capacity. Yet, the dam height is limited at the site. Estimated available capacity including sediment volume is shown below. In this case, sediment volume is estimated to be 560 m^3/km^2/year for 50 years.

Point		Available capacity (MCM)	Available runoff (MCM)	Amount of sediment (MCM)	Capacity of dam (MCM)		Dam scale (m)	
					Total capacity	Effective capacity	Dam height	Dam crest-length
M-4	El Ingenio	440	431	80	440	360	161	800

In the case of the dam site of Colina, the C-1 (El Cepo) site is selected for dam construction site because the C-2 site is developed for a park. Accordingly, available supply of the new water source is estimated 398.6 MCM as follows;

River	Site	Area of basin (km^2)	River bed elevation (m)	Dam height (m)	Dam crest-length (m)	Storage capacity (MCM)
Maipo	El Ingenio	2,785	1,159	161	800	360
Colina	El Cepo	208	970	45	630	4.6
Rosario	Patagua Chica	184	120	37	350	29.3
Curacavi	El Flamenco	244	331	27	250	4.7

It is also possible to construct small reservoirs in minor streams in the area beside the dams above. The small reservoirs can be used as storage of surplus water from irrigation canals and discharge of its basin by rainfall, and as supplementary water source during irrigation period.

(2) Water saving for irrigation water

Changing irrigation method of furrow irrigation to Californian method (Californiano) and drip irrigation, and lining of existing main canals and rehabilitation of division structures are effective for water saving at the fields and canals. Those saving water amount can be expressed with irrigation efficiency and conveyance loss in a calculation for irrigation water. Changing furrow irrigation to Californian method increases irrigation efficiency from 10 to 15% at the field level. Changing unlined canals to lining canals increase canal conveyance efficiency from about 5 to 10 %.

When furrow irrigation changes into Californian method and unlined canals changes into lining ones in the study area, total irrigation efficiency would improve 15 %, in detail, from 0.45 X 0.8=0.36 to 0.6 X 0.85=0.51. Annual average irrigation water in the whole basin is 2,460 MCM and among it, 29% or 720 MCM can be saved theoretically. However, water losses such as seepage water from the earth canals and at fields are utilized as the return flow at the downstream areas and fostering source of groundwater. In INIA, overall irrigation efficiency in the Maipo basin is estimated at 80% and it can be said that the most of calculated water amount of 720 MCM is made circulatory utilization at present.

From the point of actual irrigation use, it is hard to implement the projects which aim at water saving as irrigation system because of following reasons. They are that the rehabilitation of irrigation facilities is basically beneficial principal, water is divided proportionally, water use fully depends on users after receiving water from division inlet decided by water right, and aquifer charging effects with unlined canals' percolation and irrigation. On the other hand, in the recent years, introduction of Californian method and drip irrigation has been progressed rapidly for effective use of irrigation water at the levels after division inlet.

Under the present water right system and its water use, if available supply increases because of water saving at the levels of after division inlet, intake amount would not decrease at division inlet. Increased water amount is distributed to those who have water right at the levels after division inlet. Thus, increased water amount by water saving of irrigation use contributes to stability and expansion of water use at the field level. This also will result in alleviating the present shortage of water. Accordingly, the development plan do not expect newly developed water amount by water-saving.

(3) Effective utilization of unused water right

Unused water rights occur due to suspension of water source development program and farm retirement because prevailing water utilization is being carried out under the water right system. These unused water rights make objects for buying and selling in the market. Due to difficulties of utilization on its location and volume, however, no transition of right is occurred and leaves as unused water right as it was. Recently, some movement is occurred to take measures by law for activation of such unused water right.

DOH has an undistributed but available water right of 25.0m^3/s (Decreto No.1039) for the irrigation project in the second section. In the development plan, the irrigation utilization plan is formulated through utilization of these water rights held by DOH from the view of effective utilization of unused water right.

(4) The other measures for water source

- Treated sewerage

  EMOS has the plan of using treated water of $3.5m^3/s$ as irrigation water because an urban sewerage–treatment plant, the first period, in South Santiago will start to work from 2001. Utilization of the treated water has some problems to be solved in near future, such as decreasing return flow in the downstream basin and water right on the treated water. The development plan assumes the problems would be solved. Thus, the those treated water includes the development plan mentioned above.

- Groundwater

  Groundwater use for water supply, industries, and irrigation have been increasing annually since 1950. Groundwater level has been lowered noticeably in the northern part of Santiago city, Lampa and Casablanca in the V region. Thus, development of groundwater is limited at present. It should be careful in the other areas beside two areas mentioned above in the study area because groundwater use for irrigation by farmers has been increasing there. In the development plan, groundwater use recognizes as small supplementary water source, thus, the water resources development does not deal with a large scaled groundwater development.

5.1.3 Distribution of Water Resources

As for the distribution of newly developed water amount by dams, in the case of a large-scale dam, water will be distributed optimally based on the development costs of irrigation and domestic water uses. Conditional formula is settled by cost and benefit of irrigation and domestic water use. As analyzing a target function, which maximizes B/C by optimizing method, the result is when all newly developed water amounts is used for irrigation, B/C is maximized. However, concerning the competition between expanding domestic water use in Santiago area and agricultural use, 40 MCM among 360 MCM of newly developed water amount, which is expected water demand growth in Santiago City, 2010 is allocated for domestic water use. Thus, the rest of it, 320 MCM is new irrigation water source. The irrigation area is expected to be about 18,500ha.

On the other hand, available supply of middle and small-scaled dams, 39 MCM is regarded as new irrigation or supplementary water sources around reservoir sites. Their available irrigation area is estimated to be about 2,300ha.

The water with unused water right in the downstream basin of the Maipo river is distributed only for irrigation use. As available discharge with the water right is $25.0m^3/s$ in the second section, new irrigation area will be 21,000ha on the base of peak water requirement for irrigation. Moreover, as available supply by disposed waste water is $3.5m^3/s$, it can irrigate about 3,000ha.

New irrigation areas in the study area are distributed in the northern and southern, and the downstream basin of the Maipo river. In the case of new water source utilization, the southern part and the downstream basin of the Maipo river will be irrigated by unused water right. The developed water by large reservoirs will be distributed for irrigation of the northern part.

5.1.4 Alternatives to Water Resources Development

The water distribution mentioned above, the alternatives to newly developed water amount are summarized as follows;

Item	The alternatives of water source development plan			
	Without dams	With dams		
	A−1	A−2 (middle and small scale dams)	A−3 (Large scale dam)	A−4 (A-2+A-3)
Large dam	—	—	360 MCM	360 MCM
Middle and small dam	—	39MCM	—	39MCM
Water right of the 2nd section	25.0 m^3/s	25.0 m^3/s	25.0 m^3/s	25.0 m^3/s
Treated sewerage use	(3.5 m^3/s)	(3.5 m^3/s)	(3.5 m^3/s)	(3.5 m^3/s)
Water supply	—	—	40 MCM	40 MCM
Irrigation development				
(With existing water right)	21,000 ha	21,000 ha	21,000 ha	21,000 ha
Treated sewerage use	(3,000 ha)	(3,000 ha)	(3,000 ha)	(3,000 ha)
Total (1)	21,000 ha	23,300 ha	39,500 ha	41,800 ha
Total (2)	(24,000 ha)	(26,300 ha)	(42,500 ha)	(44,800 ha)

5.2 Land Resources Development Plan

5.2.1 Basic Concept of the Land Resources Development Plan

The Metropolitan Region of Santiago has been expanding by the sprawl of farmland. In the recent years, once expansion toward the southern area has reached to its limit, that toward the northern area has started and proceeded rapidly. At the result, Chacabuko Province must be included into the Metropolitan Region of Santiago, now.

In order to control such disordered expansion of urban area, " Plan Regulador Metropolitano de Santiago" was established by SEREMI-MINVU in 1994. On the other hand, Low No. 3516 admits to sell a farmland with sub-division up to 0.5 ha. This system encourages the sprawl in surroundings of metropolitan area. A trend on expansion of metropolitan area and decrease of farmland will be continued for the time being.

While the farmland around the metropolitan area has been decreasing drastically, in the rural areas which are located within about 40 km from the center of the metropolitan area, reclamation of large arboricultural land has been progressed in grassland and hilly area. The form of land use within farmland has been changing. Moreover, there are natural parks, conservation areas, protection areas, and sanctuaries in the study area. These areas must remain as what to be.

Based on the observation above, land resources development plans in the study area aims at land use plan in the study area and selection of newly irrigated farmland. Following is the basic approach for planning and selection.

1) Maintaining the sustainable regional society,

2) Clarifying promotion areas for urbanization, agricultural promotion area, and natural environmental conservation area, and

3) Effective land use of available land is aimed in each district/ area.

5.2.2 Land Use Plan

(1) Land use

Based on the concept stated in the previous chapter, urbanization promotion area is established through the urban planning by SEREMI-MINVU.(Fig. 5.2.1) The whole present land use remains except the urbanization promotion area. The land use plan in the target year is established as follows;

Land use	1998 (1,000ha)	2010 (1,000ha)	Change (1,000ha)
Urbanization promotion area	49	62	13
Land for agricultural use	1,465	1,452	-17
Forest	325	325	0
Others	112	116	4
Total	1,951	1,951	0

(2) New irrigation area

New available irrigation area is selected among present farmland based on land productivity classification. The classification is led by the condition of soil, and agricultural climate. As have mentioned in "3.2.3 Soils and Land Use," based on the land productivity potential classification which summarized in the study through using land productivity potential classification by REA and data by CIREN, if the subjects of this plan are areas from I to IV in the potential classification, the new available irrigation area is estimated about 112,000ha. The areas from I to IV have high possibility of irrigation development.

Division of basin	Land productivity potential I－IV	
Est. Yali	26,002	*
Est. Casablanca	25,779	**
Est. Alhué	19,184	*
Est. Lampa	20,688	**
Est. Puangue (Curacaví, Maria Pinto)	9,634	*
Cue. Melipilla	10,383	*
	111,670	

*Source : * CIREN, **REA*

5.3 Agricultural Promotion Plan

5.3.1 Principles of Agricultural Promotion Plan

The agricultural problems of the project area are recognized disparity caused by landholding scale, decreasing farmland in farming environment, contamination of irrigation water, and tightness of water use.

Agricultural policy given by Ministry of Agriculture aim at more stable agricultural export through improving farming infrastructure and at the same time support and strengthening of small scale farmers who operate sustainable agriculture. Direct aims of support and strengthening of small scale farmers are improving farm household economy and intending stable supply of agricultural products. This can also contribute to maintaining local vitality and natural ecology through restraining migration to urban areas that will be led by the settlement of small farmers who dominate a large part of rural population in rural areas.

Based on the present situation of the problems which regional agriculture structurally contains and the development target on the overall goal, a measure for agricultural promotion in the project area aim mainly at agricultural development by development of agriculture that makes most use of regional characteristics. The measure consists of infrastructure's improvement including improvement of irrigation facilities, and applying to the established agricultural support program through forming farmers' organizations aimed at educating and strengthening small farmers. This will be supported and reinforced through improvement of living infrastructure as the basic condition for small scale farmers' permanent settlement.

5.3.2 Agricultural Production Plan

Agricultural production plan is proposed mainly in the new irrigation area. Study on crop production plan is also made on both rehabilitation area of existing irrigation facilities and the area of water quality improvement.

(1) New Irrigation Area

The agricultural production plan established in the study is backed up basically by the condition of new irrigation areas selected in the study. The production plan which is implemented at present is conditioned by economically successful export. Nevertheless, the basic approaches of the plan are supplementing insufficiency of small scale farmers' production opportunities and increasing their productivity because their productivity is low in agricultural production structure and modernization of agriculture burdens them. So as to promote agriculture in the metropolitan area, which is the target of the Study Plan, selection of new irrigation areas is required to deal with decreasing farmland. In the Master Plan, 6 areas (Popeta, Yali, Alhué, Puangue, Casablanca, and Lampa) will be new irrigation areas. These areas are selected based on examination of land and water resources from the view point of agricultural development.

1) Distribution of new water right

Based on the regulation of new water right created by a large dam construction from the legal point of view, the owners of farmland benefited by irrigation have the priority of this water right. So as to achieve the permission of constructing facilities by MOP, it is required to be satisfied with the demand of DL No.1123 that regulates implementing a large project. According to the law, there must be demanders for at least more than 50% of new water right, and the sum of unirrigated farmland's price and total project cost should not exceed the price of irrigated farmland. In case of this, the project cost needs to be estimated with the standard of DOH. Moreover, according to DL No.1123, the President of Chile can approve the project in the case that implementation of the project is desirable from the point of public benefit even if the project is not satisfied with the conditions above.

The water right which the landowners do not want to obtain is sold by DOH at market price and the formalities for this is regulated by the law.

- Distribution of water right to small scale farmers

  From the point of landholding, most of new irrigation areas are occupied by large and middle scale farmers. The number of small scale farmers who can be beneficiaries of irrigation is estimated by the new irrigation area as follows; 117 households in Alhué (504ha), 324 households in Yali (1,322ha), 261 households in Curacaví (1,266ha), 314 households in María Pinto (1,523ha), 400 households in Melipilla (1,940ha), and 500 households in Lampa(2,500ha). In this estimation, all small scale farmers in each Comuna are the subjects of the estimation, and it is assumed that half of total households could be distributed irrigation water in all areas except Melipilla. This percentage is very high as the assumption but it is led by the fact that

most farmland of small scale farmers is located in unirrigated areas and its use of irrigation water is limited (cf. Echenique J. Rolando N, "Small Scale Agriculture"). In Alhué and Casablanca where the percentage of unirrigated areas is very high, 100% and 70% of present small scale farmers are regarded as small scale farmers in new irrigation areas respectively. In case of Melipilla, available irrigation area is limited by area. This is about 6,000ha located between Popeta and Ibacache.
There are two alternatives to distribute more irrigation water to small scale farmers. One is that assuming that whole less than 15ha land be available unirrigated farmland, and the land is tried to be included the Plan as large as possible. Then, the necessary cost for constructing diversion facilities up to fields is estimated. However, it is almost impossible for small scale farmers to pay this kind of expense, and the subsidy from the government is necessary. The other one is that the government of Chile buys the land for irrigation and distributes irrigation water to small scale farmers. Nevertheless, this is out of the present political framework and it is difficult to alter it in the Plan.

- Distribution of water right to large and middle scale farmers

  The rest of distributed irrigation water to small scale farmers as mentioned above will distribute to large and small scale farmers based on the system which regulated in DL 1123.

2) Planting program of new irrigation areas

The crop cultivation plan by new irrigation area shown in this chapter is established based on following advantages ;

- Warm climate and the possibility of various highly commercial valued fruits and flowers. Advantage in international markets due to the inverse season of the Northern Hemisphere.

- Fertile soil which is available for intensive cultivation of various crops.

- Under the isolated condition from disease and insect pest of animals and plants in this area due to natural barriers such as the Andes mountains in East, Pacific Ocean in West, Patagonia and the Southern edge of the ocean in South, and desert in North.

- Location of the area closed to the markets which supply perishable and other foods to cities such as Santiago and Valparaíso.

- Geographical condition, which suits for shipment by land, sea, and air, promotes cultivation of agricultural export products more.

- Road network which consists of main and branch roads that sustain the access of regional agriculture to market.

- Close to the most important technical center that is built by universities of Santiago and Valparaíso and agricultural research center.

- Existence of agricultural products processing industries. This can be basic measures for agricultural promotion such as securing markets, and technical support, innovation, and promotion, and simultaneously promote the credit for production.

- Possibility of developing established industries of agricultural products processing. Most of present agricultural export products (tomato paste, concentrated juice and so on) are commercial products, but there is the possibility of transferring from this stage to production of final consumption goods such as wine.

- It is possible for middle and small scale farmers to specify crops because this area is close by Santiago market which consists of sections by kind of each agricultural product. In addition, there are many alternatives for farming improvement such as the cropping relevant to agricultural product processing.

Moreover, the present crop cultivation is the base of establishing the framework of farming in the Study mentioned above.

Based on the framework above and following view points, the crop cultivation plan is established for small scale farmers and large and middle scale farmers by new irrigation area. Table 5.3.1 shows the crop cultivation plan.

The preconditions of the established crop cultivation plan are as follows;

- The farmland which plans to be newly irrigated is unirrigated land at present.

- The crop cultivation plan includes estimation of unused land area for production such as follow land, staircase land and meadow on both small scale farmers and large and middle scale farmers. Under the present condition, the area is estimated at from 27 to 69% with small scale farmers' and from 15 to 20% with large and middle scale farmers. In the Plan, it is estimated at from 22 to 33% with small scale farmers and from 9 to 20% with large and middle scale farmers. The average percentage in the new irrigation areas is 12.7%.

- On the other hand, from the point of land use in the crop cultivation plan, one of the standards is not beyond largely the portion of intensive cultivation (fruits, vegetables, grapes for wine and table grapes, seed production, and seed) in Lampa, Mapocho Bajo, and Angostura where intensive cultivation has been already operated. In case of subjecting average regions, the degree of intensity in these three basins is realistic, feasible and best level for reaching under the present market condition and the framework of economic policy.

- In crop selection, available crops in basins of the Maipo river and crops whose planting and cultivation area is large in the project area and its suburb are selected.

In addition, the possibility of introducing mainly following crops is taken into account for deciding land use in the project area.

- Total area of fruits cultivation in the new irrigation areas, Popeta, Yali and Alhué where located in Melipilla province, has increased 12.4% from 1994 to 1998. While in the metropolitan area, it has decreased 9.7%. The main cultivation area of fruits has been transferring from the suburb of Santiago city, where the competition with real estate business is very severe, to the neighboring areas of the new irrigation areas where have advantages on climate, soil, transportation infrastructure, agricultural product processing industries, and geographical condition for domestic market and export port. New cultivation crops are mainly avocado, oranges, stone fruits, and table grapes. The newly developed area has exceeded 3,000ha during these four years in Melipilla province. It is planned to expand the cultivated area 5,500ha in these three new irrigation areas.

- Through making use of commerce on grapes for wine and established facilities of agro-industry, cultivation of grapes for wine is plans to be expanded. Beside the varieties which are produced domestically at present, new varieties which is suitable for the characteristics of the climate in this area will be planted. In these areas, fruits are matured slowly because of climatic characteristics which relates to superior quality of wine. Many large vineyards consider that the areas of Popeta, Yali, and Alhué are the best places for producing grapes for wine. They have already started cultivation of them with irrigation by groundwater in these areas. Investors also have started to cultivate grapes for wine largely in these areas. Main varieties of cultivation are Cabernet, Sauvignon, Merlot, and Chardonnay. Moreover, according to Santa Lita vineyard, it has the opinion that these areas is under very appropriate condition for organic cultivation of new grapes. It also expects the possibility of developing a new market on the field in the future. Total newly cultivated area has already exceeded 2,000ha, but the Plan proposes 3,300ha.

- Cultivation of vegetables (if water quality is improved) and flowers plans to be expanded to the new planning area because the location is close to Santiago and health resorts and easy to access export market. Nevertheless, according to the report on small scale farmers in Melipilla province (agricultural survey based on ENA 86), vegetable cultivation is occupied 24% of the area but the percentage is too big in case that subjective areas were Popeta, Yali and Alhué. Thus, in the Plan, the percentage assumes about 10%.

- Crop cultivation for seed production is going to be expanded to the areas, where are few problems of insect pest, located near a seed control plant, and the producers who knows the system of seed production a lot live closed by. According to Agricultural and Livestock Farming Survey '97, the crop cultivation area for seed production is more than 1,000ha and 700ha in Melipilla area and San Pedro area respectively. In the Plan, it is proposed to expand the crop cultivation area for seed production 500ha in the new irrigation areas.

- So as to maintain the area for grains, potatoes and beans (*Chacra*), and forage crop cultivation, crop rotation plans to be adopted. Cultivation of these crops is realistic selection when they start to produce in new irrigation areas because small scale farmers know at least basic production skill of them. Therefore, these crops will occupy more than 30% in new cultivation plan, and higher percentage is shown in Yali, Alhué, and Casablanca.

3) Crop cultivation by the areas

Following is the relation between present cultivated crops and proposed crop cultivation plan in view of the geo-graphical location in the study area.

- Popeta area

The cultivation plan is mainly relevant to the present crop cultivation in present irrigated areas, Melipilla and Popeta. In irrigated areas in Popeta (including Cholqui, Carmen Alto, Culiprán, Tantehue, and Los Guindos), a lot of grapes, vegetables and fruits are cultivated due to its climatic condition. Many private investors promote cultivation by groundwater and rainfall in unirrigated area here.

- Alhué area

It is planed that the present level of Alhué area, where large unirrigated land exists even it is blessed with fertile soil and fine climatic condition, alters to the level of Melipilla basin and irrigated areas in Cabras where a lot of fruits and grapes for wine are cultivated. This area is provided very appropriate climatic condition for grape cultivation as well as Casablanca area. High potentials of this area is supported by keen interest of many vineyards and investors on the expanding cultivation plan in this area. On the other hand, there is possibility of cultivation crop diversification on vegetables, flowers, crop cultivation for seed production because of advantage on the aspect from producing environment, which is isolated condition due to natural condition, the neighboring of markets, and blessed climatic condition.

- Yali area

San Pedro area where much fruits, grapes, and crop cultivation for seed production have been cultivated in these years is provided with blessed climatic condition. Nevertheless, there is large area of unirrigated land. Because of this, the crop cultivation plan for fruits, grapes, seed production is planned.

- Puangue area (Curacaví, Maria Pinto, and Ibacache)

The idea of the crop cultivation plan in this area mainly connects with the crop cultivation system of present irrigated area in Puangue and Melipilla basin. In the plan, mainly fruits cultivation and secondly grape cultivation for wine will be major cultivation crops. Besides them, vegetable and flower cultivation will occupy some potion because this area is the suburb of Santiago.

- Casablanca area

The idea of crop cultivation plan mainly connects with present irrigated area in Casablanca basin and rapid growth of grapes for wine cultivation in these years. Therefore, grapes and fruits cultivation is planned as main crops in this area. The portion of forage crop cultivation will decrease compared to the present level, but it will remain an important crop especially in the area where irrigation water is not distributed. Furthermore, vegetable cultivation also has a certain level of possibility because main road to the central coast is passed through in this area.

- Lampa area (Colina and Polpaico)

Crop cultivation relates to crop cultivation system of present irrigated area in Lampara basin where a lot of vegetables, fruits, and crop cultivation for seed production are cultivated. At present, cultivation of vegetables, fruits, and crops for seed production occupy 69% of farmland. Yet, cultivation of vegetables and crops for seed production which need small investment will be stressed.

A new crop cultivation plan usually does not include forestry because forestry with foreign varieties does not exist in present irrigated area. In case of the project area, if exceptional forestry is implemented, its area would be limited. Livestock farming is not included in the farming plan as well. This is because it is hard for large and middle scale farmers to expand livestock farming sector in proper land for intensive agriculture. While for small scale farmers, there is the possibility of introducing livestock farming for domestic consumption rather than commercial purpose. On the contrary, forage crop cultivation is mainly included in crop cultivation plan.

In the new crop cultivation plan, fruits and grapes for wine cultivation, and then crop cultivation for seed production by small scale farmers will increase considerably. Cultivation of these crops will become an important factor for boosting small scale farmers' income. However, this depends on forming producers' organizations and establishing and implementing a contract farming system. This will be explained in the agricultural support plan in detail.

4) Rentability of new irrigation areas

Whole farmland in new irrigation areas is unirrigated land. Available producing activities are severely limited by average annual rainfall in these areas. Seeing the example of the area where is close to the coast and suitable for livestock farming, production of meat is usually 100kg/ha at annual average. It is not beyond $50,000/ha at current price. Annual production value of fire wood is less than $30,000/ha. Nevertheless, if irrigation is introduced and nice climate and soil conditions are considered, it would become possible to do production activities with high returns such as fruits, grapes for wine, crops for seed production, and vegetables cultivation. Regarding any crops, it is estimated that gross margin per hectare reaches no less than from $700,000/ha to $1,000,000/ha. Some of these crops' gross margin exceeds $2,000,000/ha. Some varieties of crops for seed production of it reach $5,000,000/ha. In the unirrigated areas where are the subjects of the plan, the profit is extremely low when the project is not implemented, if it is compared with the profit when the project is implemented.

In the agricultural development plan for the plan area, classification by landholding scale is implemented. Farming pattern of small scale farmers is set up based on average farm area in the basin which the most relates to the plan area. That of large and middle scale farmers is set by landholding scale. It is 100ha which is the landholding scale used for estimation of the present profit. The crop cultivation plan is established based on the framework of cultivation crops mentioned above by farmers' landholding scale. The profits by landholding scale when the projects are implemented are shown in Table 5.3.2.

According to the Table, average profit of small scale farmers by landholding scale in the plan area is expected to increase 72%, from $1,921,000 at present to $3,304,000 in the future. Production activities are not planned for from 22% to 33% of farmland, but fruits and vegetable cultivation in the crop cultivation plan support this increase basically. So as to achieve this estimation, cooperation agencies have to provide the necessary support for small scale farmers. This is explained in the section of the agricultural support.

In case of large and middle scale farmers, compared with the present average profit, the future one will increase by 20% over, from $109,000,000 to $130,000,000. This is due to the availability of large investment by farmers who enter newly without exception as mentioned above. So as to estimate gross benefit, all of development cost and farming cost are subtracted. All of mechanization cost is also subtracted as rental, and capital cost is included as loan. Basic data of each cost is obtained from institutions such as Catolica University, Department of Agriculture in Chile University, INA and Foundation of Chile (*Fundación de Chile*). Benefit of each cultivation crop is estimated through considering the present condition of the Study Area. Estimation of benefit does not include investment for irrigation project.

Calculated gross benefit per unit area by the plan area is shown in Table 5.3.3. The Table shows small difference among gross benefit per unit area in these areas.

(2) Area for rehabilitation of existing irrigation facilities

The northern part of Lampa, the left bank area of Clarillo, areas of Angostura, Puangue and Melipilla are mentioned as the areas where water resource is scarce and the level of structural condition is low on the irrigation facilities. Improvement of existing irrigation facilities is planned in these areas. The farming on these areas will maintain the present farming type but fruits growing will increase at hilly and sloping areas.

However, following small changes of cultivation area are planned through stabilizing water use resulted from rehabilitation of irrigation facilities and enabling investment in production resulted from reduction of O & M cost. Basically, small scale farmers aim at transformation of cereal cultivation and fallow land into fruits growing and forage crop cultivation, and medium and large scale farmers aims at transformation of cereal cultivation and forestation into fruits growing and forage crop cultivation.

Although stability of water use increases by improving irrigation facilities, farmers, who are holders of water right, have to take responsibility for their ways of developing agriculture balanced with its stability. Therefore, providing farming support for improvement of irrigation technique especially to small scale farmers gives important meaning on effective use of water resource and improvement of farming.

Accordingly, based on the present cultivation, main cultivation crops by the area are summarized in the table below. Details are shown in Table 5.3.4 and 5.3.5.

Farmers' scale	Small scale farmers				Medium and large scale farmers			
Farming area	24,562.9 ha				105,165.7 ha			
Sub-basin	Decreased crops		Increased crops		Decreased crops		Increased crops	
Clarillo	Cereals	17.1ha	Fruit tree	24.2ha	Cereals	120.7ha	Fruit tree	63.3ha
	Fallow land	21.4ha	Forage crop	14.3ha	Forestation	65.5ha	Forage crop	60.5ha
							Seed	62.4ha
Lampa	Cereals	65.2ha	Fruit tree	65.2ha	Forestation	155.2ha	Fruit tree	155.2ha
	Fallow land	97.9ha	Forage crop	97.9ha				
Angostura	Cereals	69.2ha	Fruit tree	34.6ha	Cereals	442.1ha	Fruit tree	443.7ha
			Vegetable / Flower	34.6ha	Forestation	492.2ha	Forage crop	490.6ha
Melipilla	Cereals	82.2ha	Fruit tree	106.8ha	Cereals	259.4ha	Fruit tree	257.8ha
	Fallow land	106.8ha	Forage crop	82.2ha	Forestation	265.2ha	Vegetable	266.8ha
Puange	Cereals	49.4ha	Fruit tree	64.2ha	Cereals	105.9ha	Fruit tree	88.8ha
	Fallow land	64.2ha	Forage crop	49.4ha	Traditional crops	102.4ha	Forage crop	119.5ha
Total		573.4ha		573.4ha		2,008.6ha		2,008.6ha
Crop transformation ratio	2.3 %				1.9 %			

(3) Area on water quality improvement

Cultivation of dedicated vegetables by the Bureau of Environmental Health in the Capital City is prohibited in 85% of the areas where utilize water of Maipo and Mapocho water systems due to contamination of water quality. Although the Study area is under the benefited production and marketing conditions, the cultivation is limited. Therefore, water quality improvement is indispensable in order to improve farming condition. Vegetable cultivation is highly beneficial, and small scale farmers can get its merits. Frozen and perishable vegetables can be sold to the neighboring countries and markets of the Northern Hemisphere.

Crop production plan in the improvement area of quality on irrigation water, cropping ratio of vegetables will be increased in case of small scale farmers introducing the chard, cabbage, cauliflower, etc. which prohibited the cultivation at present. Even the quality of irrigation water is improved, utilization of irrigation water will be made mainly on prevailing fruits cultivation in case of large and medium scale farmers. Quality of Fruits cultivated by the improved irrigation water has high marketability. With these, present cultivation of fruits will be followed on the crop production plan of the large and medium scale farmers.

5.3.3 Agricultural Support Plan

Stable development of rural areas where dominate land area and population is necessary for balanced and sustainable development of Chilean socio-economy. Exhaustion and devastation of rural areas can be the main constraints of balanced regional development because that causes loss of their land conservation function, urban concentration of population, and deterioration of natural, social and economic environment. Moreover, more than 80% of small scale farmers among those who engage in agriculture live in rural areas, and they are in charge of main role in rural and regional society in fact. Therefore, it is important for vital and stable development of rural areas to make the small scale farmers vital and settled down.

So as to make small scale farmers vital, it is required for small scale farmers, who will deal with activation, to liven them up by themselves eagerly before solving financial and economic problems. For this,

1) uniting small scale farmers
2) support for change of the present situation
3) policy for realization of the plan

are needed. In case of this area, regarding 2) and 3), supporting institutions such as SECPLAC, INDAP, and FOSIS and programs for implementation are already prepared. So, the guidance system for realizing unity of small scale farmers is wanted. Moreover, cooperation between the services of SECPLAC and INDAP which are the sector of implementing social policy are not close enough as a precondition of connecting small scale farmers with these support services. Improvement of organization of SECPLAC is required in view of the support services for small scale farmers.

Thus, SECPLAC that grasps regional condition is as an adviser, OMPC (Oficina Municipal de Planificación para Campecina) is established in Comuna. And it needs to support unorganized small scale farmers for establishing producers' organizations for enlightenment and extension of the support system, independence of small scale farmers, stabilization of their farming, and rural permanent settlement. Through this, it is significant to establish the system that those organizations can receive financial and technical support from INDAP, FOSIS and so on.

Based on the points mentioned above, the plan for agricultural support in the Study Area is to be established.

(1) Promotion of forming fundamental organization

Forming fundamental organization here means the preparatory stage of forming a producers' organization for isolated unorganized small scale farmers. In short, through

1) Analyzing characteristics and intention of each farm household,
2) Classifying them into basic groups roughly,

3) And enlightening each group about the support system and deepening their recognition of its utilization,
4) Agreement on the activities for changing their present condition is to be formed.
5) Based on this agreement, activities for forming producers' organization starts.

As the lack of these parts in the support systems so far, it was not possible to unite farmers widely. This support system intends to strengthen and systemize these parts. In this plan, OMPC is in charge of following roles as a core of the system.

- Grasp of local inhabitants' farming condition
- Grasp of farmers' intention
- Enlightenment of the support system
- Organizing the fundamental groups based on farmers' information
- Advising on obtaining agreement among a fundamental group
- Advising on forming producers' organizations based on the agreement and introducing consultants
- Support newly formed producers' organizations for attending INDAP projects
- Utilization and application of social policy subsidy to promote forming fundamental organizations
- Advising and supporting established producers' organizations for highly-advanced ones

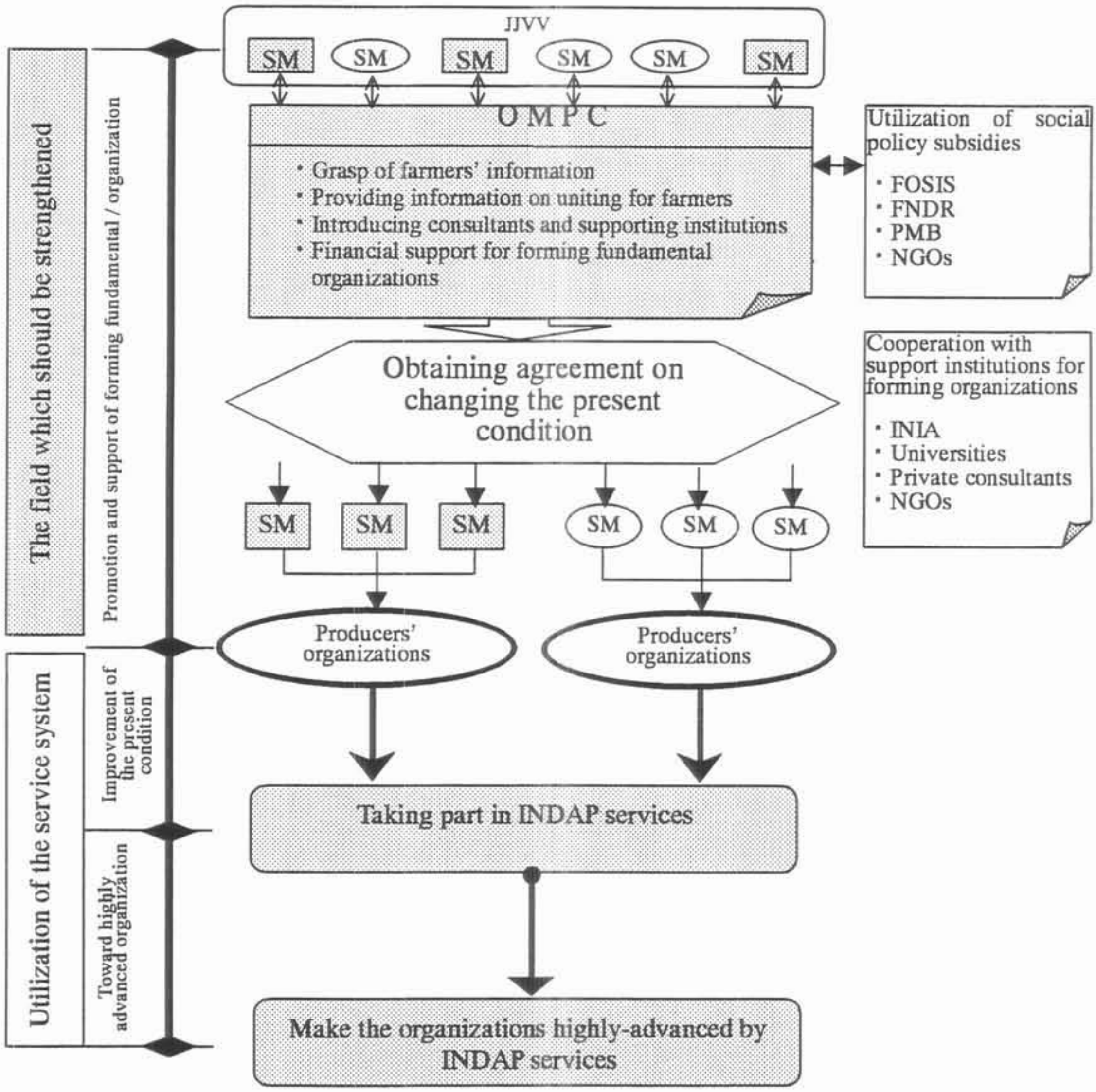
So as to organize information for implementing the roles mentioned above, following activities are also important.

- Listing up and registration of supporting institutions such as consultants
- Cooperation with and utilization of external supporting institutions (INIA, universities, consultants, and NGO)

It is also required to make most use of subsidies (FOSIS, FNDA, PMB, and NGOs) for social policy provided by the government for that OMPC implements the support services on forming organization.

Public budget provided by *Comuna* is also needed. OMPC should be set up as the special sector to promote forming small scale farmers' organizations. Then, the system for establishing required project plans should be built up through effective combination of various sources of fund. So as to implement this system efficiently and promote mutual understanding of farmers, the base facility of activities is to be constructed in *Unidad Vcinal* (UV).

The flow chart for strengthening and promoting agricultural support is presented on the next page.



In the flow, the point which should be particularly strengthened in this plan is "promotion and support of forming fundamental organizations" as mentioned above. One of the reasons why independence of small scale farmers has not been promoted well so far is the lack of this part in the public organizations. The purpose on "promotion and support of forming fundamental organizations" of small scale farmers which planned here is to establish the initial and basic part of the process to realize forming unity which is the condition of participating "the programs for independence" or the support services of government. In other words, the first step lead to forming a "producers' organization" which is the group for receiving the support services implemented by INDAP and FOSIS should be harden. In order to do this, small scale farmers should utilize the power of organization and experience which belong to *Comuna*. OMPC does not organize fundamental organizations by itself but it is just a promoter of fundamental organizations. The activities for forming organizations should be carried out by small scale farmers.

The first stage is the stage of encouraging small scale farmers to participate the activities for changing of the present situation by OMPC. Based on the cooperation with external support institutions such as INIA, universities, private consultants and NGOs, OMPC enlightens small scale farmers and carries out public relations about contents of support programs and services, and examples of the existing producers' organizations by unit of JJVV. Then, it intends to make them recognize what kind of activities should be done for changing the present situation. Afterward, it classifies small scale farmers into some groups by product, and make them clarified what is required for changing the present situation on each group and what kind of support programs can be used for this. The process up to this is the promotion stage by OMPC.

The second stage is the stage for the study of the present situation, finding problems and making a basic plan for change. Under the guidance of the external support institutions, the basic plan for the change of each group is established by farmers' participation, and obtain agreement on implementation among farmers. In this stage, introducing Regional Support Service (SAL) of INDAP should be examined.

The third stage is application to INDAP after establishing the implementation plan for application for the support programs under the agreement among farmers in the groups. After the second stages, the external support institutions and producers' group are to be cooperated.

The fourth stage is the stage for making formed producers' organizations highly-advanced, giving and boosting value added against products, and improving production skill and ability of business enterprise type farming. Project Support Service (SAP) and Specialization Support Service (SAE) are to be introduced.

As mentioned above, agricultural support system can function on the base of close cooperation among OMPC, external support institutions and small scale farmers. If any of them lacks, sound development of agricultural support could not be achieved.

Sites and numbers that required establishing the support system for small scale farmers through founding OMPC in *Comuna* are as follows;

Basin	Site	Basin	Site
1.Río Maipo	2	8.Melipilla	1
2.Río Clarillo	1	9.Río Puangue	2
3.Río Mapocho	6	10.Est. Yali	3
4.Est. Lampa	3	11.San Antonio	3
5.Río Mapocho	6	12.Est.	4
6.Río Angostura	6		
7.Río Rapel	2	Total	39

(2) Making producers' organizations highly-advanced

The support at the next stage, for instance, the support for cooperative sale, agricultural processing, and the activities to obtain sale's right of agricultural products in central market, is necessary for the producers' organization which has already formed and started their activities. The services for this are SAP and SAE which provided by INDAP. Thus, it is possible to aim at more highly-advanced organizations, corresponding with reached stages by each producers' organization.

Finally, quality of unit producers' organization will be improved through taking part in the services by INDAP leading to a highly-advanced organization. Then, the organizations is to be grown as the industry which supports regional economy.

Regular shipment, fixed quantity, and standardization are demanded to promote making organizations highly-advanced. Nevertheless, it is very hard for an unit organization to satisfy the demand. Thus, the demand should be satisfied with alliance of homogeneous unit organizations.

(3) Installation of facilities for the base of activities

Unit producers' organizations are often formed as fundamental bases through the activities of *Unidad Vecinal* (UV). It is reasonable to form organizations through UV, basically. Yet, many of UVs do not have the base facilities for meeting and training courses, and it is impossible to communicate among inhabitants smoothly. This may lead to low rate of organizations in UV and difficult environment for forming fundamental organizations aiming at improvement of the present agriculture.

So as to break this situation, it is indispensable to construct the activity base facilities for vitalization of UV's activities and smooth communication among regional inhabitants. Based on these facilities, beside promoting the activities for unity by small scale farmers, promotion of regional self-government, improvement of living environment, training and lectures on living and producing skill will be taken place. Through these activities, self-independence of UV is to be promoted.

The base facilities name Regional Communication Center (CECUV: *Centro de Communicación para UV*) and is built in each UV, each *Comuna*. The number of required CECUV by each basin is as follows;

Basin	Number	Basin	Number
1.Río Maipo Alto	13	8.Melipilla	25
2.Río Clarillo	3	9.Río Puangue	8
3.Río Mapocho Alto	36	10.Est. Yali	8
4.Est. Lampa	15	11.San Antonio	8
5.Río Mapocho Bajo	26	12.Est. Casablanca	18
6.Río Angostura	24		
7.Río Rapel	13	Total	197

Functions of CECUV are promotion of communication and of support activities for farmers. They are as follows;

- Promotion of communication
    1) Improvement of rural living environment
    2) Vitalization of communication among regional inhabitant
    3) Operation and maintenance of regional and social infrastructure
    4) Participation of inhabitants in the plan for living environment improvement
    5) Providing the place for medical and health service
    6) Promotion of cultural activities for regional inhabitants and young generation
    7) Cooperation with OMPC

- Promotion of support activities for farmers
    1) Extension and enlightenment about agricultural and livestock farming's technology
    2) Extension and enlightenment about irrigation technology
    3) Promotion of uniting activities by small scale producers
    4) Providing the place for a training course of farming improvement
    5) Providing an office for a producers' organization

CECUV should be operated with consensus of inhabitants in UV and based on discussion for obtaining the consensus among inhabitants. Therefore, if the plan is not made by inhabitants' participation on what kind of CECUV is needed for their UV and the types of operation, the CECUV would not be a necessary facility for the area truly. So as to establish the truly needed facility, it should be started from the activities to make the CECUV building plan clear through using present meeting places (for example, schools, churches, constructed producers' facilities) with the support from

SECPLAC. Therefore, in the Master Plan, the main purposes are to confirm the necessity of CECUV and pull the motivation for construction out from the inhabitants.

(4) Fund for small scale farmers' support and its utilization methods

As the funds to support public finance of each *Comuna*, there are local tax and subsidy from Municipal Community Foundation. Nevertheless, the subsidy from Municipal Community Foundation supports the public finance in local rural areas where strong manufacturers and enterprises are not located in. Most of *Comunas* in rural areas such as the Study Area are financially vulnerable. Because of this, it is extremely hard to raise fund for the support of small scale farmers from general account of *Comuna*.

Accordingly, the required project for *Comuna* should be planned by mixing various foundations with subsidies provided by governmental authorities for the projects. Making the most of these subsidies and foundations is the important role of *Comuna* and OMPC in *Comuna* is to take in charge of this role. Main foundation sources are as follows.

Main Foundation Source	Components of Foundation
Municipal Community Foundation (FCM : Fondo Común Municipal)	The subsidy consists of funds contributed from all cities of the country and subsidies from the national budget and alcohol tax and etc. and redistributed corresponding to financial situation
Solidarity and Social Investment Foundation (FOSIS : Fondo de Solidaridad e Inversión Social)	Foundation established within MIDEPLAN in 1990 for financial and technological support on social policy promotion
National Regional Development Foundation (FNDR : Fondo Nacional de Desarrollo Regional)	Foundation consists of the national budget and loans from Inter-American Development Bank and redistributed through Regional government
Environment of City District Program (PMB : Programa de Mejoramiento de Barrios)	Foundation for improvement of residential district by Ministry of interior

In order to utilize the funds of FOSIS, FNDR, and PMB, the clear implementation plan should be made by farmers. Among them, while fund of FNDR and PMB is public work type's fund, fund of FOSIS is so flexible that it is possible to promote software projects by concluding agreement between *Comuna* and FOSIS. For example, cultural events for young generation were undertaken and "Youth Hall" was built by the agreement on "Young generation development plan" between FOSIS and the city. The hall is utilized multiply as the place for vocational education and sports recreation activities, and succeeds in promoting permanent settlement of young generation.

Like this example, under concluding the agreement on "small scale farmers development plan" between OMPC in *Comuna* and FOSIS, the receiver of INDAP service can be formed through support for forming organizations and promotion of constructing CECUV by utilizing private consultants in this area, too.

The basic purpose of "small scale farmers development plan" is forming organizations of small scale farmers. OMPC in *Comuna* undertakes intention survey on small scale farmers and survey on farming condition to collect basic information by utilizing the funds as mentioned above and private consultants. Moreover, under cooperation with INDAP or consultants, OMPC makes small scale farmers recognize necessity and importance of changing the present situation through enlightenment about, public relations and extension of the service system.

Number of required consultants per *Comuna* is set as follows.

Required items	No. of Consultants
· Basic information such as intention survey	2 personnel
· Enlightenment about materializing the project	1 personnel
· Guidance for forming organizations	2 personnel
· Guidance for farm management	2 personnel
· Guidance for irrigation	2 personnel

When consultant fee is average $800,000/month, annual necessary expense is estimated at $86.4 million. If the subsidy for the project is 70% of the annual necessary expense under the agreement, expense of *Comuna* would be about $2.6 million (about ¥8.7 million).

Because the cooperation with NGOs is possible on the field of basic information collection and guidance on farming and irrigation, contact with NGOs is promoted. Moreover, a woman of Japan Overseas Cooperation Volunteers is posted as a village development extension worker in Provincia Melipilla, the Study Area, and takes in charge of San Pedro area. In April, 1999, another four volunteers will dispatch to Alhué area. Accordingly, under cooperation with international institutions, the support program for independence of small scale farmers is to be established.

5.3.4 Rural Infrastructure Improvement Plan

(1) Improvement of basic infrastructure

Improvement of basic infrastructure in rural areas is promoted from the view point of rural permanent settlement's promotion and agricultural production environment's improvement. As shown in analysis of the present condition, installation rate of basic infrastructure which is relevant to living is relatively high in rural areas, the Study Area. Yet, installation of water supply service and road construction fall behind mainly in mountainous areas. So, improvement of basic infrastructure will start mainly from installation of these facilities. Because waste water is not treated at all in local middle and small cities, it damages production and living environment. Countermeasures are needed for forming safe and comfortable rural environment.

Based on the points of view above, in living basic infrastructure improvement, installation of rural water supply facilities, construction of waste water treatment plan and wide ranged local road network are mainly promoted.

Amount of installation is as follows;

Basin	Installation of rural water supply	Waste water treatment plants	Local road installation
	Unit	Unit	Km
1.Río Maipo Alto	-	2	-
2.Río Clarillo	4	1	-
3.Río Mapocho	-	6	-
4.Est. Lampa	3	3	-
5.Río Mapocho	-	6	-
6.Río Angostura	4	6	15
7.Est. Alhué	8	2	35
8.Melipilla	5	1	20
9.Est. Puangue	9	2	12
10.Est. Yali	8	3	55
11.San Antonio	3	3	28
12.Est. Casablanca	8	4	26
Total	52	39	191

So as to promote the projects, following project systems will be utilized.

Projects	Development Projects	Ministry
Agua Potable	Programa de Agua Potable Rural	MOP
Tratamiento de agua negura	Fondo Nacional de Desarrollo Regional : Subsector Alcan-tarillado Sanitario	MI
Camino	Fondo Nacional de Desarrollo Regional : Subsector Caminos Rulales	MI
	Programa de Conservacion de Caminos Secundarios	MOP

(2) Community center for *Unidad Vecinal* (CECUV: Centro de Communicación para *Unidad Vecinal*)

CECUV will be constructed as the place for promoting communication and supporting activities for farmers as mentioned in the section of farmers' support organizations. The facility composition is proposed as follows;

Facilities	Scale (m^2)
Study room	48.6
Conference room	24.3
Supervision room	12.2
Producers' organizations room	48.6
Warehouse	12.2
Bath room	12.2

(3) Construction and improvement of other facilities

It is also important to construct or improve educational facilities and medical and health institutions for promoting rural permanent settlement and growing agricultural successors. However, they are not the facilities or institutions which should be constructed or improved in the field of agricultural development but should be constructed or improved as fundamental right of inhabitants. Therefore, they will not be constructed or improved within this plan but following facilities and institutions need to be constructed for guaranteeing fundamental right of inhabitants and regional stable development.

Basin	Construction and improvement of basic educational facilities	Construction and improvement of medical and health facilities
	Unit	Unit
1.Río Maipo Alto	-	-
2.Río Clarillo	-	-
3.Río Mapocho Alto	-	-
4.Est. Lampa	4	2
5.Río Mapocho Bajo	-	-
6.Río Angostura	6	4
7.Est. Alhué	5	3
8.Melipilla	6	3
9.Est. Puangue	4	2
10.Est. Yali	5	3
11.San Antonio	2	2
12.Est. Casablanca	4	2
Total	36	21

5.3.5 Agricultural Infrastructure Improvement Plan

The agricultural infrastructure improvement plan in the objective area is an irrigation facility improvement. The irrigation facility improvement is divided into a two targets. One is the existing irrigated areas and the another is construction of facilities in new irrigation areas.

(1) Structural improvement in the existing irrigation areas

Based on the survey results of existing irrigation facilities, the plan try to reduce O & M cost of canals and water shortage at the field level by improvement of diversion weirs and main canals.

At the present, sub-basin of Clarillo, Angostura, Puangue, Lampa and Melipilla in which indicated significant shortage of irrigation water with existing irrigation facilities by the results of water balance study are to be selected. Integration of intake structure at the second and third sections of the Maipo river is to be implemented to establish an order of water use by improvement of the facility. Summary of the development plan is as follows;

Sub-basin	Area (ha)	Main improvement structures Intake structures (unit)	Diversion works (unit)	Canals (km)
Río Clarillo	2,500	-	12	16
Río Angostura	45,105	22	47	235
Est. Puangue	13,412	6	17	98
Est. Lampa	13,381	-	14	63
Melipilla	28,690	5	34	211
Total	103,088	33	127	623

Preconditions to establish the structural improvement plan are as follows;

- Improvement plan of weirs such as integration of intake structures does not exceed the river section, which formulated by water use system.

- Increase of intake amount by transferring or buying water right is not considered.

- For the project implementation, application of the Irrigation Law No.1123 and No.18450 are considered. The scale of the plan should not exceed that of support projects.

- The plan does not include a construction or improvement plan of water saving irrigation facilities at field level because the facilities must be improved by farm households.

(2) New irrigation plan

- Irrigation plan by utilization of unused water right in the downstream reach of the Maipo river

  Using DOH's water right of 25 m^3/s, newly irrigated areas of total area of 21,000ha is planned at Yali (10,000ha), Alhué (6,000ha), and Popeta (5,000ha). The areas of Yali, Alhué, and Popeta are to be integrated to one irrigation system since they are holding same intake structures and main canals. Construction of four power generations is planned by utilization the fall on the way of a main canal. The purpose is the decrease of O & M cost by selling the generated power.

- Irrigation plan by a large scale dam

  Expected available supply of 320 MCM by construction of a large scale dam distributes to total area of 18,500ha to sub-areas of Lampa (Colina 2,000ha, Porpaico 3,000ha), Curacavi (6,500ha) and Casablanca (7,000ha). Construction of four power generations is planned by utilization the fall on the way of a conduction canal from the dam.

- Irrigation plans by middle and small scale dams

  Expected available water of 39 MCM by construction of middle and small dams is new irrigation for around the dam sites and supplementary water source for areas of Colina and Curacavi by 270 ha and 280 ha respectively. Rosario area is no new irrigation area and is reserved as a future water source.

The irrigation plans mentioned above are summarized by alternative plan of water source development as follows;

Item	Alternatives to water source development			
	Without dams	With dams		Combination
	A−1	A−2 (Middle and small scale dams)	A−3 (A large scale dam)	A−4 (A-2+A-3)
Available developing area	—	2,300 ha	18,500 ha	20,800 ha
(With existing water right)	21,000 ha	21,000 ha	21,000 ha	21,000 ha
Total	21,000 ha	23,300 ha	39,500 ha	41,800 ha
Development plan	—	550 ha	18,500ha	19,050ha
(With existing water right)	21,000ha	21,000ha	21,000ha	21,000ha
Total	21,000ha	21,250ha	39,500ha	40,050ha

(3) Utilization of treated sewerage

The treated sewerage is to be used as irrigation water in Curacavi. Irrigation area comes 3,000ha.

(4) O & M plan for existing irrigation system

O & M organizations are formed with all irrigation systems in the study area and is implemented by canal organizations. As have mentioned so far, the Mapocho river and the Maipo main river course are divided into 5 sections and 3 sections respectively in the Maipo river basin. Although the arrangement of water use should be carried out based on these sections, *Junta de Vigilanccia*s has not established in the 2nd and the 3rd sections in the Maipo river, yet. However, the water users prepare to establish *Junta de Vigilanccia* in two sectors, too. This is because the requirement of water use arrangement by *Junta de Vigilanccia* has been recognized through increasing water use and frequent shortage of water in recent years. According to the present situation, in the study, the plan concerned with O & M of the existing irrigation system will not be established.

In the areas where irrigation will be newly introduced by the study, irrigation beneficiaries need to establish a new water users' association. The water users' association is established according to the Law of Water Users' Association, and will be approved by DGA. Water management and O & M of newly constructed irrigation structures are implemented by the newly organized water users' association.

5.4 Environmental Conservation Plan

5.4.1 Basic Concept of the Environmental Conservation Plan

Based on the study results of present environmental situation, problems regarding the objective areas are recognized as the contamination of irrigation water, deterioration of social environment and environmental impact by development. Summaries are as follows;

- In the construction plan of the sewage treatment plants in Santiago by EMOS, three plants will be completely constructed along the Mapocho River in 2024 to ameliorate water quality. However, it will have taken about 25 years to obtain the excellent water for irrigation from the river since the completion of the plants. Therefore, the progressive measures to ameliorate water quality by the agricultural side in order to obtain the desirable environment for agriculture in the whole period including the process period.

- The establishment of CONAMA in 1994 became in the areas a start of the local environmental preservation. It is promoted to make the countermeasure against air pollution, illegal dumping of waste, and discharging factory effluent without being treated and to preserve the local environment in cooperation with residents. The activity for environmental preservation in accordance with the CONAMA's plan is needed for preservation of the future regional environment.

- Only the control system of air pollution over the metropolitan region is working as the present environmental monitoring system. In order to preserve the local environment, it is necessary to observe continuously the environmental factors such as forest, current, water quality, use of land or the like. Therefore, it is also necessary to establish the system to investigate continuously and periodically the influence by agricultural development on the area or by the local environment on the new development section.

According to the above-mentioned problems on the regional environment and the method to solve them in future, it is a step of amelioration of agricultural environment in the area in this project to improve water quality from the agricultural side, preserve the regional environment in accordance with the CONAMA's plan, and establish the monitoring system. The method to solve them needs to be approached in diversity and general ways including the systematic supports from the resident group.

5.4.2 Irrigation Water Conservation Plan

According to the plan by EMOS, water contamination is decreasing gradually by the development plan, however, it takes about 25 years to obtain adequate irrigation water from the rivers after completing of the plants. Therefore, the countermeasures for water quality improvement from agriculture side are needed in order to recover the function of the suburban agricultural area as a perishable food supply center by establish preferable environment for agricultural production.

The measures can be considered as follows;

a. Avoiding contamination source: Conveying adequate irrigation water through bypasses to avoid contamination sources
b. Changing water sources: Obtaining irrigation water from uncontaminated areas or groundwater
c. Improving water quality: Obtaining irrigation water by treatment of contaminated water

The areas are not to be included where contaminated irrigation water is to be improved until the target year of 2010 by the sewerage-treatment plants of EMOS in order to corresponds with the sewerage treatment plan of EMOS. The countermeasures of each intake source are summarized as follows;

Area / Measures	Appearance of treatment's effect by EMOS	Avoiding contamination source	Changing water source	Improving water quality
The midstream basin of the Mapocho river (up to the confluence of Z. de la Aguada)	The end	San Carlos with canals	Impossible	Not needed
The downstream basin of the Mapocho river (from the confluence of Z. de la Aguada to confluence of the Maipo river)	From the middle to the end	Impossible	The area with groundwater regulation	Possible
The midstream of the Maipo river	The beginning	—	—	—
After the confluence of the Maipo river and the Mapocho river	The end	Impossible	Groundwater (possibly)	Possible

The measures for improvement of water quality with canals are summarized as follows;

Measures for improving water quality	The objective canals	Intake amount (m^3/sec)
Avoiding contamination sources (through bypass)	Canal La Polvora	0.5
	Canal La Punta	5.8
	Canal Casas de Pudahuel	0.8
	Total	7.1 m^3/sec (3 canals)
Improving water quality	Canal Las Mercedes	10.5
	Canal Esperanza Alto	0.7
	Canal Esperanza Bajo	1.7
	Canal Romero	1.0
	Canal Castillo	2.0
	Canal Domingano	0.8
	Canal Mallarauco	8.5
	Canal El Paico	2.5
	Canal San Miguel	4.2
	Canal Lo Aguirre	3.6
	Canal Lo Chacon	3.6
	Canal La Manresa	1.2
	Total	40.3 m^3/sec (12 canals)

Among the measures of water quality improvement, the targets on water quality improvement is shown in the table below. The targets concerns forbidden vegetable cultivation caused by contaminated irrigation water and quality of products as agricultural exporting products (mainly toward the United States). These are the problems which agriculture in the metropolitan faces.

Subject	Crops	Criteria
Bureau of Environment and Health in Chile	Vegetables	Less than 1,000 groups of colitis germ/100ml
For agricultural export	Grapes	For sprinkler irrigation, primary treatment water is not permitted.
(toward the United States)	Forage and seed crops	For irrigation, primary treatment water is permitted.
	Food crops	For surface irrigation, primary treatment water is permitted. For sprinkler irrigation, water should be disinfected and groups of colitis germ should be less than 23/100ml.
	Table crops	For surface irrigation, groups of colitis germ should be less than 2.2/100ml.

Prevailing irrigation methods are furrow and drip irrigation methods. In the case of improving water quality, groups of colitis germ should be less than 23/100ml. If chlorine disinfection is planned, a domestic criteria and the criteria for exporting food crops can be cleared. Accordingly, the targets of water quality improvement are less than 23/100ml groups of colitis germ and chlorinated. In the case of cultivation of fruits, because sprinkler irrigation is the objective of criteria, a plan on improvement of water quality which focused on vegetable cultivation is established. The method of sewerage treatment is planned in accordance with the method of Standard Activated Sludge as well as the treatment method planned by EMOS based on treatment scale and capacity.

Vegetable cultivation by canals was set by crop cultivation in '97 Census as follows and volume of improvement is estimated from required irrigation water to the cultivation area.

Objective canal	Vegetable cultivation area (ha)	Treated (irrigation) water m^3/s
Canal Las Mercedes	1,500	1.50
Canal Esperanza Alto	150	0.15
Canal Esperanza Bajo	240	0.24
Canal Romero	100	0.10
Canal Castillo	30	0.03
Canal Domingao	200	0.20
Canal Mallarauco	1,500	1.50
Canal El Paico	200	0.20
Canal San Miguel	300	0.30
Canal Lo Aguirre	200	0.20
Canal Lo Chacon	300	0.30
Canal La Manresa	20	0.02
Total	4,740	4.74

The canal associations are to execute the water quality improvement, however, the project has an effect for conservation on natural, social and economic environments and required to promote by introduction of the government finance as the public project. In case of discharging domestic sewage into the canals that cause contamination of water for irrigation, such case is related to the construction of the sewage treatment plant in the local city so that it is solved in the arrangement of the living environments within the study area.

5.4.3 Environmental Management Plan

(1) Promotion of environmental education in basins

Urban areas have the problems of illegal disposal of wastes and non-treated discharge of contaminated water by industries while rural areas have the problems of the canal contamination by domestic wastes, miscellaneous sewerage and waste of animals. An areal approach is to play an important role based on the national environmental conservation policy in order to solve these problems. At the present, CONAMA is implementing "The countermeasures against contamination campaign." This is a fourteen years plan. Activity area limits only to the Centro area and Las Condes area at present but the plans to extend to rural area.

Volunteers are organized from youth groups, various organizations and farmers' organizations under the cooperation with SECPLAC of *Comuna*. The volunteers obtained CONAMA certificate of the environmental conservation's extension workers carry out environmental education and enlightenment activities in each Community.

(2) Promotion of agriculture concerned environment

The plan is to avoid environmental contamination caused by increment of fertilizer and agricultural chemicals use in the agricultural development. The measures for decreasing inputs of pesticide and fertilizer by the cooperation of INIA and public research institute such as Chile University in order to promote sustainable agriculture based on utilization of available resources in area are to be planned. Technology transfer or technological instruction to farmers is implemented by the cooperation of INDAP and private agricultural consultants.

When carrying out the promotion, SECPLAC will become the core of the promotion to which the Ministry of Agriculture is to give instruction on the planning.

(3) Establishment of an environmental monitoring system

Chile has a management system for air pollution in the metropolitan area at present. Thus, an environmental management system will be established by utilizing the system and expanding its function the management. The environmental management subject in the development plan covers wide range of fields such as natural resources (i.e. forestry), condition of rivers, water quality, land use, agricultural development, irrigation, cropping, plant growth and so on. Accordingly, compulsory environmental monitoring by Landsat and Spot satellite pictures is needed to monitor environment periodically for global supervision of the subjects. Organization related to Ministry of Agriculture by cooperation with the environment center is to establish the system.

The core organization of the promotion is set CONAMA. The national environment center is in charge of measuring and analyzing each environmental factor.

5.5 Selection of the Agricultural Development Scenario

5.5.1 Development Components of Each Scenario

Based on the alternatives of water resource development in the study area described in the water source development plan, following four agricultural development scenarios is proposed in the study area. Each agricultural development scenario formulates agricultural promotion and environmental conservation plans. Agricultural promotion plan consists of following sub-development plans described in the agricultural promotion plan.

- Construction of the irrigation system including water source facilities for the new irrigation development,
- Rehabilitation of existing irrigation system,
- Improvement of water quality for the existing irrigation system using the contaminated irrigation water, and
- Improvement of rural infrastructure to facilitate the settling condition of in the rural area.

Environmental conservation plan consists of promotion of environmental education, sustainable agriculture taking the regional environment and establishment of environmental monitoring system to control the regional environment.

The structural components of each agricultural development scenario are as follows;

Item	Component	S - 1	S - 2	S - 3	S - 4
1 Agricultural infrastructure Development					
Irrigation development					
Colina-Casablanca	Irrigation area (Colina, Porpaico, Curacavi, Casablanca)	-	-	18,500 ha	18,500 ha
	Water source facilities (Maipo Dam)	-	-	1 site	1 site
	V=360 MCM, H=161 m, L=800 m				
	Main canal	-	-	296.5 km	296.5 km
	Related structures (tunnels、 siphons)	-	-	21.7 km	21.7 km
	Power station	-	-	4 sites	4 sites
Colina	Irrigation area (Colina)	-	270 ha	-	270 ha
	Water source facilities (Colina Dam)	-	1 site	-	1 site
	V= 4.6 MCM, H= 45 m, L=230 m				
	Main canal	-	4 km	-	4 km
Curacavi	Irrigation area (Curacavi)	-	280 ha	-	280 ha
	Water source facilities(Cracavi Dam)	-	1 site	-	1 site
	V= 4.7 MCM, H= 27 m, L=150 m				
	Main canal	-	30 km	-	30 km
Yali -Popeta	Irrigation area (Yali, Albué, Popeta)	21,000 ha	21,000 ha	21,000 ha	21,000 ha
	Headworks (Integration)	1 site	1 site	1 site	1 site
	Main canal	140.5 km	140.5 km	140.5 km	140.5 km
	Related structures (tunnels、 siphons)	13.6 km	13.6 km	13.6 km	13.6 km
	Power station	4 sites	4 sites	4 sites	4 sites
Improvement of existing irrigation system	Objective sites (Carillo, Angostura, Lampa, Puangue, Melipilla)	5 sites	5 sites	5 sites	5 sites
	Objective area	103,088 ha	103,088 ha	103,088 ha	103,088 ha
	Objectives for improvement				
	rehabilitation of intake structures	33 sites	33 sites	33 sites	33 sites
	:rehabilitation of main canal	623 km	623 km	623 km	623 km
2 Rural Living infrastructure Development	Rural water supply	52 sites	52 sites	52 sites	52 sites
	Rural sewerage system	39 sites	39 sites	39 sites	39 sites
	Local roads improvement	191 km	191 km	191 km	191 km
3 Environmental conservation	Improvement of water quality				
	Bypass canal	3 sites Q= 7.1 m^3/s	3 sites Q= 7.1 m^3/s	3 sites Q= 7.1 m^3/s	3 sites Q= 7.1 m^3/s
	Treatment of water quality	12sites Q=4.74m^3/s	12sites Q=4.74m^3/s	12sites Q=4.74m^3/s	12sites Q=4.74m^3/s

Summaries of each agricultural development scenario are shown in Fig. 5.5.1 to Fig. 5.5.4.

5.5.2 Evaluation of Agricultural Development Scenarios

Even though this is an agricultural development project, some of the four scenarios included water uses other than irrigation, namely, electricity generation and drinking water supply. Benefits from hydroelectric generation along irrigation canals were estimated in term of the value of the generated electricity. Likewise, benefits from drinking water were estimated in terms of the lower cost of the Maipo river as water source, compared with groundwater as the alternative water source.

Benefits from agriculture were estimated on the basis of three components: annual crops, fruits species, and seed production. Fruit species were assumed to take fifteen years to reach full production stage. On the other hand, grapes for wine were assumed to take nine years to reach full production stage. The evaluation of agricultural development scenarios was conducted using current market prices, without adjustments for price distortions.

(1) Project cost estimation

The unit price used for estimation is formulated by the data obtained from DOH.

a) As for unit price of dam, unit price per m^3 is calculated by dam construction costs which were constructed from 1930 to 1995 by DOH.
b) Unit cost for earth work and for related structures is referred to unit price of implemented projects by DOH.

(2) Basic assumption of the evaluation

a) Useful life of the project: 30 years, with implementation period between the year 2000 and 2010
b) Price level of August 1998
c) Benefits from drinking water : \$35/m^3 (difference in production cost between surface water and groundwater), 30% water loss, 85% bill collection rate
d) Benefits from hydroelectric generation : \$25/kwh, 10% loss, 95% bill collection rate
e) Benefits from agriculture : gross margin per ha, which varies depending on the location of the irrigation area, and type of crops. Annual crops were assumed to start in 2005, while fruits and grapes for wine in 2004. Fruit species were assumed to reach full production in 15 years, while grapes for wine in 9 years.

Irrigation Development Area		Benefits
Section	Area (ha)	(1,000\$/ha)
Alhué	6,000	1,143.2
Popeta	5,000	981.1
Yali	10,000	1,073.5
Curacavi	280	1,073.7
Colina-Casablanca	18,500	1,025.6
Colina	270	1,027.6

(3) Results of evaluation

The evaluation results of four agricultural development scenarios are shown as IRR in the table below. IRR of agricultural development scenario 1 and 2 exceeds social discount rate of 12% set by MIDEPLAN. On the contrary, IRR of agricultural development scenario 3 and 4 are less than 12%.

Development scenario	IRR(%)	NPV (12%, Million)	B/C (12%)
S-1	14.95	22,043.3	1.37
S-2	14.19	15,076.8	1.22
S-3	2.52	-172,863.6	0.48
S-4	2.56	-179,830.2	0.48

Project cost and benefit of each agricultural development scenario are as follows;

(Mil \$)

Scenario	Item	Project Cost	O&M Cost	Project Benefit	IRR (%)
S-1	Popeta-Yali				
	Bocatoma	7,840.1	40.7		
	Canales	76,540.5	178.6		
	Obras de Arte	31,783.8	24.5		
	Total	116,164.4	243.8	38,696	16.69
S-2	Popeta-Yali				
	Sub-Total	116,164.4	243.8		
	Colina				
	Embalse	6,750.0	18.6		
	Canales	362.5	0.0		
	Obras de Arte	1,443.5	0.0		
	Sub-Total	8,556.0	18.6		
	Curacavi				
	Embalse	2,680.0	12.3		
	Canales	1,346.0	0.0		
	Obras de Arte	949.0	0.0		
	Sub-Total	4,975.0	12.3		
	Total	129,695.4	274.7	40,234	14.77

To be continued

Scenario	Item	Project Cost	O&M Cost	Project Benefit	IRR (%)
S-3	Popeta-Yali				
	Sub-Total	116,164.4	243.8		
	Colina-Casablanca				
	Embalse	202,397.0	404.8		
	Canales	173,442.6	351.4		
	Obras de Arte	126,389.3	0.0		
	Central Hidroelect.	45,941.2	229.7		
	Sub-Total	535,251.3	985.9		
	Total	651,415.7	1,229.7	40,234	14.77
				To be continued	
S-4	Popeta-Yali				
	Sub-Total	116,164.4	243.8		
	Colina				
	Sub-Total	8,556.0	18.6		
	Curacavi				
	Sub-Total	4,975.0	12.3		
	Colina-Casablanca				
	Sub-Total	535,251.3	985.9		
	Total	664,946.7	1,260.6	65.928	3.55

(4) Social and environmental impacts

In case of large scale dam related to the scenarios S-3 and S-4, social impact is estimated around 200 households including one school, and each 6.5 km of roads and pipelines as compensation of removal. As for the natural environmental impact, each development scenario has the protection area which locates the mouth of the Yali river in the downstream of the development area, though protection area locates out of proposed development area. Also, sanctuary is located at the downstream reach of the proposed site of large scale dam.

Social and environmental impacts of each agricultural development scenario are summarized as follows;

Item	S-1	S-2	S-3	S-4
Social impact				
Change of basins	+	+	+	+
Removal of inhabitants			++	++
Compensation except land				
Roads			+	+
Pipelines			++	++
Environmental impact				
Designated environmental conservation area				
Protection area	++	++	++	++
Sanctuary			++	++
Lowering river bed			+	+
Sight			+	+
Change of land category and topography	+	+	+	+

(5) Selection of the agricultural development scenario

As considering the results of economic evaluation and the degree of social and environmental impacts of each agricultural development scenario, S-1 and S-2 have same degree of social and economic impact. Taking effective utilization of water resources, S-2 is prior to S-1 because S-2 has the plan of constructing new water source facilities. Accordingly, S-2 is selected as the agricultural development plan aimed at 2010 (the target year).

5.6 Salient Features of Development Projects Proposed in the Master Plan

Based on the study results described above, the following projects is proposed to contribute utilization of water and land resources, environmental conservation of basins, and agricultural promotion in the study area.

Projects		Description	Quantities
Agricultural promotion measures	1 Irrigation development Colina	Irrigation area (Colina) Major crops : Vegetables and seeds, Fruits Water source facilities (Colina Dam) V= 4.6 MCM, H= 45 m, L=230 m Main canal	270 ha 1 site 4 km
	Curacavi	Irrigation area (Curacavi) Major crops : Fruits, Grapes for wine, Vegetables and flowers Water source facilities (Curacavi Dam) V= 4.7 MCM, H= 27 m, L=150 m Main canal	280 ha 1 site 30 km
	Popeta - Alhué	Irrigation area (Popeta, Yali, Alhué) Major crops : Fruits, Grapes for wine, Vegetables and seeds Headworks (Integrated weir) Main canal Related structures (Tunnel, Syphon) Power station	21,000 ha 1 site 140.5 km 13.6 km 4 sites
	2 Agricultural infrastructure	Improvement of existing irrigation system Objective sites (Clarillo, Angostura, Lampa, Puangue, Melipilla) Objective area Objectives for improvement rehabilitation of intake structures rehabilitation of main canal	 5 sites 103,088 ha 33 sites 623 km
	3 Agricultural support	Promotion of organization on small-scale farmers Advancement of function on existing producers group Provision of base facility for agricultural activity	L. S. L. S. L. S.
	4 Rural infrastructure	Rural water supply Rural sewerage system Local roads improvement	52 sites 39 sites 191 km
Environmental conservation measures	1 Improvement of water quality	Bypass canal Treatment of water quality	3 sites Q= 7.1 m³/s 12sites Q=4.74m³/s
	2 Environmental control	Promotion of environmental education in the basin Promotion of sustainable agriculture Establishment of environmental monitoring system	L. S. L. S. L. S.
Contents of the alternative study on development plans in the master plan			
Measures on practical use of natural resources	1 Alternatives on water source development	Utilization of reservoir water Total 369 MCM Maipo dam (360 MCM, irrigation 320 MCM, drinking water 40 MCM) Colina dam (4.6 MCM), Curacavi dam (4.7 MCM) Utilization of unused water right Total 25 m³/sec (Utilization of treated sewerage water Total 3.5 m³/sec)	
	2 Irrigation area	Available irrigation area Total 40,050 ha (based on the alternatives on water source development) Colina - Casablanca 18,500 ha, Popeta – Alhué 21,000 ha Colina 270 ha, Curacavi 280 ha	

Total cost to implement the proposed projects is estimated at 280,363 million peso (equivalent to US$ 623 million as of August 1998) and details are as follows;

Name of project	Scale	Unit	Project cost Mill. Peso ($)	O&M cost Mill. Peso ($)/ann.
1. New irrigation development				
1) YALI – ALHUE - POPETA	21,000	ha	116,164.4	243.8
2) COLINA (dam)	270	ha	8,556.0	18.6
3) CURACAVI (dam)	280	ha	4,975.0	12.3
Sub-total	28,250	ha	129,695.4	274.7
2. Improvement of existing irrigation system				
1) Río Clarillo	2,500	ha	393.9	3.9
2) Estero Lampa	13,381	ha	845.6	8.5
3) Río Angostura	21,105	ha	6,160.4	61.6
4) Melipilla	28,691	ha	8,687.9	86.9
5) Estero Puango	13,412	ha	4.693.7	46.9
Sub-total	79,089	ha	20,781.5	207.8
3. Improvement of water quality				
1) Treatment of water quality	4,740	ha	85,831.0	10,852.0
2) Bypass canal	2,300	ha	5,044.0	50.4
Sub-total	7,040	ha	90,875.0	10,902.4
4. Rural water supply	52	unit	3,195.0	383.4
5. Rural sewerage system	39	unit	20,344.8	1,973.0
6. Local roads improvement	191	km	15,471.0	30.9

To be continued

Name of project	Scale	Unit	Project cost Mill. Peso ($)	O&M cost Mill. Peso ($)/ann.
7.Environmental conservation				
1) Promotion of environmental education	1	unit	—	432.6
2) Promotion of the agriculture concerned environment	1	unit	—	160.0
3) Establishment of the environmental monitoring system	1	unit	—	185.0
Sub-total	3	unit	—	777.6
Total			280,362.7	14,549.8

5.7 Priority Projects

5.7.1 General

For the priority projects and/or areas, model or pilot project components for the agricultural promotion in the objective area will be selected among the projects proposed in the master plan study.

In the existing irrigated farmlands, agricultural infrastructure improvement concerned environmental conservation consisting water quality improvement for irrigation and rehabilitation of existing irrigation system will be proposed as the priority project at the area that improvement of water quality for irrigation is required. This priority project is settled as the pilot scheme related to the water quality improvement. Also, in the existing non-irrigated farmland, agricultural development with effective use of present water resources is proposed as the priority project. As for living environment improvement, the plan that concerned living environment improvement is established in the areas where priority projects will be implemented.

5.7.2 Selection of the Priority Projects

(1) Selection of the area for agricultural infrastructure improvement concerned environmental conservation

Required area of the rehabilitation on the existing irrigation system composes 5 areas, Clarillo, Puangue, Lampa, Melipilla and Angostura. Both Puangue and Melipilla areas are entirely being used contaminated river water for irrigation, however, contaminated water utilization for irrigation is limited partly in the remaining three areas.

Required area for rehabilitation of irrigation system	Clarillo	Puange	Lampa	Melipilla	Angosutura
Area utilized contaminated water for irrigation	-	○	-	○	-

Out of three areas, bypasses method to avoid contamination sources is applied for the Lampa area. Cralillo and Angostura areas are eliminated for the objective area of improvement because water quality of both areas will be improved by the plan of EMOS up to target year of 2010. Contaminated water of the Mapocho river is used for irrigation water through Canal Las Mercedes, and Canal Mallarauco in the area of Puangue and Melipilla, respectively. EMOS has the plan to use the disposed sewerage water for irrigation in the Puangue area. So, in the study, the agricultural infrastructure improvement concerned with environmental conservation is planned in the existing irrigation area with Canal Mallarauco. 1,500ha is selected as the areas to be ameliorated in its farming and farm management due to improvement of water quality.. The development outline under the plan is as follows;

Objective site	Objective area	Details of improvement	
Mallarauco	1,500ha	Treatment capacity	: 1.5 m^3/sec
		Improvement of main canal	: 12.0km
		Lateral canals	: 24.0km

(2) Selection of the area for agricultural development with water resource utilization

The areas for agricultural development with water resource utilization are the new irrigation areas by utilizing unused water right such as Yali-Alhué-Popeta. Areas to be irrigated by construction of small scale dams are Colina and Curacavi. Total area of irrigation is 21,550ha. Results of comparison by IRR on each area are as follows;

Section	IRR	NPV	B/C
Yali-Alhué-Popeta	16.69	$22,043.4	1.37
Colina	-2.90	$ -4,729.0	0.17
Curacavi	-1.63	$ -2,237.6	0.37

According to the economic viability, Yali-Alhué-Popeta irrigation areas are selected as the priority project areas.

The total area of the Yali-Alhué-Popeta irrigation system is 21,000ha. It consists of three irrigation areas, Yali, Alhué, and Popeta. Intake structure and a main canal will be used as the joint operation. As estimating the burden ration of construction cost in each irrigation block, cost per household and per ha are as follows;

	Index	Yali	Alhué	Popeta
1	Projected irrigation area (ha)	10,000	6,000	5,000
2	Number of farm households	1,873	765	1,020
3	Number of farm households who hold less than 15ha of farmland	1,095	440	724
4	3/2= (%)	58.5	57.6	71.0
5	Burden ratio on construction cost	0.52	0.36	0.12
	Distance ratio	0.37	0.45	0.18
	Area ratio	0.49	0.28	0.23
6	Cost per irrigation block (million peso)	60,405	42,052	13,707
7	Cost per household (million peso)	32.3	55.0	13.4
8	Cost per ha (million peso)	6.04	7.01	2.74
9	IRR (%)	16.27	13.07	27.69

The summary of comprehensive evaluation based on the standard of project evaluation method by PROMM-World Bank is as follows;

	Index		Yali	Alhué	Popeta
1	Impact on environment		2	5	5
2	Project economy	IRR	0	0	10
		Cost/ha	6	3	6
3	Number of beneficiaries		10	10	10
4	Ratio of small farmers		10	10	10
5	Actual results of former development survey		0	0	0
6	Impact on other facilities		0	0	0
7	Existence of water right		3	3	3
8	Adjustment with the national development policy		10	10	10
9	Spread effects		10	10	10
	Total		51	51	64

According to the table above, irrigation area of Popeta is selected as the priority area for agricultural development through utilizing water resource. Following is the summary of proposed facilities in the Popeta area;

Objective site	Objective area	Details of improvement
Popeta	5,0 00ha	Intake Structure : 1 unit (unified weir) Main canal : 25.3 km (140.5 km) Related structures : 6.0 km (Tunnel, Syphon)

Tabla 5.1.1 Runoff Resume at Dam Sites

(Unit: mm)

			JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Maipo (1-1,2)	Average	m3/sec	74.050	46.019	24.645	9.278	4.813	4.984	3.929	4.124	5.351	17.728	46.489	84.666	
		MCM	198.335	111.330	66.009	24.048	12.890	12.920	10.524	11.045	13.869	47.484	120.499	226.771	855.723
	85%	m3/sec	27.380	19.910	7.637	2.495	0.957	0.592	0.741	0.877	1.230	6.544	26.339	38.482	
		MCM	73.336	48.166	20.456	6.467	2.562	1.534	1.984	2.349	3.188	17.527	68.272	103.071	348.909
	Eventual	m3/sec	13.325	6.763	4.839	1.875	1.087	1.186	0.894	0.917	1.122	3.272	5.769	13.274	
		MCM	35.690	18.113	12.959	5.023	2.911	3.176	2.395	2.457	3.006	8.763	15.451	35.552	145.496
Station : RIO MAIPO EN LAS MELOSAS															
Maipo (2-1,2,3)	Average	m3/sec	79.9607	49.6929	26.6121	10.0186	5.19679	5.38229	4.24293	4.45293	5.77786	19.1436	50.2	91.425	
		MCM	214.167	120.217	71.278	25.9681	13.9191	13.9509	11.3643	11.9267	14.9762	51.2741	130.118	244.873	924.032244
	85%	m3/sec	29.566	21.499	8.247	2.694	1.033	0.639	0.8	0.947	1.328	7.066	28.442	41.554	
		MCM	79.1896	52.0104	22.0888	6.98285	2.76679	1.65629	2.14272	2.53644	3.44218	18.9256	73.7217	111.298	376.761456
	Eventual	m3/sec	14.3888	7.30254	5.22474	2.02496	1.17344	1.28026	0.96569	0.99041	1.21191	3.533	6.22936	14.3331	
		MCM	38.5389	19.5591	13.994	5.42365	3.14293	3.42904	2.5865	2.65273	3.24599	9.4628	16.6847	38.3897	157.11
Maipo (3)	Average	m3/sec	81.573	50.695	27.149	10.221	5.302	5.491	4.328	4.543	5.894	19.530	51.212	93.268	
		MCM	218.485	122.641	72.715	26.492	14.200	14.232	11.593	12.167	15.278	52.308	132.742	249.810	942.662
	85%	m3/sec	30.162	21.932	8.413	2.748	1.054	0.652	0.816	0.966	1.355	7.208	29.015	42.392	
		MCM	80.786	53.059	22.534	7.124	2.823	1.690	2.186	2.588	3.512	19.307	75.208	113.542	384.357
	Eventual	m3/sec	14.679	7.450	5.330	2.066	1.197	1.306	0.985	1.010	1.236	3.604	6.355	14.622	
		MCM	39.316	19.953	14.276	5.533	3.206	3.498	2.639	2.706	3.311	9.654	17.021	39.164	160.278
Station : RIO MAIPO EN SAN ALFONSO															
Alfonso	Average	m3/sec	166.569	120.647	79.739	56.156	53.867	50.189	45.661	44.306	51.989	75.422	125.172	169.978	
		MCM	446.138	291.869	213.573	145.555	144.276	130.09	122.299	118.668	134.755	202.011	324.446	455.268	2728.949
	85%	m3/sec	90.707	75.168	55.751	42.463	32.495	29.936	29.711	31.549	37.118	57.133	88.506	94.566	
		MCM	242.95	181.846	149.323	110.064	87.0346	77.5941	79.5779	84.5008	96.2099	153.025	229.408	253.286	1744.819
	Eventual	m3/sec	30.918	17.726	10.981	6.076	9.681	8.964	7.405	5.880	6.644	8.659	16.967	34.873	
		MCM	82.812	47.476	29.412	16.275	25.929	24.009	19.833	15.748	17.796	23.191	45.444	93.405	441.330
Maipo (4-1,2)	Average	m3/sec	162.770	117.895	77.920	54.875	52.638	49.044	44.620	43.295	50.803	73.702	122.317	166.101	
		MCM	435.963	285.213	208.702	142.236	140.986	127.123	119.509	115.962	131.682	197.404	317.047	444.885	2666.710
	85%	m3/sec	88.638	73.454	54.479	41.495	31.754	29.253	29.033	30.829	36.271	55.830	86.487	92.409	
		MCM	237.409	177.699	145.918	107.554	85.050	75.824	77.763	82.574	94.016	149.535	224.175	247.509	1705.025
	Eventual	m3/sec	30.213	17.321	10.731	5.938	9.460	8.760	7.236	5.745	6.493	8.461	16.580	34.078	
		MCM	80.923	46.394	28.742	15.903	25.338	23.462	19.380	15.389	17.390	22.662	44.407	91.274	431.265
Station : RIO MAPOCHO EN LOS ALMENDROS															
Mapocho	Average	m3/sec	10.046	5.642	3.426	2.667	3.448	4.363	7.034	5.869	7.654	11.666	14.140	13.261	
		MCM	26.908	13.648	9.177	6.912	9.235	11.308	18.839	15.721	19.838	31.247	36.651	35.519	235.003
	85%	m3/sec	3.449	2.551	1.785	1.406	1.357	1.521	1.767	2.086	3.017	4.241	5.103	4.200	
		MCM	9.238	6.171	4.781	3.644	3.635	3.942	4.733	5.587	7.820	11.359	13.227	11.249	85.387
	Eventual	m3/sec	1.099	0.544	0.316	0.250	0.412	0.550	0.852	0.935	1.093	1.741	2.286	1.930	
		MCM	2.945	1.316	0.845	0.647	1.102	1.424	2.283	2.505	2.834	4.664	5.924	5.170	31.660
Mapocho (1)	Average	m3/sec	9.463	5.314	3.227	2.512	3.248	4.109	6.625	5.529	7.209	10.989	13.319	12.491	
		MCM	25.345	12.856	8.644	6.511	8.699	10.651	17.745	14.808	18.686	29.433	34.523	33.456	221.358
	85%	m3/sec	3.249	2.403	1.681	1.324	1.278	1.433	1.664	1.965	2.842	3.995	4.807	3.956	
		MCM	8.701	5.813	4.503	3.433	3.424	3.714	4.458	5.263	7.366	10.700	12.459	10.596	80.429
	Eventual	m3/sec	1.036	0.512	0.297	0.235	0.388	0.518	0.803	0.881	1.030	1.640	2.153	1.818	
		MCM	2.774	1.239	0.796	0.610	1.038	1.342	2.150	2.359	2.669	4.393	5.580	4.870	29.822
Colina (C-1)	Average	m3/sec	0.857	0.518	0.458	0.435	0.514	0.555	0.582	0.739	0.883	1.290	1.892	1.508	
		MCM	2.295	1.252	1.228	1.127	1.376	1.437	1.559	1.980	2.289	3.456	4.903	4.038	26.941
	85%	m3/sec	0.326	0.235	0.231	0.230	0.267	0.295	0.352	0.360	0.473	0.659	0.804	0.580	
		MCM	0.872	0.570	0.619	0.596	0.716	0.764	0.944	0.965	1.225	1.766	2.083	1.553	12.673
	Eventual	m3/sec	0.169	0.080	0.073	0.067	0.083	0.081	0.077	0.123	0.131	0.211	0.337	0.299	
		MCM	0.453	0.216	0.196	0.178	0.222	0.217	0.206	0.329	0.352	0.566	0.903	0.800	4.638
Colina (C-2)	Average	m3/sec	0.968	0.585	0.518	0.491	0.580	0.627	0.658	0.835	0.998	1.458	2.137	1.703	
		MCM	2.592	1.415	1.387	1.273	1.554	1.624	1.762	2.237	2.586	3.905	5.540	4.562	30.438
	85%	m3/sec	0.368	0.266	0.261	0.260	0.302	0.333	0.398	0.407	0.534	0.745	0.908	0.655	
		MCM	0.986	0.644	0.699	0.674	0.809	0.863	1.066	1.090	1.384	1.995	2.354	1.754	14.318
	Eventual	m3/sec	0.191	0.091	0.083	0.075	0.093	0.092	0.087	0.139	0.148	0.239	0.381	0.338	
		MCM	0.512	0.243	0.221	0.201	0.250	0.245	0.232	0.372	0.397	0.640	1.020	0.904	5.240
Rosario	Average	m3/sec	0.000	0.000	0.275	1.079	4.458	6.226	5.111	5.214	1.704	1.106	0.092	0.179	
		MCM	0.000	0.000	0.736	2.797	11.942	16.137	13.690	13.966	4.416	2.962	0.239	0.478	67.362
	85%	m3/sec	0.000	0.000	0.155	0.610	2.518	3.517	2.887	2.945	0.962	0.625	0.052	0.101	
		MCM	0.000	0.000	0.416	1.580	6.745	9.115	7.733	7.889	2.494	1.673	0.135	0.270	38.051
	Eventual	m3/sec	0.000	0.000	0.120	0.470	1.940	2.709	2.224	2.269	0.741	0.481	0.040	0.078	
		MCM	0.000	0.000	0.320	1.217	5.196	7.022	5.957	6.077	1.922	1.289	0.104	0.208	29.311
Yali	Average	m3/sec	0.011	0.016	1.080	5.386	16.022	26.204	19.740	14.931	6.747	3.663	1.094	0.913	
		MCM	0.029	0.038	2.892	13.961	42.914	67.922	52.872	39.992	17.489	9.810	2.835	2.445	253.199
	85%	m3/sec	0.006	0.008	0.633	3.142	9.236	15.244	11.309	8.676	3.920	2.145	0.625	0.542	
		MCM	0.015	0.020	1.696	8.145	24.739	39.512	30.290	23.239	10.160	5.745	1.620	1.451	146.633
	Eventual	m3/sec	0.005	0.007	0.446	2.244	6.786	10.961	8.431	6.255	2.827	1.518	0.469	0.371	
		MCM	0.014	0.018	1.196	5.817	18.175	28.410	22.581	16.753	7.329	4.065	1.214	0.994	106.566
Station : ESTERO PUANGUE EN BOQUERON															
	Average	m3/sec	0.060	0.042	0.038	0.046	0.181	1.345	2.442	2.036	1.521	0.553	0.233	0.097	
		MCM	0.162	0.102	0.103	0.120	0.484	3.486	6.541	5.453	3.942	1.480	0.603	0.259	22.734
	85%	m3/sec	0.020	0.015	0.010	0.009	0.010	0.034	0.242	0.289	0.171	0.098	0.072	0.041	
		MCM	0.054	0.036	0.027	0.023	0.027	0.088	0.648	0.774	0.443	0.262	0.187	0.110	2.679
	Eventual	m3/sec	0.005	0.004	0.004	0.005	0.022	0.171	0.290	0.230	0.177	0.060	0.021	0.007	
		MCM	0.014	0.009	0.010	0.013	0.060	0.443	0.776	0.615	0.458	0.161	0.055	0.020	2.632
Curacavi	Average	m3/sec	0.108	0.075	0.068	0.082	0.322	2.396	4.349	3.626	2.709	0.984	0.414	0.172	
		MCM	0.288	0.181	0.183	0.214	0.862	6.209	11.649	9.712	7.021	2.636	1.074	0.461	40.490
	85%	m3/sec	0.036	0.027	0.018	0.016	0.018	0.061	0.431	0.515	0.305	0.175	0.128	0.073	
		MCM	0.095	0.065	0.048	0.042	0.048	0.157	1.154	1.379	0.789	0.467	0.332	0.196	4.772
	Eventual	m3/sec	0.010	0.006	0.007	0.009	0.040	0.304	0.516	0.409	0.315	0.107	0.038	0.013	
		MCM	0.026	0.015	0.018	0.022	0.106	0.788	1.381	1.096	0.815	0.286	0.098	0.035	4.688

Table 5.3.1 Crop Cultivation Plan

New Irrigation Area	Total Area (ha)	Farming Type	Area by Scale (ha)	Cereal Crops Area (ha)	%	Traditional Crops* Area (ha)	%	Vegetables Area (ha)	%	Flowers Area (ha)	%	Forage Crops Area (ha)	%	Fruits Area (ha)	%	Grape Vines Area (ha)	%	Seedlings Production Area (ha)	%	Seed Production** Area (ha)	%	Sub-Total Area (ha)	%	Others Area (ha)	%
1.-Alhué	6,000																								
		Medium & Large Scale Farmers	5,527	829	15	553	10	332	6	55	1	663	12	1,382	25	995	18	0	0	166	3	4,975	90	552	10
		Small Scale Farmers	473	99	21	47	10	14	3	0	0	71	15	71	15	33	7	0	0	0	0	335	71	138	29
2.- Popeta	5,000																								
		Medium & Large Scale Farmers	3,496	524	15	0	0	350	10	35	1	524	15	1014	29	385	11	70	2	280	8	3,182	91	314	9
		Small Scale Farmers	1,504	226	15	75	5	165	11	0	0	241	16	301	20	60	4	0	0	45	3	1,113	74	391	26
3.- Yali	10,000																								
		Medium & Large Scale Farmers	7,400	1,110	15	296	4	740	10	74	1	1,332	18	1,850	25	1,036	14	0	0	222	3	6,660	90	740	10
		Small Scale Farmers	2,600	442	17	260	10	130	5	0	0	364	14	364	14	260	10	0	0	0	0	1,820	70	780	30
4.-Puangue (Curacavi M. Pinto, Ibacache)	6,500																								
		Medium & Large Scale Farmers	3,900	507	13	0	0	390	10	78	2	546	14	1,170	30	468	12	0	0	312	8	3,471	89	429	11
		Small Scale Farmers	2,600	390	15	130	5	520	20	26	1	416	16	260	10	182	7	0	0	78	3	2,002	77	598	23
5.- Casablanca	7,000																								
		Medium & Large Scale Farmers	6,046	605	10	0	0	484	8	0	0	1,209	20	1,209	20	1,512	25	60	1	121	2	5,200	86	846	14
		Small Scale Farmers	954	153	16	76	8	38	4	0	0	153	16	153	16	114	12	0	0	0	0	687	72	267	28
6.- Lampa	5,000																								
		Medium & Large Scale Farmers	2,500	125	5	0	0	625	25	50	2	450	18	750	30	0	0	25	1	250	10	2,275	91	225	9
		Small Scale Farmers	2,500	0	0	125	5	750	30	25	1	500	20	375	15	0	0	0	0	50	2	1,825	73	675	27
TOTAL	39,500		39,500	5,010	13	1,563	4	4,538	11	343	1	6,469	16	8,899	23	5,045	13	155	0	1,524	4	33,545	84	5,955	26

Source: Censo Nacional Agropecuario 1997

* Chacras (Traditional Crop) : Main crops which farmers cultivated in the land where was provided instead of salary during the plantation era (Potato, Maize, Beans, Melon and etc.).

** Seed Production: Seed for export and domestic consumption (Vegetable, Maize, Wheat and etc.).

Table 5.3.2 Benefit of "with-Project" Condition by Land Holding Scale

Small Scale Farmers

New Irrigation Area	Cultivation Area of Each Farming Type		Cereal Crops Area (ha)	Traditional Crops* Area (ha)	Vegetables Area (ha)	Flowers Area (ha)	Forage Crops Area (ha)	Fruits Area (ha)	Grapes (wine & Table) Area (ha)	Seedlings Production Area (ha)	Seed Production** Area (ha)	Subtotal	Others	Gross Income or Net Income of Farming Type ($000)
			300	480	1,206	1,600	500	1,800	1,800	1,400	1,100			
1.-Alhué	4 ha	Ha/Crop	0.84	0.40	0.12	0.00	0.60	0.60	0.30	0.00	0.00	2.86	1.14	
		Benefit/Crop	252	192	145	-	300	1,080	540					2,509
2.- Popeta	5 ha	Ha/Crop	0.75	0.25	1.00	0.00	0.75	0.70	0.00	0.00	0.10	3.55	1.45	
		Benefit/Crop	225	120	1,206	-	375	1,260	-	-	110			3,296
3.- Yali	5,5 ha	Ha/Crop	0.94	0.55	0.28	0.00	0.77	0.77	0.55	0.00	0.00	4.00	1.50	
		Benefit/Crop	282	264	337.68	-	385	1,386	990	-	-			3,645
4.-Puangue		Ha/Crop	0.68	0.23	0.90	0.05	0.72	0.45	0.32	0.00	0.14	3.49	1.01	
(Curacavi M.	4,5 ha	Benefit/Crop	204	110	1,085	80	360	810	576	-	154			3,380
Pinto,Ibacache)														
5.- Casablanca		Ha/Crop	0.72	0.36	0.18	0.00	0.72	0.72	0.54	0.00	0.00	3.24	1.26	
	4,5 ha	Benefit/Crop	216	173	217	-	360	1,296	972	-	-			3,234
6.- Lampa		Ha/Crop	0.0	0.25	1.50	0.10	1.00	0.75	0.00	0.00	0.20	3.80	1.200	
	5 ha	Benefit/Crop	-	120	1,809	160	500	1,350	-	-	220			4,159

Medium and Large Scale Farmers

New Irrigation Area	Cultivation Area of Each Farming Type		Cereal Crops Area (ha)	Traditional Crops* Area (ha)	Vegetables Area (ha)	Flowers Area (ha)	Forage Crops Area (ha)	Fruits Area (ha)	Grapes (wine & Table) Area (ha)	Seedlings Production Area (ha)	Seed Production** Area (ha)	Subtotal	Others	Gross Income or Net Income of Farming Type ($000)
			356.70	605.46	1,206.90	2,000.00	637.00	2,330.00	2,400.00	2,000.00	1,597.00			
1.-Alhué	100 ha	Ha/Crop	15	10	6	1	12	25	18	0	3	90	10	
		Benefit/Crop	5,351	6,055	7,241	2,000	7,644	58,250	43,200	-	4,791			134,532
2.- Popeta	100 ha	Ha/Crop	20	0	10	1	15	29	6	2	8	91	9	
		Benefit/Crop	7,134	-	12,069	2,000	9,555	67,570	14,400	4,000	12,776			129,504
3.- Yali	100 ha	Ha/Crop	15	4	10	1	18	25	14	0	3	90	10	
		Benefit/Crop	5,351	2,422	12,069	2,000	11,466	58,250	33,600	-	4,791			129,948
4.-Puangue	100 ha	Ha/Crop	13	0	10	1.5	14	30	12	0	8	89	11	
(Curacavi M.		Benefit/Crop	4,637	-	12,069	3,000	8,918	69,900	28,800	-	12,776			140,100
Pinto,Ibacache)														
5.- Casablanca	100 ha	Ha/Crop	10	0	8	0	20	20	25	1	2	86	14	
		Benefit/Crop	3,567	-	9,655	-	12,740	46,600	60,000	2,000	3,194			137756
6.- Lampa	100 ha	Ha/Crop	5	0	25	2	18	30	0	1	10	91	9	
		Benefit/Crop	1,784	-	30,173	4,000	11,466	69,900	-	2,000	15,970			135,292

Source: Censo Nacional Agropecuario 1997

* Chacras (Traditional Crop) : Main crops which farmers cultivated in the land where was provided instead of salary during the plantation era (Potato, Maize, Beans, Melon and etc.).

** Seed Production: Seed for export and domestic consumption (Vegetable, Maize, Wheat and etc.).

Table 5.3.3 Gross Income per Unit Area in Project Area-wise

New Irrigation Area	Total Area (ha)	Farming Type		Area by Scale (ha)	Cereal Crops Area (ha) / $000	%	Traditional Crops+ Area (ha) / $000	%	Vegetables Area (ha) / $000	%	Flowers Area (ha) / $000	%	Forage Crops Area (ha) / $000	%	Fruits Area (ha) / $000	%	Grapes Area (ha) / $000	%	Seedlings Production Area (ha) / $000	%	Seed Production++ Area (ha) / $000	%	Subtotal %	Others %	Annual Income by Farming Scale	Project Area Total Annual Income	Project Area Total Yield
			Medium & Large		356.7		605.5		1,206.0		2,000.0		637.0		2,074.0		1,600.0		2,000.0		1,597.0						
			Small Scale		300.0		480.0		1,206.0		1,600.0		500.0		1,400.0		1,200.0		1,400.0		1,100.0						
1. Alhué	6,000	Medium & Large Scale Farmers	Land Holding Area	5,527	829.0	15	553.0	10	331.6	6	55.0	1	663.0	12	1,382.0	25	995.0	18	0.0	0	165.8	3	90	10			
			Total Benefit		295,704.3		334,841.5		399,933.7		110,000.0		422,331.0		2,866,268.0		1,592,000.0		0.0		264,798.6				6,285,877.09		
		Small Scale Farmers	Land Holding Area	473	99.0	21	47.0	10	14.2	3	0.0	0	71.0	15	71.0	15	33.0	7	0.0	0	0.0	0	71	29			
			Total Benefit		29,700.0		22,560.0		17,113.1		0.0		35,500.0		99,400.0		39,600.0		0.0		0.0				243,873.14	6,529,750.23	1,088.29
2. Popeta	5,000	Medium & Large Scale Farmers	Land Holding Area	3,496	524.0	15	0.0	0	350.0	10	35.0	1	524.0	15	1,014.0	29	385.0	11	70.0	2	280.0	8	91	9			
			Total Benefit		186,910.8		0.0		422,100.0		70,000.0		333,788.0		2,103,036.0		616,000.0		140,000.0		447,160.0				4,318,994.80		
		Small Scale Farmers	Land Holding Area	1,504	226.0	15	75.0	5	165.0	11	0.0	0	241.0	16	301.0	20	60.0	4	0.0	0	45.0	3	74	26			
			Total Benefit		67,800.0		36,000.0		198,990.0		0.0		120,500.0		421,400.0		72,000.0		0.0		49,500.0				966,190.00	5,285,184.80	1,057.04
3. Yali	10,000	Medium & Large Scale Farmers	Land Holding Area	7,400	1,110.0	15	296.0	4	740.0	10	74.0	1	1,332.0	18	1,850.0	25	1,036.0	14	0.0	0	222.0	3	90	10			
			Total Benefit		395,937.0		179,228.0		892,440.0		148,000.0		848,484.0		3,836,900.0		1,657,600.0		0.0		354,534.0				8,313,123.00		
		Small Scale Farmers	Land Holding Area	2,600	442.0	17	260.0	10	130.0	5	0.0	0	364.0	14	364.0	14	260.0	10	0.0	0	0.0	0	70	30			
			Total Benefit		132,600.0		124,800.0		156,780.0		0.0		182,000.0		509,600.0		312,000.0		0.0		0.0				1,417,780.00	9,730,903.00	973.09
4. Puangue (Curacavi, M. Pinto, Ibacache)	6,500	Medium & Large Scale Farmers	Land Holding Area	3,900	507.0	13	0.0	0	390.0	10	78.0	2	546.0	14	1,170.0	30	468.0	12	0.0	0	312.0	8	89	11			
			Total Benefit		180,846.9		0.0		470,340.0		156,000.0		347,802.0		2,426,580.0		748,800.0		0.0		498,264.0				4,828,632.90		
		Small Scale Farmers	Land Holding Area	2,600	390.0	15	130.0	5	520.0	20	26.0	1	416.0	16	260.0	10	182.0	7	0.0	0	78.0	3	77	23			
			Total Benefit		117,000.0		62,400.0		627,120.0		41,600.0		208,000.0		364,000.0		218,400.0		0.0		85,800.0				1,724,320.00	6,552,952.90	1,008.15
5. Casablanca	7,000	Medium & Large Scale Farmers	Land Holding Area	6,046	605.0	10	0.0	0	484.0	8	0.0	0	1,209.0	20	1,209.0	20	1,512.0	25	60.0	1	121.0	2	86	14			
			Total Benefit		215,803.5		0.0		583,704.0		0.0		770,133.0		2,507,466.0		2,419,200.0		120,000.0		193,237.0				6,809,543.50		
		Small Scale Farmers	Land Holding Area	954	153.0	16	76.0	8	38.0	4	0.0	0	153.0	16	153.0	16	114.0	12	0.0	0	0.0	0	72	28			
			Total Benefit		45,900.0		36,480.0		45,828.0		0.0		76,500.0		214,200.0		136,800.0		0.0		0.0				555,708.00	7,365,251.50	1,052.18
6. Lampa	5,000	Medium & Large Scale Farmers	Land Holding Area	2,500	125.0	5	0.0	0	625.0	25	50.0	2	450.0	18	750.0	30	0.0	0	25.0	1	250.0	10	91	9			
			Total Benefit		44,587.5		0.0		753,750.0		100,000.0		286,650.0		1,555,500.0		0.0		50,000.0		399,250.0				3,189,737.50		
		Small Scale Farmers	Land Holding Area	2,500	0.0	0	125.0	5	750.0	30	25.0	1	500.0	20	375.0	15	0.0	0	0.0	0	50.0	2	73	27			
			Total Benefit		0.0		60,000.0		904,500.0		40,000.0		250,000.0		525,000.0		0.0		0.0		55,000.0				1,834,500.00	5,024,237.50	1,004.85
Total				39,500	1,717,800.0	13	857,871.5	4	5,477,136.7	11	665,943.0	1	3,888,157.0	16	17,438,249.0	22	7,817,445.0	13	310,155.0	0	2,349,067.4	4	84	26			

Source: Censo Nacional Agropecuario 1997

\+ Chacras (Traditional Crop) : Main crops which farmers cultivated in the land where was provided instead of salary during the plantation era (Potato, Maize, Beans, Melon and etc.).

++ Seed Production: Seed for export and domestic consumption (Vegetable, Maize, Wheat and etc.).

Table 5.3.4 Small Scale Farmers' Farming Plan in Rehabilitation Area

crop \ Sub-basin		2. Río Clarillo		4. Est. Lampa		6. Río Angostura (Cachapoal)		8. Cue. Melipilla		9. Est. Puangue		Total	
		present	plan	present	plan	present	plan	present	plan	present	plan	present	plan
1. Fruits	ha	145.2	169.4	117.4	215.3	394.6	429.2	591.7	698.5	355.4	419.5	1,604.3	1,932.0
	%	10.2	12.5	1.8	3.3	11.4	12.4	7.2	8.5	7.2	8.5	6.5	7.9
2. Grapes for Wine Production	ha	21.4	21.4	-	-	-		-	-	-	-	21.4	21.4
	%	1.5	1.5	-	-	-		-	-	-	-	0.1	0.1
3. Vegetables and Flowers	ha	226.4	226.4	3,262.2	3,262.2	394.6	429.2	1,955.9	1,955.9	1,174.7	1,174.7	7,013.7	7,048.3
	%	15.9	15.9	50.0	50.0	11.4	12.4	23.8	23.8	23.8	23.8	28.6	28.7
4. Cereals	ha	435.7	418.6	1,122.2	1,056.9	1,145.6	1,076.4	1,331.4	1,249.2	799.6	750.2	4,834.4	4,551.3
	%	30.6	29.4	17.2	16.2	33.1	31.1	16.2	15.2	16.2	15.2	19.7	18.5
5. Field Crops	ha	54.1	54.1	163.1	163.1	138.4	138.4	427.4	427.4	256.7	256.7	1,039.7	1,039.7
	%	3.8	3.8	2.5	2.5	4.0	4.0	5.2	5.2	5.2	5.2	4.2	4.2
6. Industrial Crops	ha	27.1	27.1	-	-	100.4	100.4	-	-	-	-	127.4	127.4
	%	1.9	1.9	-	-	2.9	2.9	-	-	-	-	0.5	0.5
7. Forage Crops	ha	165.2	179.4	117.4	182.7	100.4	100.4	394.5	476.7	236.9	286.3	1,014.4	1,225.4
	%	11.6	12.6	1.8	2.8	2.9	2.9	4.8	5.8	4.8	5.8	4.1	5.0
8. Forage	ha	225.0	225.0	815.5	815.5	1,086.8	1,086.8	2,342.2	2,342.2	1,406.7	1,406.7	5,876.1	5,876.1
	%	15.8	15.8	12.5	12.5	31.4	31.4	28.5	28.5	28.5	28.5	23.9	23.9
9 .Fallow	ha	123.9	102.5	926.5	828.6	100.4	100.4	1,175.2	1,068.4	705.8	641.6	3,031.7	2,741.5
	%	8.7	7.2	14.2	12.7	2.9	2.9	14.3	13.0	14.3	13.0	12.3	11.2
Total	ha	1,423.8	1,423.8	6,524.3	6,524.3	3,461.0	3,461.0	8,218.2	8,218.2	4,935.6	4,935.6	24,562.9	24,562.9
No. of Small Farmers	No.	341		1,331		901		2,184		1,018		5,775	
Farming Area	ha	1423.8		6,524.3		3,461.0		8,218.2		4,935.6		24,562.9	
Average Farming Area	ha	4.18		4.90		3.84		3.76		4.85		4.25	

Table 5.3.5 Medium and Large Scale Farmers' Faming Plan in Rehabilitation Area

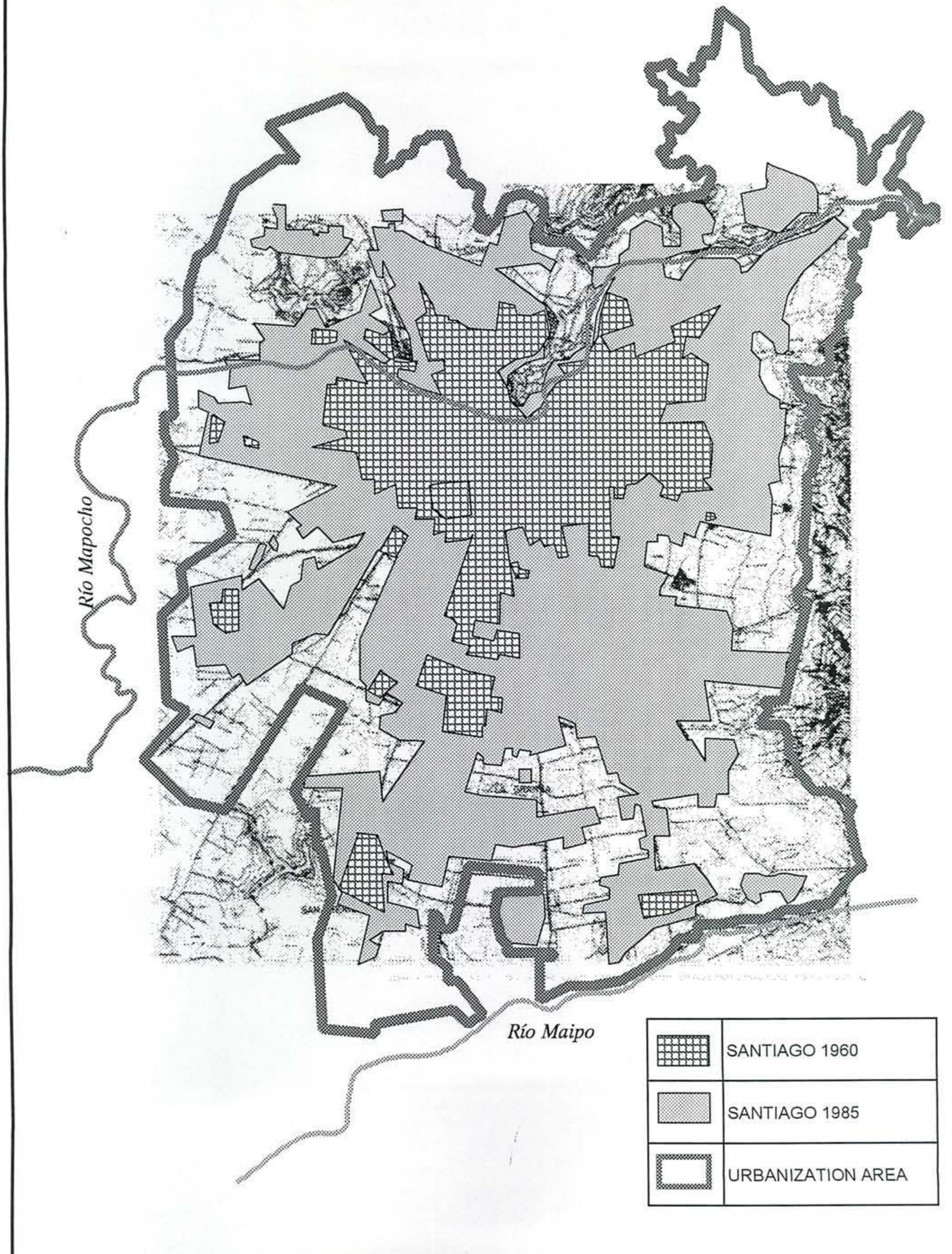
Crop \ Sub-basin / Region		2. Río Clarillo		4. Est. Lampa		6. Río Angostura		8. Cue. Melipilla		9. Est. Puangue		Total	
		Cordillera		Chacabuco		Talagante, Maipo Cachapoal		Melipilla		Melipilla			
		present	plan	present	plan	present	plan	present	plan	present	plan	present	plan
Fruits	(ha)	1,573.2	1,636.5	5,601.9	5,757.1	20,647.8	21,091.5	6,245.4	6,503.2	1,619.0	1,707.8	35,687.3	36,696.1
	%	25.7	26.7	37.7	38.7	43.0	44.0	24.3	25.3	15.5	16.5	33.9	35
Grapes	(ha)	563.4	563.4	93.5	93.5	3,951.1	3,951.1	410.7	410.7	314.6	314.6	5,333.3	5,333.3
	%	9.2	9.2	0.6	0.6	8.2	8.2	1.6	1.6	3.0	3.0	5.1	5.1
Vegetables	(ha)	0.0	0.0	3,520.9	3,520.9	3,045.0	3,045.0	1,872.2	2,139.0	1,034.5	1,034.5	9,472.6	9,739.4
	%	0.0	0.0	23.7	23.7	6.3	6.3	7.3	8.3	9.9	9.9	9.0	9.00728954
Flowers	(ha)	22.3	22.3	11.4	11.4	48.5	48.5	6.7	6.7	1.6	1.6	90.5	90.5
	%	0.4	0.4	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1
Cereals	(ha)	267.7	147.0	0.0	0.0	7,545.4	7,103.3	6,032.2	5,772.8	1,834.3	1,728.4	15,679.6	14,751.5
	%	4.4	2.4	0.0	0.0	15.8	14.8	23.4	22.4	17.6	16.6	14.9	14
Field Crops	(ha)	0.0	0.0	0.0	0.0	871.0	871.0	612.2	612.2	1,216.5	1,114.1	2,699.7	2,597.3
	%	0.0	0.0	0.0	0.0	1.8	1.8	2.4	2.4	11.7	10.7	2.6	2.5
Industrial Crops	(ha)	0.0	0.0	24.0	24.0	0.0	0.0	1.7	1.7	1.0	1.0	26.7	26.7
	%	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Forage Crops	(ha)	1,453.5	1,514.0	3,773.2	3,773.2	3,541.0	4,031.6	8,426.9	8,426.9	3,326.9	3,446.4	20,521.5	21,192.1
	%	23.7	24.7	25.4	25.4	7.4	8.4	32.7	32.7	32.1	33.1	19.5	20.2
Seedling	(ha)	5.1	5.1	20.4	20.4	332.7	332.7	35.9	35.9	0.5	0.5	394.6	394.6
	%	0.1	0.1	0.1	0.1	0.7	0.7	0.1	0.1	0.0	0.0	0.4	0.4
Seeds	(ha)	90.7	153.1	1,081.1	1,081.1	3,489.0	3,489.0	1,037.8	1,037.8	851.4	851.4	6,550.0	6,612.4
	%	1.5	2.5	7.3	7.3	7.3	7.3	4.0	4.0	8.2	8.2	6.2	6.3
Forest Products	(ha)	2,149.7	2,084.2	734.8	579.6	4,523.8	4,031.6	1,089.9	824.7	211.7	211.7	8,709.9	7,731.8
	%	35.0	34.0	4.9	3.9	9.4	8.4	4.2	3.2	2.0	2.0	8.3	7.4
Total	ha	6,125.6	6,125.6	14,861.2	14,861.2	47,995.3	47,995.3	25,771.6	25,771.6	10,412.0	10,412.0	105,165.7	105,165.7

Source; Agriculture and Forestry Census 1997

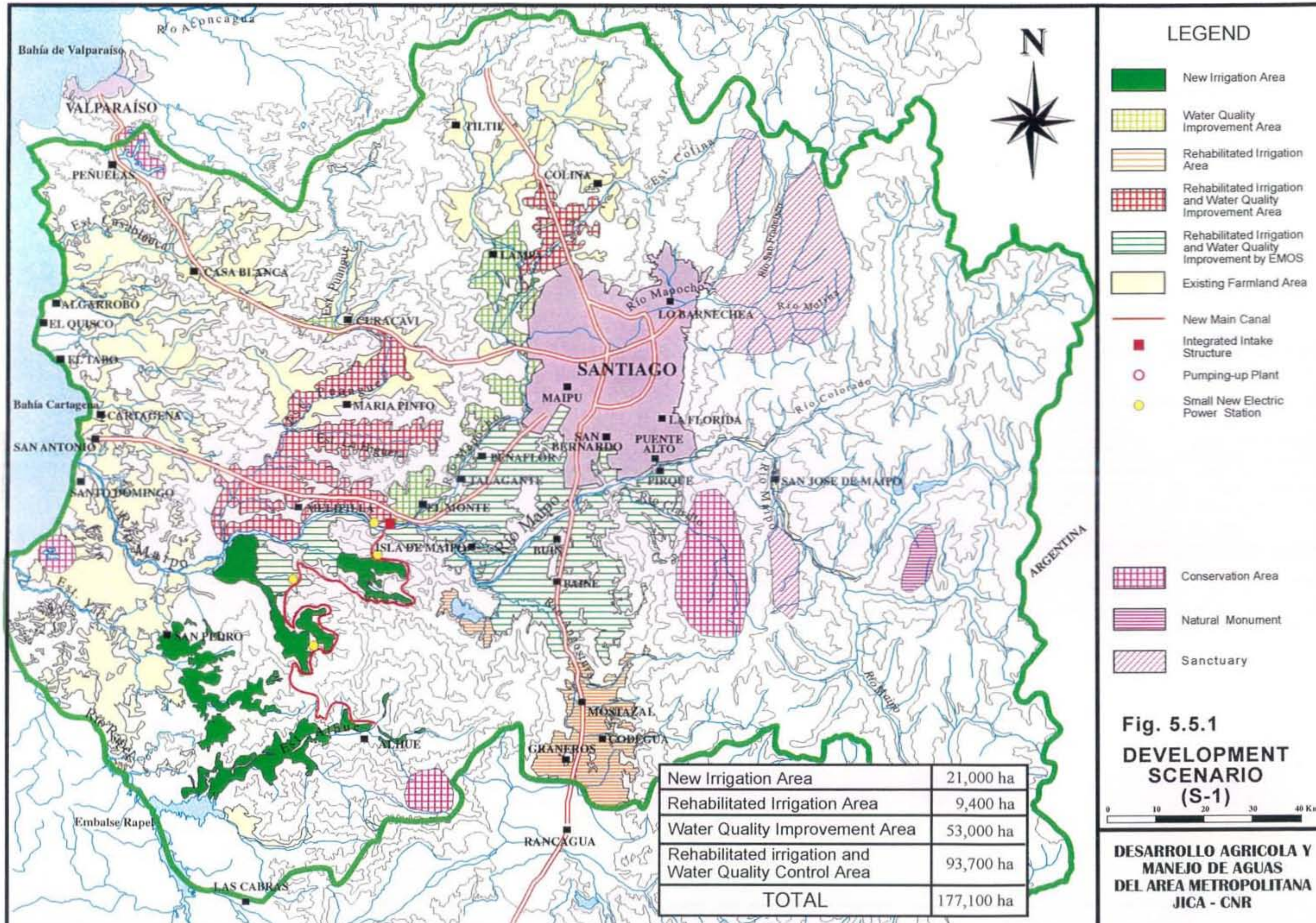
Table 5.6.1 Project Implementation Schedule

Development Items	Main Component	Quantities	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1. Agricultural Production Development Project														
Provision of Fund		1.0	Unit	□	□									
Survey and Design		1.0	Unit	□	□	□	□							
(1) New Irrigation Development Project														
Construction of Middle Scale Dams	Dams	2.0	Places		■	■	■	■	■	▨	▨	▨	▨	▨
Construction of Canals	Canals	12.0	km			■	■	■	■	■	▨	▨	▨	▨
Construction of Field ditches	Field Ditches	550.0	ha					■	■	■	■	▨	▨	▨
Construction of Integrated Diversion Weir	Diversion Weir	600.0	m			■	■	■	■	▨	▨	▨	▨	▨
Construction of Canals	Canals	154.0	km			■	■	■	■	■	■	■	■	■
Construction of Field ditches	Field Ditches	21,000.0	ha						■	■	■	■	■	■
(2) Irrigation Facilities Rehabilitation Project														
Rio Clarillo	Irrigation Facilities	15.0	km		■	■	▨	▨	▨	▨	▨	▨	▨	▨
Est. Lampa	Irrigation Facilities	62.5	km		■	■	■	▨	▨	▨	▨	▨	▨	▨
Rio Angostura	Irrigation Facilities	235.0	km		■	■	■	■	■	▨	▨	▨	▨	▨
Est. Melipilla	Irrigation Facilities	211.0	km		■	■	■	■	■	▨	▨	▨	▨	▨
Est. Puange	Irrigation Facilities	98.0	km		■	■	■	■	▨	▨	▨	▨	▨	▨
2. Water Quantity Improvement Project														
Provision of Fund		1.0	Unit	□	□									
Survey and Design		1.0	Unit	□	□									
(1) Sewage Treatment Facilities	Treatment Facilities	12.0	Places		■	■	■	■	■	■	■	■	■	■
(2) Detour	Canals	5.0	km			■	■	■	■	■	▨	▨	▨	▨
3. Rural Infrastructure Development Project														
Provision of Fund		1.0	Unit	□	□									
Survey and Design		1.0	Unit	□	□	□								
(1) Rural Water Supply Facilities	Water Supply Facilitie	52.0	Places		■	■	■	■	▨	▨	▨	▨	▨	▨
(2) Rural Sewage Treatment Facilities	Sewage Treatment Fac	39.0	Places		■	■	■	■	■	■	■	■	▨	▨
(3) Rural road	Low Cost Pavement	191.0	km		■	■	■	■	■	■	■	▨	▨	▨
4. Environmental Management Project														
Preparation and Plan		1.0	Unit	□	□									
(1) Educational Promotion Project	Promotion Project	2.0	Peoples		▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
(2) Agricultural Environment Promotion Project	Promotion Project	2.0	Peoples		■	■	■	■	▨	▨	▨	▨	▨	▨
(3) Environmental Monitoring Project	Monitoring Project	3.0	Peoples			■	■	■	▨	▨	▨	▨	▨	▨

□ Preparation and Plan ■ Execution ▨ Management



DESARROLLO AGRICOLA Y MANEJO DE AGUAS DEL AREA METROPORITANA (JICA - CNR)	Fig. 5.2.1 Urban Planning Area

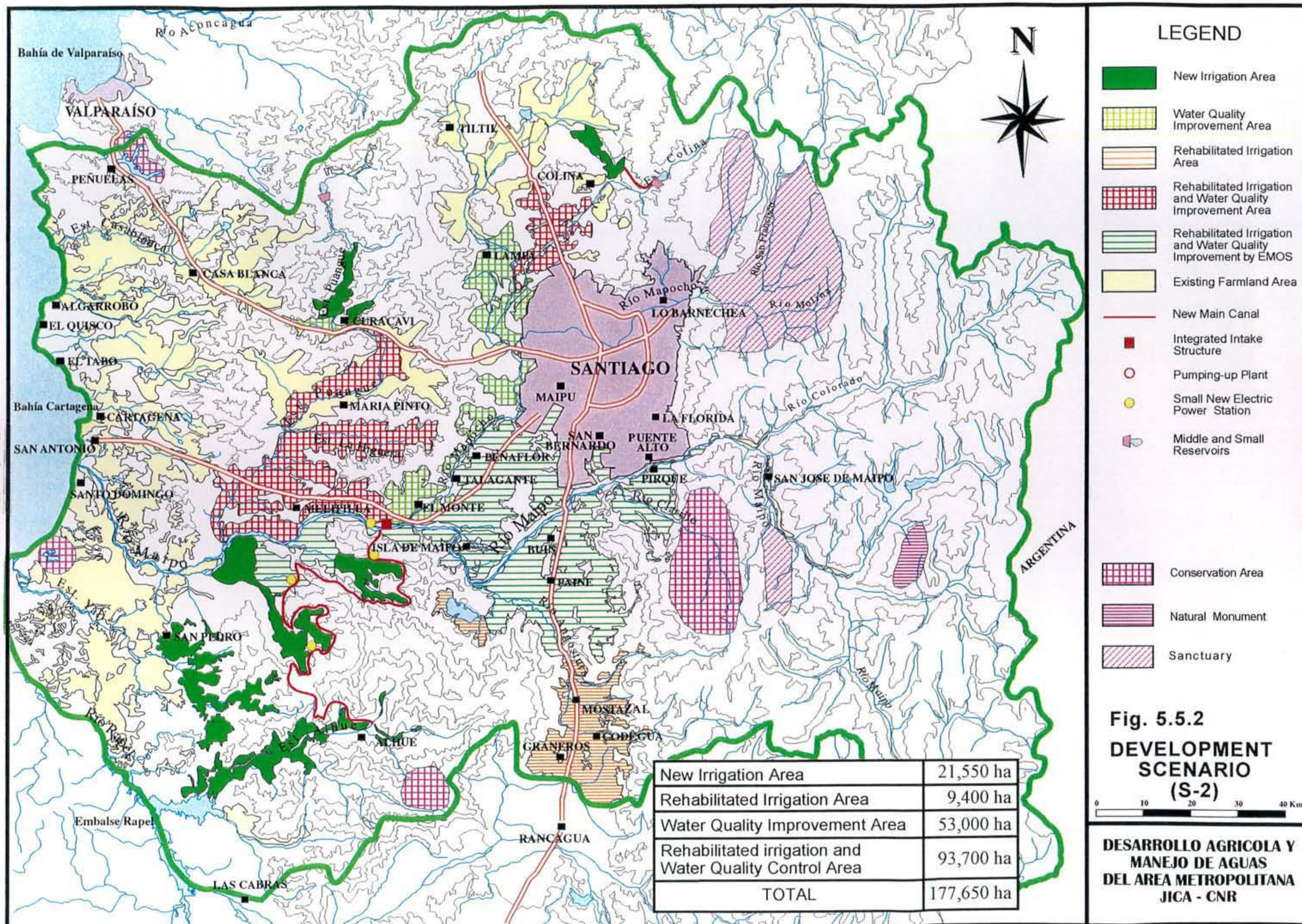


New Irrigation Area	21,000 ha
Rehabilitated Irrigation Area	9,400 ha
Water Quality Improvement Area	53,000 ha
Rehabilitated irrigation and Water Quality Control Area	93,700 ha
TOTAL	177,100 ha

Fig. 5.5.1

DEVELOPMENT SCENARIO (S-1)

DESARROLLO AGRICOLA Y MANEJO DE AGUAS DEL AREA METROPOLITANA
JICA - CNR

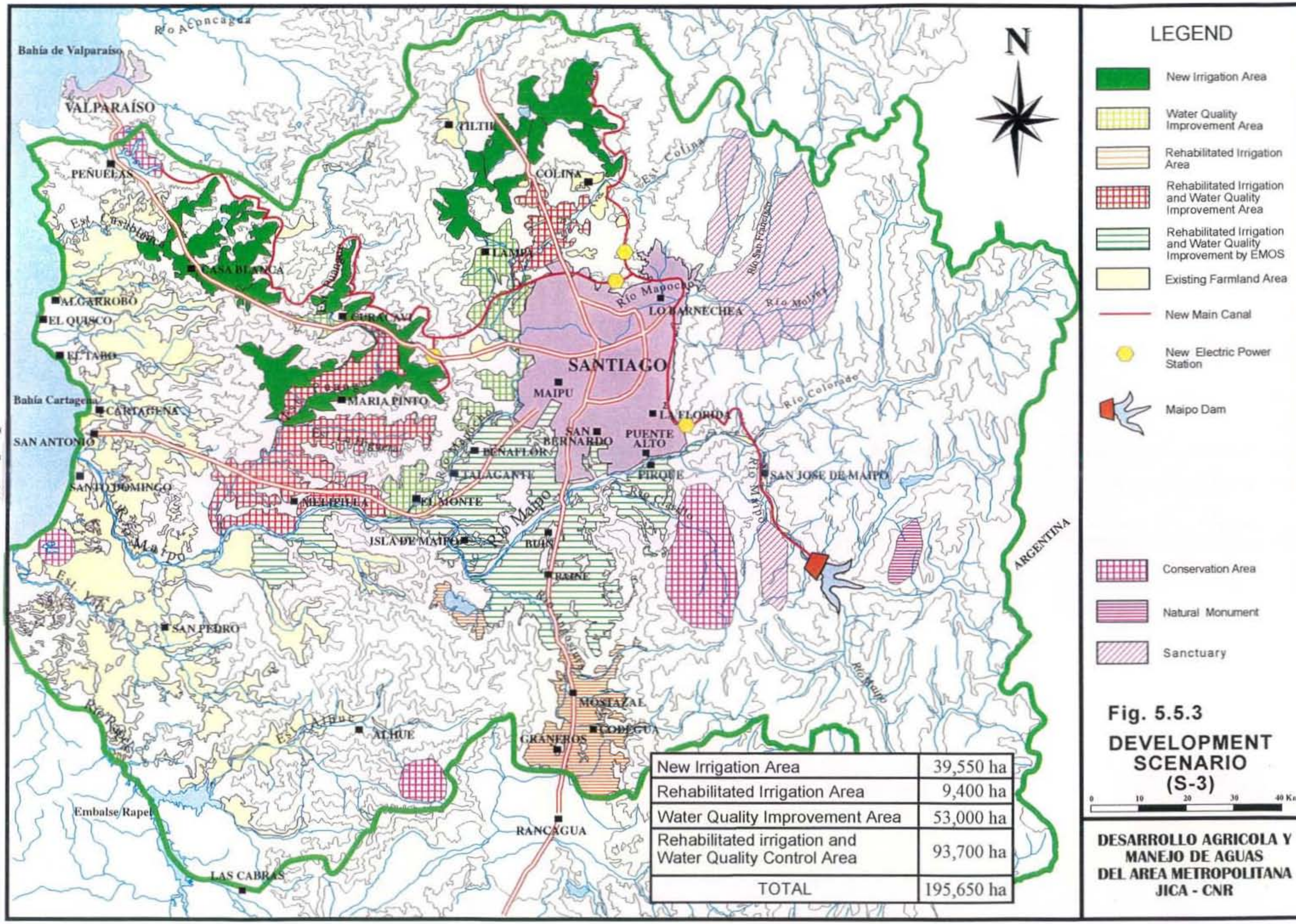


New Irrigation Area	21,550 ha
Rehabilitated Irrigation Area	9,400 ha
Water Quality Improvement Area	53,000 ha
Rehabilitated irrigation and Water Quality Control Area	93,700 ha
TOTAL	177,650 ha

Fig. 5.5.2

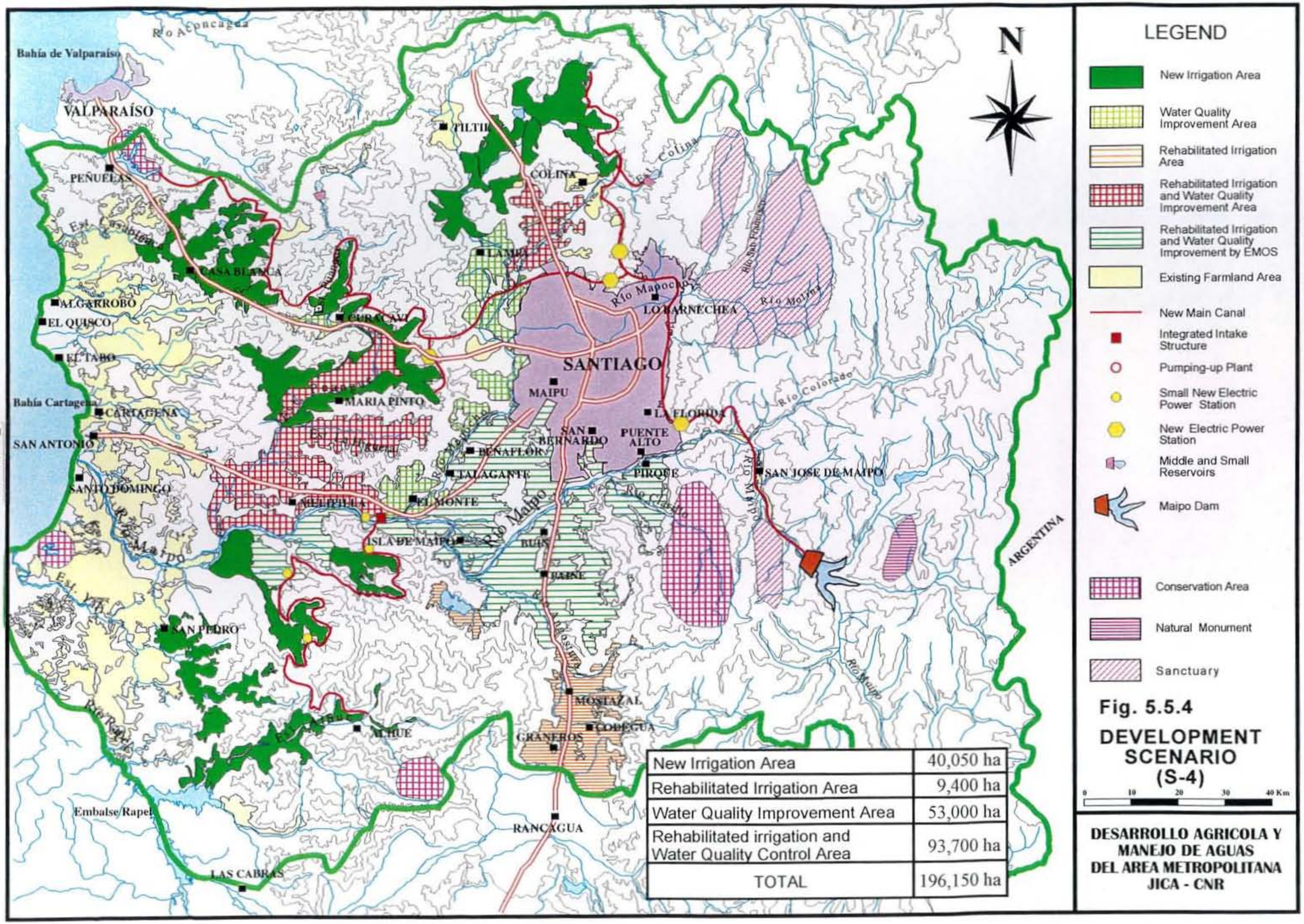
DEVELOPMENT SCENARIO (S-2)

DESARROLLO AGRICOLA Y MANEJO DE AGUAS DEL AREA METROPOLITANA
JICA - CNR



New Irrigation Area	39,550 ha
Rehabilitated Irrigation Area	9,400 ha
Water Quality Improvement Area	53,000 ha
Rehabilitated irrigation and Water Quality Control Area	93,700 ha
TOTAL	195,650 ha

Fig. 5.5.3
DEVELOPMENT SCENARIO (S-3)



New Irrigation Area	40,050 ha
Rehabilitated Irrigation Area	9,400 ha
Water Quality Improvement Area	53,000 ha
Rehabilitated irrigation and Water Quality Control Area	93,700 ha
TOTAL	196,150 ha

Fig. 5.5.4

DEVELOPMENT SCENARIO (S-4)

DESARROLLO AGRICOLA Y MANEJO DE AGUAS DEL AREA METROPOLITANA JICA - CNR

CHAPTER 6

CONCLUSION AND RECOMMENDATION

6 CONCLUSION AND RECOMMENDATION

6.1 Conclusion

(1) The study area inhabiting over one third (1/3) of national population plays an important role on the national economy as a major area on fresh food supply to the capital areas and export crop cultivation. Recent progress of the national economy is accelerating an expansion of infrastructure regarding land and water, which are to utilize for non-agricultural purpose, and invading to farmland and using irrigation water mostly occurs its expansion. Also, agriculture in the study area involves structural problems caused by the scale of land holding such as a gap on infrastructure of farming and management among the farmers. It is urgently required that increase of agricultural productivity including the development of new irrigated land in the existing farmland in order to maintain stable supply of fresh agricultural products to the capital market and to play role of major production area for export agricultural cultivation.

(2) Through the study on present situation of the objective area, problems inherent in the regional agriculture are recognised as difficulties of farm management on small scale farmers, tightness and competition of water utilisation, pollution of irrigation water and decrease of farmland. Measures to solve such problems, master plan of "Agricultural development and water management in Metropolitan area" targeted year 2010 is studied comprising of promotion of agriculture, effective use of natural resources and environmental conservation. In the study, development scenarios of the study area are set up on the basis of the newly usable water resources development alternatives. After evaluation of each scenario in view of the social and economical impacts, optimum scenario is proposed as the master plan to develop the study area. Major components of the master plan consist of the following;

- 21,550 ha of new irrigation area using the newly constructed small dams and unused water rights,
- structural rehabilitation on 5 existing irrigation systems commanding of 103,088 ha,
- water quality improvement related to 15 existing irrigation system, and
- improvement of rural living condition composing rural water supply, rural sewage works and rural road improvement.

6.2 Recommendation

(1) In the proposed new irrigation plan on the middle and the lower streams (the second and the third sections) of the Maipo river, integration of the existing intake structures is planned in connection with the rehabilitation works of the existing irrigation systems. Those intake structures of the existing irrigation system are scattered at present in the second and the third sections of the Maipo river. Recently, preparation of establishing the "Junta de Vigilancia" for adjustment of water utilization among water users is going on in the second and the third sections. Integration of the intake structures proposed in the master plan supports from the aspect on facilities for adjustment of water utilization among the users. With these views, it is recommended to execute the project urgently.

(2) In case of Chile, water is belong to personal property based on the water right. It is also a social common capital . In other word, its perception is that it is important for construction, management and preservation of the property essential for existence of human life. Therefore, it is necessary to take legal measures for punishment in somehow for the purpose of effective use of limited resources against to unused water right and reusable water right.

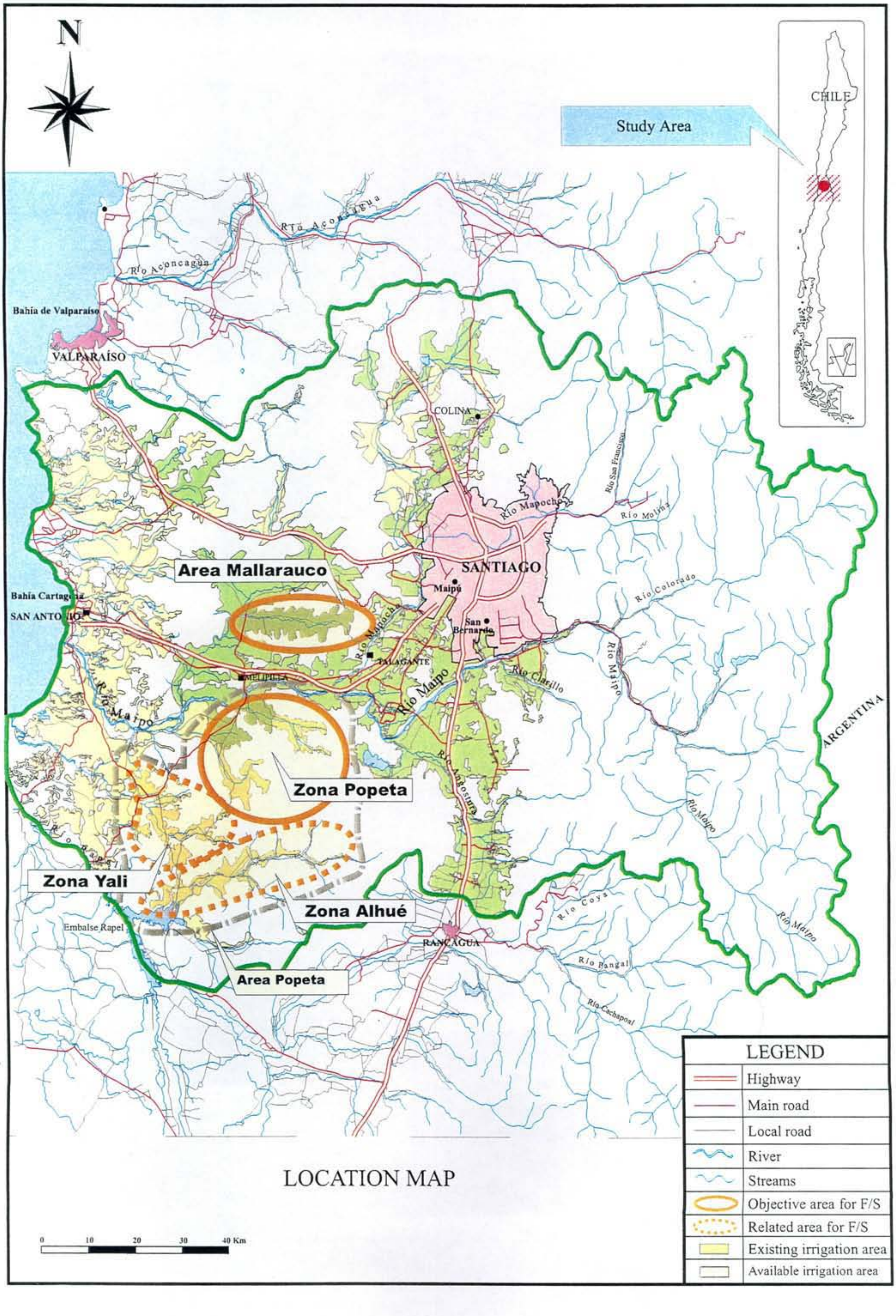
(3) Water quality improvement of canals drawing water from the Mapocho river is to be benefited entire environment of rural livings on not only economic factor such as crop diversification and maintaining quality of products for export but also health care and reduction of malodorous etc. Environmental improvement works is required to execute as public works by utilizing government fund because it is difficult to carry out as the projects of private sector and is required large amount of investment compared with the benefit obtained directly.

(4) Active situation of recent export agricultural market has accelerated development of new farmland and water source for cultivation is mostly depend on groundwater due to the condition of development area. Such situation showed decline of water level and interference of groundwater, and some area take an action to control for new groundwater development in the study area. Groundwater development under the present situation is not possible for large scale agricultural development. Groundwater utilization shall be limited only to small scale development or supplemental use taking the fostering amount into account.

(5) Decrease of water losses in major facility of present irrigation systems, especially lining of main canals, is to increase availability of water use at farm level. Irrigation is shared majority of water use in the study area and effects of saving water is high, therefore, positive promotion of improvement on major facility of present irrigation system is proposed.

(6) Conversion of land use from farmland to urban use is irreversible. Farmland located in urban area is commonly involving alteration factor to the urban land use. Based on the expanding metropolitan economic bloc, alteration of land use is accelerated at the farmland in the study area located the suburbs of metropolitan area. This phenomenon is occurred by the demand on expansion of urban land use from the urban side, and abandonment of agricultural land use due to aggravation of farming condition. Aiming at the balanced development between urban and rural areas, conservation plan of the farmland located the suburbs of metropolitan area should be taken along with the present urban planning. In view of the market oriented economy, strengthening of the regulations from the taxation system is required for the land acquisition, alteration on purpose of utilization and so on.

Part II Feasibility Study



LOCATION MAP

AGRICULTURAL DEVELOPMENT AND WATER MANEGEMENT IN METROPOLITAN AREA, CHILE

FEASIBILITY STUDY

Table of Contents

Page

Location Map

1 AGRICULTURAL DEVELOPMENT PROJECT IN POPETA AREA

2 AGRICULTURAL DEVELOPMENT PROJECT IN MALLARAUCO AREA

List of Tables

List of Figures

CHAPTER 1

AGRICULTURAL DEVELOPMENT PROJECT IN POPETA AREA

1 AGRICULTURAL DEVELOPMENT PROJECT IN POPETA AREA

1.1 Present Situation of Popeta Area

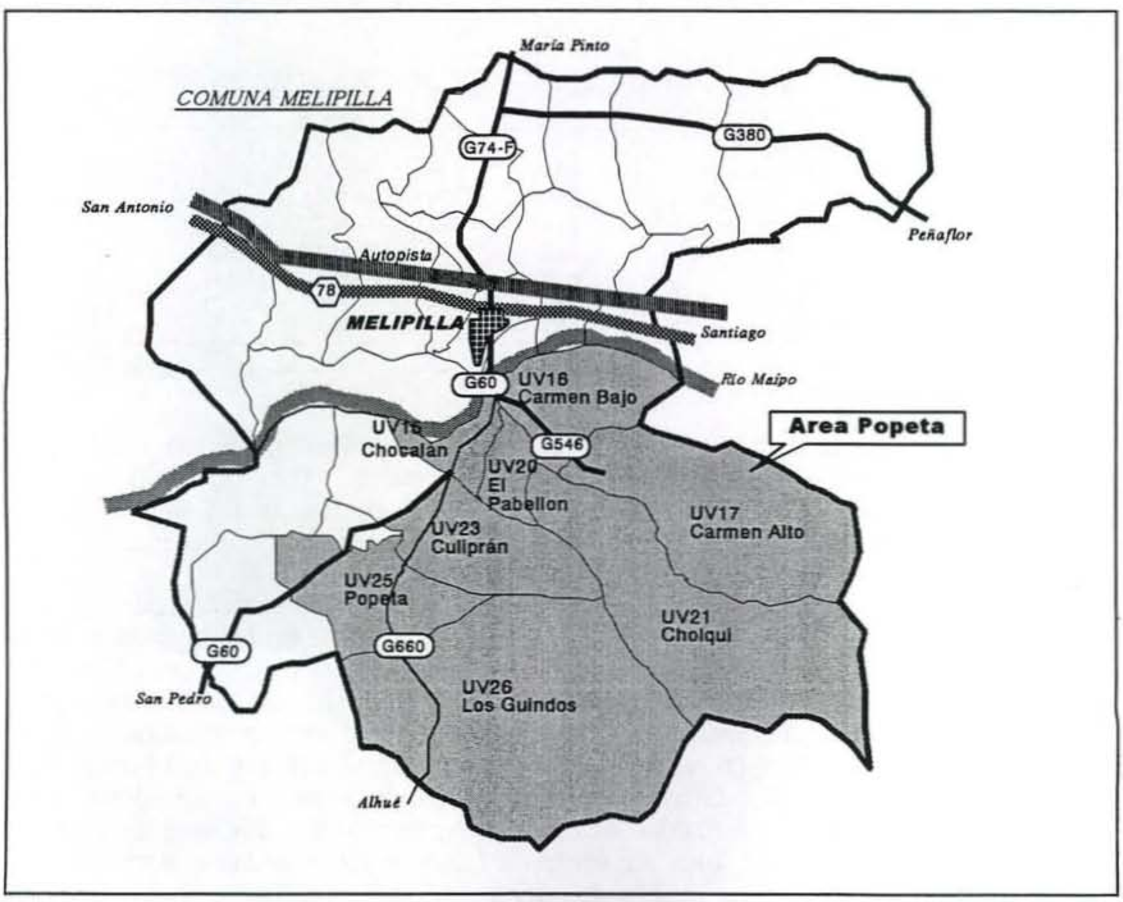
1.1.1 Present Social Situation

(1) Administrative organizations

Popeta area where is the objective area of Feasibility Study belongs to *Comuna* Melipilla and is located in the southern part of the Maipo river. Administratively, Popeta area consists of eight (8) *Unidad Vecinal* (United community: hereinafter referred to as the UV), and each *UV* consists of several *Junta de Vecinos* (Council of community: hereinafter referred to as the JJVV). UV and JJVV are defined as organizations which approved their right of self-governance legally and promote decentralization. Constitutions of the area are as follows;

Area	No.	UV	No. of Council of community
Popeta area	UV15	Chocalán	2
	UV16	Carmen Bajo	3
	UV17	Carmen Alto	2
	UV20	El Pabellon	1
	UV21	Cholqui	3
	UV23	Culiprán	4
	UV25	Popeta	2
	UV26	Los Guindos	2

Distribution of UV in Popeta area is as following figure.



(2) Population

Population of Popeta area is 8,447 persons, according to the Census '92. Population of each UV are as follows;

Area		*Unidad Vecinal*	Household	Total	Male	Female
Popeta area	UV15	Chocalán	177	687	341	346
	UV16	Carmen Bajo	285	1,125	595	530
	UV17	Carmen Alto	217	849	453	396
	UV20	El Pabellon	344	1,211	651	560
	UV21	Cholqui	240	915	484	431
	UV23	Culiprán	413	1,736	923	813
	UV25	Popeta	321	1,309	690	619
	UV26	Los Guindos	107	615	399	216
		Total	2,104	8,447	4,536	3,911

Source : Melipilla - SECPLAC

Age composition in the study area represents almost same shape with national average. Yet, the ratio of economically inactive population (0-15 years old and older than 65 years old) is higher, 32% while the main population of economic production activities (from 31 to 50 years old) is lower than national average. This might be caused by following reasons; the principal industry in the area is agriculture and the area is a pure farm area where most of inhabitants engage in agriculture; a part of economically active population demand job opportunities out of region because it is relatively close to the metropolitan area of Santiago.

(3) Rural society

About 84% of constituents of rural society in Popeta area are farmers. Among them, small scale farmers occupies about 90%. Breakdown of constituents is as follows.

Area		*UV*	Household	Farmer	Small scale	Medium scale	Large scale
Popeta area	UV15	Chocalán	177	115	98	12	5
	UV16	Carmen Bajo	285	198	145	45	8
	UV17	Carmen Alto	217	206	186	15	5
	UV20	El Pabellon	344	224	207	13	4
	UV21	Cholqui	240	216	185	24	7
	UV23	Culiprán	413	392	373	14	5
	UV25	Popeta	321	305	278	21	6
	UV26	Los Guindos	107	99	83	13	3
Total			2,104	1,755	1,555	157	43

Source : REA-CIREN 95

Among the constituents of UV mentioned above, most of medium and large scale farmers carry out enterprise type of farm management. They do not live in the area and has become absentee landowners. Therefore, operation of UV is undertaken by small scale farmers who settle down in the area.

The smallest unit as a group is JJVV in the area. It is possible to consider that the JJVV is an unit of community because it is organized based on territorially related connection. Hereafter, when the Report says "community," it refers to JJVV. The communities in the area are extended into both sides of main roads and shape row communities. There are few concentrated communities and dense communities. This is because farmland was divided at right angle along with roads and distributed with long and narrow shaped. So, farm households constructed their houses along with roads, and then this shape was formed. Consequently, farmland and houses are located in the same lots. It is hard to form the centers of communities because communities shape row but the places where public facilities such as churches and schools are located are regarded as the centers of the communities. Distance between communities is ranged approximately from 1 to 4 km.

(4) Rural organizations

UV is a core of rural society. As the other associations that form the rural society, there are Council of community (*JJVV*), Center of Mother (*Centro de Madres*), Sports club (*Clubes Deportivos*), Aid committee (*Comités Allegados*), Young man's association (*Grupos Juveniles*), Culture club (*Centros Culturales*), and so on. Through activities of these associations, inhabitants of the area promote the activities of self-governance in the area with deepening solidarity by enhancing mutual friendship and help.

The fundamental of each organization is JJVV, and its integrated unit is UV. So, basically JJVV is established in each organization.

Establishing JJVV, the mother bodies are often territorially related groups. The membership is the inhabitant who is older than 18 years old. President, director general, and secretary are selected by mutual vote. JJVV have to submit a members' list to *Comuna*, hold general meeting, and make an annual report. Each JJVV holds monthly meetings and discusses the present facing problems, the direction of regional operation, project plans, and so on.

Distribution of each inhabitants' organization in the area is as follows;

Area	*UV*		Juntas de Vecinos	Centro de Madres	Clubes Deportivos	Comités Allegados	Grupos Juveniles	Centros Culturales
Popeta	UV15	Chocalán	2	1	2	1	-	-
	UV16	Carmen Bajo	3	1	3	1	-	1
	UV17	Carmen Alto	2	1	2	1	-	-
	UV20	El Pabellon	1	1	1	1	-	-
	UV21	Cholqui	3	1	3	1	-	-
	UV23	Culiprán	3	1	3	1	1	1
	UV25	Popeta	2	1	2	1	-	-
	UV26	Los Guindos	2	1	2	1	-	-
	Total		18	8	18	8	1	2
Comuna Melipilla			100	50	84	42	2	21

(5) Gender

According to the data of MIDEPLAN-CASEN 96 (Socio-economic Characterization Survey), the effect of economic growth and social policy is shown at the national level, for example, the percentage of poor and extremely poor households got about halved, compared with 1987. Nevertheless, income disparity has not shrunken but relatively expanded.

The ratio of the extremely poor in *Comuna* Melipilla is high, compared to that in whole the Metropolitan Region. Yet, the ration is 3.4% and is about 60% of national average. That of the poor is also low, 17.5% and 76% of national average. The other indicators also tend to be more improved, compared with the national average. Nevertheless, illiteracy rate is 1.5 times as much as national average and 2.7 times as much as the Metropolitan Region's one, or 7.2%. The improvement of educational environment can be said the problem. Indicators in *Comuna* Melipilla are summarized as follows;

Index			*Comuna*	Metropolitan	Nation wide
Illiteracy rate	Total	%	7.2	2.7	4.9
Poverty line	The extremely poor	%	3.4	2.7	5.7
	Non extremely poor	%	13.3	12.1	17.5
	Not extremely poor	%	83.3	85.2	76.8

Source; Casen96, MIDEPLAN

In many cases, the women's share of works in Popeta area is also limited to housework and bringing up children as well as other rural areas. The concept that men work outside and women protect houses takes root. Therefore, women are isolated from the activities of JJVV and economic activities. The reason of this situation is that there are not enough training and education of skills for economic independence and of organized activities for women.

Dealing with this, INDAP promotes the support program for rural women's independence (PRODEMU) under the cooperation with National Service of Women (SERNAM, set up within MIDEPLAN in 1991). PRODEMU promotes participation of women on the field of green house cultivation and agricultural processing as the main activity. There is one organizations (*Taller Tierra Verde*) which is working with acquisition of skills for economic independence through establishing producers' organizations by women in Popeta area. Producers' organizations by rural women are also working in El Bajo area and San José area which are located around Popeta area.

Accordingly, the activities for improving rural women's status are taking root, gradually. So as to establish this tendency more effectively, establishing organizations of women in community level is needed. For this, improvement and construction of the base facilities for interchange among rural women and the support system for establishing organization are indispensable. It is also important to establish the system that each producers' organization by rural women can interchange about experience of establishing organization and management method, problems from now on and, so on. Interchanging between the existing organizations and rural women encourages the rural women who want to establish organizations greatly, and will be a motive power to promote independence of rural women. Therefore, careful systematization as mentioned above is an important problem for SECPLAC which promotes decentralization.

1.1.2 Natural Resources

(1) Geology

Popeta basin consists of a plain where old riverbed deposit and terrace deposit of Quaternary age cover the valley formed by impervious bed rock. However, the surface layer is a tableland composed by Alluvial pumice volcanic ash. The existing rivers flow and erode these tableland. Diluvium aquifers are overlain by the volcanic ash deposit, and development of alluvial deposit along the existing rivers is poor. Pumiceous volcanic ash deposit is not distributed at Yali and Alhué areas. Deposits of Diluvium and Alluvium accumulates continuously and forms terraces ranging from 2 to 5m high along the existing river bed. Groundwater is taken from deep Diluvium layer for agriculture and from shallow Alluvium layer for drinking water at present. The former is superior on the amount of pumping discharge than that of latter.

(2) Climate

Popeta area is located in the south-west of the objective area. Melipilla meteorological station represents the climatic factors in the south-west of the area. The station is located in the coastal mountainous areas and being observed the items to estimate the crop evapo-transpiration. Study on the meteorological items concerning the priority development area will be made using the observed value at the Melipilla station. General climatic features of the Melipilla station are as follows;

Item	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Temperature (°C)													
Max.	32.2	32.4	31.1	29.0	25.2	21.8	21.9	23.8	26.8	28.4	31.1	32.5	28.0
Min.	7.4	7.2	5.3	2.9	1.2	0.4	0.0	0.2	1.4	2.7	4.4	6.3	3.3
Mean	19.1	18.9	17.7	15.1	12.6	10.7	10.1	11.0	12.6	14.5	16.5	18.4	14.8
Precipitation (mm)													
	0.1	0.2	3.0	17.8	76.1	94.7	107.4	57.6	25.4	10.9	6.0	1.3	400.6
Evaporation (mm)													
	206.3	165.9	124.9	70.7	34.9	20.1	21.8	36.2	62.2	112.5	154.8	202.0	1212.4
Relative Humidity (%)													
	60.1	62.5	66.3	70.9	77.5	80.7	80.1	77.1	72.9	67.2	62.5	58.7	69.7
Sunshine Hours (Hr)													
	10.5	9.6	7.7	6.1	4.2	3.4	3.6	5.0	5.8	8.0	8.9	9.9	6.9
Wind Velocity (km/month)													
	1599.5	1158.1	877.9	508.1	526.5	693.6	845.6	751.2	900.3	1158.6	1381.8	1641.8	1003.6

(3) Soils and land use

According to the data of REA, the total area of the objective area is summarized as follows. Present land use in Popeta area shown in Figure 1.1.1.

Unit: ha

Area	UV		Total area	Farmland	Others
Popeta	UV15	Chocalán	1,577.8	915.1	662.7
	UV16	Carmen Bajo	4,502.1	1,620.8	2,881.3
	UV17	Carmen Alto	9,886.3	3,262.5	6,623.8
	UV20	El Pabellon	1,408.7	1,098.8	309.9
	UV21	Cholqui	12,924.7	3,101.9	9,822.8
	UV23	Culiprán	5,291.0	2,910.1	2,381.0
	UV25	Popeta	5,470.6	2,625.9	2,844.7
	UV26	Los Guindos	19,764.8	7,708.3	12,056.5
		Total	60,826.0	23,243.3	37,582.7

Crop cultivation suitability of soils in the new irrigation area are clarified using the soil series derived from the soil survey results of CNR as well as the land productivity classification drawn up by REA. Beneficial farmers in the new irrigation area are clarified by the orthophoto and the classification code of REA on the beneficial area are fixed. As for approximately 1,000 ha of beneficial area where are not classified in the data of REA and CNR, their classification code are assumed by their neighbor land. The land productivity classification of the project area are as follows.

	Land productivity classification	Area by REA (ha)
I	(No limitation for cultivation)	0.0
II	(A little limitation)	479.0
III	(Necessary to select crops)	647.0
IV	(Serious limitation for cultivation)	2,393.3
V	(Difficult for farmland)	0.0
VI	(Impossible excluding pasture land)	1,436.0
VII	(Impossible for farmland)	336.8
VIII	(Impossible for whole land use)	34.8
	Total	5,326.9

According to the above table, the farmland which belong to until class VI of the land productivity classification is approximately 5,000 ha in Popeta area. The farmland classified as class VI used to be defined as unsuitable land for permanent cultivation located at sloping area mainly. However, the fruit cultivation is now being progressed in the farmland classified as class VI and high potential of cultivation is recognized among the farmers. Moreover, orchards are reclaim at the farmland classified as class VII in Cholgui and los Guindos area out of Popeta area.

The fruit growing method at sloping area is promoting rapidly. For example, the soil permeability is enhanced by plowing to replace surface soil with subsoil before opening the orchard and the orchard is protected from soil erosion. The fruit growing has been possible by this method at land of cheep cost. Moreover, a preferable changes of quality and productivity on fruits growing are brought by the evasion of frostbite using the air temperature of an inversion layer.

(4) Water resources

1) Surface water

The Popeta-Yali-Alhué irrigation system is taken water from the third section of Maipo river. Cabimbao observatory is available as the long term discharge observatory. Monthly average discharge and its 85% exceedance probability at Cabimbao observatory are as follows;

Item	Unit	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Cabimbao														
Average	m^3/s	112.2	76.1	62.6	72.6	107.6	151.1	193.1	181.4	115.0	77.4	100.7	130.1	
	MCM	300.39	184.00	167.73	188.08	288.09	391.77	517.25	485.73	298.14	207.4	261.09	348.38	3638.1
85%	m^3/s	25.94	15.70	22.07	39.15	62.78	76.46	95.65	83.04	47.42	27.13	35.81	38.38	
	MCM	69.48	37.98	59.11	101.48	168.15	198.18	256.19	222.41	122.91	72.66	92.82	102.80	1504.2

2) Groundwater

Popeta area where is the target area of irrigation development extends between *Estero* Cholqui and its branch of *Estero* Carmen, and *Estero* Popeta and its branch of *Estero* Tantehue. The areas concerned with the irrigation development are Yali and Alhué. Yali area locates at upper stream of *Estero* Yali, and Alhué area locates at upper stream of *Estero* Alhué which is branch of *Estero* Rapel. According to data of DGA and CNR, average permeability coefficient is 5×10^{-4} m/sec in the objective area. Percolation coefficient is from 2 to 5 l/s/m in a part of Alhué and less than 2 l/s/m in the others areas. Coefficient of specific capacity of 2 to 5 l/s/m means 20 to 50 l/sec of pumping discharge volume when the water level of pumping is dropped by 10 m.

a) Distribution and the number of wells

There is the survey results on the distribution of wells in Popeta area (Carmen Alto and Cholqui) by DGA in 1998. In the study, the inventory survey is carried out regarding the distribution of wells, purpose of its use, and so on in Yali and Alhué basins (including a part of Popeta). Distribution of wells based on the data described above are as follows.

Area	*Estero*	Number	For agriculture	For domestic water	others
Popeta	Cholqui	38	16	5	17 (15)
	Popeta	31	16	2	13 (5)
Sub-total		69	32	7	30 (20)
Yali	Yali	104	67	6	31 (3)
Alhué	Alhué	61	26	3	32 (21)
Total		234	125	16	93 (44)

( ) has been dug as well for irrigation but the well is not utilized at present.

Total number of wells is 234. Out of which 125 wells are used for irrigation and 16 for domestic utilization. The others include the wells for the purpose of poultry, hog raising, mining and is not clear. However, the actual situation of their use is not clear. The number of wells in the study carried out in 1999 shows 2.8 times increase, or from 84 to 234, compared to that in 1984.

b) The number of wells for agriculture and its irrigation area

According to the results of field survey and the well registration of DGA, the number of well and its irrigation area are summarized as follows.

Area	Popeta	Yali	Alhué	Total
No. of well for agriculture	32	67	26	125
Irrigation area (ha)	Well register 16 x 30 = 480 ha Field survey 16 wells, 544 ha	Field survey 67 wells 1,850ha	Field survey 26 wells 758ha	
Total (ha)	1,024	1,850	758	3,632

The irrigation area of wells which irrigation area is not clear is assumed by the average irrigation area (30ha / well). There are 125 wells for irrigation and total irrigation area is 3,632 ha.

c) Pumping situation of groundwater

Monthly pumping volume of wells for agriculture that was studied by the field survey is estimated by unit pumping discharge as follows.

Area	No. of wells for agriculture (wells)	Irrigation area (ha)	Unit pumping volume (l /sec)	Monthly pumping volume (m^3/Month)
Popeta	16	543.6	506.2	1,312,070
Yali	67	1,850	1384.8	3,589,402
Alhué	26	758	890.4	2,307,917
Total	109	3,151.6	2,781.4	7,209,389

On the table above, the volume of monthly pumping discharge shows the maximum volume because it is assumed that a well pumps up for 24 hours per day and for 30days per month continuously by the unit pumping discharge. When a well pumps up for 8 hours per day on average, the volume of monthly pumping discharge would be approximately 2,403,100 m^3. On the other hand, the volume of pumping discharge on 16 wells in Popeta area which are registered in the well register of DGA is about 248,800m^3. Thus, the monthly volume of pumping discharge in Popeta, Yali, and Alhué areas is estimated approximately 2.7MCM.

d) Fluctuation of groundwater level

Fluctuation of groundwater level has been observed at Cholqui and Popeta for long time. According to the data of wells which are relatively good, groundwater level of each basin tends to be reduced, or has the possibility to be reduced in the future. It can be supposed that deep wells in Yali and Alhué basins also have same tendency due to the situation of distribution. It is judged that the large scaled development of groundwater for irrigation is impossible in any areas in the future.

1.1.3 Agriculture

(1) Farming scale

Farmers in the project area are classified by scale of landholding according to the data of REA. The class consists of three groups, small scale farmers of 0.5～15ha, medium scale farmers of 15.1～100ha and large scale farmers of over 100ha. The land belongs basically to an individual farmer in the data of REA, however at the time of the agrarian reform, there are some cases of the registration that several owners' land belongs to one owner. The table below shows farming scales modified these cases.

Land Holding Size		No. of Farmers	Total Area (ha)	Average Farming Area (ha)
Small scale	0.5 – 15	172	506.8	3.0
Medium Scale	15.1 – 100	54	2,285.6	42.3
Large Scale	Over 100.1	8	2,534.5	316.8
Total		234	5,326.9	22.8

Approximately thirty percent (30%) of total area, 5,326ha, belongs to class IV of the land productivity classification. Small scale farmers are usually situated in high productive farmland of the lower land except a few cases.

(2) Present cropping system, agricultural production and income of farm household

Medium and large scale farmers in the irrigated area of Popeta are in generally high technical level. Fruit growing area in Melipilla Province has increased by 12.4 % in the last four years. On the other hand, its cultivation is decreased by 9.7 % in the same period in the Metropolitan Region. Popeta area is included in a part of the increased areas. Recently in Popeta area, enterprises implement agricultural development projects for fruits and forage crop cultivation. Most of the projects are carried out with irrigation by using groundwater and surface flow of small streams in the farmland which belongs to class IV and VI of the land productivity classification. Those areas of the projects reach 1,000ha. However, a problem of reducing groundwater which is the water source is raised in those projects.

There are two significant facts on wine production in the area. The first one is that vineyard and winery established by a French family after the agrarian reform in the beginning of this century in Tantehue area although there is no operation at present. The second one is that very effective winery whose production capacity is 1,000,000 liters has been constructed in a small vineyard (72ha), San Juan de Popeta, recently. The wine produced in this winery is called "*Aurelio Montes*." It passed only two years after it began to be produced, but it has achieved prestige as one of export wines and recorded good sale. This suggests a possibility of further expansion of vine cultivation. Popeta area has the similar climate characteristics to Alhué area where is one of the most promising areas for expanding wine production in the country.

Other important crop in Popeta area is vegetable cultivation by small and large scale farmers. The most of crops, such as pumpkins, melons, watermelons, tomatoes, green beans and others, belongs to the category of irrigation by using surface flow. However, the area has cultivated lettuces and other regulated vegetables by using groundwater and sold them very successfully in the Santiago market. According to the Master Agricultural Survey of INE, 24 % of farmland, in case of small scale farmers, had been utilized for vegetable production before the Cholera outbreak which caused the prohibition of vegetable cultivation by surface flow in the Metropolitan Region. These facts indicate a possibility of expansion of vegetable production in the area.

Forage crop cultivation shares an important portion in Popeta area although all dairy farmers in the area have left. The products are sold mainly as dried feed to other regions. Seed production is also important even though the produced area is small. Income per unit area of seed production is high. Not only soil and climatic condition but also connection with private enterprises which contract with specific farms are also important to introduce seed production. According to Agricultural Census 1997, 4 % of cultivated land is occupied by seed production in Melipilla Province and seed production is also important crop in Popeta area.

On the other hand, the present land use of the projected new irrigation area is utilized for farming minimally because there is arid area. Minimum farming means that poor cattle raising or wood collection for charcoal. Introduction of irrigation by the project is going to increase drastically its land productivity in the area. A big difference is created between incremental net benefit at present and that in the plan.

There are agricultural activities whose gross income ranges between $50,000/ha of cattle raising and $30,000/ha of charcoal in the projected irrigation area at present. However, income from these activities are so small that farmers must depend on non-agricultural income for their living. Otherwise, the present projected irrigation area exists as abandoned land because land price increase can be expected due to land use opportunities for other purposes. If irrigation is introduced, gross income from the land would increase by $1,000,000/ha on average of both high and low productive lands. In case of high productive farmland, the gross income is expected $2,000,000/ha. The present gross income is approximately $10,000/ha on average, which is 1% of irrigated farmland. Even in the most profitable land, it is less than 5 % of that.

(3) Agro-processing

Agro-processing in the new irrigation area needs to consider that Popeta area is located in 65~80 km from Santiago and roads to Santiago are improved. In Santiago, many fields of agro-processing are operated. Different field activities of Santiago are also operating in the suburbs of Santiago such as Paine, Pirque, Linderos, Lampa, Isla de Maipo and Talagante. Any of those areas are located within 90 km from Popeta area and some of them are within 25 km. In *Comuna* of Melipilla Province where the project area is located, there are food processing facilities shown in a following table.

Type of processing facility	No. of Facility	Capacity
Fruits Dehydration Facility	1	45,000 kg/day
Nuts Processing Facility	1	7,500 kg/day
Freezing Facility	12	25,000m^3
Packing Facility	46	500,000 kg/day
Sterilizing Facility	19	318,000 kg/day
Winery	2	3,000,000lt
Horse Slaughter	1	-

1.1.4 Agricultural Support and Farmers' Organizations

(1) Agricultural support

Agricultural support in Chile is principally conducted through INDAP. The INDAP's local office which covers Melipilla Province is established in the Melipilla city. Therefore in the Project, agricultural support is to be provided by the INDAP-Melipilla.

In order to utilize the service of INDAP, farmers are required to establish organization by themselves. This was a big bottle neck on extension of INDAP services. Area Advisory Services (SAL), Project Advisory Services (SAP) and Specialized Advisory Services (SAE) were newly established in 1997 so as to promote and expand INDAP's services for conducting works step by step including establishing organizations.

It becomes easier than before to newly receive INDAP services through establishing the systems of SAL, SAP and SAE. However, a problem of how to build up organizations at the initial stage still remains. Therefore, a certain system of intermediation for establishing organization is required. It is also required to strengthen the function of SECPLAC which set up in each *Comuna*. It is practical to arrange establishing organizations through having advisors who are closely related to the area.

At present, agricultural supports are not provided by NGOs at all in the project area. On the contrary, private agricultural consultants and private agricultural extension workers are utilized as advisers. These advisers are employed by specific farmers' organizations. They establish and implement project plans, improvement of farm management plan, and operate and management plans. Moreover, they give advice on management and operation of organizations. Especially, they give consulting services on INDAP services; establishment of organizations, application for projects, and financial procedures. Then, they also continue to give guidance on operation and management after the project. In addition, because the advisers are close to the area, they often know a lot about local information, farming condition, and so on. They contribute largely to promoting improvement of agriculture in the area.

(2) Farmers' organizations

There are five types of farmers' organizations. Beside canal associations, there are irrigation organization, milk collecting cooperatives, potato production organization and flower production organization as producers' organizations in the study area.

In Popeta area, there are seven canal associations; Canal Chocalan, Canal Carmen Alto, Canal Cholqui, Asoc. Canal Wode House, Canal Culipran, Culipran la Higuera, and Canal Basurero. These associations are working by unit of association, and mainly deal with fair distribution of irrigation water and operation and maintenance of irrigation canals. They can utilize INDAP services for rehabilitation and new construction of facilities. They also apply for services and initiate the projects by using INDAP services. So that, the canal associations employ full-time advisers, and intend to promote their duties and implement smooth operation and maintenance of facilities.

Irrigation organization (*Grupo de Riego*) as a producers' organization was established by 91 small scale farmers who lived in Culipuran and Popeta by SAL of INDAP. The irrigation organization improves irrigation technology and canals for effective use of irrigation water, and deals with increase of productivity and improvement of quality of strawberries, vegetables, and fruit trees by utilizing irrigation technology.

A milk collecting cooperative is a producer's organizations. This is a milk producers' cooperative and managed by 15 small scale dairy farmers. The bases of them are milk collection centers which equipped with a fixed temperature storing facilities by INDAP projects. Based on the centers, the cooperatives intend to control milk quality for maintaining the selling price through controlling animal raising, feed and milking of each farm. The quality is strictly controlled because the selling destination is mostly large scale milk processors. Some of the cooperatives aim at construction of dairy processing facilities of original brand through establishing an united organization of small scale milk collection centers, based on the experience of the quality control.

A flower production organization (*Taller Tierra Verde*) is managed by 8 women of farm households in Carmen Bajo area. The organization was set up by PRDEMU which is a rural women support program of INDAP. The center of its activity is carnation cultivation. It deals with production up to shipment to a central market, and promotes improvement of rural women's status and entrance into socio-economic activities.

A potato production organization (*Grupo Cultivos de Papas*) was established by 104 small scale farmers in Culpuran and Popeta through SAL of INDAP. It promotes socio-economic independence of farmers through improving productivity and establishing marketing advantage by quality control based on improvement of potato cultivation technique.

These producers' associations have finished establishing fundamental organizations and aims at next steps of development. Based on a similar idea, a farmers' organization which deals with agricultural processing is operating in San Pedro where is near the study area. This cooperative, which is invested by small and medium scale farmers, produces, grades, and collects by a quick cooling storage as a whole, and expands the market from domestic market to European markets. Due to appearance of this facility, employment opportunity is created and local employment of about 300 workers is secured. This facility contributes to stable development of the region largely through creating not only economic effects but also promoting stable production and permanent settlement of inhabitants. These experience and knowledge can be utilized as a model of agricultural development in Popeta area.

1.1.5 Agricultural Economy and Marketing

(1) Marketing of agricultural products

1) Production and distribution

Marketing of farm products in the study area can be (a) individual, in which the producer sells his/her products to an intermediary without a contract, generally obtaining low prices, but leaving the option open for good prices when market conditions turn favorable, and (b) group marketing, or through a trade association of the producers themselves, which not only improves marketing by replacing intermediaries, but permits access to credit and technical assistance.

As marketing channel, small producers in the priority study area mention intermediaries in the first place. Intermediaries bridge the gap between producers and wholesale markets in Santiago. Apparently there are two types of intermediaries: (a) those who pay before taking the products, and (b) those who combine transportation and sale services, paying the producer after selling the products, thereby making them more akin to consignees. Wholesale markets in Santiago are the main destination of most agricultural products, and serve as suppliers to regional consumption centers.

Concerning direct sale from producers to consumers, farmers who own land along a trunk road have the option of selling their produce in makeshift stands, which allow them to obtain better prices. For instance, a 5 kg tray of strawberry is sold at $2,000 to intermediaries but can fetch $4,000 if sold in 4 smaller trays at $1,000 each in roadside stands. Another direct sale channel is the popular fair, one of which operates in San Pedro during weekends. Participants in this popular fair can be one of the 68 members of a trade association that sets up the fair, or any farmer interested in selling his product. The fair sets prices at prevailing market prices, charging 10% as administrative expenses.

Another marketing option is contract production, generally involving agro-industry or packing plants. To ensure the quality of agricultural products, these firms set a number of requirements, which are not always accessible or economically justifiable for the small producer.

Collective milk marketing is becoming a required step for small producers, due to the refrigeration requirement set by the milk buyers. The price differential between non-refrigerated and refrigerated milk can be as much as 50% ($40 against $60 per liter some time ago). A center for collective milk marketing can be set up by a group of dairy farmers who finance the necessary investments, but when there is surplus capacity it is usually open to non-members as well, paying a lower price than to members or charging around $2/liter as refrigeration service.

The purpose of quality control upon milk reception at the collective milk marketing center is to detect acidity and to prevent milk dilution with water. The milk price paid to producers is the same in some places, regardless of quality differences. However, better-organized collective milk marketing centers have all producers identified by individual codes, and their milk samples are analyzed in the laboratories of the final buyer who sets prices according to the milk quality. Milk quality requirements are defined by buyers, usually major dairy firms or local cheese factories, but small milk producers generally do not know what these requirements are.

Small collective milk marketing centers in the study area include Codigua, Culiprán, Popeta, Puerta Colorada. A recent trend is the joining of small collective milk marketing centers into associations, one of which is known as Micro-Regional Melipilla encompassing the Melipilla administrative district. This association operates with a staff that includes a manager and a veterinarian, and provides the necessary inputs, technical assistance and services such as administrative procedures.

(2) Marketing facilities

Within the priority study area, there are facilities for the marketing of perishable products. These facilities consist of packing plants and cold storage, which permit value added to the produce, either through processing or through an improved inter-temporal distribution of the product. One such example is *Agrofrutilla San Pedro SAC*, resulting from strawberry cultivation introduced by INDAP into San Pedro in 1964 and has become the main crop in the area. Up to 1988, producers sold their strawberries individually to intermediaries and wholesale markets, at low prices due to insufficient negotiation capabilities. In order to improve this situation, the Strawberry Growers Association of San Pedro was created in 1988. In 1994, a strawberry based business idea came up and appropriated by the Strawberry Growers Association of San Pedro, finally resulting in the establishment of the agro-industrial plant *Agrofrutilla San Pedro SAC* in 1997 by 63 small and medium size strawberry producers of the San Pedro district. INDAP financed 77% of investments consisting of the packing plant, offices, refrigerated truck, and strawberry platelets for its members, while the producers contribution reached 23%.

Agrofrutilla San Pedro SAC receives strawberry produced by members and non-members, providing services in marketing, processing (classification and stem removal), packaging, refrigeration, and refrigerated transportation to different markets consisting of agro-industry (70%), domestic market (20%) and exports (10%). Service fees are charged for marketing (4%), and for classification and packaging in standardized containers ($45/kg + sales tax). Buyers pay to the packing plant, which pays the producers after deducting the service fees.

The stem of the strawberry for processing is removed by hand, and the strawberry is washed with water under pressure. The clean strawberry is classified for the second time, and packaged in plastic trays that are transported to the agro-industry. The stem removal fee is charged to the agro-industry ($65 + sales tax), in addition to a 4% surcharge for the refrigerated transportation.

The business plan for the packing plant is exclusively based on strawberry production between October and May. Therefore, the key to this business is the plant utilization during the off-season. Under consideration is year-round production of strawberry in greenhouses, vegetable production (spinach, cabbage, Chinese cabbage, cauliflower, broccoli, green peas, okra), or simply cold services for seed conservation, hibernation of plants, storage of fruit and vegetable, etc.

Future plans include marketing of farm inputs, machinery and equipment on consignment, to be sold to members and non-members, receiving a sales commission (10 to 30%).

(2) Price and quality of agricultural products

Agricultural products identified in the study area by the questionnaire survey were corn and potato were the most common crops, and occasionally onion, tomato, pumpkin, melon, cucumber, beans, sunflower, wheat, fruit like avocado and lemon, in addition to alfalfa and natural pasture for cattle.

1) Farm gate price

The farm gate price received by the small producer appears to be influenced more strongly by the harvest time, rather than by the quality of the product. In the case of strawberry, small producers lack the facilities needed to clean the strawberry, whereby they visually classify the strawberry into first class and second class, and pack it by class in 5 kg trays. By so doing, the price received for the first class strawberry early in the season in October is around $2,300 per tray, $2,000 in November and $1,800 in December. Meanwhile, the price of the second class strawberry does not change much, being sold between $1,000 and $1,200 per tray during the same period. Similarly, potato harvested in early October can be sold at around $14,000 per 80 kg bag, but the price goes down to $10,000 in November and $2,000 in December.

Month	Strawberry Price ($/5kg tray)		Potato Price ($/80kg sac)
	First Class	Second Class	
October	2,300	1,000-1,200	14,000
November	2,000	1,000-1,200	10,000
December	1,800	1,000-1,200	2,000

Farmers receive price information through 2 or 3 radio stations, and they are aware of the existence of such service. However, they argue that these radio stations broadcast price information during the morning when they need to be working in the field. The prestigious daily El Mercurio publishes an agricultural supplement on Mondays, with extensive information on prices of inputs and outputs. The Office of Studies and Agricultural Policy (ODEPA) of the Ministry of Agriculture provides price information by fax to interested farmers, and sends regional price information to the relevant local government office.

2) Wholesale price

The price recorded by ODEPA in wholesale markets specify the area where the product originates, three levels of prices (low, high, and common) by variety and quality of products, and the transaction volume per day. Price information is also available as weekly averages by variety and quality of products, and the transaction volume per week. Finally, price information is available as the monthly average between 1975 and 1998.

Wholesale price differentiation by quality of products indicates that some kind of classification takes place between the farm and the wholesale market. The tables below show examples of wholesale prices in two wholesale markets of Santiago, Lo Valledor and Mapocho, choosing the products originating in the Central Zone or in Santiago. Price differences can be noticed between the wholesale markets, prices being higher in the Mapocho market as a reflection of its convenient location in downtown Santiago, while Lo Valledor is located in the outskirts of the city.

3) Quality standards

The National Standards Institute (INN) defines quality standards for a variety of products, including some agricultural products. Quality standards for grapes, apple, pear, avocado and lemon are set for both the domestic market and export markets. In the case of Thompson Seedless variety of grapes, and taking the bunch weight as the criterion, standards for the domestic market and the export markets differ as follows:

Class	Domestic Standard (gram/bunch)	Export Standard (gram/bunch)	
		Thompson Seedless, Cardinal, Perlette	Other Varieties
1	225	250	300
2	180	200	250
3	115		
4	115		

Source: NCh1818.Of 80, NCh1925.Of 82

The quality standards set by INN are used by Agriculture and Livestock Service (SAG) to control the quality of agricultural products for export, through its regional offices located in Melipilla and Talagante within the priority area. On the other hand, in the case of domestic market, no control seems to exist for the enforcement of quality standards set by INN. Quality standards of some agricultural products are presented as an appendix to Annex J.

4) Marketing improvement

There are favorable factors that can enable producers in the study area to improve the marketing of their products. The favorable factors are the proximity to the main consumption centers of the country, and the relative abundance of information on prices and quality of agricultural products.

The long-term price trend can give an indication on promising products. The quality standards for the promising products will indicate market requirements, and therefore, the technology that will be required in the production of such products. Once the selected products are produced, recent or short-term price information will give the pattern to decide in which market to sell.

Small producers should set up their own trade associations in order to take over the role of intermediaries. Trade associations will give their members additional advantages, such as access to technical assistance and credit offered by government institutions. A trade association can rent a sale and exhibit module in the new Santiago Wholesale Market (MERSAN), to make it possible to sell directly to consumers. If the rental fee of a sale and exhibit module in MERSAN is out of reach of a trade association, a group of trade associations can share the same space. In this case, each trade association can directly sell to consumers a specific product, which should ideally be produced successively during the year, so as to permit an efficient rotation in the use of the sale and exhibit module.

(3) Household income

The following table shows the monthly income gap between the non-poor population and the indigent population in the administrative district of Melipilla, as compared with the Metropolitan Region and the whole country. The data indicate that the 1996 monetary income gap between the non-poor population and the indigent population was 7,78 in the Melipilla district, 14,36 in the Metropolitan Region, and 10,85 at the national level, thereby indicating a relatively more equitable income distribution in the Melipilla district.

Monthly Income ($)	Melipilla District	Metropolitan Region	Country Total
Indigent			
Autonomous income	47,158	37,935	38,992
Monetary subsidy	3,823	3,074	4,994
Monetary income	50,981	41,009	43,986
Non-Indigent Poor			
Autonomous income	84,901	108,122	98,273
Monetary subsidy	6,806	4,764	5,720
Monetary income	91,707	112,886	103,993
Non-Poor			
Autonomous income	393,538	586,463	473,995
Monetary subsidy	2,988	2,560	3,368
Monetary income	396,526	589,023	477,363
Non-Poor/Indigent Gap			
Autonomous income	8.35	15.46	12.16
Monetary subsidy	0.78	0.83	0.67
Monetary income	7.78	14.36	10.85

Source: CASEN 1996, Módulo Comunal, MIDEPLAN, Enero 1998

Results from the questionnaire survey were analyzed with reference to small farms of less than 15 ha. In the Popeta area, the survey included small farms, one medium size farm and one large farm. Small farms in the Popeta area were analyzed as a whole, and also classified into those that produce only corn and potato, and those with diversified crops. The economic results from these farms in the Popeta area, as indicated by the questionnaire survey, are presented below.

Popeta Total Small Farms

Item	Area (ha)	Income ($)	Expenses ($)	Result ($)
Farm Area	4.91			
Used Area	3.61			
Gross Farm Income		943,808		
General Expenses			265,028	
Net Farm Income				678,780
Family Labor		97,529		
Off-farm Income		313,719		
Family Expenses			757,538	
Household Income				332,490

Item	Popeta Small Farm with Corn and Potato: Area (ha)	Income ($)	Expenses ($)	Result ($)	Popeta Diversified Small Farms: Area (ha)	Income ($)	Expenses ($)	Result ($)
Farm Area	4.75				5.11			
Used Area	3.22				4.09			
Gross Farm Income		499,571				1,506,507		
General Expenses			224,861				315,907	
Net Farm Income				274,711				1,190,600
Family Labor		136,000				48,800		
Off-farm Income		417,632				182,097		
Family Expenses			751,821				764,780	
Household Income				76,521				656,717

Item	Popeta Medium Size Farm				Popeta Large Farm			
	Area (ha)	Income ($)	Expenses ($)	Result ($)	Area (ha)	Income ($)	Expenses ($)	Result ($)
Farm Area	21.0				321.0			
Used Area	8.0				315.0			
Gross Farm Income		1,115,600				6,220,000		
General Expenses			140,000				369,000	
Net Farm Income				975,600				5,851,000
Family Labor								
Off-farm Income		720,000						
Family Expenses			1,630,000				2,440,000	
Household Income				65,600				3,411,000

Note: 8 ha of wheat completely lost

The economic results presented above indicate that the small farm is in a difficult situation, requiring off-farm income to make the farm viable. It can be seen that the small farm producing only corn and potato in the Popeta area is in the most difficult situation. The choice of corn and potato is attributed to the hope of hitting it big if market conditions turn favorable. This is because the price of a corn cob in recent years has been low at around $25 to $30 each, but sometimes it reaches $100, and it is this possibility that induce small farmers to produce corn year after year in spite of low prices. The possibility of big profit is also open to early harvests of potato and pumpkin. Despite the unfavorable economic results obtained by small farms, the positive aspect consists of small farms as employment sources for the farmer and some family members, who would be unemployed if they were not working their farms.

1.1.6 Agricultural Infrastructure

(1) Target areas for new irrigation

The area for Feasibility Study represents Popeta area, in which consists of four small basins; Carmen, Choluqui, Culiprán and Popeta. These basins belong to "Popeta-Yali-Alhué" development plan of agricultural development project through water resources utilization by using 25 m^3/sec of the unused water-rights of the Maipo river proposed in the Master Plan. Considering the location of water source in these three areas and irrigation area, the diversion weir and main canals are planned to be used in common. Accordingly, Yali and Alhué areas are also mentioned in relation with Popeta area in the study.

In the basior c plan on agricultural infrastructure of the Master Plan, Popeta new irrigation areas are the area of present unused land, the poor farming area where used for only rainy season's cultivation, the area where cultivated only during the season when surface flow of small streams is available (mostly no crop cultivation in summer), and the area where enough irrigation water cannot be obtained from existing irrigation canals. Diversion weir, a main canal, secondary and tertiary canals are planned as water supply facilities for the new irrigation areas. The plan also includes a part of existing facilities' improvement for supplemental water. Route of the main canal is planned on the slope of mountain foot in the irrigation area. The tunnels and aqueducts are also included.

(2) Irrigation and drainage condition in the new irrigation area

1) Irrigation facilities

The new irrigation area is unused land and has no organized irrigation facilities. Some small scale areas use water taken from small streams as irrigation water. Yet, shortage of water is always happened, and so new irrigation water is desired. The situation of irrigation facilities in respective areas is described below.

- Popeta Area

Although existing irrigation areas are excluded from the proposed irrigation areas, water supplement is required because water shortage occurs constantly in 290ha of Culiprán area. There is also 420ha irrigated area by groundwater, but it is also excluded from the new irrigation areas.

- Yali Area

In Yali area, there is no irrigation system by using river flow though whole Yali river basin is the target of the project. Construction of large scale irrigation system using groundwater has increased recently. These areas are excluded from the proposed new irrigation areas because farm management of these is stable due to highly efficient water use irrigation by pumping in the area (1,850ha).

- Alhué Area

In Alhué area, the new irrigation area is spread over the Alhué river basin. At present, irrigation system taking water from tributary of the Rapel river at downstream has managed in about 1,200ha. Beside this, 760ha of irrigated areas by groundwater are scattered. These existing irrigated farmland are excluded from the proposed irrigation areas.

2) Drainage facility

The problem of poor drainage exists in a part of Yali and Alhué areas among the proposed irrigation areas; Popeta, Yali and Alhué. The cause of poor drainage is due to impervious hardpan which formed at from 1.0 to 1.5m of ground surface.

(3) Canal associations

Most part of the proposed new irrigation areas is non-irrigated land without sources of water and canal associations. Although there is some irrigated land by using surface flow of small streams in rainy season, canal associations are not organized in these areas.

1.1.7 Rural Infrastructure

(1) Present situation of basic infrastructure

Present situation of basic infrastructure in the study area is shown in the table below.

Unit: %

Area		*UV*	Electricity	Water supply	Sanitary
Popeta	UV15	Chocalán	100	100	30
	UV16	Carmen Bajo	100	100	23
	UV17	Carmen Alto	85	80	0
	UV20	El Pabellon	100	100	5
	UV21	Cholqui	100	100	12
	UV23	Culiprán	100	95	8
	UV25	Popeta	100	90	5
	UV26	Los Guindos	90	80	5
	Total		99	92	14

Source : Melpilla - SECPLAC

Regarding basic infrastructure in the study area, installation of electricity and water supply is almost completed. Electricity is supplied by an electric supply company. Drinking water is all from groundwater. Water supply facilities are constructed by the rural water supply projects of MOP with community as an unit. However, in mountainous communities, Carmen Alto and Los Guindos, the installation ratio is low and it needs to promote installation.

On the other hand, installation of sewage facilities has almost not proceeded, and there are no sewerage treatment facilities even in the communities where water supply facilities have already installed. Generally, excreta is treated by the septic tank of individual houses, and domestic sewage is directly discharged into drain canals. Therefore, contamination of agricultural water and river flows by domestic sewage is getting noticeable in some places. It is time to start examining installation of rural sewerage facilities for conservation of living environment in the rural area. However, it is economically difficult for many communities to do so due to the size of communities and their locations at present. Meanwhile, individual treatment including domestic sewage is practical. It means that discharge of untreated sewage into rivers and irrigation canals has to be banned at least, and treatment within housing lot such as penetration inlet should take priority.

(2) Road / Transportation facilities

Road network is formed by MOP managed roads and Municipality managed roads (*Municipalidad*). Trunk road system consists of MOP managed roads, and lateral roads consists of Municipality managed roads. All inter-regional roads and 60 % of the trunk roads are paved. However, all roads except inter-regional roads are dead-ended and only few roads connect between communities. Although lateral roads are not paved at all, they have already widened enough for passage of vehicles. Connection between lateral roads are very poor because most of lateral roads are arranged as comb-shape against the trunk roads. According to the road situation mentioned above, pavement of trunk roads which connect between inter-regional roads and communities, and connection between lateral roads should be promoted.

On the other hand, regarding public transportation facilities, there is a route bus service mainly on the trunk roads and connects with Melipilla city. The route busses run frequently between Melipilla city and Santiago or Valparaíso cities. It takes about 1.5 hours to Santiago city.

(3) Other facilities

Concerning educational facilities, primary education facilities are constructed mainly in each UV. High schools and colleges are established in Melipilla city. Through them, improvement of educational environment has been promoted. Distribution of primary education facilities is as follows.

Area	*Unidad Vecinal* (UV)		No. of teachers	Kindergartner	Pupil
Area Popeta	UV15	Chocalan	-	-	-
	UV16	Carmen Bajo	10	17	249
	UV17	Carmen Alto	3	0	19
	UV20	El Pabellon	12	33	321
	UV21	Cholqui	2	0	54
	UV23	Culipran	14	55	374
	UV25	Popeta	3	0	52
	UV26	Los Guindos	1	0	18
	Total		45	105	1,087

Source : Melpilla – SECPLAC

As medical facilities, a health center (*Posta Pahuilmo*) is set up in UV-20 (El Pabllon), and a health nurse is always posted. However, a medical doctor and a dentist make their rounds once a week. A clinic (*Consult. San Manuel*) is set up in San Manuel which is near the area. In the clinic, two doctors and four nurses are always posted and spread out the health activities in rural areas. Moreover, a city-owned hospital which equipped with emergency facilities and a Red Cross Hospital (*Policlinicos Cruz Roja*) are located in Melipilla city.

ENTEL (*Empresa National de Telecomunicaciones S.A.*) and CTC (*Compañia de Telecomunicaciones de Chile S.A.*) provide various types of telecommunication services in Melipilla city. Especially, significant dissemination of cellular telephone contributes largely to improvement of telecommunication environment in local cities. Regarding telecommunication in rural areas, coin type public telephones of CTC which utilize cellular telephone networks is arranged in each community and it is possible to contact with outside by dialing.

1.1.8 Environment

(1) Designated area such as natural parks

Designated areas in Popeta, Yali, and Alhué such as natural parks are shown in the table below.

Type of designation	Name of areas	Size	Place (Basin)
National Reserve	ROBLERIA DEL COBRE DE LONCHA (DECRETO No.62 1996/7/25)	5,870 ha	Est. Alhué
	ESTERO EL YALI (DECRETO No.41 1996/5/23)	520 ha	Est.Yali
Protected Area	HACIENDA TANTEHUE (DECRETO No.427 1968/8/30)	11,775 ha	Cue. Melipilla
Wild Life Protection Area	LAGUNA DE ACULEO, ALTOS DE CANTILLANA Y TANTEHUE (DECRETO No.382 1998/1/24)	156,117 ha	Cue. Melipilla, Rio Angostura, Est. Alhué y Est.Yali

ROBLERIA DEL COBRE DE LONCHA in the Caren Basin is designated as National Reserve where its original animals and plants are distributed.

ESTERO EL YALI is a marsh registered as the marsh of Ramsar Convention in December 1996, located in the mouth of the Yali river near the Vth Region, Santo Domingo. The marsh includes three lakes and the mouth and is a bait and rest area for migratory birds. It is confirmed that 115 species of birds inhabit the marsh, 71 of which are water birds. 13 birds to be preserved are registered as the table below. Cisne coscoroba and Cuervo del pantano are categorized as endangered, Bandurria, Flamenco chileno, Cisne de cuello negro, Becasina, and Gaviota garuma as Vulnerable, Garza cuca, Huairavillo, Pato gargantillo, and Pato cuchara and Nuco as Insufficiently Known.

Category	Scientific Name	Local Name
Endangered (En Peligro)	*Coscoroba coscoroba*	Cisne coscoroba
	Plegadis chihi	Cuervo del pantano
Vulnerable (Vulnerables)	*Theristicus caudatus*	Bandurria
	Phoenicopterus chilensis	Flamenco chileno
	Cygnus melancoryphus	Cisne de cuello negro
	Gallinago paraguaiae	Becasina
	Larus modestus	Gaviota garuma
Rare (Rara)	*Ardea cocoi*	Garza cuca
	Ixobrychus involucris	Huairavillo
	Anas bahamensis	Pato gargantillo
	Heteronetta articapilla	Pato rinconero

Insufficiently Known (Inadecuadamente conocida)	*Anas platalea* *Asio flammeus*	Pato cuchara Nuco

Source: RESERVA NACIONAL EL YALI, CONAF,1998.

Although 15 species of floras are found, no species to be preserved inhabit. Two species of amphibian registered as Vulnerable, 1 of amphibian as Insufficiently Known, and 3 of reptile(*Libro Rojo de los Vertebrados Terrestres de Chile, CONAF, 1988*) are found.

Hacienda Tantehue categorized into Protected Area is a supplementary area to National Reserve, located in Cajon del Rey sector. The following areas are to be designated as National Reserve: Carmen Alto-La Viluma-Cuesta El Cepillo(Melipilla); Cajon del Rey-Stream de Piche(Melipilla and Alhue); Cajon de Aculeo and Cajon del Rey sector(Melipilla); and Streams de Piche and El Membrillo sector(Alhue). LAGUNA DE ACULEO and ALTOS DE CANTILLANA Y TANTEHUE are designated as Wild Life Protection Area in order to preserve the area where the most number of wild animals inhabit over the Metropolitan Region. Main wild animals inhabiting the area are shown in the table below.

Local Name	Scientific Name
Garza cuca	*Ardea cocoi*
Torcaza	*Columba araucana*
Cisne de Cuello Negro	*Cygnus melancorypha*
Cuervo de Pantano	*Plegadis chini*
Iguana chilena	*Callopistes palluma*
Lagartos	*Pristydactilus spp*
Sapo Arriero	*Alsodes nodosus*
Zorros	*Pseudalopex spp*

Source: Decreto No 382 del 24 de Enero de 1998.

The table below shows the number of species of animals and plants to be preserved, living in LAGUNA DE ACULEO and ALTOS DE CANTILLANA.

Category	Flora	Mammal	Bird	Reptile	Amphibian
Endangered	1	2	4	-	1
Vulnerable	4	2	7	3	1
Rare	1	-	8	1	-
Insufficiently Known	-	3	4	-	1

Source: Libro Rojo de los Vertebrados Terrestres de Chile, CONAF, 1988

(2) Present condition of water contamination

The table below shows the analysis of water quality in Popeta, Yali, and Alhue.

Date		22/7	12/8	10/12	23/7	12/8	7/12	11/12	Standard			
Item	Unit	St.7	St.7	St.7	St.23	St.23	St.23	C18	SA	SB	SC	EMOS
pH	-	7.3	7.2	8.2	7.1	7.6	7.5	8.1	5.5-9.0		6.5-8.3	
BOD	mg/l	32.0	65.0	16.0	3.8	<10.0	25.0	6.2				<20
No. of Coliform Group												
	MPN/100ml	9.2E+05	9.2E+06	1.6E+04	3.5E+04	1.1E+02	3.5E+03	1.7E+05				
No. of Fecal Coliform Group												
	MPN/100ml	9.2E+04	2.8E+06	3.5E+03	3.5E+03	4.9E+01	1.4E+02	9.2E+03		1000	1000	1000
Cu^{2+}	mg/l	0.003	0.019	0.058	0.007	0.006	0.017	0.013	0.20			
$SO4^{2-}$	mg/l	390.0	351.0	350.0	980.0	515.0	410.0	300.0	250.00			
Cl^-	mg/l	220.0	275.1	196.1	82.5	275.1	83.6	177.5	200			

St..7:Rio Maipo despues Río Mapocho (Haras Los Boldos), St.23:*Estero* Alhué en Quilamuta,
C:18:Canal Culiprán(en puntilla El Cerrillo)
SA:Chilian Standard for Irrigation SB:Chilian Standard for Recreation SC:Standard for growing specified Vegetables

The analyses were made three times on the point where the Maipo River joins the Mapocho River, three times on the point of the Alhue river, and once of the Canal Culipran. Compared to the standard value shown in the table above, all three points in all seasons meet the standard requirement of water for agricultural use as to pH and Cu^{2+}, while some of points meet as to Cl^-. Concerning $SO4^{2-}$, all points in all seasons exceed the standard value. As to fecal coliform, except for two analyses on the Alhue river, all points in all seasons exceed the standard value of water for recreation use and water for growing the specified vegetables.

(3) Water quality in Popeta area

According to the construction plan of the sewage treatment plant in Santiago by EMOS, three plants will be constructed along the Mapocho River in 2024 and then the treated water of approximately 25 m3/sec will be discharged into the Mapocho River. Consequently, water quality of the Maipo River joining the Mapocho River will be greatly improved. The table below shows the volume of water to be treated in 2010 in order to predict the quality of water for irrigation in the priority project area in the same year. Water quality to be achieved is set at 20 mg/l in BOD.

Plan	Volume of treated water (m^3/sec)	BOD (mg/l)
1 st Stage	4.7	20
2 nd Stage	5.2	20
3 rd Stage	6.4	20
Total	16.3	20

The point to predict water quality whose index is BOD is set the position to take water of the Maipo River. The table below shows the predicted value of BOD in 2010 in each of the maximum, minimum, and average flow of water selected from the average annual flow. The BOD value in 1998 is an average value of the water analysis made in the present investigation.

Point of prediction	River flow (m^3/seg)		BOD in 1998 (mg/l)	BOD in 2010 (mg/l)
Intake of Canal Mallarauco at Mapocho River	Qmax	35	64	44
	Qmin	16	64	20
	Qave	25	64	35
Up Maipo River joining Mapocho River	Qmax	96	14	12
	Qmin	29	14	12
	Qave	63	14	12
Intake at Maipo River	Qmax	131	38	20
	Qmin	45	38	15
	Qave	88	38	19

According to the table above, the BOD value at the intake water points for Popeta-Yali-Alhue will be 20 mg/l or less in 2010, that results in the water quality improvement.

1.1.9 Problems and Development Approach

Present problems on agriculture is confirmed in the Master Plan of "Agricultural Development and Water Management in Metropolitan Area, Chile." They are ; 1) difficulty of farming on small scale farmers involved in the agricultural sector and regarded as a problem on the structure of agricultural production, 2) tightness and competition of water use as a basic agricultural condition, 3) contamination of irrigation water and 4) decrease of farmland. Countermeasures to solve these problems are recognized as ; 1) agricultural promotion from inside of the sector, 2) effective use of resources as an improving condition for agricultural promotion and 3) environmental conservation.

Taking these conditions into accept, Popeta area is selected as the objective area for the feasibility study according to the standard that development of new irrigation farmland by utilizing the unused water rights and main beneficiary is to be small scale farmers.

Following points are raised as particular problems of the area through reviewing the present situation based on the background of selection of Popeta area for the Feasibility Study.

- Existence of large number of small scale farmers

  Farm management of small scale farmers is difficult at present, and it needs the support on basic infrastructure for agricultural production, technical and financial support, and improvement of settlement condition relevant to BHN such as roads and drinking water under the present situation.

  Stable surface flow which is easy to use is not available in the area. A certain size of deep wells for using groundwater is needed for stable farming, but small scale farmers are not able to invest for such farming infrastructure. Groundwater development by a form of enterprise farms reaches the limit of available groundwater.

  Establishing farmers' organizations is recognized as a base for receiving the support service on farming improvement and reinforcement of negotiation power at markets. At present, establishing farmers' organizations is in progress among the producers of a single crop, however it is hard for small scale farmers, who do not have the farming infrastructure which ensures stable shipment and quality, to have motivation of establishing organizations.

- Agricultural development by a form of enterprise using groundwater

  The enterprises and large scale farmers, which have sufficient capital and high farming technology, carry out large scale orchard or poultry farm in the area by using climate condition which is suitable for cultivation and groundwater. This kind of groundwater use causes decreasing water level and affects small scale farmers in dry-up of shallow wells.

Based on the problems in the area mentioned above, the measurement to solve them and to promote a well-balanced rural development is recognized improvement of farming condition with small scale farmers through agricultural development which utilizes water and land resources in the area. The contents of development plan should be proposed are not only improvement of production and living infrastructure but also farming support, as a core, through using productive infrastructure. On the other hand, for large and medium scale farmers who hold land in the benefited area, implementation of the new irrigation system in the project area is to alleviates dependency on groundwater for development. Thus, it contributes to conservation of groundwater which is reaching its limit.

1.2 Agricultural Development Plan

1.2.1 Basic Concept of Development

(1) General

The Master Plan on "Agricultural Development and Water Management in Metropolitan Area" targeted at the year 2010 was established with the frames of effective use of land and water, environmental conservation and agricultural promotion as countermeasures to solve the problems (disparity caused by landholding scale, decrease of farmland, contamination of irrigation water and tightness of water use) on agriculture in the metropolitan area. Based on the Master Plan, Popeta area, where is located in the southwest of the study area, was selected as the priority area for undertaking the Feasibility Study where will be a new irrigation area for agricultural development plan through effective water use.

Agricultural development plan for approximately 5,000ha of Popeta Area described in the Master Plan consists of agricultural infrastructure improvement establishing a new irrigation system with Yali and Alhué areas which covers about 21,000ha totally and utilize the unused water right of the Maipo river, agricultural production plan including the support system, and rural infrastructure improvement plan.

Farmland in Popeta, Yali and Alhué areas extend into the valleys formed by branches of *Estero* Popeta, *Estero* Yali and *Estero* Alhué. *Estero* Popeta finally flows in the Maipo river, but *Estero* Yali discharges into the Pacific Ocean directly and *Estero* Alhué also discharges into the Pacific Ocean after joining with the Rapel river. Farming in the area was mainly cereal crops such as wheat and livestock because available surface water is only rainfall of winter in most of the land. Yet, recently, year-round cultivation of large scale fruit trees, forage crops and maize by using groundwater increases. Many commercial poultry farms are operating in each area.

(2) Development approach

New agricultural development in Popeta area by installation of irrigation facilities aims at agricultural promotion by replenishment of water supply to the agricultural area located in the southwestern part of the Metropolitan Region. The development in the area corresponds with the development which contributes to improvement of infrastructure and supporting and strengthening of medium and small scale farmers that proposed in agricultural policy, "Strategic Agenda" by Ministry of Agriculture. Regarding the facilities relevant to new irrigation, it is planned to design organization of the facilities which realize smooth management of water use in the upstream third section of the Maipo river and stable supply of irrigation water to the downstream of the existing irrigation facilities. Through them, it is planned to contribute to future water management of the Maipo river basin as a whole from the structural aspect.

The new irrigation farmland which classified into the suitable land for irrigation by the land productivity classification extends below about elevation 210m in Popeta area and below about elevation 180m in Yali and Alhué areas. Related with the intake level required for new irrigation, the proposed new irrigation canal passes unirrigated land located in the upstream Calmen Alto, Cholqui and Culiprán, where are present irrigated areas and take water from the Maipo river. The irrigation plan includes these upstream unirrigated farmland. The most farmland of the new irrigation areas is used as pasture at present.

Farming in the new irrigation area is proposed according to the specific characteristics of the area. Small scale farmers intend the intensive crop cultivation mainly with fruits trees such as avocados and citrus kinds and cereal crops, traditional crops, forage crops and vegetables. On medium and large scale farmers, the cropping pattern whose key crop is perennial crop is proposed. The cropping pattern puts stress on fruit trees and grapevine, and includes cereal crops, forage crops, seed and nursery production, vegetables and flowers.

Water is conveyed to the new irrigation areas basically by the gravity method. The intake level of the Maipo river is about elevation 220m due to the elevation of the new irrigation area. A new intake weir is to be constructed around the existing intake facilities of Carmen Alto. In the plan for new intake weir, integration of the existing intake facilities is planned to simplify control of water use in the third section of the Maipo river. The existing intake facilities which are to be integrated are six; Puangue, Picano, Calmen Alto, Cholqui, Chocalan and Culiprán. Integration of Puangue and Picano is planned in the right bank and the others in the left bank.

On the newly proposed irrigation canals, distributing determined amount of water by water right to the areas where enough irrigation water is not supplied due to canal losses of the existing canals is also planned. The present irrigated farmland by groundwater in the proposed area is excluded from the new irrigation plan. Small scale reservoirs are planned to impound surplus water at small valleys where canals pass through. Regulation reserves are also planned to solve the time difference between irrigation use and conveyance of water at the diversion points.

1.2.2 Agricultural Production Plan

(1) Cropping system

The cropping system is formulated based on the present cultivation crops in the project area. According to Agricultural Census in 1997, present crop cultivation in the project area is as follows,.

Crop	Cultivation Area (ha)	Cropping Rate (%)
Cereal crops	7,363.5	24.10
Traditional Crops*	1,039.6	3.40
Processing crops**	1.7	0.00
Vegetables	3,828.1	12.60
Flowers	6.7	0.02
Forage Crops	8,821.4	28.90
Fruits	6,837.1	22.40
Grape Vines	410.7	1.30
Green House	35.9	0.10
Seeds Production	1,037.8	3.40
Forest products & Others	1,089.9	3.60
Total	30,492.4	100.00

* Traditional crops such as Beans, Lentils and Peas

** Crops sold to factories for processing such as tobaccos, sunflowers, and sugar beats

The present crop cultivation reflects the conditions of agricultural production in the project area such as landholding scale, ability for investment, farming technology, opportunities of non-agricultural business and labor forces.

On the other hand, regarding the changes of farming environment by introduction of irrigation in the project area, farmers who can invest for introducing irrigation facilities in their own farmland and business enterprise type farmers who have technology and fund to buy farmland in the project area for development of highly productive agriculture will take the advantage of irrigation benefit, because productivity of agriculture is high in the project area, and especially fruit growing has high potential. For medium and large scale farmers, changes of farming environment by introduction of irrigation develop the present cultivation system more intensive in the project area. The stories mentioned above are realistic for two kinds, medium and large scale, of farmers, while small scale farmers have limitation on landholding scale and it is not realistic for them to expand landholding scale by purchasing newly irrigated farmland. Therefore, the cultivation crops of small scale farmers proposed by introduction of irrigation should be highly realistic, based on the present farming condition. Support services for small scale farmers are indispensable for realizing this objectives.

On the selection of cultivation crops, prospects on respective crops are as follow.

1) Fruit growing

To confirm the direction of change caused by the irrigation project, the trend of agricultural development carried out by private investment at present in Popeta can give a certain indication. In case of Popeta area, fruit tree growing is carried out by using groundwater in actually abandoned unirrigated land and the land classified in Class IV, VI and VII of the Land Productivity Classification. Cultivation crops are a kind of stone fruits (peaches, nectarines, plums and apricots), avocados and grape vines. Small amount of lemons and kiwis are also cultivated. A group of small scale farmers has a plan to cultivate avocados in about 600ha farmland, and a part of it includes the project area of Popeta area. This group is to produce in individual land and grade, pack and distribute at the common facility of the organization.

2) Grape vines

Although it is not comparable with Yali and Alhué areas, private sector invests to the vineyard in Popeta area. One of the reasons for this is that cost of production is relatively high due to requirement of improving soil of Popeta area. Even so, the climate condition is the same as Alhué area and very similar to Yali. Viña Santa Rita, a distinguish vineyard in the country, made a contract with small scale farmers for purchasing products from them and this contract business will expand in the future.

3) Vegetables

Vegetables have not been important for private projects util these years. This is because management of labor intensive crop cultivation was difficult in large scale farms. The exception is green peas for frozen food. This cultivation has possibility of mechanization. However in the project area, medium scale project by private sector including vegetable cultivation is planned. This seems important for small scale farmers.

4) Seed production

As alternatives of introducing crops to the new irrigation area, seed production is worth to be raised. Produced seeds are mainly two types at least; one is F1 hybrid seeds of maize and sunflower which are produced in several hundreds hectors of relatively large farms at present. Production of F1 seeds is rational and highly profitable. The other one is F1 hybrid of vegetable seeds which are produced mainly in from 5 to 10ha small farms. Vegetable F1 hybrid seed production provides extremely good benefit per ha due to very labor intensive production with skilled hand works. The former is mainly produced in Yali area at present and the latter is produced by medium scale private project in Popeta area.

5) Forage crops

Forage crops, especially Alfalfa shares 22% of crop cultivation in Melipilla Province. The purpose of cultivation is sale to other provinces after drying and consumption by a few dairy farmers who remain in the province. Small scale farmers produce for feeding their own cattle. Actually, in Popeta area, dairy farms do not remain at all. Milk produced by small scale farmers is purchased at low price by the national milk processing factory. However, in the recent years, a milk collection center is constructed by small scale farmers and contributes to improvement of selling produced milk. Anyway, forage crops are expected to gain considerable profits when they are dried, and they are important components of normal crop rotation.

6) Cereal crops

The profit of cereal crops is the lowest among cultivation crops. However, they also consist of a part of the crop rotation system. Cereal crop cultivation is easy to be managed and very easy to be mechanized. Wheat is an important self-consuming crop for small scale farmers.

7) Traditional crops

Potato is the only important traditional crop (*Chacra*) in Popeta area where beans are almost not cultivated. Popeta area is close to the Santiago among the potato production areas and very popular in rural markets.

8) Flowers and others

Flowers and so-called green-house products are expected to become more important in the future because the location of the project area is close to Santiago and the seaside resorts. Nevertheless, there is almost no importance at present.

Based on the considerations above, crop cultivation plans are formulated for four farming types classified according to landholding scale in the project area. Among the plans, two of them are for small scale farmers and the other two are for medium and large scale farmers. Number of farmers in each landholding scale is as follows.

Average landholding area	5ha	15 ha	40ha	200ha
No. of farmers	132	40	54	8

- Cultivation plan for average landholding of 5ha (small scale farmers)

Farming area of 5ha is the majority of small scale farmers. However, it is easy for these farmers to have problems on entrance of markets, advanced farming technology, capital investment for grapevine and fruit growing, and profitable production activities for other crop cultivation in the field of capital, technology and negotiation power. Over 60 % of their farmland is uncultivated or natural grassland at present. Cultivation plan considering such situation is shown in the table below.

Crop	Cultivation Area (ha)		Share of Cultivation Area (%)	
Cereal Crops	0.65		13.0	
Wheat		0.65		13.0
Traditional Crops	0.50		10.0	
Potatoes		0.50		10.0
Vegetables	0.80		16.0	
Pumpkins		0.20		4.0
Onions		0.20		4.0
Watermelons		0.20		4.0
Green beans		0.20		4.0
Forage Crop	0.70		14.0	
Alfalfa		0.70		14.0
Fruits	1.00		20.0	
Avocados		1.00		20.0
Subtotal	3.65		73.0	
Others	1.35		27.0	
Total	5.00		100.0	

Intensive cultivation crops for this scale farmers are planned to be vegetables and fruits, relevant to the present situation. Vegetable and fruit trees share 16% (0.8ha) and 20% (avocados 1ha) of the total cultivation area, respectively. Traditional crop shares 10% (Potatoes 0.5ha). Vegetables which have no restriction on cultivation irrigated by surface water are pumpkins, onions, watermelons and green beans. Alfalfa which shares 14 % and cereal crops which shares 13 % will provide highly productive farmland and complete rational crop rotations (vegetables-wheat-vegetables-alfalfa-vegetables) for small scale farmers. In any cases, technical, economical and marketing supports are required for implementation of the farming plan.

- Cultivation plan for average landholding of 15ha (small scale farmers)

  It is relatively easy for these scale farmers to access market's entrance and technology among small scale farmers, and they have ability to get some amount of capital for investment. The farmers belonging to this class also have possibility to obtain larger farm. However, as same as 5ha landholding farmers, they have unproductive land such as uncultivated land or natural grassland. Cultivation plan considering such situation is shown in the table below.

Crop	Cultivation Area (ha)		Share of Cultivation Area (%)	
Cereal Crops	1.3		9.00	
Maize		1.3		9.00
Vegetables	1.0		6.66	
Pumpkins		0.2		1.33
Onions		0.3		2.00
Watermelons		0.2		1.33
Green beans		0.3		2.00
Forage Crop	1.5		10.00	
Alfalfa		1.5		10.00
Fruits	4.0		26.60	
Avocados		4.0		26.60
Grape Vines	3.0		20.00	
Seeds	0.5		3.32	
Vegetable seed		0.5		3.32
Subtotal	11.3		75.3	
Others	3.7		24.7	
Total	15.0		100.00	

As intensive cultivation, fruit trees growing is planned to share 4ha. Grapevine for wine is planned 3ha, according to the idea of selecting suitable varieties for wine and selling to wineries for final processing. The share of vegetables has been reduced, compared with fruits and grapevines. Yet, in the cultivated area, the area for vegetable seed production increases by 3.3 % and the share of intensive cultivation crop will be 49.9 %. Cereal crops and alfalfa are planned 9 % and 10 %, respectively.

- Cultivation plan for average landholding of 40ha (medium scale farmers)

  This scale farmers represent the farmers who undertake medium scale and modernized farming in the area. They are easily access to markets and technology. They have restraints but can obtain capital enough for investment. Among medium scale farmers, about 10 % of cultivated land is used for natural grassland. Cultivation plan is shown in the table below.

Crop	Cultivation Area (ha)		Share of Cultivation Area (%)	
Cereal Crops	5.0		12.50	
Wheat		1.6		4.00
Maize		3.4		8.50

to be continued

Crop	Cultivation Area (ha)		Share of Cultivation Area (%)	
Vegetables	1.6		4.00	
Pumpkins		1.6		4.00
Flower	1.2		3.00	
Forage Crop	6.0		15.0	
Alfalfa		6.0		15.0
Fruits	14.4		36.00	
Avocados		4.0		10.00
Table Vines		3.2		4.00
Peaches		5.6		14.00
Cherry		1.6		4.00
Grape Vines	5.0		12.50	
Seeds	3.2		8.00	
Vegetable seed		0.8		2.00
Maize		2.4		6.00
Subtotal	36.4		91.00	
Others	3.6		9.00	
Total	40.0		100.00	

Regarding intensive cultivation crops, 14.4ha of fruit trees and 5ha of grapevine for wine are planned to be cultivated. Major fruits planted at present are kinds of stone fruits (peaches, plums, and yellow peaches), avocados and table vines. Each farmer concentrates on the different crop cultivation. Grapevine for wine is sold to winery or larger farms after harvest. On the other intensive cultivation crops, the share of vegetables, flowers, and vegetable and F1 hybrid maize seed production plan to be 4%, 3%, and 8% of the cultivated area, respectively. Flower cultivation and seed production are very suitable for medium scale farmers who have high technology. Intensive crop cultivation shares 71% of total cultivated area.

- Cultivation plan for average landholding of 200ha (large scale farmers)

Average farmers who hold 200ha represent either large scale and highly modernized farmers or farms owned by private enterprises. They hold a favorable position in relevant markets, high technology and management ability. They also have appropriate capacity for investment, and their farming is flexible on such determination of effective management scale. The reason for the selection of this holding area is that more than 200ha landholders as a large scale farmers are rare, and they contribution to the area on agricultural processing products and finance. About 10% of the cultivated land is used for unproductive purposes. Cultivation plan is as follows.

Crop	Cultivation Area (ha)		Share of Cultivation Area (%)	
Cereal Crops	27.0		13.50	
Maize		27.0		13.50
Vegetables	23.0		11.50	
Melons		12.0		6.00
Green Beans		11.0		5.50
Forage Crop	20.0		10.00	
Alfalfa		20.0		10.00
Fruits	72.0		36.00	
Avocados		20.0		10.00
Table Vines		32.0		16.00
Peaches		20.0		10.00
Grape Vines	24.0		12.00	
Seeds	12.0		6.00	
Maize		12.0		6.00
Crop	Cultivation Area (ha)		Share of Cultivation Area (%)	
Subtotal	178.0		89.00	
Others	22.0		11.00	
Total	200.0		100.00	

The shares of fruit growing and grapevine are 36% and 12% of total cultivated land, respectively. On vegetables, the planning shares of each vegetables are as follows; green beans which are cultivated under the contract with a frozen food factory is 6%, melons which are easy to be managed due to large scale cultivation is 6 %, and seed production of F1 maize or sunflower is 6%. Intensive cultivation shares 65.5 % of the total cultivated area. Cultivation of cereals and forage crops are planned 23.5 % of the cropping pattern.

(2) Farm income

Gross income brought about the crop cultivation plans for each management scale is shown in the table below.

Small Scale Farmer(Average farming Area 5 ha)

Crops	Cultivation Area (ha)	Farm Income ($000)
Wheat	0.65	162.5
Potatoes	0.50	500.0
Pumpkins	0.20	240.0
Onions	0.20	260.0
Watermelons	0.20	280.0
Green Beans	0.20	180.0
Alfalfa	0.70	315.0
Avocados	1.00	1,000.0
Pasture	1.35	135.0
Total	5.00	3,072.5

Small Scale Farmer(Average farming Area 15 ha)

Crops	Cultivation Area (ha)	Farm Income ($000)
Maize	1.3	390
Pumpkins	0.2	240
Melons	0.3	480
Peas	0.2	300
Alfalfa	1.5	300
Avocados	4.0	750
Grapevine (Wine)	3.0	4,000
Seed Production	0.5	3,000
Pasture	3.7	370
Total	15.0	10,830

Medium Scale Farmer(Average farming Area 40 ha)

Crops	Cultivation Area (ha)	Farm Income ($000)
Wheat	1.6	480
Maize	3.4	1,360
Pumpkins	1.6	2,240
Flowers	1.2	3,600
Alfalfa	6.0	5,200
Avocados	4.0	3,520
Grapevine (Table)	3.2	11,200
Peaches	5.6	8,500
Grapevine (Wine)	5.0	2,400
Seed	0.8	1,920
Seed (Maize)	2.4	360
Pasture	3.6	42,060
Total	40.0	

Large Scale Farmer(Average farming Area 200 ha)

Crops	Cultivation Area (ha)	Farm Income ($000)
Maize	27	12,150
Melons	12	19,200
Peas	11	11,000
Alfalfa	20	12,000
Avocados	20	26,000
Grapevine (Table)	32	35,200
Peaches	20	40,000
Grapevine (Wine)	24	40,800
Seed (Maize)	12	9,600
Pasture	22	2,200
Total	200	184,150

1.2.3 Farmers' Organizations and Agricultural Support Plan

In order to promote socio-economic independence of regional agriculture, establishing organizations of farmers who are beneficiaries is indispensable. Through uniting the power of inhabitants in the area, irrigation facilities are to be constructed and improved. This leads to diversification of agricultural products and improvement of productivity. Then, the base for regional agricultural development is established. Accordingly, organizations of beneficiaries who are recipients of the Project are required to be improved in the study area for proceeding to implement projects, and utilization and promotion of effective use of improved facilities. A consensus should be obtained for improving the present situation by inhabitant's participation.

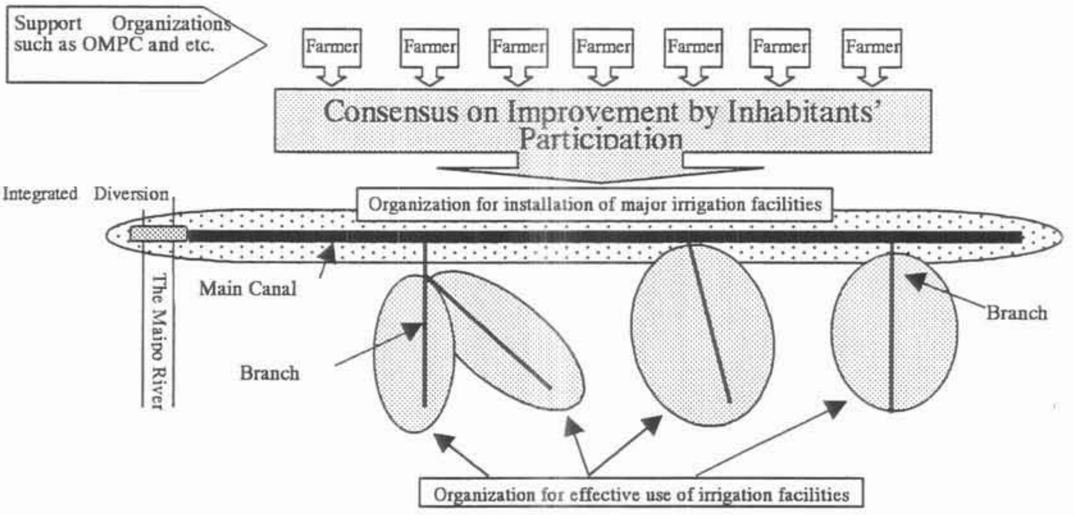
Based on the consensus for improvement of the present condition, following two systems as beneficiaries required to be established.

- Organization for installation of major irrigation facilities (according to the

Irrigation Promotion Law No. 18450)

- Organization for effective use of irrigation facilities (according to agricultural development by INDAP services and etc.)

A flow chart of the promotion system is described in the following figure.



(1) Setting of mutual consensus

The beneficiaries of the project in the study area are mostly small scale farmers according to the structure of regional society. Participation of inhabitants as democratic procedure is indispensable at every stage of the plan because the project plan directly connects with the interest of farmers. Participation of inhabitants is to be implemented in accordance with the purpose of each stage by following activities such as a conference with experts (INIA, universities, private consultants and so on), discussion among representatives of farmers, and a workshop among farmers and experts. Participation of inhabitants in these activities leads to deepening farmers' understanding against the project and promoting establishment of identity as the regional inhabitants. Moreover, this also creates derived effects such as growing regional leaders and providing accurate information for farmers.

In case of Popeta area, the present situation is to be improved through obtaining stable irrigation water and development of new irrigation farmland. Therefore, construction of the integrated diversion weir and main irrigation canals are set up as the main projects. Accordingly, mutual consensus on the project of farmers are indispensable to promote these projects. The process on setting of mutual consensus is proceeded as follows;

1) Motivating: regarded the necessity of the plan, the project system, right and duty of beneficiaries based on the present situation

2) Problem finding: finding the problems to be changed, setting the purpose of the plan, and then clarifying the problems to be struggled for solving the problems

3) Analysis of plan: analysis and appraisal of the project including alternatives to solve the problem or achieve the purpose

4) Determination of plan: based on the comparative analysis of the

alternatives, corresponding with the projects which are not main such as water use plan at the terminal, water management plan, and farming plan, determining the final plan, and then, setting of mutual consensus of beneficiaries on the project

In the procedure on setting of mutual consensus of the beneficiaries, the most important part is the first part, "motivating." Because this part has been lacking in the agricultural support plan so far, sufficient consensus has not been formed and the plan has broken down.

The agricultural support plan in the project strengthens this part. OMPC is regarded as the go-between organization between beneficiaries and the project plan. Based on the cooperation of external supporters (INIA, universities, private consultants and so on) employed by OMPC, the workshop for "motivating" will be held through JJVV and UV.

After 2) of the procedure on setting of mutual consensus, beneficiaries and external supporters mainly implement. Consulting fee is supported by OMPC and about 10% of it is paid by the beneficiaries. The burden of the beneficiaries is clarified at the stage of "Motivating."

Based on the procedure on setting of mutual consensus mentioned above, organization for installation of major irrigation facilities and the organization for effective use of irrigation facilities are to be established.

(2) Organization for installation of major irrigation facilities

Acquisition of the new water right, construction of integrated diversion weirs and new irrigation canals are planned in the Popeta area. In the third section of the Maipo river, nine canal associations which belong to Sector Sur de Melipilla are established at present. Therefore, Association of United Canals (Asoc. UCM3: Asoc. Unidad Cnalista Maipo 3ra Sección) which established by existing canal associations and canal association relevant to new irrigation canals (Canal PYA: Canal Popeta-Yali-Alhué) is required to be established for construction of an integrated weir. Asoc. Canalista PYA is established with new irrigation canals. This is the organization for proceeding to implement the projects such as distribution of the new water right.

Based on the Irrigation Promotion Law, financial support for the main facility is to be received from MOP-DOH. Asoc. UCM3 is to be the receiver of financial support service as the organization of beneficiaries.

Area	Related Project	New Organization	Implementation Body
Popeta	New Integrated Diversion Weir	Asoc. UCM3	Asoc. UCM3
	New Irrigation Main Canal	Asoc. PYA Canal association	Asoc. PYA Canal association
	Intake & Distribution of New Water right	Asoc. PYA Canal association	Asoc. PYA Canal association

(3) Organization for effective use of irrigation facilities

Construction of branch canals is necessary for irrigating in the project area by using irrigation water distributed from the main canal. Regarding financial support required for construction of branch canals, the service systems of the Irrigation Promotion Law (The Law No. 18450) and INDAP will be utilized. A recipient organization of the project is formulated by organizing canal association of terminal beneficiaries. A part of work, which can be handled by existing canal associations and irrigation organizations, is coped with by expanding the function of the association. When a new canal association or a new irrigation organization is required to be established, application for organization is prepared by the arrangement of OMPC.

Regarding technical and financial supports against producers' groups for management of irrigation water at field level and for improving farming, INDAP service systems are to be utilized. An advisor is to be employed to promote grouping producers through arrangement of OMPC

On the promotion of the project implementation, SAL, SAP, or SAE is to be utilized according to the level of organization.

In the area introducing new irrigation facilities, although entering the existing producers' organizations should be considered, large technical gap among them can be predicted. Thus, a new organization is to be established.

Existing producers' organizations and producers' organization which can be newly established are as follows.

Organization	Name of Organization
Existing Producers' Organizations	Canal association Milk Collecting Cooperatives Potato Production Organization Flower Production Organization
New Producers' Organizations	Canal association Citrus Organization Grape Organization Avocado Organization Horticulture Organization Cereals Organization Multiple Production Organization Production Organization for Rural Women

(4) Installation of base facility for agricultural support

Many of UV in Popeta area do not have base facilities for meeting and training courses. Thus, it is impossible to communicate smoothly among inhabitants, and this leads to difficult environment for establishing fundamental organizations aiming at improvement of present agricultural situation. Thus, it is indispensable to construct the activity base facilities for vitalization of UV activities and smooth communication among regional inhabitants. This base facility is named Communication Center for UV (CECUV) and is constructed in each UV. Based on these facilities, beside promoting the activities for unity by small scale farmers, promotion of regional self-government, improvement of living environment, training and lectures on living and producing skills, and training of rural women for self-independence will be taken place. Through these activities, self-independence of UV will be promoted.

Functions of CECUV are promotion of communication, of support activities for farmers, and of independence of rural farmers. The details are as follows;

- Promotion of regional communication
  1) Improvement of rural living environment
  2) Activating communication among regional inhabitants
  3) Operate and maintenance of regional social infrastructure
  4) Participation of inhabitants in the plan for living environment improvement
  5) Providing the place for medical and health service
  6) Promotion of cultural activities for regional inhabitants and young generation
  7) Cooperation with OMPC

- Promotion of support activities for farmers
    1) Extension and enlightenment about agricultural and livestock farming's technology
    2) Extension and enlightenment about irrigation technology
    3) Promotion of uniting activities by small scale producers
    4) Providing the place for a training course of farming improvement
    5) Enlightenment about self-independence and promotion of rural women
    6) Providing an office for a producers' organization
    7) Interchange with producers' organizations in the other areas and exchange of information

Among agricultural support activities, promotion of uniting, enlightenment about and technical guidance of agricultural support activities are undertaken by advisors organized by OMPC through cooperation with external support organizations (INIA, universities, private consultants and NGOs). These advisors make their rounds and give guidance in each CECUV, *Communa*. The contents of uniting promotion, enlightenment and technical guidance provided by OMPC are summarized as follow.

Agricultural Production	Economic Activity and Management	Living Improvement
- Guidance for organization	- Guidance of farm management	- Guidance & training on house works
- Guidance of cropping	- Guidance of income generation	- Guidance of health control
- Guidance on subject of crops	- Guidance of group activity	- Guidance of group activity
- Guidance of irrigation	- Guidance on example of advanced area	
- Guidance of fertilization	- Guidance of business and finance	
- Guidance of marketing	- Guidance of merchandize	

Facilities of CECUV are as follows.

Facility	Size (m^2)
Training room	48.6
Meeting room	48.6
Administration office	12.2
Producers' group office	72.9
Store	12.2
Toilet	12.2
Total	206.7

Because Popeta UV in Popeta area has already had the Resident Center, agricultural support and living improvement is to be facilitated by using this center. Therefore, CECUVs which should be constructed are presented in the table below. Planned design of CECUV is shown in the Figure 1.2.1.

UV	Population	Household	CECUV
Chocalán	687	177	1
Carmen Bajo	1,125	285	1
Carmen Alto	849	217	1
Cholqui	1,211	344	1
El Pabellon	915	240	1
Culiprán	1,736	413	1
Popeta	1,309	321	-
Los Guindos	615	107	1

1.2.4 Agricultural Infrastructure Development Plan

(1) Area of new irrigation

A new irrigation development area in Popeta is a part of "Popeta-Yali-Alhué agricultural development plan" in the "Agricultural development plan with effective use of water resources" by unused water right (25m^3/sec) of the Maipo river proposed in the Master Plan. The diversion weir and the main canal are planned to use commonly considering a water source of three areas and the location of the irrigation area. Accordingly, the feasibility study will cover an agricultural development plan in Popeta area, determination of irrigation area and its water requirement in Yali and Alhué, and main and secondary canals.

The upper limit of the new irrigation area in Popeta-Yali-Alhué is a skirt of the mountain which the main canal passes through. As sum of irrigable land (except the areas where hold organized irrigation areas at present) in respective area is calculated, gross and net areas are 23,400ha and 21,100ha, respectively. The details are shown in the table below. Although irrigated farmlands by using groundwater are scattered in the proposed new irrigation area, the area which clarified by the data for groundwater use survey is subtracted from the proposed new irrigation area. The net irrigation area was adjusted by 10% of reduction rate to the gross area in order to subtract the area for canals and roads, and etc.

Area			Gross Irrigation Area (ha)	Net Irrigation Area (ha)	Remark groundwater irrigation Area (ha)
1	Popeta	Carmen	540	486	60
		Choluqui	535	481	420
		Popeta	4,454	4,008	544
	Sub-Total		5,529	4,975	1,024
2	Yali		10,905	9,815	1,850
3	Alhue		6,993	6,294	758
	Total		23,427	21,084	3,632

(2) Plan for intake and conveyance of irrigation water

1) Intake weir

a) Location

There are five existing intake weirs in the left bank and three in the right bank in the upstream basin of the third section of the Maipo river. These intake facilities are functioned to supply water to Choluqui, Carmen Alto, Culiprán and Popeta areas in the left bank, and to Melipilla area in the right bank. The reconciliation organization regarding the water utilization, *Junta de Vigilancia* is not established in this section, and water utilization of the Maipo river is managed by each intake unit. Because improvement level of each intake facilities is low, headraces and intake facilities are damaged by every flood. Therefore, stable intake of water has not been achieved.

Although proposed plan of the project purposes to supply water to the new irrigation areas after taking water from the Maipo river, existing intake structures that elevation of intake could maintain and the existing canals can utilize are to be integrated with a new intake weir, because proposed weirs construct next to existing intake facilities. The results of the existing facility survey are shown in the table below.

Site	Amount of water right (m^3/sec)	Present water (m^3/sec)	Irrigation area (ha)	Canal length (km)	Action (unit)	Member (person)	Annual O/M cost (mil. Pesos)
Left Bank							
Calmen Alto	8.0	3.5	1,200	36.0	100	78	60.1
Cholqui	2.0	-	2,000*	28.0	74	-	30.0
Chocalan	5.0	2.7	2,350	9.8	1,562	-	31.3
Culiprán	5.0	3.0	1,800*	35.9	-	-	-
Codgua	4.8	2.7	-	20.0	-	-	-
Right Bank							
San Jose	5.7	3.7	-	35.0	-	-	-
Puangue	3.6	2.9	-	38.0	-	-	-
Picano	8.7	4.0	3,000	30.0	150	-	17.5

(Area of * mark is estimated from the map of 1/10,000)

As the site for the proposed integrated diversion weir, the upstream reach of the third section on the Maipo river is selected relevant to geographic condition and intake level because the main canal is planned as a canal for supplying water to three areas, Popeta–Yali–Alhué. An elevation of intake level should be maintained at more than EL 220.00m for gravity irrigation, considering the elevation of proposed irrigation area, prolongation of canal length, and canal bad gradient. The elevation of the irrigation areas is presented in the table below.

	Irrigation Area	Altitude of Irrigation Area EL (m)	Altitude of Canal EL (m)	Distance from Weir (km)
1	Popeta	220-120	220	5-59
2	Yali	200-130	200	62-73
3	Alhué	180-130	185	77

Selecting the suitable sites for constructing the weir within the area ranging between the confluence of the Maipo river and the Mapocho and the downstream 8km, they are around the Canal Calmen Alto intake in the downstream 5km and around the downstream 7km. However, the selection sites are limited from the confluence up to 5.5km downstream because a riverbed elevation is EL 205m between the confluence point and around the downstream 7km due to the intake level. Therefore, the sites are selected at the highest point as much as possible within the area ranging from EL 240m at around the confluence to EL 215m at the downstream 5.5km (C axis).

Concerning the river flow condition in the area, the river divided into several major water flows after confluence of the Mapocho river and the Maipo river, and then the major water flows discharge along with the left bank at the downstream 5km of the confluence. The tendency that the major water flows discharge along with the left bank has not changed, although the location of the water flows had been changed by flood, according to the aerial photographs of 1979 and 1992, these mapped materials, and finding by field survey. The river width is 1.9km (A axis) at the downstream 2.4km around the confluence, however the water flows are divided into several ways and changed their locations with every flood. The flows bend to the left bank and gather at the overhung hillside of Loma la toma at the Canal Calmen Alto intake point (B axis). Accordingly, the intake point of Canal Calmen Alto is desirable for the new weir site, considering stable water distribution and maintenance of the weir. The river flow condition at three points described above is summarized in the table below and location map on comparison of weir axis is shown in figure 1.2.2.

Weir site	River width (m)	Riverbed EL (m)	River flow condition: Water route	River flow condition: Width of water route	River flow condition: Position of water route	Stability of river
A axis	1,900	235	3	100-150	Center	Unstable
B axis	1,800	222	1	150	Left Bank	Stable
C axis	1,700	215	1	100	Left Bank	Stable

Results of reviewing three sites on river conditions on intake level of weirs and stable distribution: 1) A axis; the downstream 2.5km from the confluence of the Maipo river and the Mapocho river, 2) B axis; Bocatoma Carmen Alto and 3) C axis; downstream 500m of Bocatoma Carmen Alto are;

- Stable intake is possible because a major water flow approaches to the mountainside of the left bank by a spur of Loma la toma
- Foundation of intake structure reaches to bedrock in the left bank and durable foundation works can be constructed
- Intake level of more than EL 220m which is the essential condition for irrigation, can be secured

Considering the advantages above, B axis; Bocatoma Carmen Alto, whose construction cost is lower than the other alternatives is selected for the site of the integrated weir. The intake level of this point will maintain the elevation of 223.00m.

b) Present situation of river flow

Integrated diversion weir to be constructed in the Maipo river-course as the intake facilities of Popeta-Yali-Alhué irrigation system is planned at 6 km downstream from the confluence of the Mapocho and the Maipo rivers. There are no discharge measurement stations which continue observation on the Maipo river-course around the proposed sites of the integrated diversion facilities in the Maipo river. However, discharge observation had been made at Chiñihue located near the proposed weir site from October, 1964 to January, 1977. Those observed records can be utilized.

As the long term discharge measurement points in the Maipo river, Manzano and Obra are located in the upper stream of the proposed site, and Cabimbao is located in the lower stream of the proposed site. Based on the prescribed discharge data available and basin characteristics on each discharge measurement point, available water for the Popeta area at the site of integrated diversion weir estimates using the regression equation constructed by the correlation with the Cabimbao discharge data.

Monthly average discharge data at Cabimbao observatory are available for the duration of 57 years from 1941 to 1997. Regression equation at Chiñihue can be constructed as $y = 1.3969\,x^{0.8633}$ (y: Chiñihue, x: Cabimbao) on the basis of discharge data at Chiñihue and the discharge data on same period at Cabimbao observatory.

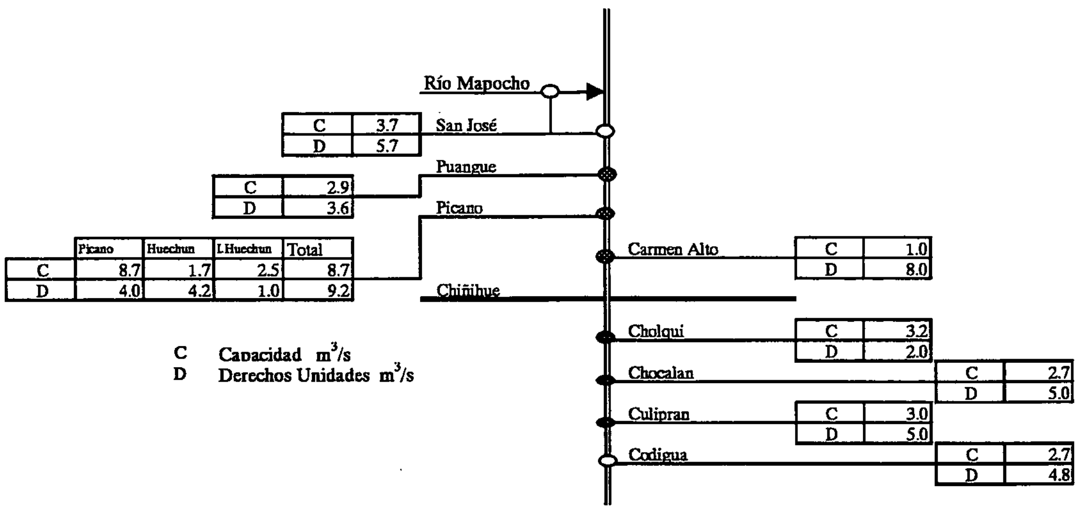
Discharge on average monthly and 85% exceedance probability at Cabimbao observatory and the proposed site of integrated diversion weir (Chiñihue) are as follows;

Item	Unit	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Cabimbao														
Average	m^3/s	112.2	76.1	62.6	72.6	107.6	151.1	193.1	181.4	115.0	77.4	100.7	130.1	
	MCM	300.39	184.00	167.73	188.08	288.09	391.77	517.25	485.73	298.14	207.4	261.09	348.38	3638.1
85%	m^3/s	25.94	15.70	22.07	39.15	62.78	76.46	95.65	83.04	47.42	27.13	35.81	38.38	
	MCM	69.48	37.98	59.11	101.48	168.15	198.18	256.19	222.41	122.91	72.66	92.82	102.80	1504.2
Chiñihue														
Average	m^3/s	117.7	74.8	47.3	45.8	70.0	101.7	131.4	118.2	54.2	42.6	90.9	132.8	
	MCM	315.11	181.36	126.65	118.61	187.55	263.63	352.06	316.58	142.36	114.14	235.47	355.68	2709.2
85%	m^3/s	31.83	18.29	18.31	22.98	43.28	49.47	66.99	54.04	33.51	25.28	33.42	35.25	
	MCM	85.25	44.25	49.04	59.56	115.92	128.23	179.43	144.74	86.86	67.71	86.62	94.41	1142.0

Eventual discharge (surplus discharge with 85% exceedance probability over 85% exceedance probable runoff) at Chiñihue is as follows;

Item	Unit	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Chiñihue	(Eventual discharge)													
Average	m^3/s	86.70	57.45	29.46	23.21	27.71	53.32	65.70	65.38	22.37	18.12	59.55	98.64	
	MCM	232.20	138.97	78.92	60.16	74.22	138.19	175.97	175.11	57.98	48.55	154.35	264.19	1598.8
85%	m^3/s	5.00	1.76	0.92	1.92	0.90	3.34	3.61	3.63	1.06	1.73	3.15	4.34	
	MCM	13.39	4.26	2.46	4.98	2.41	8.66	9.67	9.72	2.75	4.63	8.16	11.62	82.7

On the other hand, distribution of the existing intake facilities near the proposed site of integrated diversion weir (Chiñihue) for irrigation purpose can be summarized as follows. In the figures, C means maximum capacity of existing canals and D is the discharge on registered water rights.



When the integrated diversion weir is planned at Chiñihue, 6 existing intake facilities of irrigation system, Puangue, Picano, Calmen Alto, Cholqui, Chocalan and Culiprán, can be considered as the target intake facilities for unification taking the connection to the existing canals after water taking from the diversion weir into account. Puangue and Picano locate in the right bank and others are in the left bank of the proposed headwork.

Distribution of the available water at the integrated diversion weir will be made by the water right registered. When river runoff is lower than the discharge of 85% exceedance probability, river runoff will be distributed by the ratio of water right registered among the users. Following distribution ratio is employed to settle the available intake water volume for Popeta-Yali-Alhué irrigation system on 85% exceedance probable discharge condition. (Intake facilities of San José, Puangue, Picano and Calmen Alto irrigation systems are located in the upstream reach of proposed integrated diversion weir. Because discharge at Chiñihue expressed after deductions for intake water of those irrigation systems, distribution ratio at the proposed integrated diversion weir will be constructed by the balance of discharge between the water rights and existing canal capacity.)

Unit : m^3/s

Item	San José	Puangue	Picano	Calmen Alto	Cholqui	Chocalan	Culiprán	Codigua	(Total)	P-Y-A	Total
Existing Canal Capacity	3.7	2.9	8.7	1.0	3.2	2.7	3.0	2.7	27.9	-	-
Discharge on Water Right	5.7	3.6	9.2	8.0	2.0	5.0	5.0	4.8	43.3	25.0	68.3
Discharge for Distribution	2.0	0.7	0.5	7.0	2.0	5.0	5.0	4.8	27.0	25.0	52.0
Distribution Ratio	0.03846	0.01346	0.00962	0.13462	0.03846	0.09615	0.09615	0.09231	0.51923	0.48077	1.00000

With those 85% exceedance probable condition on permanent and eventual discharge, and distribution ratio for each irrigation system, available irrigation water for Popeta-Yali-Alhué irrigation system on 85% exceedance probable discharge condition can be estimate as follows;

Item	Unit	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Popeta-Yali-Alhué Irrigation System		(85% exceedance probability)												
Permanent	m^3/s	15.30	8.79	8.80	11.05	20.81	23.78	25.00	25.00	16.11	12.15	16.07	16.95	
Eventual	m^3/s	2.40	0.85	0.44	0.92	0.43	1.22	0.00	0.00	0.51	0.83	1.51	2.09	
Total	m^3/s	17.70	9.64	9.25	11.97	21.24	25.00	25.00	25.00	16.62	12.99	17.58	19.03	
	MCM	47.43	23.32	24.76	31.03	56.89	64.81	66.96	66.96	43.08	34.78	45.57	50.98	556.57

As described in the previous chapter regarding the available water for the Popeta-Yali-Alhué irrigation system, in the estimation of flood discharge within the Popeta area, data of Cabimbao observatory are used for estimation of flood discharge taking into account the discharge data available and basin characteristic of discharge observatories. Secure flood discharge for the structural design will be employed with the comparative study on discharge amount both basin ratio and regression equation

Data on maximum annual daily discharge at Cabimbao observatory are available for the duration of 57 years from 1941 to 1997. Regression equation at Chiñihue can be constructed as $y = 1.3969\ x^{0.8633}$ (y: Chiñihue, x: Cabimbao) on the basis of discharge data at Chiñihue and the discharge data on same period at Cabimbao observatory. Exceedance probable flood discharge at Cabimbao observatory and flood discharge estimated by the basin ratio and the regression equation at the proposed site of integrated diversion weir (Chiñihue) are as follows;

Exceedance probability		Flood discharge Q : m^3/sec		
		Cabimbao	Proposed site of integrated diversion weir	
Year	%	A = 15,040 km^2	A = 12,043 km^2 Basin Ratio	Caimbao-Chiñihue Regression Equation
200	0.5	7,843.2	6,280.3	3,215.7
100	1	6,027.5	4,826.4	2,561.9
50	2	4,524.8	3,623.1	2,000.1
20	5	2,954.6	2,365.8	1,384.3
10	10	2,032.4	1,627.4	1,002.2
6.7	15	1,581.6	1,266.4	807.1
5	20	1,302.9	1,043.3	682.8

c) Integration of intake facilities

Four sites in the left bank and two sites in the right bank are planned to be integrated. The quantity of water intake is 45m^3/sec in the right bank and 12.8m^3/sec in the right bank. The detail is shown in the table below;

Left Bank Intakes		Discharge (m^3/sec)	Right Bank Intakes		Discharge (m^3/sec)
New Irrigation Area Intake		25.0	New Irrigation Area Intake		-
Existing Intakes	Calmen Alto	8.0	Existing Intakes	Picano	3.6
	Cholqui	2.0		Puange	9.2
	Chocalan	5.0			
	Culiprán	5.0			
Total		45.0			12.8

2) Conveyance system of irrigation water

The discharge of the main canal from the intake weirs is 45m^3/sec until the first diversion facility and 7.5m^3/sec at the diversion of Alhué. Because both of discharge scale are large, the conveyance system of the main canal is planned to be the gravity system considering convenience and economy of operation and maintenance. Basically the gravity conveyance applies also to the secondary canal, however the higher area where large irrigable land is located is supplied irrigation water by pumping. The area which needs water supply by pumping from the secondary canal is about

2,419ha in the proposed new irrigation area. The details are shown in the table below. In the planning of the proposed new irrigation canals, rehabilitation of existing canals are also planned to the areas where insufficient irrigation water supply is being made due to losses of existing irrigation canals.

Irrigation Area	Irrigation Area by Gravity Conveyance (ha)	Irrigation Area required Pumping-up (ha)	Total Irrigation Area (ha)
Popeta	4,975	-	4,975
Yali	8,309	1,506	9,815
Alhué	5,381	913	6,294
Total	18,665	2,419	21,084

(3) Diversion points and irrigation diagram

1) New irrigation areas

Sixteen diversion facilities to new irrigation areas and five to existing irrigation areas are to be constructed in the main canal starting from the diversion weir. The irrigation diagram consisted of these irrigation facilities in the new irrigation areas is shown in Fig. 1.2.3. Irrigation area and diversion amount at each diversion point from the main canal are shown in the table below. The diversion amount represents one at the maximum intake amount of 25m^3/sec at the intake weirs.

Irrigation Area		Diversion Point No.	Irrigation Area (ha)	Diversion Amount (m^3/sec)		
				Existing	New	Total
Popeta	Carmen	1	-	7.6	-	7.6
	Carmen	2	194	6.4	0.2	6.6
	Carmen	3	292	-	0.3	0.3
	Choluqui	4	316	0.2	0.4	0.6
	Choluqui	5	165	4.3	0.2	4.5
	Culiprán	6	257	1.5	0.3	1.8
	Popeta	7	1188	-	1.5	1.5
	Popeta	8	155	-	0.2	0.2
	Popeta	9	187	-	0.2	0.2
	Popeta	10	625	-	0.7	0.7
	Popeta	11	254	-	0.3	0.3
	Popeta	12	1,342	-	1.6	1.6
Yali		13	4,157	-	4.9	4.9
		14	629	-	0.7	0.7
		15	100	-	0.1	0.1
		16	4,929	-	5.8	5.8
Alhué		17	4.657	-	5.1	5.1
		18	1,637	-	2.4	2.4
Total			21,084	20.0	25.0	45.0

(Location of diversion No. is shown in Figure 1.2.4)

2) Existing irrigation areas

On water distribution to existing canals by integration of diversion weirs, water is divided after intake at Picano and Puangue respectively in the right bank, and then, directly discharges into the existing irrigation canals. On four canals located in the left bank, water is conveyed to each irrigation areas after taken at the weirs and detouring behind of the mountain at present. Yet, intaked water will pass through the mountain by tunnel and be raced to the upstream of *Estero* Carmen Alto after intake at the proposed integrated diversion weir, then conveyed to Yali and Alhué via Cholqui, Culiprán and Popeta. Water distribution to existing irrigation areas is basically divided at intake points and connect to existing canals, however, water will be distributed from new canals to the area where new canals pass through and water can be divided. On diversion amount, the amount determined by water right to the area of the diversion facilities is to be distributed.

Existing Canal	Planned Diversion Point	Planned Discharge (m^3/sec)	Irrigation Area (ha) to new Diversion Point	Water right m^3/sec)
Puangue	Diversion Weir	3.6	-	3.6
Picano	Diversion Weir	9.2	-	11.6
Carmen Alto	Diversion Weir (No.1)	1.7	-	8.0
	Main Canal Diversion Point No.2	6.3	355.5	
Cholqui	Diversion Weir (No.1)	0.6	-	2.0
	Main Canal Diversion Point No.3	0.2	84.5	
	Main Canal Diversion Point No.4	1.2	392.9	
Chocalan	Diversion Weir (No.1)	5.0	-	5.0
Culiprán	Diversion Weir (No.1)	0.3	-	5.0
	Main Canal Diversion Point No.5	3.2	1,314.9	
	Main Canal Diversion Point No.5	1.5	635.0	

(4) Available water for irrigation and water requirement

As formulating the irrigation plan for Popeta area where is a new irrigation area, required amount of irrigation for the Popeta-Yali-Alhué irrigation system corresponds to 85% probability of exceedance on both intake amount and precipitation in hydraulic condition. According to the discharge of water at 85% probability of exceedance at the weir point, available water amount for the Popeta-Yali-Alhué irrigation system and precipitation at 85% probability of exceedance in the area are presented in the table below.

Type	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Popeta-Yali-Alhué Irrigation System (85% probability of exceedance)														
Permanent	m^3/s	15.30	8.79	8.80	11.05	20.81	23.78	25.00	25.00	16.11	12.15	16.07	16.95	-
Eventual	m^3/s	2.40	0.85	0.44	0.92	0.43	1.22	0.00	0.00	0.51	0.83	1.51	2.09	-
Total	m^3/s	17.70	9.64	9.25	11.97	21.24	25.00	25.00	25.00	16.62	12.99	17.58	19.03	-
	MCM	47.43	23.32	24.76	31.03	56.89	64.81	66.96	66.96	43.08	34.78	45.57	50.98	556.57
Precipitation		0.1	0.1	1.6	9.4	40.4	50.3	57.0	30.6	13.5	5.8	3.2	0.7	212.70

Based on the cultivation plan by farming scale proposed in the agricultural production plan, unit water requirement is calculated. Preconditions of calculation are as follows;

Effective Rainfall : according to USDA, SCS method
Irrigation Efficiency : Field - Furrow Irrigation 50%, California Type 60%, Drip Irrigation 90%, Canal - 80%

Summary of unit water requirement by farm scale at the integrated weir point which is calculated based on the conditions mentioned above, is as follows. Details of the water requirement calculation (field level) is shown in Table 1.2.1.

Type	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
5 ha	mm	91.51	66.56	47.72	29.80	2.37	0.00	0.00	23.69	83.77	150.32	170.81	146.77	813.32
10 ha	mm	126.18	90.71	65.03	40.47	3.19	0.00	0.00	20.46	74.83	139.29	169.02	157.16	886.34
15 ha	mm	161.67	116.90	75.12	40.95	2.03	0.00	0.00	7.92	44.31	96.48	146.05	170.55	861.96
50 ha	mm	145.23	107.14	71.46	39.77	1.91	0.00	0.00	10.49	65.76	138.70	192.03	195.93	968.43
100 ha	mm	160.66	123.30	82.99	46.57	2.26	0.00	0.00	11.94	66.68	133.95	185.65	193.48	1007.47
200 ha	mm	163.73	128.49	85.45	47.75	2.37	0.00	0.00	9.70	58.70	117.19	167.47	184.22	965.09

Irrigable area calculated from the available water amount at the integrated weir and the unit water requirement are presented in the table below.

Type	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5 ha	ha	51,836	35,039	51,923	104,101	100,000<	100,000<	100,000<	100,000<	51,425	23,145	26,678	34,727
10 ha	ha	37,592	25,710	38,098	76,663	100,000<	100,000<	100,000<	100,000<	57,566	24,978	26,961	32,432
15 ha	ha	29,341	19,949	32,983	75,760	100,000<	100,000<	100,000<	100,000<	97,229	36,062	31,201	29,886
50 ha	ha	32,661	21,768	34,668	78,006	100,000<	100,000<	100,000<	100,000<	65,512	25,084	23,730	26,014
100 ha	ha	29,525	18,935	29,854	66,621	100,000<	100,000<	100,000<	100,000<	64,609	25,974	24,544	26,344
200 ha	ha	28,971	18,150	28,993	64,976	100,000<	100,000<	100,000<	100,000<	73,391	29,688	27,209	27,667

According to the table above, irrigable area would be less than the proposed irrigation area, 21,084ha in February if farming scale is over 15ha in the cropping plan. In case that irrigable area is the smallest, deficit of water amount is calculated as follows.

$$\{(21,084 - 18,150) \times (142.27/1,000) \times 10,000\}/1,000,000 = 4.17 \text{ MCM}$$

This deficit amount planned to be adjusted by impounding water in the regulation reservoir constructed in the main canal.

(5) Supplemental water supply by regulation reservoirs

Regulation reservoirs are planned to impound the discharge of water right during non-irrigation period for the purpose of supplementing water resources and preventing ineffective discharge of the available water at 17 sites in the area. The scale and capacity of reservoirs are shown in the table below. Regulation ponds (storage water is supplied from canals) are planned at diversion points in the secondary and the tertiary canals for adjusting irrigation time in the field. Ten regulation ponds are to be constructed in the Popeta area.

No.	Site	Capacity (m^3)	Crest Length (m)	Crest Height (m)	Area
1	Loma El Litre	113,000	400	5	Carmen Alto
2	Pintilla de la Guaitata	265,000	280	10	Cholqui
3	Cholqui	165,000	280	10	Cholqui
4	El Cajon	1,029,000	750	10	Culiprán
5	*Estero* Tantehve	428,000	240	10	Popeta
6	Lomo La Curz	587,000	750	10	Popeta
7	Cajon del Rey	2,780,000	780	10	Popeta
8	Rincon lao Guindos	198,000	400	10	Popeta
9	Rincon La Monja	1,466,000	1,000	10	Popeta
10	S/N (Los Guidos)	493,000	600	10	Popeta
11	S/N (Co. Pordices)	416,000	400	10	Yali
12	S/N (Logovilo)	346,000	180	10	Yali
13	*Estero* El Parvon	2,517,000	670	10	Yali
14	Los Molles	1,988,000	900	10	Alhué
15	S/N (Santa los del Pecal)	848,000	600	10	Alhué
16	*Estero* Huillin	1,327,000	650	10	Alhué
17	S/N (La Sepulfura)	1,337,000	300	10	Alhué
	Total	16,303,000			

The storage capacity of the largest reservoir is 2,800,000m^3, and total storage capacity is about 16,303,000m^3. Through these, each irrigation area will hold freedom and safety of irrigation. Water amount relevant to the F/S area, Popeta is 7,524,000 $m^{3.}$

(6) Water management system

New diversion weirs are purposed to take water for Popeta-Yali-Alhué area at first, and integration of intake facilities close to new diversion weirs is also planned. The integration of intake facilities will realize accurate water distribution and intake management based on the water right of the third section. There are eight intake facilities and thirteen canal associations (*Asociacion de Canalistas*) in the third section at present. Although there is movement of establishing *Junta de Vigirancia* in some canal associations for equitable intake management, it has not realized, yet. Exercise of the unused water right of $25m^3$/sec is to give effect on the existing water right. Therefore, it is required to clarify the river discharge, accurately and fairly management of water diversion under the establishment of *Junta de Vigirancia*. Distribution of water from the main canal to respective irrigation area is planned to be managed by a *Cerrador* (gate manager) dispatched from a newly established canal association on the integrated diversion weir by canal associations concerned.

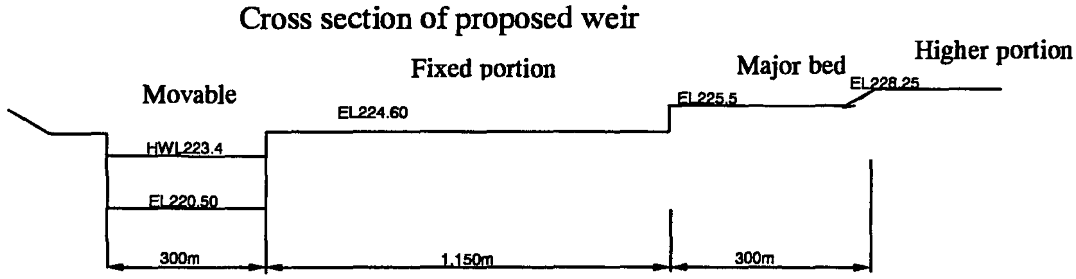
(7) Structural planning for Irrigation

1) Intake facilities

a) Design flood discharge and closing width of river

Design flood discharge at weir site is taken $4,826m^3$/sec of 1 % probability of exceedance. The river width from the spur point of Loma la toma of the left bank to the river terrace of the right bank is 1,750m. Major water flows of river are generally running within the range of 300m along the left bank. Small water flows maintain to take water for Picano and Puangue irrigation systems in the right bank. The bear-trap weir, which does not disturb running flow at flood, is to be constructed at the part of water flows to maintain stable water intake at shortage of water and water routes. The concrete fixed weir is to be constructed to close cross direction entire sections in the other river sections. The water-level at closing sections are shown in the figures below. (See Annex K for hydraulic calculation)

Cross section of proposed weir



b) Structural arrangement of weir body

At the proposed weir site in the left bank, steep mountains reaches the river bank and it geologically consists of hard Andesite of the Cretaceous's lower part. The riverbed which water flows exist is covered with sandbars of riverbed, and Andesite which consists of the mountain is assumed to get in deep suddenly. The soil borehole log of the boring survey (two sites, at river center of left side of the weir) and N value of the standard penetration test are shown in Annex K. Riverbed deposit mostly consists of sandbars mixed with boulder. N value from 1 to 6m in depth is over 50, and at deeper place is over 30. Bearing capacity is judged enough for base of the weir.

The weir body is to be fixed at the mountain along the river in the left bank and at the river terrace which is from 3 to 5 meters above the river. The structure of weir is planned to consist of scouring sluice, movable part and fixed dam part. Dam-up height and the rate of movable and fixed parts will be planned within the range that the water level at flood does not overflow the river terrace of the right bank. Structure of the weir for planned flood discharge of $4,826m^3$/sec is shown in the table below. (Detailed design is shown in Annex K)

Hydraulic Section	Structure	Dam-up Height(m)	Width (m)	Flood Depth (m)	Flow Speed (m/sec)	Discharge (m^3/sec)
Scoring Sluice (Left Bank)	Sluice Gate	2.7	30(15 x 2 gates)	3.4	3.0	500
Scoring Sluice (Right Bank)	Sluice Gate	2.7	10	3.4	2.5	168
Movable Part	Bear-trap weir	2.4	250	3.4	2.5	4,200
Fixed Part	Concrete Weir	1.5	1,150	-	-	-
Total			1,440			4,868

The structure of major parts of the weir is planned to be formed with steel sluice gate at the scouring sluice, bear-trap weir at the movable part and concrete structure at the fixed part.

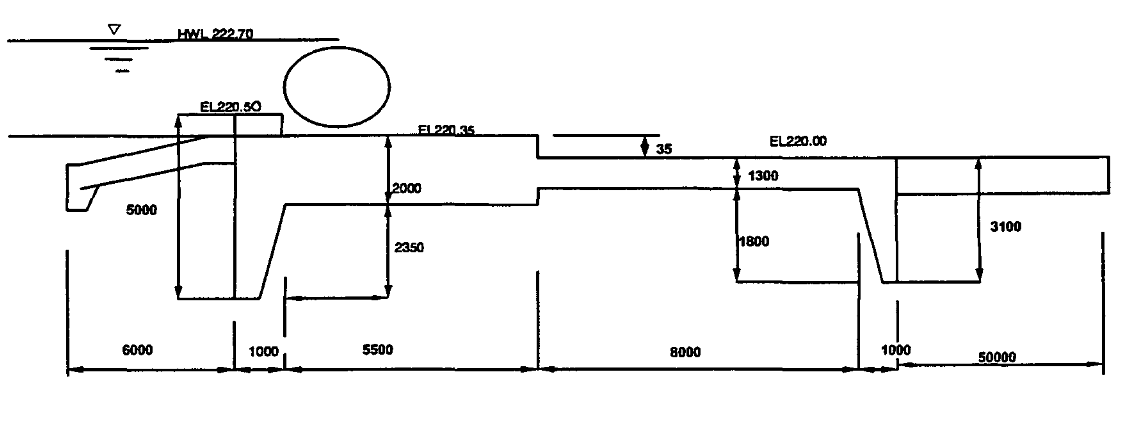
c) Selection of movable weir type

Considering the conditions of discharge duration for constructing the integrated diversion weir: the entire river width, flood discharge, moving range of the water flows, discharge depth and sediment run-off, closing length of the movable part is 250m. Dam-up depth is 2.4m according to intake level. Movable type weir under these conditions, steel sluice gate, steel hydraulic overturning gate, radial gate and rubber dam can be proposed. Based on the results of comparison among them, rubber dam is applied because it maintains easily and is economically reasonable.

Evaluation Term	Steel Sluice Gate	Steel Overturning Gate	Radial Gate	Rubber Dam
Gate Size & No.	25 m x 10 Gates	50 m x 5 gates	25 m x 10 gates	80 m x 3 gates
Gate Price (US$)	11,000,000	8,000,000	6,400,000	3,500,000
Engineering construction Cost (US$)	14,730,000	14,640,000	14,690,000	14,610,000
Total (US$)	25,730,000	20,640,000	21,090,000	18,410,000
Evaluation	Economically most expensive	Maintenance cost is higher than rubber dam due to hydraulic control	Damaged by obstacles such as drift wood leads to higher cost	Easy maintenance and economical compared to the others

d) Cross-section of the rubber dam

Height of the rubber dam is to be 2.40m because the placing elevation is 220.35m and intake level is EL 222.70m. The foundation which supports rubber dam, is planned to be constructed at 13.5m in total length and cutoff wall is constructed with 4m in the upstream side and 2.5m in the downstream side, so as to stabilize the dam and prevent piping. Cross-section of rubber dam is shown in the figure below.



Riprap block is planned to be constructed at the downstream apron of the dam for keeping the dam safety. Length of the consolidation works is 50m and the size of a block is 4 ton per piece.

e) Water-intake and settling basin

At the water-intake point in the left bank, intakes for the new irrigation area and four existing irrigation systems (Calmen Alto, Cholqui, Chocalan and Culiprán) are to be integrated. Two existing intakes for Puangue and Picano are also integrated. Water intake structure is planned to be constructed in front of scouring sluice, and be set up with the gate for controlling diversion volume and stopping mud-flow at flood. Planned stream velocity at the intake is to be 0.8~1.0m/sec. Settling basin is planned after taking water for stopping sediment flow.

Intake Site	Intake Structure				Settling Basin			
	Diversion Volume (m^3/sec)	Structure	Intake Depth (m)	Intake Width (m)	Basin Width (m)	Basin Length (m)	Average Depth (m)	Basin Area (m^2)
Left Bank	45.0	Gate	1.2	37.5	60	150	0.3	9,000
Right Bank	12.8	Gate	1.2	9.2	40	100	0.3	4,000

2) Canals and related structures

a) Main canal route alignment

The main canal in the new irrigation area is planned as common use system of Popeta area where is the F/S area in the project and Yali and Alhué where are located in the lower part of the main canal. The route of the main canal is set up by the elevation of the diversion weir and required water level for irrigation use in the area. Most of the route is planned to pass on the foot of mountain and the extension from the intake structure to Alhué area is 75km. Partially, the route reaches finally to the irrigation area along the Alhué river after penetrating the mountains by nine tunnels. The extension of the route is varied between 3 and 5km. Seven of nine tunnels can detour the mountain by open canals, however the extension of the open canals becomes five times as much as tunnel's extension. Thus, tunnel works are selected because the construction cost is economical.

The head loss of conducting water can be reduced by more than 15 m through taking tunnel works, and irrigation water supply by gravity method becomes possible for most of the area (93%) except some plateaus. Three canals taking water from the Maipo river which are detouring the hillside from the intake point to Culiprán are constructed. The selection of tunnel method considers the influence on these existing canals.

The bedrock of the route is shown in the table below. Many of main canals and aqueducts are to be constructed on the Colluvial soils covering on the bedrock.

Area			Geological Feature	
			Bedrock of Foot of Mountain	Valley of *Estero*
1	Popeta	Carmen	Marine Sedimentary Rock, Effusive Rock	Colluvial soil of Alluviam & Diluviam (Q)
		Choluqui	Granites	Colluvial soil of Alluviam & Diluviam (Q)
		Popeta	Granites	Colluvial soil of Alluviam & Diluviam (Q)
2	Yali		Granites	Colluvial soil of Alluviam & Diluviam (Q)
3	Alhué		Marine Sedimentary Rock, Granites	Sand Bars of Alluviam & Diluviam (Q)

b) Structural planning of the main canal

The structure of the main canal consists of the open channel which passes foot of the mountain, the tunnel passing through the mountain and aqueducts crossing the streams. In the main canal, the siphon structure which will have the problems on maintenance (removing silt and leakage by water pressure) in the future is not planned as the structure passing through the small streams Canal gradient is to be set at not less than 185m at diversion point of Alhué. Average gradient of all canals is approximately 1 / 3,000 considering diversion loss. The canal is to be constructed by concrete lining for prevention of leakage and simplifying maintenance. The tunnels are planned to shape the standard horseshoe type and free-flow without pressure tunnels. Major structure of the main canal in each irrigation area is as follows.

Area	Main Canal			Lateral Canal			
	Open Canal (km)	Tunnel (km)	Aqueduct (km)	Open Canal (km)	Tunnel (km)	Aqueduct (km)	Siphon Works (km)
Popeta	45.95	13.52	0.44	44.70	-	-	-
Yali	10.25	3.35	0.07	117.45	0.73	0.32	0.05
Alhué	-	3.90	-	91.86	0.28	0.31	1.60
Total	56.20	20.77	0.51	254.01	1.01	0.63	1.65

- Structure of the main canal

The main canal is to be constructed in tails along with foot of the mountain by concrete lining because large leakage is occurred in case of earth canals, and the face of slope is easy to be collapsed. Inspection road is constructed beside the canal. Cross section of the canals is classified into 11. Hydraulic elements, scale of cross-section and structures of major canals are presented in the following table.

Hydraulic Elements	Type I	Type II	Type III
Canal Height (m)	3.00	2.5	1.5
Canal Bed Width (m)	6.0	4.0	2.0
Side Slope	1:0.3	1:0.3	1:0.3
Flow Velocity (m/sec)	1.5	1.3	1.3

- Structure of the secondary canals

The secondary canals are canals conveying water from the main canal to a field canals (tertiary canals). They are set up outside of irrigation area and foot of a mountain. Canal type is a open canal and lining for prevention of leakage and smooth maintenance. Dimension of major canals is as following table.

Hydraulic Elements	Type I	Type II	Type III
Canal Height (m)	1.5	1.0	0.7
Canal Bed Width (m)	3.0	1.5	1.0
Flow Velocity (m/sec)	1.3	1.2	1.0

- Structure of the tertiary Canal

A tertiary canal is to be set up at intervals of 200m in the field. The canal structure is open channel at area where ground slope is less than 1/50, and is pipeline type where ground slope is over 1/20 of for preventing erosion of farmland by irrigation and that fruit growing can be a major farming, there.

- Diversion facilities

Diversion facilities from the main canal is set up in each irrigation area. However, the irrigation area where divided by large stream needs the crossing structure in the secondary canals. Therefore, diversion facilities are planned to be constructed in each valley. Total diversion facilities from the main canal are 18. Diversion facility structure of the main canal is a longitude separation work which divides a canal by the rate of flow. Each diversion facility is set up with a gate so as to maintain the canals by each diversion unit. Diversion facility structure of the secondary canals are longitude separation works divided by the rate of flow and set gate for maintenance.

c) Tunnel

Tunnels which get beyond mountains and distribute water to the other area are set up in two sites, between Popeta and Yali, and Yali and Alhué. In other areas, when a canal which detours the mountain is more than five times as much as the tunnel extension, tunnels are applied because the canal takes economical disadvantage. Geological feature and construction conditions of the areas where tunnels are applied are shown in the table below. The type of tunnel is a horseshoe type and slop of canal at tunnel part designed to be steep as much as possible in order to make the cross section small.

Area	Tunnel Length (m)	Stratum	Size of Cross Section Dia. & Length (m)	Alternative Method and Evaluation
Popeta	5,549	Sedimentary Rock, Igneous Rock	5.2	Detouring 36km: Tunnel is profitable
	300	Sedimentary Rock, Igneous Rock	4.6	Detouring 2.8km: Tunnel is profitable
	3,350	Sedimentary Rock, Igneous Rock	4.1	Detouring 46km: Tunnel is profitable
	3,210	Granites	4.1	Detouring 34km: Tunnel is profitable
	730	Granites	3.9	Detouring 3.4km: Tunnel is profitable
Yali	2,500	Granites	3.8	Crossing river basin, only tunnel
	250	Granites	3.6	Detouring 1.0km: Tunnel is profitable
	490	Granites	3.4	Detouring 3.2km: Tunnel is profitable
Alhué	3,930	Granites	2.6	Crossing river basin, only tunnel
Total	20,309			

d) Regulation reservoir plan

- Dam body structure

The reservoir is to be constructed at the lower site than the canal's elevation because redundant water is to be stored within available water of Popeta-Yali-Alhué irrigation system. The construction site is to be selected at a ravine of valleys within the storage depth of 10m. On storage capacity, that in two sites is around 2,000,000 m^3 , five sites is about1,000,000 m^3 and others areas is 300,000 to 600,000 m^3. Dam body will be the earth-fill type from the point of their capacities and construction materials. Homogeneous type or center core type is to be selected according to available materials of each dam body.

- Foundation treatment

Geologically foundation of each reservoir area is formed by gravel such as Colluvial soils of the Diluviam age and riverbed deposit of the alluvial age. Generally, the depth of cutoff wall is designed by 1.5 times of water depth in the site which has this kind of geological composition, but there is regional difference and confirmation of the geological composition is required. Accordingly, examination of the foundation treatment plan based on geological survey such as the seismicity, boring, permeability of Colluvial soil and groundwater level is necessary at the detailed design stage.

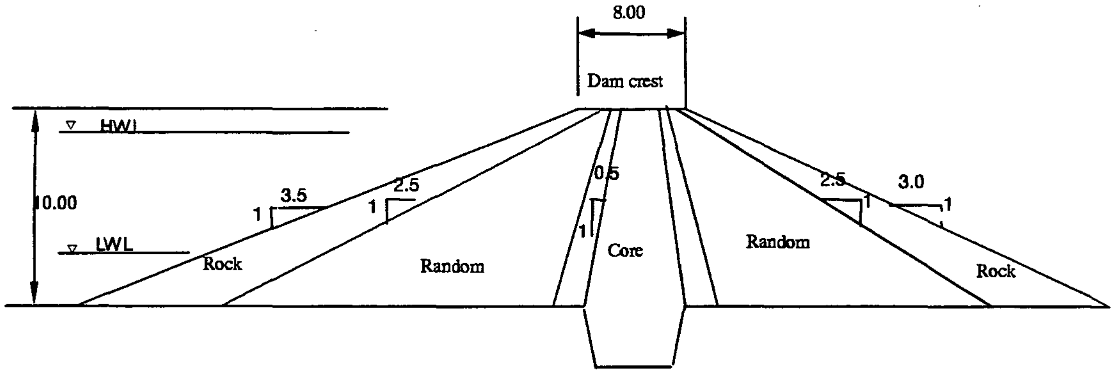
There is no concern on lack of bearing capacity or piping in bedrock of each reservoir, however, it should be careful with leakage water through sand layer. Because as the depth of the reservoir is deeper, leakage is larger, the depth of reservoir is designed by less than 10m. Planned cutoff wall is to be around water depth. Spillway is planned at flood discharge of 1% probability of exceedance (50 years probability) for safety of the dam body. Type of spillway is side spillway and foundation is designed to be rock mass.

- Cross-sectional structure of dam body

Standard cross section of the fill type dam is planned as follow based on the results of stability analysis. (See Annex k for stability analysis)

Type	Water Depth (m)	Crest Height (m)	Crest Width (m)	Crest Type	Dam Slope		Foundation Treatment (m)	Spill way	
					Upstream	Downstream		Probability Year	Flood Discharge (km²/m³/sec)
Type I	7	9	8.0	Center Core Earthfill	1 : 3.5	1 : 3.0	15	1/100	2.45~7.74
Type II	10	12	8.0	Center Core Earthfill	1 : 3.5	1 : 3.0	10	1/100	2.45~7.74

Typical cross section of the dam body is shown below.



Proposed Dam Dimension

No.	Site	Storage Capacity (m³)	Side Slope of Dam (1: n)		Soil Volume (m³)	Flow Volume of Spillway (m³/sec)	Spillway Length (m)	Type
			Upper Slope	Lower Slope				
1	Loma El Litre	113,000	3.5	3.0	30.000	10.1	9	I
2	Pintilla de la Guaitata	265,000	3.5	3.0	27,000	21.8	20	II
3	Cholqui	165,000	3.5	3.0	54,000	26.8	24	II
4	El Cajon	1,029,000	3.5	3.0	180,000	73.2	66	II
5	*Estero* Tantehve	428,000	3.5	3.0	120,000	161.2	79	II
6	Lomo La Curz	587,000	3.5	3.0	230,000	7.7	7	II
7	Cajon del Rey	2,780,000	3.5	3.0	376,000	322.4	75	II
8	Rincon lao Guindos	198,000	3.5	3.0	65,000	67.9	63	II
9	Rincon La Monja	1,466,000	3.5	3.0	289,000	69.4	61	II
10	S/N (Los Guidos)	493,000	3.5	3.0	109,000	7.0	6	II

e) Field irrigation plan

The main and secondary canals are to be lining with concrete or masonry. The tertiary canals are earth canals at flat areas and employing the California type irrigation in the field.

At sloping land (gradient ; 1/20), the canals are to be pipelines for protecting canal and preventing erosion. Fruit growing is to be the major cultivation at the sloping land. Pipeline type tertiary canals make drip-irrigation by pressure from the secondary canals possible. Irrigation area and irrigation efficiency of the pipeline type tertiary canals which are earth canals are as follows.

Tertiary Canal Structure	Irrigation Method	Area (ha)	Irrigation Efficiency (%)
Earth Canal	Furrow irrigation	3,800	48
Pipeline	Drip Irrigation	1,200	72

f) Plan for electric generation

Electric generation is feasible at two sites in Carmen Alto, one site at Cholqui and one site at Culiprán by integration of existing intakes. Proposed dimension of proposed electric generation is as follows.

	Canal	Water Volume (m^3/sec)	Water Level (m)	Penstock Ø (mm)	Generation Capacity (kW)	Avg. Annual Production (MKW)
1	Carmen Alto	5.70	23.4	2000	970	262
2	Carmen Alto	6.30	20.6	2000	940	253
3	Cholqui	1.15	31.0	700	230	63
4	Culiprán	3.18	45.7	1200	1,040	281
					3,180	859

Agricultural infrastructure development plan is described in Fig. 1.2.4.

1.2.5 Rural Infrastructure Development Plan

Rural infrastructure development plan promotes from the point of permanent rural settlement through agricultural promotion, soundness and safety of inhabitants in the area. Accordingly, based on the present situation survey, the sectors where installation is behind (connecting roads, water supply facilities, rural sewerage treatment facilities and meeting facility) intend to be improved.

- On road improvement, it is planned to put stress on the establishment of road networks in the area. Trunk roads are to be paved up to the center of each community. On lateral roads, new connection roads between lateral roads are to be constructed and improved at the level for vehicle traffics.

- Regarding the improvement of rural water supply facilities, underdeveloped facilities in Carmen Alto and Cholqui are to be improved by a water source of new groundwater development. Estimated water supply amount is 100lit./day/head (drinking water: 50lit./day/head, domestic water: 50 lit/day/head).

- Rural sewage treatment facilities are to be improved mainly in the center of each *UV* for living and production environmental conservation. Because operation and management of treatment facilities are to be handled by community members, high operation technique and special chemical treatment should not be required. Treated water can be reused for agriculture. The target of treatment level is less than 30 mg/lit. on BOD and less than 1,000 MPN on coliform groups.

- CECUV is established for technical support on agriculture in the area, and providing the place for fostering agricultural successors, meeting of inhabitants, various subjects of training and rural women's activities. Obtaining the rooms of each producers' group for technical support in the center expects to result in easy access to effective support services and technology transfer. Popeta already has community center. Thus, existing facilities can be utilized as the place for agricultural support and community activities.

Based on the survey of the present situation and the irrigation facility improvement plan, required items and quantity for improvement of living environmental facilities are shown in the table below. Outline of the rural infrastructure development is described in Fig. 1.2.5.

Improvement Item	Popeta Area		
Road Improvement			
Trunk Road Pavement	5 routes	L= 30.0 km	W= 6.0
Lateral Road Improvement	4 routes	L= 21.6 km	W= 5.0
New Lateral Road	5 routes	L= 14.5 km	W= 5.0
Rural Water Supply Facility	2 sites		
	Carmen Alto	849 people	Ø100L= 16 km
	Los Guindos	615 people	Ø100L= 28 km
Rural sewage treatment Facility	8 sites		
	Chocalán	687 people	Ø150L= 19 km
	Carmen Bajo	1,125 people	Ø150L= 38 km
	Carmen Alto	849 people	Ø150L= 23 km
	Cholqui	1,211 people	Ø150L= 32 km
	El Pabellon	915 people	Ø150L= 27 km
	Culiprán	1,736 people	Ø150L= 33 km
	Popeta	1,309 people	Ø150L= 29 km
	Los Guindos	615 people	Ø150L= 16 km
Community Center (CECUV)	7 sites, 210 m2 / site		
	Chocalán, Carmen Bajo, Carmen Alto, Cholqui, El Pabellon, Culiprán, Popeta, Los Guindos		

1.2.6 Environmental Conservation Plan

(1) Water quality in Popeta area

According to the construction plan of the sewage treatment plant in Santiago by EMOS, three plants will be completed along the Mapocho river in 2024 and then the treated water of approximately 25m^3/sec will be discharged into the Mapocho river. Consequently, water quality of the Maipo river joining the Mapocho River will be greatly ameliorated. Based on the predicted results of water quality at target year of 2010, water quality at the intake point of Popeta-Yali-Alhué irrigation system will be achieved less than 20mg/l in BOD according to the stage-wised completion of the treatment plant of EMOS.

(2) Environmental management plan

1) Promotion of environmental education in basins

After the construction of the plants proposed in this project, those plants will be managed by the canal associations. However, at the points where canals pass through villages, it is considered that the canals and irrigation water will be contaminated by wastes, domestic sewage, and livestock farming wastes.

UV, the smallest unit of the organizations for administrative support in *Comuna*, has a role of promoting to abide the hygiene regulation, of carrying out the activities for the environmental hygiene, pushing on the environmental conservation, and keeping the balance of ecosystem. In this project, it is planned that a campaign for enlightenment on the-village-basis with respect to the environmental conservation to maintain high quality of water. The promotion campaign of environmental education is also planned by recommending to have a qualification to be engaged in the environmental conservation among the youth group of UV or other groups, and farmers' groups.

2) Promotion of agriculture with environmental consideration

In order to prevent environmental pollution by expansion of utilization on pesticide and fertilizer and to promote sustainable agriculture, skill guidance and technology transfer to farmers concerning the reduction of using pesticide and fertilizer are executed by the public institutions such as INIA. These activities are carried out on the farmers' organizations established to receive the agricultural support services from INDAP.

(3) Environmental impact assessment (EIA)

EIA System in Chile, No. 35,731, established in April 1997 provides the object to be assessed from the environmental view. Related items between the EIA System and the development plan of Popeta area including Yali and Alhué are: "projects giving a great influence on waterworks, dams, drainage, and natural water system"; and "works or activities in the natural parks designated officially."

Environmental assessment with regard to the EIA System is conducted by the Chile side when the execution of this project is determined definitely as a project. In the process of the assessment, the environmental factors as to the conduction of the project are investigated and predicted on the basis of the contents of the project including the alternatives. The predicted results and designated goal for the environmental conservation are assessed, and then the goal is achieved by preparing the measures for the goal. If the goal is not achieved, the alternative is predicted and assessed instead, and the goal is achieved by making measures for the goal.

- Environmental impact in development of Popeta, Yali, and Alhue.

With respect to the environmental impact in the construction of canals and drainage from the new irrigated farmland, the following items are considered as the objects assessed by the results of scooping on environmental factors.

Livings of inhabitants	Planned or involuntary resettlement, and conflict among inhabitants.
Demographic issues	Drastic change in population composition by the changes in rural population engaged in agricultural production .
Economic activities of inhabitants	Relocation and change of bases for economic activities, and increase of unemployment and income disparities.
Institutions and customs	Readjustment of water right, social and structural changes such as establishing organizations and changes in existing institutions and customs.
Environment and sanitation	Generation of construction wastes, increased use of pesticide, and increase in domestic and human wastes.
Historic remains, cultural assets, landscape and others	Deterioration of aesthetic harmony
Precious biological and ecological system areas	Negative impacts on diversity of precious or indigenous fauna and flora, vegetation, and living things, invasion and proliferation of hazardous species, and extinction of wetland and wild land.
Soil	Erosion, salinization, deterioration of fertility and contamination.
Hydrology	Changes in surface water condition, and changes in groundwater condition and its level .
Water quality and temperature	Water contamination of surrounding rivers and canals during construction, deterioration of water quality and lowering its level after use for construction, eutrophication and changes in water temperature.
Air pollution	Dust generated by vehicles during construction
Noise and vibration	Noise and vibration during construction.

As the evaluation standard, the influence of qualitative objects is set at the minimum, while water quality and noise are set at as follows:

Water quality	Turbidity 50-Silica, Color 100, Temperature 30℃, Transparency 1.2m, pH 6.5-8.3, Fecal coliforms 1000MPN/100ml
Noise	45-55dB

1.2.7 Summary of Agricultural Development Plan in Popeta Area

Proposed structural installation in Popeta area which relates to the priority project proposed in the Master Plan of the Study is formed as following contents.

Project	Project component				
Agricultural production infrastructure development project	1. Irrigation area	Popeta	Yali	Alhué	Total
	(ha)	4,975	9,815	6,294	21,084
	2. Integrated diversion weir: Intake volume Left bank: 45.0 m³/s Right bank: 12.8 m³/s Total: 57.8 m³/s				
	3. Irrigation canals	Popeta	Yali	Alhué	Total
	(1) Open canal				
	Main canal (km)	45.72	10.29	-	56.38
	Secondary canal (km)	66.73	133.80	110.90	311.43
	Tertiary canal (km)	235.00	(Excluding F/S)	(Excluding F/S)	235.00
	(2) Tunnel				
	Main canal (km)	13.14	3.24	3.93	20.31
	Secondary canal (km)	0.60	0.73	0.28	1.61
	(3) Aqueduct				
	Main canal (km)	0.44	0.07	-	0.51
	Secondary canal (km)	-	0.32	0.31	0.61
	(4) Diversion facility				
	Main canal (Nos.)	12	4	2	18
	(5) Improvement of existing canal				
	Main canal (km)	22.0	-	-	22.0
	4. Regulation reservoir				
	Number of place	10	3	4	17
	Capacity (1,000 m³)	7,524	3,279	5,500	16,303
Rural infrastructure development project	1 Road improvement		(Excluding F/S)	(Excluding F/S)	
	Pavement of main road (km)	5 routes 30.0			30.0
	Improvement of lateral road (km)	4 routes 21.6			21.6
	Construction of lateral road (km)	5 routes 14.5			14.5
	2 Rural water supply facilities (Nos.)	2	(Excluding F/S)	(Excluding F/S)	2
	3 Rural sewage treatment facilities (Nos.)	8	(Excluding F/S)	(Excluding F/S)	8
	4 Community center (Nos.)	7	(Excluding F/S)	(Excluding F/S)	7

Development plan in Popeta area including Yali and Alhué is described in Fig. 1.2.6.

1.3 Project Cost

1.3.1 Basic Conditions of Cost Estimation

Project costs are estimated at the price level of December 1998 based on the results of field survey regarding the costs of labor, construction materials and equipment. Basic conditions of cost estimation are as follows.

(1) Construction cost

Construction works is executed by the contractor with contract basis. Since contractor prepares construction materials and equipment, which are necessary to execute the works, costs of construction materials and equipment are estimated by depreciation cost. Referenced materials for construction costs are as follows.

- Cost of Corrales project which were executed by DOH（December/'98）
- Commodity price book published by ONDAC（December/'98）
- Prevailing costs in Chile is used on working ratio and depreciation cost of construction equipment, depreciation cost for temporary works.

(2) Project cost component and ratio applied for estimation

Component and ratio of indirect costs of the project against direct construction cost are assumed as follows.

- Project cost consists of preparation cost, direct construction cost, engineering and administration cost as well as physical contingency.
- Direct construction cost includes overhead and profits.
- Engineering and administration cost is assumed as 10% of direct construction cost.
- Each cost is divided into local and foreign currency portions. Labor costs and materials such as sand, aggregate, are assumed as local currency portion and others are foreign currency portion. Physical contingency is 10% of total costs from direct construction cost to engineering and administration costs.
- Price escalation is assumed as 5% of inflation index.
- Land acquisition and compensation costs are applied 600 to 1000 thousand pesos per ha based on kind of land.
- Operation and maintenance cost is estimated separately as the Operation and maintenance cost of canal association for water management.

1.3.2 Project Cost

Project component of the area is broadly divided into two (2). There are agricultural infrastructure development which main component is irrigation facilities improvement, and rural infrastructure development project consist of road improvement, rural sewage treatment facilities, rural water supply facilities and CECUV. Project costs of principal components are as follows. Detail of the cost is shown in Table 1.3.1. While, disbursement schedule of the project is shown in Table 1.3.2.

Unit: Thousand Pesos.

	Component	F.C	L.C	Total
1	Preparation cost	1,376,694	1,882,527	3,259,221
2	Construction cost			
	Agricultural production infrastructure development	26,572,601	35,803,362	62,375,963
	Rural infrastructure development	961,281	1,847,184	2,808,465
3	Land acquisition and compensation cost	-	40,894	40,894
4	Engineering and administration cost	2,716,686	4,479,185	7,195,871
5	Physical contingency (10%)	3,162,262	4,405,315	7,568,041
	Total	34,789,988	48,458,467	83,248,455

Total project cost on agricultural development project in Popeta area is estimated at 83,200 million pesos.

The integrated diversion weir which is constructed in the Maipo river, and the main irrigation canals from the integrated diversion weir to Popeta area, are proposed in the structural plan. The facilities' capacity is added the capacity of the integrated diversion weir which integrated six existing intake structures and intakes of Popeta, Yali and Alhué, and irrigation water of the main canals to the newly irrigated areas which attached three existing irrigation areas and Yali, Alhué areas. Therefore, construction cost has to be allocated in order to estimate the individual economic evaluation on

Popeta area. The construction cost of the integrated diversion weir and main irrigation canals are allocated to the beneficiaries based on the ratio of their water right discharge and distance ratio. Then, beneficiaries pay for their allotment. The cost allocation ratio is shown in the following table.

Cost allocation of integrated diversion weir		
Related canals	Intake volume (m^3/sec)	Allotment
1 Puange	3.6	0.062
2 Picao	9.2	0.159
3 Carmen Alto	8	0.138
4 Cholqui	2	0.035
5 Chocalán	5	0.080
6 Culiprán	5	0.087
7 Popeta	5.9	0.102
8 Yali	11.64	0.201
9 Alhué	7.46	0.129
Total	57.8	1.000

Cost allocation of main canals					
Related canals	Discharge (m^3/sec)	Related length (km)	Ratio of discharge	Ratio of length	Allotment
1 Carmen Alto	6.52	5.6	0.181	0.022	0.019
2 Cholqui	1.4	20.6	0.039	0.081	0.015
3 Culiprán	3.2	20.6	0.089	0.081	0.035
4 Popeta	5.9	59	0.163	0.231	0.183
5 Yali	11.64	73	0.322	0.285	0.446
6 Alhué	7.46	77	0.207	0.301	0.302
Total	36.12	255.8	1.000	1.000	1.000

1.4 Project Implementation Schedule

1.4.1 Executive Agencies

Agricultural development project in Popeta area (irrigation project) is evaluated by CNR, and its implementation is approved by *Consejo de Riego*. Approved projects are classified into direct controlled projects of DOH (MOP) as a national project and irrigation encourage projects of CNR by the project scale (construction cost). In case that project cost is more than 24,000UF, the projects will be national irrigation projects (Government ordinance No. 1123), and the projects whose cost is less than 24,000UF will be irrigation encourage projects (Law No. 18450). As for the scale of facilities, Government ordinance No. 1123 determines diversion weir, main canals, secondary canals as large scale irrigation facilities. Law No. 18450 determines tertiary canals to the fields as medium and small scale irrigation facilities. According to the project scale, the executive bodies of the project are classified as follows;

Classification of Project	Implementation agency	Project scale	Component of project
Government ordinance No. 1123	DOH	More than 24,000 UF	Diversion weir, main canals, secondary canals
Law No. 18450	PROMM	Less than 24,000 UF (*Comuna*: irrigation association)	Tertiary canal to farm ditches
	CNR	Less than 12,000 UF (private)	

1.4.2 Burden of Project Cost (Source of funds)

The project will be implemented by following governmental subsidy systems based on Government ordinance No. 1123 and Law No. 18450.

Laws	Ration of subsidy	Burden of beneficial farmer	Remarks
Government ordinance No. 1123	Maximum 70%	The rest	Ratio of subsidy is changed by the project components and the project scale.
Law No. 18450	Maximum 75%	The rest	Low interest rate credit UF+4.5%, long term loan Applicant applies advantageous rate for the proposal.

Farmers can use a long-term loan at low interest rate for the irrigation project in order to pay their burden. As for the project cost itself, the government of Chile will provide from a national budget or fund of international financial organizations.

1.4.3 Process of the Project Implementation

(1) Agreement on the project of beneficiaries

As for the projects under Government ordinance No. 1123 (main irrigation facilities), DOH examines the project implementation after *Consejo de Riego* approved the project. In the examination, at first, DOH carries out questionnaire survey on approval or disapproval of the project for expected beneficiaries, and then confirms if more than 50% of the benefiting farmland area agrees with the project (agreement on the repayment of the project cost). DOH usually explains and collects agreement sheets directly. In case of an irrigation project under Law No.18450 (terminal irrigation facilities), CNR decides approval or disapproval of the project based on the proposals from the beneficiaries.

(2) Establishment of canal associations

There is no existing canal association in the new irrigation area. Therefore, so as to distribute irrigation water, establish water right, and obtain land for irrigation facilities, it is required to establish canal associations by beneficiaries in each new irrigation area at early stage as a core organization for promoting projects. Establishment of canal associations and decision of the project implementation should be promoted at the same time.

For existing and new canal associations related to the construction of the integrated diversion weir in the project, establishment of the integrated canal association to distribute fairly and manage water right volumes and of *Junta de Vigilancia* to manage intake water from the rivers in the third section are needed.

1.4.4 Implementation Schedule

As for integrated weirs and the main canal facilities, DOH employs consultants to execute the detailed design (D/D) after confirmation of beneficiaries' agreement on participation of the project. Then, DOH promotes the project from the contract by competitive bidding among constructors to commencement of construction works. In case of the tertiary canals (terminal facilities), the canal associations concerned or individual farmers employ a consultant and submit the implementation plan to CNR. After approval of the project, they prepare fund and implement the project. Procedure of the project implementation is following.

(1) Consulting works

DOH will consign topographic survey, geological survey, survey for structural design and the survey relevant to the construction schedule for the detailed design to a consultant. The consultant restudies and examines the general issues on the project implementation such as the project plan and the detailed design of integrated diversion weir, canals, and regulation reservoirs, as well as the cost estimation, the bidding, the contract documents, quality control of the construction in accordance with indication of DOH.

(2) Preparation works

Preparation works consist of the topographical survey for the detailed design, additional geological survey for the integrated diversion weir and acquisition of land for facilities.

Topographical survey

- Longitudinal section, cross section and location of the main canal route in

Popeta-Yali-Alhué (Scale: 1/1000) : 57.00km
- Drawing the topographical map of Popeta area (Scale: 1/5,000) : 6,000ha
- The topographical map of location of the integrated diversion weir and regulation reservoirs (Scale: 1/1,000), longitudinal survey of dam axis (Scale: 1/5,000) : 40ha

Geological survey
- Additional geological survey of the integrated diversion weir, geological survey of tunnels and regulation reservoirs.

General quantities of the geological survey in Popeta area

Components	Drilling survey (m)	Soil test (No. of sample)	Permeability test (No. of test place)	Drawing up geological map (km^2)	Seismic survey (km)
Integrated diversion weir	210	105	42	-	-
Tunnels	900	-	-	26	16.0
Regulation reservoirs	1,500	780	300	-	6.0

Components	Rock test (No. of test place)	Horizontal loading test (No. of test place)	Dam body material test	
			Hand auger	Test pit
Integrated diversion weir	-	-	-	-
Tunnels	90	36	-	-
Regulation reservoirs	20	-	150	30

Required facilities for the supervision of the project implementation are prepared by the consultant or the constructor before starting the construction works.

(3) Land acquisition

The land for construction of the integrated diversion weir, canals, regulation reservoirs and so on is acquired by the consultant through the procedure of land acquisition under the consignment of DOH. Estimated land area is as follows.

Components	Area of land acquisition (ha)
Integrated diversion weir	2
A main canal	45
Regulation reservoirs	110
Total	157

(4) Construction method

The contractors who have qualification are selected through international competitive bidding for the contract of engineering works of irrigation projects under Government ordinance No. 1123. The construction work is executed by the contractor under the supervision of DOH and the consultant. On the other hand, as for the construction works after tertiary canals, the canal associations concerned and farmers' group take responsibility of the project. With this, the consultant designs and surveys and the contractor undertakes the construction works under the guidance of CNR, PROMM and other government concerned.

1.4.5 Construction Planning

The construction works such as the integrated diversion weir, irrigation canals and regulation reservoirs are ordered by DOH and the construction works are executed through the contract system under the supervision of the consultant.

(1) Construction materials and equipment

- Aggregates for concrete (sand, crushed stone) and crusher-run for

pavement of roads are produced at the site.
- Cement and reinforcement are carried from neighbor factories.
- Steel gates, hard rubber dams, pumps and vinyl chloride pipes for the integrated diversion weir and canals are foreign made.
- Although required equipment for construction is foreign made, the contractor should prepare contractor themselves.
- Embankment materials for construction of reservoirs is collected at the site principally. However, in case that there is no suitable material for embankment in Popeta area, clay soil in Yali area would be used.

(2) Construction method and notes

The notes concerned with the construction works are as follows.

- The weir is constructed by the temporary closure of half stream method all the year round. Since flood can be forecasted during the rainy season, a bypass canal is proposed at 10 year exceedance probability flood equivalent to $1,002m^3/sec$.
- The main and secondary canals can be constructed all the year around because the route does not overlap with existing canals. However, construction of the crossing structure with stream needs measurements for safety against the freshet during the rainy season.
- Construction of tunnels plans to proceed from both sides of tunnels because the length of them is about 3 to 5 km. On construction, safety regulation of tunnel construction which DOH provides should be observed.
- Concrete is mixed at the site. The integrated diversion weir, a main canal and aqueducts are constructed through concrete placing by truck cranes. Concrete placing for the secondary canals is undertaken mainly by man power. Countermeasures should be taken against water flow contamination during the concrete works.
- In case that the construction gives negative influence on the existing canals such as obstacles or interruption of water flow, compensation would be considered.

(3) Implementation method of construction

Implementation schedule of the project is formed under the plan in which implementing projects of each field interact effectively each other. Construction in the project starts from the integrated diversion weir, then the main canals connecting with the weir (including tunnels and aqueducts), secondary canals, tertiary canals, connecting canals to the existing canals and regulation reservoirs.

1) Construction works of the integrated diversion weir

Construction of the integrated diversion weir which closes the river is undertaken by temporary closure of half stream method because the length of weir is 300m. One of three rubber dams for spillway, intake facilities of the left bank and scouring sluice are to be constructed at the first stage, and two of them, the scouring sluice and the intake facilities of the right bank and a headrace are to be constructed at the second stage. Principal construction machines are bulldozers for foundation excavation, back hoe, dump truck for conveyance of sedimentation. For concrete placing, batching plants and truck cranes are main machines. Fitting construction of rubber dams, intake gates, and scouring sluice gates is undertaken under the technical guidance of professional companies. Main works of the sedimentation basin constructed next to the weir are foundation excavation and then concrete placing.

2) Construction works of canals

The construction of canals consists of open canals along with the skirts of mountains, tunnels passing through mountains, aqueducts crossing rivers and diversion facilities and so on.

Canals

Canals are evacuated mainly by bulldozers and backhoes because the scale of main canals (width: from 15 to 5m, height: 3m) is large. Especially, as the canals which run the skirts of mountains pass through the slope, it is necessary to note that the canals are located on the natural ground. Concrete placing is undertaken by agitator trucks and truck cranes because the temporary road for construction is constructed at only one side of canals. As for the embankment works, soils should be compacted carefully taking the moisture rate into account.

Tunnels

Nine tunnels are planned to be constructed in the project. The longest tunnel is 5.6km. Both of width and height are 5.2m, and the section is the horseshoe culvert. Therefore, it is possible to excavate the tunnel by machines. The tunnel is excavated by full face excavation method from both sides of the tunnel. The steel sliding form is favorable to line the tunnel lining concrete. The air conditioner should be equipped as health control.

Aqueducts

Aqueducts are constructed for main canals to cross mountain streams. The structure of aqueducts is precast concrete type, and the foundation is spread foundation. Construction equipment is same as that of canal construction. It had better avoiding construction of the aqueducts at the time of freshet during the rainy season.

3) Construction works of regulation reservoirs

Since construction sites of the regulation reservoirs are located in the mountain streams, the embankment works should avoid during the rainy season but concentrate during the dry season because the regulation reservoirs is constructed through using the streams. On the embankment materials, soils around the site are utilized basically, however, in case that there is no clay soil, suitable materials should be procured from other places.

1.4.6 Implementation Schedule of the Project

The implementation period of the project as a whole is planned to be for 7 years, from 2000 to 2006. In the project, the irrigation water supply project for the irrigation areas in Popeta area is a main project. Beside this, the components of the project includes the project evaluation and the reservation of budget by government of Chile, the establishment of canal associations, the agreement of farmers for the burden of the project cost, the detailed design, construction works, and so on. The implementation schedule should be planned to make benefit at the early stage. The implementation schedule of the project as a whole is shown in Table 1.4.1.

1.4.7 Operation and Maintenance Plan

(1) O & M organizations

The irrigation facilities that are transferred from DOH after completion of the construction works are operated and maintained by beneficiaries in Culiprán-Popeta-

Yali-Alhué irrigation area and canal associations concerned which use the integrated diversion weir commonly. Each facility is managed by a canal association which use the facility. Especially, in the new irrigation areas in Popeta-Yali-Alhué, canal associations should be established. The canal associations operate and maintain common irrigation facilities and own facilities, and manage water. The canal associations consist of two associations; the integrated water management association which manages the integrated diversion weir and main canals, and the regional canal association which operates and maintains canals after the secondary canals by regional unit.

1) Integrated water management association

The integrated water management association consists of all canal associations which use the irrigation water from the integrated diversion weir. The roles of this association are O & M of the integrated diversion weir, management of intake water, O & M of the main canals from the weir to Popeta-Yali-Alhué and diversion management. In the integrated water management association, president is selected above the board of directors that formed by chiefs of each canal association as directors. Under the board of directors, executive organizations for O & M and water management are set up.

2) Regional canal association

After diversion discharge (secondary canals) from the main canal, canal associations are established by each secondary canal and they manage water of the water systems concerned. Although existing canal associations which get benefit of water intake by the integration are maintained, new canal associations are established by each new irrigation area in Popeta-Yali-Alhué area. The new canal associations are Calmen-Cholqui canal association which is the integrated association of Calmen and Cholqui basins, Culiprán canal association in Culiprán basin, Popeta canal association in Popeta basin.

3) Establishment of canal association

Existing and new canal associations concerned with the areas which benefited by irrigation facilities including the integrated diversion weir are shown in the table below.

Area	Canal association	Remarks
Popeta	Carmen Alto	Existing
	Cholqui	Existing
	Calmen-Cholqui	New
	Chocalán	Existing
	Culipurán	Existing
	Popeta	New
Yali	Yali	New
Alhué	Alhué	New

Since existing canal associations have operated and maintained existing canals and managed water, they hold enough capacity to participate the integrated canal association. Newly organized canal associations need to be approved by DGA in order to get a qualification of juridical person as canal associations. Documents on components of the association and water right prepared for application for a qualification of juridical person submit to DGA under the guidance of the consultants.

(2) Operation and maintenance plan

1) O & M of facilities

The integrated canal association and the regional canal associations operate and maintain weirs and main canals, and secondary and tertiary canals, respectively. In regular maintenance of facilities, water intake from the weirs should be stopped during winter season when irrigation area is reduced. At that time, main and lateral canals are maintained together.

2) Water management

Intake water management of the integrated diversion weir is carried out by *Junta de Vigilancia* which organized in the third section. Water flow of the river which changes seasonally is distributed by proportional allotment in accordance with number of *Acción* which belongs to the third section as a whole. Irrigation water taken from the integrated diversion weir in the right and left banks is distributed by a water manager (*Cerrador*). As for the main canal, water flow of the main canal which changes seasonally as well as the weirs', is distributed at diversion point by proportional allotment in accordance with number of *Acción*. This water management is operated by a water manager who is dispatched from the canal association as well as the case of the weir.

3) Management items and allocation of manpower, material and equipment plan

Management items and allocation of manpower related to O & M plan, and material and equipment plan are summarized as follows.

Component	Management items	Allocation of man power	Material and equipment
Integrated diversion weir	Management of gut, scouring sluice Management of settlement basin	Driver: 1 person	Bulldozer 1 unit
	Management of gate operation	Mechanic: 1 person	
	Management of intake water volume	Manager of discharge measurement : 1 person	Water level gage, Stuff gauge
Main canals	Management of diversion gate	*Cerrador*: 2 persons	Small truck 1 unit
	Management of canal (canal, diversion facility)	Manager of canal, and diversion facility: 3 persons	Small truck 3 unit Small back hoe: 1 unit
Administration	Budget, provision of material and equipment, vehicle General affair	Accountant, mechanic, general affair, typist: 4 persons	Administrative material and equipment: 1 unit

4) O & M cost

Integrated canal association

O & M cost consists of repairing costs of the integrated diversion weir, main canals, diversion facilities, maintenance cost of the office, personnel expenses, maintenance cost of management equipment and so on. These costs are paid by farmers who use the facilities concerned in accordance with the number of *Acción*.

- O & M cost of the weir is paid by farmers who belong to 10 canal associations in the right bank and 2 canal associations in the left bank. Allotment is collected through regional canal associations.
- O & M cost of the main canal is paid by canal associations in the left bank.

Regional canal associations

Components of O & M cost of regional canal associations which are self-independent by regional water system organization are O & M cost of the secondary and tertiary canals, a maintenance cost of the office, personnel expenses, maintenance cost of management equipment, and so on. These costs are paid by beneficiaries of the facilities in accordance with the number of *Acción*.

Components of O & M cost

The integrated diversion weir and the main canal

Items of expense	Components of O&M	Expense (pesos)
O&M cost of facilities	Clerical staff and engineer	43,200,000
O&M cost of materials and equipment	Maintenance materials and equipment, operation of bulldozer	4,000,000
Personnel expenses of maintenance works	Labor for repairing and O&M	7,200,000
Total		54,400,000

Canals after the secondary canals (by regional canal associations)

Items of expense	Components of O&M	Expense (pesos)
O&M cost of facilities	Clerical staff and engineer	21,600,000
O&M cost of materials and equipment	Maintenance materials and equipment, operation of bulldozer	2,500,000
Personnel expenses of maintenance works	Labor for repairing and O&M	1,800,000
Total		25,900,000

1.5 Development Impact and Evaluation

1.5.1 Project Evaluation

(1) Basic assumption

1) The economic life of the project facilities is 30 years. Replacement costs for gates and machinery are included after 20 years when project works are completed.
2) All prices are shown in 1998 prices of Chilean pesos.
3) Evaluation is made on financial and economic aspects. Market prices are used for financial evaluation and economic prices for economic evaluation.
4) Economic evaluation of the project requires conversion of market prices into economic prices. For this purpose, adjustment factors provided by the Chilean Planning Ministry consist of the following:

Foreign currency	1.06	Skilled labor	1.00
Semi-skilled labor	0.65	Unskilled labor	0.85
Social Discount Rate	12%		

On economic prices, tariff of 11% and value added tax of 18% are subtracted as transfer expenditure.

(2) Benefits

1) Quantified benefits in the Popeta project area include increase of agricultural production and hydroelectric generation.
2) Financial agricultural benefits in the Popeta area takes $916,642/ha "with project" condition, because present value of agricultural production "without project" is so small that it is negligible.
3) Transformation of agricultural benefit into economic prices is undertaken

by applying the standard coefficient of transformation. The production costs are classified into foreign and local currency portions. In case of foreign currency portion, transformation coefficient is applied to it after excluding tariff and value added tax. On the other hand, in case of local currency portion, transformation coefficient is applied to personnel expenses after excluding value added tax. Share of personnel expenses is adopted at 25% of local currency portion. The rest of that, 75% is cost of input materials and equipment. The transformation coefficient is applied to it after excluding value added tax.

4) Benefits from hydroelectric generation are estimated at $25/kwh, 10% generation loss, and 95% of bill collection rate. Marginal cost estimated at $7.657/kwh by the National Energy Commission (CNE) in April 1998 applies to economic benefits from hydroelectric generation.
5) Transformation of items which cannot be divided clearly is undertaken by applying the standard transformation coefficient of 0.96, which is used in the Chilean foreign trade data.

Accordingly, market prices and economic prices of the project are presented in the table below.

Benefits	Market Prices	Economic Prices
Agriculture	916,642 ($ /ha)	1,122,311 ($ /ha)
Hydroelectric generation	487 ($ Million)	149 ($ Million)

(3) Costs

Costs used in the project evaluation are allocated costs to the project of the Popeta area among total project cost. The project cost in market prices is the cost which was estimated in the previous chapter. On transformation of the project cost into economic prices, the project cost is divided into foreign and local currency portion. In case of foreign currency portion, transformation coefficient is applied to it after excluding import tariff and value added tax. In case of local currency portion, transformation coefficient is applied to personnel expenses after excluding value added tax. Share of personnel expenses is adopted at 20% of local currency portion. The rest of that, 80% is cost of input materials and equipment. Land acquisition cost is excluded from economic prices.

Accordingly, market prices and economic prices of the project are presented in the table below.

	Market Prices ($ Million)	Economic Prices ($ Million)
Project costs	29,258	22,565

(4) Evaluation

Evaluation results indicated in internal rate of return (IRR), benefit cost ratio (B/C), net present value (NPV) at social discount rate of 12% are shown in the table below. The details are presented in Table 1.5.1.

Evaluation	IRR (%)	NPV at 12% ($ Million)	B/C
Financial	15.4	3,949.1	1.26
Social	21.1	9,231.3	1.80

(5) Sensitivity analysis

Sensitivity analysis is conducted in case that 10% increase in cost and 10% reduction in benefit are occurred, simultaneously. As shown in the table below, even in case that increase of cost and decrease of benefit are occurred simultaneously, internal rate of return (IRR) exceeds the social discount rate of 12%.

Sensitivity Analysis	Internal Rate of Return (IRR)	
	Economic	Financial
1. Basic Case	21.1%	15.4%
2. Cost Increase: + 10%	19.4%	13.9%
3. Benefit Reduction: -10%	19.2%	13.8%
4. 2+3	17.6%	12.5%

1.5.2 Financial Analysis

The effects of the project on typical farms are examined in the table below on the basis of the improving farmers' income and expenditure, repayment of the project cost and operation & maintenance cost relevant to each farmer stemming from the agricultural development plan. The repayment of the project cost by farmers is examined in the cases that the subsidy for the project is not provided, and 75% of the project cost is subsidized. In those cases, the term of repayment is set up at 20 years at 12% of interest rate. Annual operation and maintenance cost does not include subsidy.

Item	5 ha	15 ha	40 ha	200 ha
Popeta Project				
Average area (ha)	5	15	40	200
Number of farms	132	40	54	8
Investment cost	$3,846,827,092	$3,497,115,538	$12,589,615,936	$9,325,641,434
O&M cost	$3,405,179	$3,095,618	$11,144,223	$8,254,980
Investment/farm	$29,142,629	$87,427,888	$233,141,036	$1,165,705,179
O&M/farm	$25,797	$77,390	$206,375	$1,031,873
Income and Expenditure of Farmers				
Gross income	$6,526,045	$15,182,713	$58,173,310	$270,436,670
Production cost	$3,453,545	$4,352,713	$16,113,310	$86,286,670
Net income	$3,072,500	$10,830,000	$42,060,000	$184,150,000
Living expenses	$1,800,000	$2,400,000	$3,000,000	$6,000,000
Net profit	$1,272,500	$8,430,000	$39,060,000	$178,150,000
Without subsidy				
Investment/year/farm	$3,901,580	$11,704,739	$31,212,637	$156,063,187
O&M/year/farm	$25,797	$77,390	$206,375	$1,031,873
Total cost/year/farm	$3,927,377	$11,782,129	$31,419,012	$157,095,060
Net profit/year/farm	$1,272,500	$8,430,000	$39,060,000	$178,150,000
Surplus/year/farm	($2,654,877)	($3,352,129)	$7,640,988	$21,054,940
With 75% subsidy				
Investment/year/farm	$975,395	$2,926,185	$7,803,159	$39,015,797
O&M/year/farm	$25,797	$77,390	$206,375	$1,031,873
Total cost/year/farm	$1,001,192	$3,003,575	$8,009,534	$40,047,670
Net profit/year/farm	$1,272,500	$8,430,000	$39,060,000	$178,150,000
Surplus/year/farm	$271,308	$5,426,425	$31,050,466	$138,102,330

In Popeta, farmers who hold 5ha or 15ha land need 75% subsidy to repay the project cost. Although the annual surplus of 5ha farmers is low, $271,308, their living expenses would be improved significantly. In case of farmers who hold more than 5ha land, annual surplus is $5,426,425 with 15ha farmers, $31,050,466 with 40ha farmers, and $138,102,330 with 200ha farmers. Accordingly, in Popeta area, any landholding scale farmers have ability to repay the project cost and to pay operation and maintenance cost, in case that there is 75% subsidy against the project cost.

1.5.3 Other Development Impact

By the project implementation, following socio-economic impacts is expected in addition to the benefit estimated by financial and economic evaluation. The effect of the project implementation will be borne by following conditions ;

- Inhabitants' will to improve the present situation

- Promotion of the project by participation of inhabitants
- Support organization system for realizing the will of improvement
- Construction and improvement of irrigation facilities and highly-advanced land use
- Expansion of irrigable area
- Activation of agriculture by improvement of irrigation facilities, highly-advanced land use and improvement of farming technique.
- Advancement of product marketability and promotion of diversification
- Promotion of socio-economic interchange by improvement of roads
- Activation of the area based on CECUV
- Conservation of regional environment through permanent settlement of farmers

Main expected socio-economic impact by the project implementation is as follows;

(1) Creation of the solidarity among inhabitants

In the process of the project, the beneficiaries themselves are to participate the plan for improvement of the present situation, and agreement on the goal of better improvement is formed. As a result, solidarity of inhabitants is created. Based on the solidarity of inhabitants, it is expected that mutual confidence of farmers, who are easy to be isolated, is created and then motivation of creating various organizations such as producers' cooperation is established.

(2) Stable supply and diversification of agricultural products

The project implementation is expected to promote stable self-sufficiency of main crops and contribute to economic independence of the area by regular and stable supply of agricultural products such as vegetable and the others. Corresponding to regular and stable supply of agricultural products to markets, a planned commercial crop production system will be established in the future. This leads to organizing collection and shipment, and promoting agricultural processing industries. Moreover, it is expected that quality of the production for shipment is improved in order to enhance the marketable value of productions.

(3) Establishment of systematic water use

Existing individual canal associations are integrated by construction of the integrated diversion weir in the project and then, the systematic water use for the area as a whole is established. As a result, in the existing irrigation systems, accuracy of agricultural water conveyance increases due to diversion discharge from the newly constructed main canals. This contributes to the improvement of agricultural environment in the area as a whole. Moreover, establishment of systematic water use brings about forming feeling of the solidarity among the beneficiaries and contributes to smooth operation of various activities in the area as a whole.

(4) Promotion of organizing farmers

In the process of promoting the project by participation of inhabitants, individual farmers' viewpoints and direction of eagerness for improvement are clarified. This is an opportunity to promote establishing organizations such as producers' organizations. It is expected that uniting farmers, who are responsible for the management of the area, becomes the motive power to promote socio-economic self-reliance.

(5) Increase of job opportunity

During the construction period of the project, job opportunity is created because most of construction workers might be recruited from farmers in and around the project area. It is expected that the technique which the employed farmers achieve through the construction works is useful for operation, management and maintenance of the constructed irrigation system and roads by farmers.

After implementation of the project, activation of agricultural production activities in the area crate job opportunity. Creation of job opportunity for non-farm households can be also expected because increased farm works by irrigation and intensive land use boosts the demand of labor force in and around the project area.

These created job opportunity alleviates out flow of rural population to big cities such as Santiago and contributes to balanced development of the country.

(6) Increase of intention for working

Compared to low productivity of the present agriculture, increase of agricultural production and its result, improvement of living standard after the project implementation give the farmers satisfaction and sufficiency in the area. This raises farmers' intention to increase the productivity, and promotes development of the area.

(7) Activation of socio-economic activities

Traffic condition in the area are to be significantly improved by construction of road networks. Established road network promotes activation of socio-economic activities through activating and easing interchange of people and materials not only within the area but also outside of the area. The activities of CECUV promote comprehensive interchange in the area as a whole. The comprehensive interchange leads to the motive power of activating and developing the area.

(8) Development of regional economy

It is expected that increase of agricultural products brings about increase of farmers' income after the project implementation. Increases of farmers' purchasing power can contribute largely to development of regional economy and also stable national economy of Chile.

(9) Development of human resource

CECUV is expected to be a base of manpower development for not only the area but also Chile by fostering human resources who will be in charge of rural areas through conducting social education and technical training on such as living improvement, irrigation technique, agricultural technique, operation and maintenance of various facilities and environment. The activities of the center are expected to promote women's participation in the project and to improve their social status.

(10) Impact on the environment

The project implementation contributes to conservation of national and regional natural environment through farmers' stable engagement in agricultural production activities. Conduction of environmental education in the activities of CECUV makes the relationships between agriculture and environment, and between human activities and environment clear. This becomes the motive power to promote practical activities of environmental conservation.

1.5.4 Justification of the Project

The objectives of the project implementation are providing the support for farmers' will to improve the present situation in order to improve agricultural productivity, and realizing comfortable rural areas as the place for permanent settlement. On the other hand, the precondition of the project is that the development for achieving the objectives is harmonized with the nature.

In the development plan, agricultural production increases through improvement of the present farming by improvement of basic infrastructure based on the objectives and the preconditions mentioned above. Farmers' income growth resulted from the development plan is reflected in not only household expenditure but also improvement of farmers' quality of life as a whole with development of living infrastructure and improvement of knowledge and technique. Then, it is promoted that the farmers can be free from the present situation.

Improvement of the basic rural living condition as living environment satisfies the condition of permanent settlement. At the same time, through the activities of farmers' production activities in the area, activation of socio-economic interchange such as human communication among inhabitants in the area activates the area as a whole.

The method of development intends to minimize the impacts on the natural environment and ecosystem as much as possible. Introduction of agricultural technique also cares them very carefully. As a result, the impacts of the development plan implementation on natural environment are minimized.

Evaluating implementation of the proposed development plan from the point of economic aspect, economic internal rate of return (EIRR) of the entire project is 21.1 %.

Accordingly, the implementation of the project is justified.

1.6 Conclusion and Recommendation

1.6.1 Conclusion

As the results of studying and examining the present situation, problems, development potentials in order to formulate the agricultural development project in Popeta area, following conclusions are obtained.

(1) In the project area, small scale cereal and traditional crop cultivation and extensive animal raising are mainly carried out in most farmland because surface water use is limited by rainfall in winter. Recently, large scale year-round cultivation of fruits and forage crops by utilizing groundwater has increased. In the plan, it is proposed that existing unirrigated area of 21,000ha is irrigated by unused water right ($25m^3$/sec) in the Maipo river. In this project, a part of 21,000ha, 5,000ha is to be irrigated in the Popeta area. The components of the plan are formed by improvement of production and living infrastructure, of farm management for small scale farmers, and support services for making them possible in accordance with agricultural policy, "Strategic Agenda" which aims at improving production infrastructure by irrigation improvement, and strengthening farming of medium and small scale farmers.

(2) Accordingly, the plan on facility improvement in the project area are proposed as follows.

Component	Unit	Quantities
Agricultural production infrastructure development		
Irrigation area	ha	4,975
Integrated diversion weir	unit	1
Main canals	km	59.3
Secondary canals	km	67.3
Tertiary canals	km	235.0
Improvement of existing canals	km	22.0
Regulation reservoir	sites	10
Rural infrastructure development		
Road		
Pavement of main road	km	30.0
Improvement of lateral road	km	21.6
Construction of lateral road	km	14.5
Rural water supply facilities	sites	2
Rural sewage treatment facilities	sites	8
CECUV	sites	7

(3) Total investment for implementation of the project mentioned above is estimated at 83,248 million pesos (local currency portion: 48,458 million pesos, foreign currency portion: 34,790 million pesos) as a whole. Required period of constructions is proposed 7 years including the period of the detailed design.

(4) The economic internal rate of return of the project is 21.1% according to the required cost and the expected benefit. Socio-economic impacts resulted in the project implementation are expected to be improvement of productivity through intensive utilization of land and water, strengthening small scale farmers, expansion of irrigated farmland, activation of agricultural activities and creation of job opportunity.

1.6.2 Recommendation

(1) The project implementation benefits directly to the farmers in the project area. Especially, economic balance of the small scale farmers is improved drastically. In addition, as the proposed integrated diversion weirs of the Maipo river includes water intake of existing irrigation systems, the project implementation contributes to establishing the system to adjust of water utilization among the users in the third section of the Maipo river. Therefore, it is recommended that the government of Chile would prepare to implement the project early based on the results of the F/S.

(2) Because Government ordinance No.1123 applies to the project, close cooperation between CNR and DOH is necessary at every stage such as adoption of the project, approval of the project, and implementation of the project. Therefore, establishment of the project promotion committee consisting of CNR and DOH is recommended.

(3) The beneficiaries of the project in new irrigation areas need to establish the project promotion organization as the local receiver organization under the guidance of OMPC. It is necessary to establish new canal associations relevant to new irrigation and the integrated diversion weir canal association which consists of existing and new canal associations relevant to the integrated diversion weir. Establishment of these new canal associations is carried out by the project promotion organization. Accordingly, it is recommended to start discussion early among the project promotion committee, relevant Comuna and UV which will be a core of the project promotion organizations.

(4) Agricultural development project in Popeta area is established on the premise that the unused water right of 25 m^3/sec (*Reserva Fiscal*) which DOH is reserved in the second section of Río Maipo is utilized as the water source of the project. Available irrigation water for the project is settled with the runoff condition on 85% exceedance probability of Río Maipo taking the exisiting water utilization into account. Along with the execution of the fesibility study on the agricultural development project in Popeta area, Chilian side applies to the DOH for legislation of the reserved water right as the substantial water right. No conclusion on the legislation procedures is met at the time of

compilation on this Final Report. When a change of contents on the water right is arisen through the legislation procedures of reserved water right, it is necessary to consider the supplemental and/or alternative water source for the project. Following should be studied for the supplemental and/or alternative water source; (1) Utilization of runoff on rivers flowing in the projected area is impossible because no thaw water is available in the river basin of the projected area. (2) Utilization of groundwater in the projected area is not suitable as the new water source taking the annual rainfall (450 mm), irrigation requirement (800 to 1,000 mm) and present utilization of groundwater. Groundwater utilization should be restricted to the small scale development without influences on the present utilization. (3) Flood of the Río Maipo caused by the rainfall in the winter season is discharged to the sea without contribution for the present water utilization. As an alternative water source, it should be planned to storage flood runoff in the projected areas. (4) As the facilities to storage flood runoff, heightening of dam body on regulation reservoir that designed in this report is proposed as realistic measures to increase storage volume for the project.

Table 1.2.1 Irrigation Water Requirement (Popeta)

	Item	Area (ha)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
5 ha														
	Wheat	0.130	0.00	0.00	0.00	0.00	0.00	0.00	0.00	48.98	148.78	217.31	159.68	44.25
	Potato	0.100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	48.98	142.24	250.74	291.18	247.80
	Pumpkin (1)	0.020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.90	111.40	191.04	169.45	86.45
	Pumpkin (2)	0.020	90.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	62.12	176.71	244.22	191.58
	Cucumber (1)	0.020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.74	104.93	138.74	64.58	0.00
	Cucumber (2)	0.020	76.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	31.44	139.30	219.17	205.67
	Tomato	0.040	0.00	0.00	0.00	0.00	0.00	0.00	0.00	26.66	106.27	197.01	216.56	88.50
	Forage Crop (Maiz)	0.040	204.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	82.40	198.20	303.71	371.70
	Alfalfa	0.140	278.54	240.41	172.35	102.92	6.95	0.00	0.01	18.81	75.37	159.20	234.83	265.50
	Avocado	0.200	113.48	97.94	70.22	47.17	4.63	0.00	0.00	15.16	45.78	79.60	95.67	108.17
	Unused Land	0.270												
	Total	1.000	73.21	53.25	38.17	23.84	1.90	0.00	0.00	18.95	67.02	120.26	136.65	117.42
10 ha														
	Wheat	0.120	0.00	0.00	0.00	0.00	0.00	0.00	0.00	48.98	148.78	217.31	159.68	44.25
	Potato	0.030	0.00	0.00	0.00	0.00	0.00	0.00	0.00	48.98	142.24	250.74	291.18	247.80
	Cucumber (1)	0.015	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.74	104.93	138.74	64.58	0.00
	Cucumber (2)	0.015	76.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	31.44	139.30	219.17	205.67
	Forage Crop (Maiz)	0.030	204.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	82.40	198.20	303.71	371.70
	Water Melon	0.020	141.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	36.89	160.00	266.14	300.90
	Green Bean	0.020	154.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	65.67	206.12	144.55
	Alfalfa	0.200	278.54	240.41	172.35	102.92	6.95	0.00	0.01	18.81	75.37	159.20	234.83	265.50
	Avocado	0.250	113.48	97.94	70.22	47.17	4.63	0.00	0.00	15.16	45.78	79.60	95.67	108.17
	Seed Production (Hybrid	0.050	73.53	0.00	0.00	0.00	0.00	0.00	0.00	19.34	119.47	229.25	272.40	193.92
	Unused Land	0.250												
	Total	1.000	100.95	72.57	52.02	32.38	2.55	0.00	0.00	16.37	59.87	111.43	135.21	125.73
15 ha														
	Maize	0.100	269.25	146.33	37.92	0.00	0.00	0.00	0.00	0.00	14.92	89.31	144.81	274.35
	Pumpkin (1)	0.007	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.90	111.40	191.04	169.45	86.45
	Pumpkin (2)	0.007	90.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	62.12	176.71	244.22	191.58
	Cucumber (1)	0.010	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.74	104.93	138.74	64.58	0.00
	Cucumber (2)	0.010	76.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	31.44	139.30	219.17	205.67
	Forage Crop (Maiz)	0.020	204.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	82.40	198.20	303.71	371.70
	Tomato	0.013	0.00	0.00	0.00	0.00	0.00	0.00	0.00	26.66	106.27	197.01	216.56	88.50
	Green Bean	0.020	154.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	65.67	206.12	144.55
	Alfalfa	0.100	278.54	240.41	172.35	102.92	6.95	0.00	0.01	18.81	75.37	159.20	234.83	265.50
	Avocado	0.200	113.48	97.94	70.22	47.17	4.63	0.00	0.00	15.16	45.78	79.60	95.67	108.17
	Vineyard	0.200	204.26	176.30	125.11	65.18	0.00	0.00	0.00	0.00	38.56	78.27	160.03	194.70
	Seed Production (Hybrid	0.033	73.53	0.00	0.00	0.00	0.00	0.00	0.00	19.34	119.47	229.25	272.40	193.92
	Unused Land	0.280												
	Total	1.000	129.33	93.52	60.09	32.76	1.62	0.00	0.00	6.33	35.45	77.18	116.84	136.44
50 ha														
	Wheat	0.040	0.00	0.00	0.00	0.00	0.00	0.00	0.00	48.98	148.78	217.31	159.68	44.25
	Maize	0.060	269.25	146.33	37.92	0.00	0.00	0.00	0.00	0.00	14.92	89.31	144.81	274.35
	Pumpkin (1)	0.020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.90	111.40	191.04	169.45	86.45
	Pumpkin (2)	0.020	90.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	62.12	176.71	244.22	191.58
	Flower	0.030	106.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.46	151.24	253.09	256.65
	Alfalfa	0.100	278.54	240.41	172.35	102.92	6.95	0.00	0.01	18.81	75.37	159.20	234.83	265.50
	Avocado	0.100	113.48	97.94	70.22	47.17	4.63	0.00	0.00	15.16	45.78	79.60	95.67	108.17
	Lemon	0.040	113.48	97.94	70.22	47.17	4.63	0.00	0.00	15.16	45.78	79.60	95.67	108.17
	Orange	0.040	113.48	97.94	70.22	47.17	4.63	0.00	0.00	15.16	45.78	79.60	95.67	108.17
	Peach	0.080	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	45.78	115.42	156.55	137.67
	Cherry	0.040	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	45.78	115.42	156.55	137.67
	Ciruelos	0.060	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	45.78	115.42	156.55	137.67
	Vineyard	0.200	204.26	176.30	125.11	65.18	0.00	0.00	0.00	0.00	38.56	78.27	160.03	194.70
	Seed Production (Hybrid	0.020	73.53	0.00	0.00	0.00	0.00	0.00	0.00	19.34	119.47	229.25	272.40	193.92
	Seed Production (Maize)	0.060	73.53	0.00	0.00	0.00	0.00	0.00	0.00	19.34	119.47	229.25	272.40	193.92
	Unused Land	0.090												
	Total	1.000	116.19	85.71	57.17	31.82	1.53	0.00	0.00	8.39	52.61	110.96	153.62	156.74
100 ha														
	Wheat	0.040	0.00	0.00	0.00	0.00	0.00	0.00	0.00	48.98	148.78	217.31	159.68	44.25
	Maize	0.060	269.25	146.33	37.92	0.00	0.00	0.00	0.00	0.00	14.92	89.31	144.81	274.35
	Pumpkin (1)	0.010	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.90	111.40	191.04	169.45	86.45
	Pumpkin (2)	0.010	90.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	62.12	176.71	244.22	191.58
	Alfalfa	0.100	278.54	240.41	172.35	102.92	6.95	0.00	0.01	18.81	75.37	159.20	234.83	265.50
	Avocado	0.100	113.48	97.94	70.22	47.17	4.63	0.00	0.00	15.16	45.78	79.60	95.67	108.17
	Orange	0.070	113.48	97.94	70.22	47.17	4.63	0.00	0.00	15.16	45.78	79.60	95.67	108.17
	Lemon	0.070	113.48	97.94	70.22	47.17	4.63	0.00	0.00	15.16	45.78	79.60	95.67	108.17
	Peach	0.040	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	45.78	115.42	156.55	137.67
	Cherry	0.020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	45.78	115.42	156.55	137.67
	Plum	0.050	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	45.78	115.42	156.55	137.67
	Vineyard	0.240	204.26	176.30	125.11	65.18	0.00	0.00	0.00	0.00	38.56	78.27	160.03	194.70
	Seed Production (Hybrid	0.010	73.53	0.00	0.00	0.00	0.00	0.00	0.00	19.34	119.47	229.25	272.40	193.92
	Seed Production (Maize)	0.090	73.53	0.00	0.00	0.00	0.00	0.00	0.00	19.34	119.47	229.25	272.40	193.92
	Unused Land	0.090												
	Total	1.000	128.53	98.64	66.39	37.26	1.81	0.00	0.00	9.55	53.34	107.16	148.52	154.78
200 ha														
	Maíz	0.075	269.25	146.33	37.92	0.00	0.00	0.00	0.00	0.00	14.92	89.31	144.81	274.35
	Arveja	0.055	0.00	0.00	0.00	0.00	0.00	0.00	0.01	14.17	98.21	115.58	79.21	0.00
	Alfalfa	0.100	278.54	240.41	172.35	102.92	6.95	0.00	0.01	18.81	75.37	159.20	234.83	265.50
	Paltos	0.100	113.48	97.94	70.22	47.17	4.63	0.00	0.00	15.16	45.78	79.60	95.67	108.17
	Mandarinas	0.080	113.48	97.94	70.22	47.17	4.63	0.00	0.00	15.16	45.78	79.60	95.67	108.17
	Limoneros	0.080	113.48	97.94	70.22	47.17	4.63	0.00	0.00	15.16	45.78	79.60	95.67	108.17
	Duraznos	0.050	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	45.78	115.42	156.55	137.67
	Ciruelos	0.050	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	45.78	115.42	156.55	137.67
	Viñas	0.240	204.26	176.30	125.11	65.18	0.00	0.00	0.00	0.00	38.56	78.27	160.03	194.70
	Semillero maíz	0.060	73.53	0.00	0.00	0.00	0.00	0.00	0.00	19.34	119.47	229.25	272.40	193.92
	Sin uso	0.110												
	Total	1.000	130.99	102.79	68.36	38.20	1.90	0.00	0.00	7.76	46.96	93.75	133.98	147.38

Table 1.3.1 Agricultural Development Project Total Construction Cost in Popeta Area

(Unit : Thousand Pesos)

Description		F.C	L.C	Total
1 Preparation Cost				
	1) Agricultural Production Infras	1,328,630	1,790,168	3,118,798
	2) Rural Infrastructures	48,064	92,359	140,423
	Sub-total	1,376,694	1,882,527	3,259,221
2 Civil Facilities Construction Cost				
(1)	Agricultural Production Infrastructure Construction Cost			
	1) Integrated Diversion Weir	3,082,109	2,634,195	5,716,304
	2) Main Irrigation Canal	11,229,864	18,858,582	30,088,446
	3) Secondary Irrigation Canal	743,667	3,923,895	4,667,562
	4) Regulation Reservoir	5,337,186	8,895,756	14,232,942
	5) Tertiary Irrigation Canal	1,295,407	896,329	2,191,736
	6) Small Scale Hydropower Gen	4,884,368	594,605	5,478,973
	Sub-total	26,572,601	35,803,362	62,375,963
(2)	Rural Infrastructure and Agricultural Support Facilities Construction Cost			
	1) Agricultural Support Facilities	53,534	32,854	86,388
	2) Rural Infrastructures	517,697	277,219	794,916
	3) Rural Road	295,610	1,229,305	1,524,915
	4) Community Centers (CECUV	94,440	307,806	402,246
	Sub-total	961,281	1,847,184	2,808,465
3 Land Acquisition and Compensation Cost				
	1) Agricultural Production Infras	0	38,606	38,606
	2) Rural Infrastructures	0	2,288	2,288
	Sub-total	0	40,894	40,894
4 Engineering and Administration Cost				
	1) Agricultural Production Infras	2,620,558	4,294,467	6,915,025
	2) Rural Infrastructures	96,128	184,718	280,846
	Sub-total	2,716,686	4,479,185	7,195,871
5 Total (1-4)		31,627,262	44,053,152	75,680,414
6 Physical Contingencies (10%)		3,162,726	4,405,315	7,568,041
7 Total (5+6)		34,789,988	48,458,467	83,248,455
8 Price Contingencies		6,024,516	8,022,597	14,047,113
9 Grand Total		40,814,504	56,481,064	97,295,568

Table 1.3.2 Disbursement Schedule (Total Construction Cost in Popeta Area)

(Unit : Million Pesos)

Year	F.C	L.C	Total
2000	0.0	0.0	0.0
2001	1,048.2	1,733.1	2,781.3
2002	1,702.1	2,830.3	4,532.4
2003	4,600.9	6,852.7	11,453.6
2004	9,316.9	14,861.4	24,178.3
2005	15,135.5	18,765.0	33,900.5
2006	8,885.2	11,564.2	20,449.4
Total	40,688.8	56,606.7	97,295.5

Table 1.4.1 Project Implementation Schedule in Popeta Area

Development Items	Quantities	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008
1. Project Evaluation by the Government of Chile											
2. Provision of Fund by the Government of Chile											
3. Agricultural Development Project in Popeta Area											
(1) Preparation Works for the Implementation of the Project											
Contract with Consultant Company	1.0	unit									
Detail Design Study	1.0	unit									
Land Acquisition and Compensation	1.0	unit									
Selection and Contract of Construction Co	1.0	unit									
(2) Agricultural Production Development Project											
Construction of Integrated Diversion Weir	320.0	m									
Construction of Irrigation Canals											
Construction of Main Irrigation Canals	50.0	km									
Construction of Secondary Irrigation C	130.0	km									
Construction of Farm Ditches	5000.0	ha									
Construction of Regulation Reservoir	10.0	Places									
(3) Rural Infrastructure Development Project											
Construction of Road	66.1	km									
Construction of Rural Water Supply Facili	2.0	Places									
Construction of Rural Sewage Treatment F	8.0	Places									
Construction of Community Centers (CEC	7.0	Places									

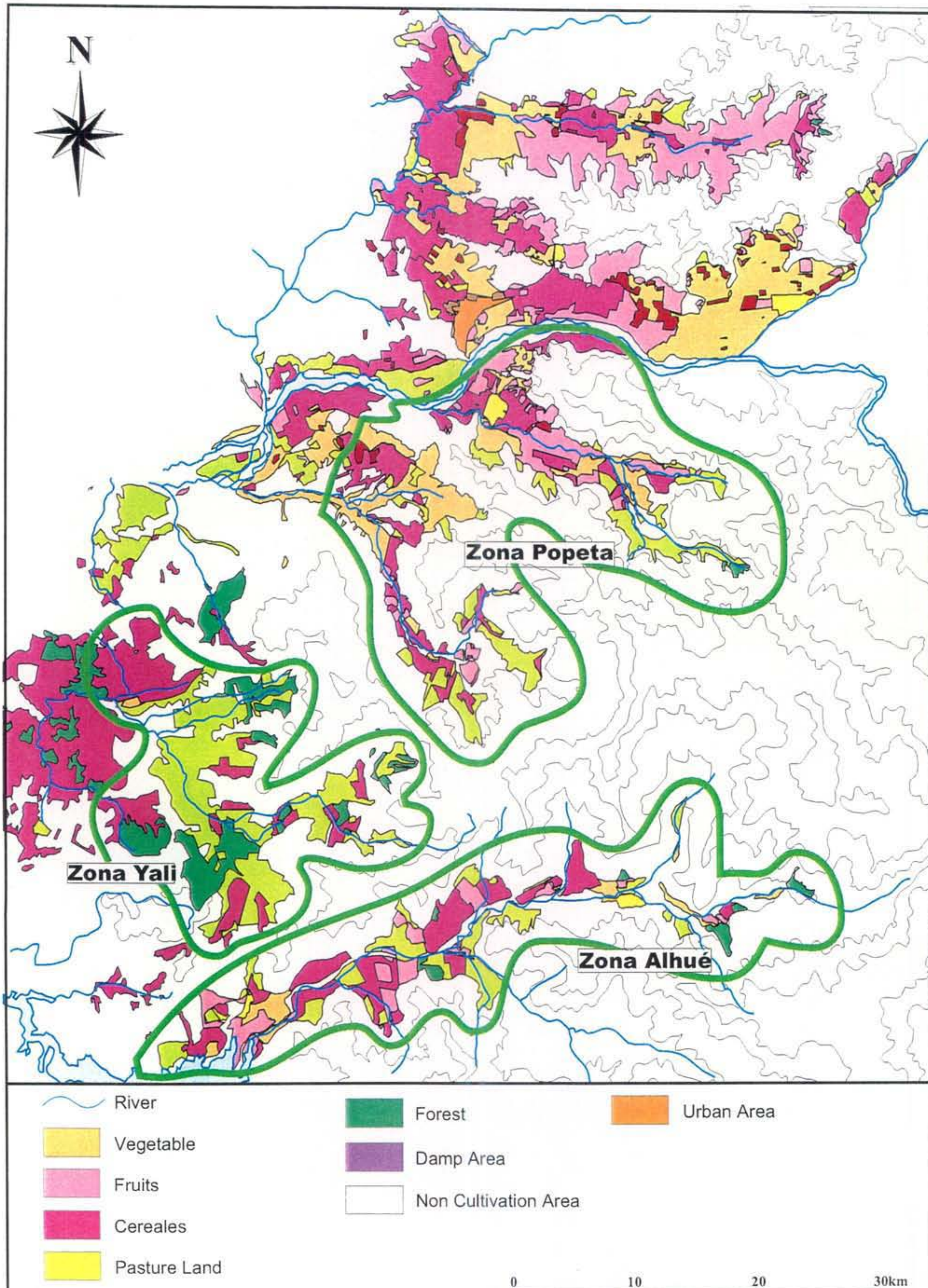
Table 1.5.1 Project Evaluation (Popeta Area)

<Financial Evaluation of the Project : Popeta>

Year	Costs			Benefits			Cash Flow	Cost [+10%]	Benefit [-10%]	Cost + 10% Benefit-10%
	Investment	O & M	Total	Agriculture	Electricity	Total				
2000			0.0			0.0	0.0	0.0	0.0	0.0
2001	528.5		528.5			0.0	-528.5	-581.4	-528.5	-581.4
2002	820.1		820.1			0.0	-820.1	-902.1	-820.1	-902.1
2003	2565.5		2565.5			0.0	-2565.5	-2822.1	-2565.5	-2822.1
2004	6469.9		6469.9			0.0	-6469.9	-7116.9	-6469.9	-7116.9
2005	10896.3	2.6	10898.9	916.6	108.6	1025.2	-9873.7	-10963.6	-9976.2	-11066.1
2006	6682.4	7.8	6690.2	2291.6	222.9	2514.5	-4175.7	-4844.7	-4427.1	-5096.1
2007		20.7	20.7	3666.6	397.1	4063.6	4042.9	4040.9	3636.6	3634.5
2008		25.9	25.9	4583.2	487.1	5070.3	5044.4	5041.8	4537.4	4534.8
2009		25.9	25.9	4583.2	487.1	5070.3	5044.4	5041.8	4537.4	4534.8
2010		25.9	25.9	4583.2	487.1	5070.3	5044.4	5041.8	4537.4	4534.8
2011		25.9	25.9	4583.2	487.1	5070.3	5044.4	5041.8	4537.4	4534.8
2012		25.9	25.9	4583.2	487.1	5070.3	5044.4	5041.8	4537.4	4534.8
2013		25.9	25.9	4583.2	487.1	5070.3	5044.4	5041.8	4537.4	4534.8
2014		25.9	25.9	4583.2	487.1	5070.3	5044.4	5041.8	4537.4	4534.8
2015		25.9	25.9	4583.2	487.1	5070.3	5044.4	5041.8	4537.4	4534.8
2016		25.9	25.9	4583.2	487.1	5070.3	5044.4	5041.8	4537.4	4534.8
2017		25.9	25.9	4583.2	487.1	5070.3	5044.4	5041.8	4537.4	4534.8
2018		25.9	25.9	4583.2	487.1	5070.3	5044.4	5041.8	4537.4	4534.8
2019		25.9	25.9	4583.2	487.1	5070.3	5044.4	5041.8	4537.4	4534.8
2020		25.9	25.9	4583.2	487.1	5070.3	5044.4	5041.8	4537.4	4534.8
2021		25.9	25.9	4583.2	487.1	5070.3	5044.4	5041.8	4537.4	4534.8
2022		25.9	25.9	4583.2	487.1	5070.3	5044.4	5041.8	4537.4	4534.8
2023		25.9	25.9	4583.2	487.1	5070.3	5044.4	5041.8	4537.4	4534.8
2024		25.9	25.9	4583.2	487.1	5070.3	5044.4	5041.8	4537.4	4534.8
2025		25.9	25.9	4583.2	487.1	5070.3	5044.4	5041.8	4537.4	4534.8
2026	1296.6	25.9	1322.5	4583.2	487.1	5070.3	3747.8	3615.6	3240.8	3108.5
2027		25.9	25.9	4583.2	487.1	5070.3	5044.4	5041.8	4537.4	4534.8
2028		25.9	25.9	4583.2	487.1	5070.3	5044.4	5041.8	4537.4	4534.8
2029		25.9	25.9	4583.2	487.1	5070.3	5044.4	5041.8	4537.4	4534.8
			$15,003.8			$18,952.9				
						IRR=	15.37%	13.94%	13.79%	12.45%
						NPV(12%)=	$3,949.1	$2,448.7	$2,053.8	$553.4
						B/C=	1.26			

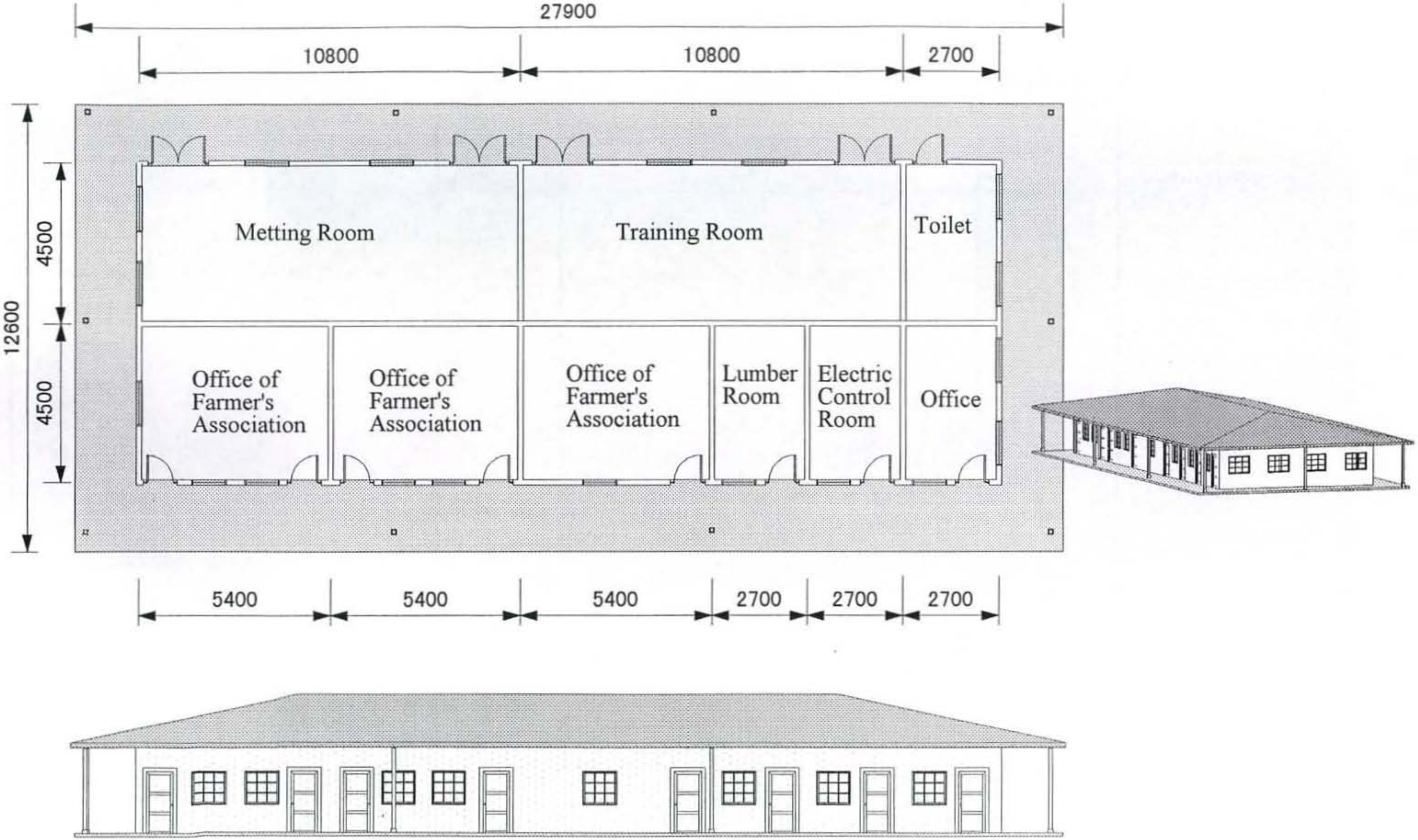
<Social Evaluation of the Project : Popeta>

Year	Social Cost			Social Benefits			Cash Flow	Cost [+10%]	Benefit [-10%]	Cost+10% Benefit-10%
	Foreign	Local	Total	Agriculture	Electricity	Total				
2000	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0
2001	154.1	251.9	406.0	0.0	0.0	0.0	-406.0	-446.6	-406.0	-446.6
2002	238.3	392.5	630.8	0.0	0.0	0.0	-630.8	-693.8	-630.8	-693.8
2003	926.4	1052.1	1978.6	0.0	0.0	0.0	-1978.6	-2176.4	-1978.6	-2176.4
2004	2124.8	2863.7	4988.6	0.0	0.0	0.0	-4988.6	-5487.4	-4988.6	-5487.4
2005	4249.0	4158.3	8407.3	1122.3	33.3	1155.6	-7251.7	-8092.5	-7367.3	-8208.0
2006	2301.5	2857.5	5159.0	1683.5	68.3	1751.8	-3407.3	-3923.2	-3582.4	-4098.3
2007	3.3	12.6	15.9	3928.1	121.6	4049.7	4033.8	4032.2	3628.8	3627.2
2008	4.2	15.8	19.9	5611.6	149.2	5760.8	5740.8	5738.8	5164.8	5162.8
2009	4.2	15.8	19.9	5611.6	149.2	5760.8	5740.8	5738.8	5164.8	5162.8
2010	4.2	15.8	19.9	5611.6	149.2	5760.8	5740.8	5738.8	5164.8	5162.8
2011	4.2	15.8	19.9	5611.6	149.2	5760.8	5740.8	5738.8	5164.8	5162.8
2012	4.2	15.8	19.9	5611.6	149.2	5760.8	5740.8	5738.8	5164.8	5162.8
2013	4.2	15.8	19.9	5611.6	149.2	5760.8	5740.8	5738.8	5164.8	5162.8
2014	4.2	15.8	19.9	5611.6	149.2	5760.8	5740.8	5738.8	5164.8	5162.8
2015	4.2	15.8	19.9	5611.6	149.2	5760.8	5740.8	5738.8	5164.8	5162.8
2016	4.2	15.8	19.9	5611.6	149.2	5760.8	5740.8	5738.8	5164.8	5162.8
2017	4.2	15.8	19.9	5611.6	149.2	5760.8	5740.8	5738.8	5164.8	5162.8
2018	4.2	15.8	19.9	5611.6	149.2	5760.8	5740.8	5738.8	5164.8	5162.8
2019	4.2	15.8	19.9	5611.6	149.2	5760.8	5740.8	5738.8	5164.8	5162.8
2020	4.2	15.8	19.9	5611.6	149.2	5760.8	5740.8	5738.8	5164.8	5162.8
2021	4.2	15.8	19.9	5611.6	149.2	5760.8	5740.8	5738.8	5164.8	5162.8
2022	4.2	15.8	19.9	5611.6	149.2	5760.8	5740.8	5738.8	5164.8	5162.8
2023	4.2	15.8	19.9	5611.6	149.2	5760.8	5740.8	5738.8	5164.8	5162.8
2024	4.2	15.8	19.9	5611.6	149.2	5760.8	5740.8	5738.8	5164.8	5162.8
2025	4.2	15.8	19.9	5611.6	149.2	5760.8	5740.8	5738.8	5164.8	5162.8
2026	1007.2	15.8	1023.0	5611.6	149.2	5760.8	4737.8	4635.5	4161.7	4059.4
2027	4.2	15.8	19.9	5611.6	149.2	5760.8	5740.8	5738.8	5164.8	5162.8
2028	4.2	15.8	19.9	5611.6	149.2	5760.8	5740.8	5738.8	5164.8	5162.8
2029	4.2	15.8	19.9	5611.6	149.2	5760.8	5740.8	5738.8	5164.8	5162.8
			$11,568.8			$20,800.2	$9,231.3	$8,074.4	$7,151.3	$5,994.4
						IRR =	21.11%	19.41%	19.23%	17.64%
						NPV =	$9,231.3	$8,074.4	$7,151.3	$5,994.4
						B/C =	1.8			

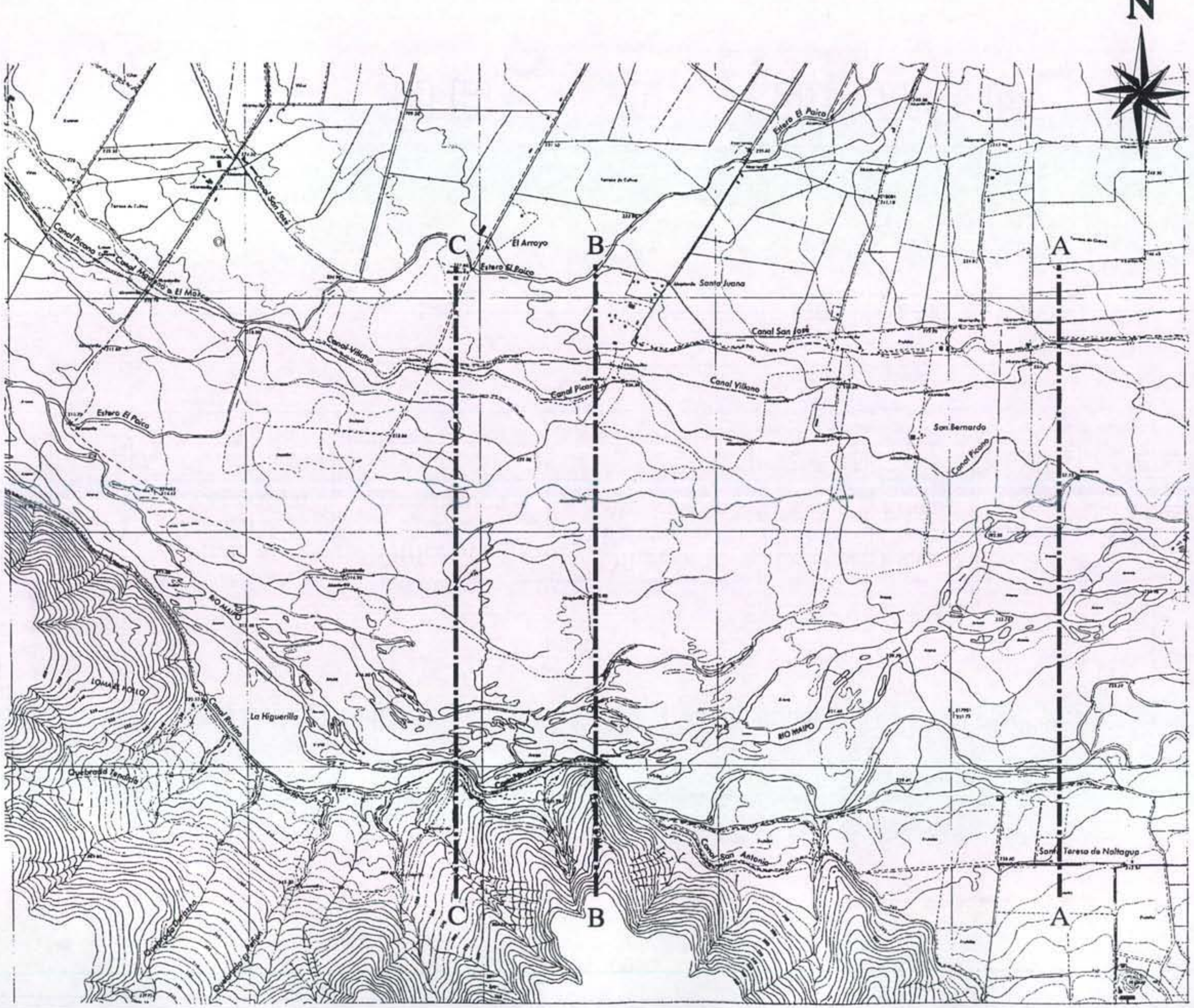


DESARROLLO AGRICOLA Y MANEJO DE AGUAS DEL AREA METROPOLITANA (JICA - CNR)

Fig. 1.1.1 Present Land Use in Popeta



DESARROLLO AGRICOLA Y MANEJO DE AGUAS DEL AREA METROPOLITANA JICA - CNR	Fig. 1.2.1 PLAN OF CECUV



LEGEND

Axis

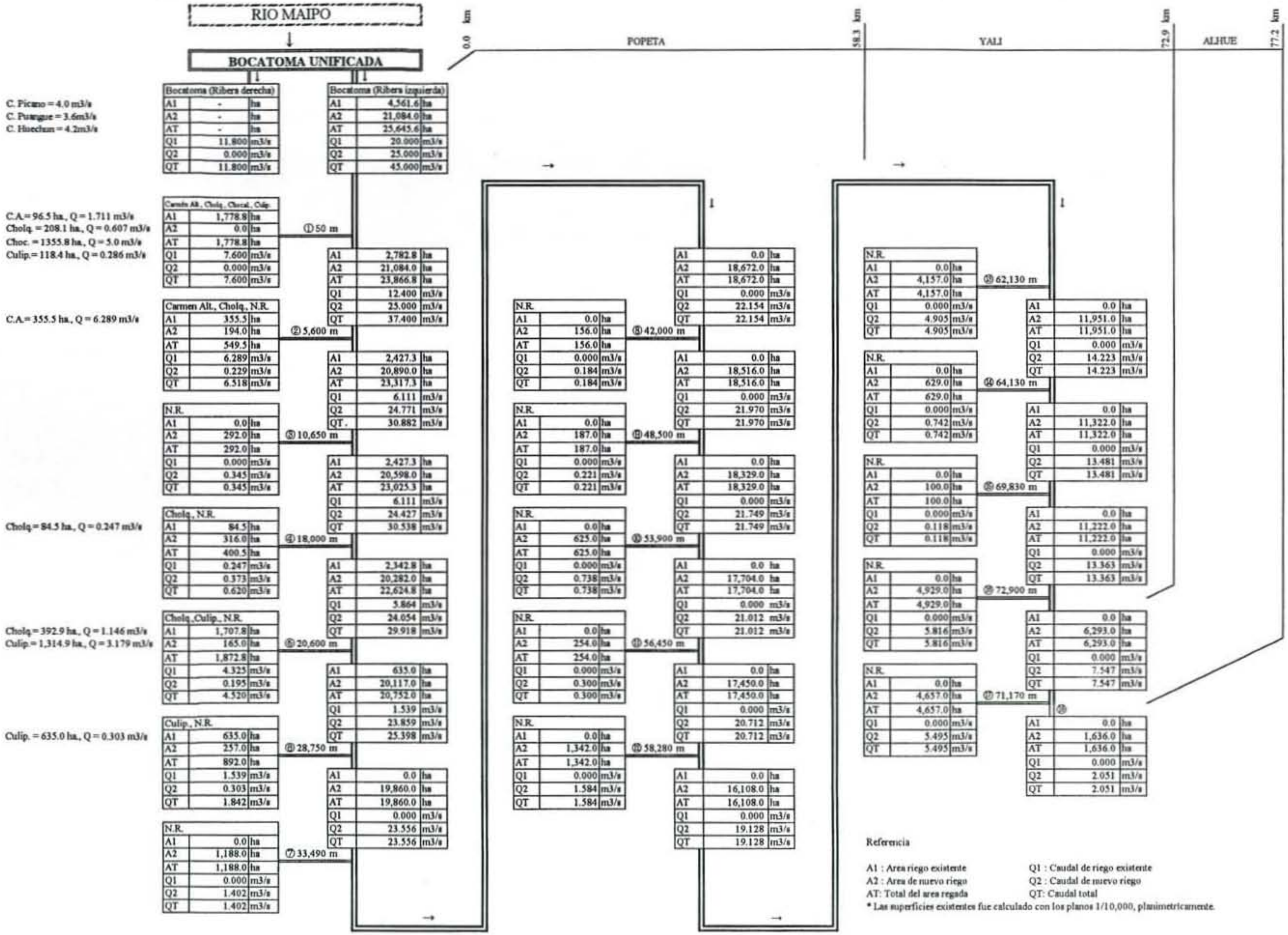
Fig. 1.2.2

LOCATION MAP ON COMPARISION OF WEIR AXIS

0 200 400 600 800 m

DESARROLLO AGRICOLA Y MANEJO DE AGUAS DEL AREA METROPOLITANA JICA - CNR

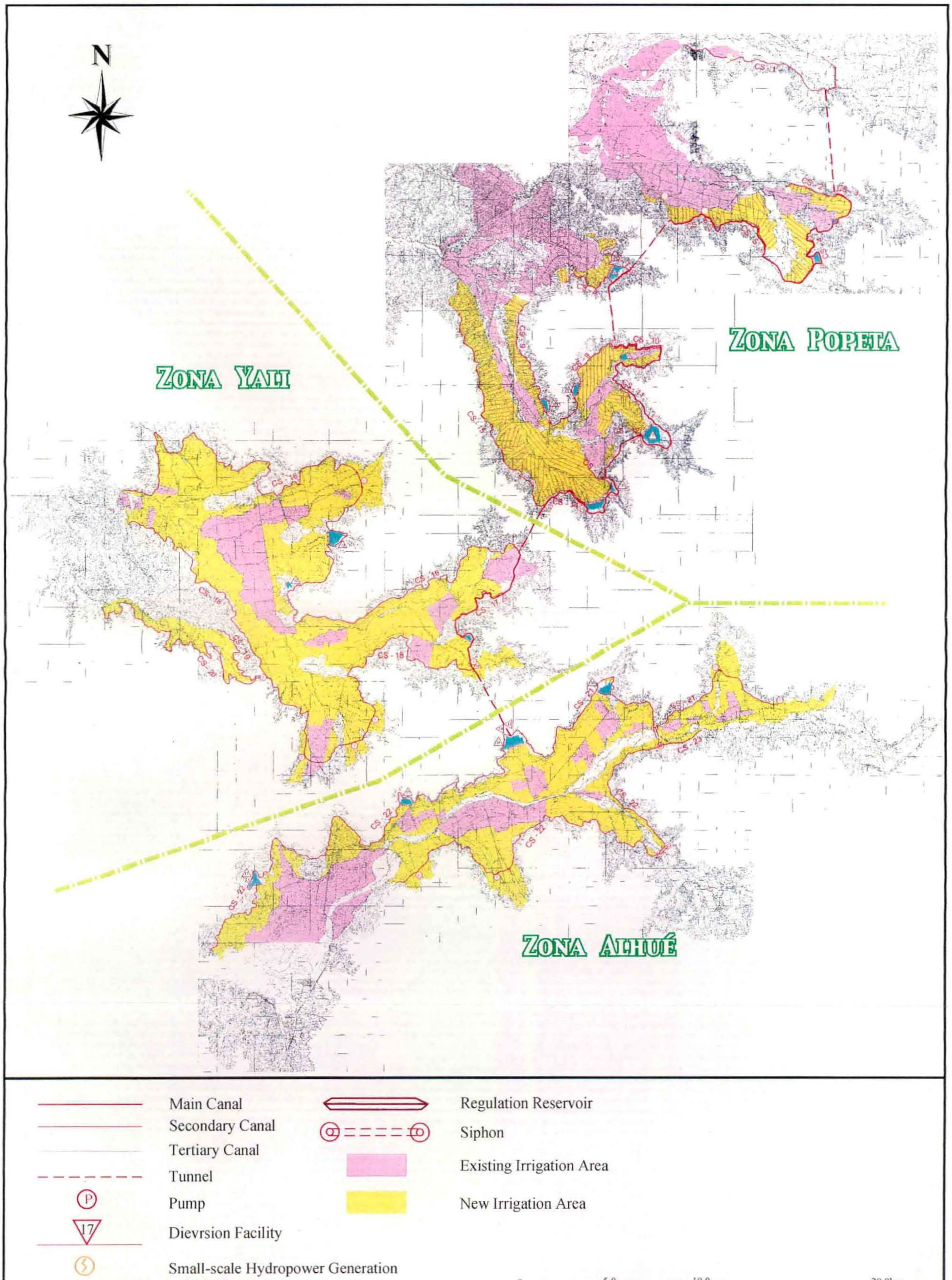
Fig. 1.2.3 Irrigation Diagram



Referencia

A1 : Area riego existente
A2 : Area de nuevo riego
AT: Total del area regada
Q1 : Caudal de riego existente
Q2 : Caudal de nuevo riego
QT: Caudal total

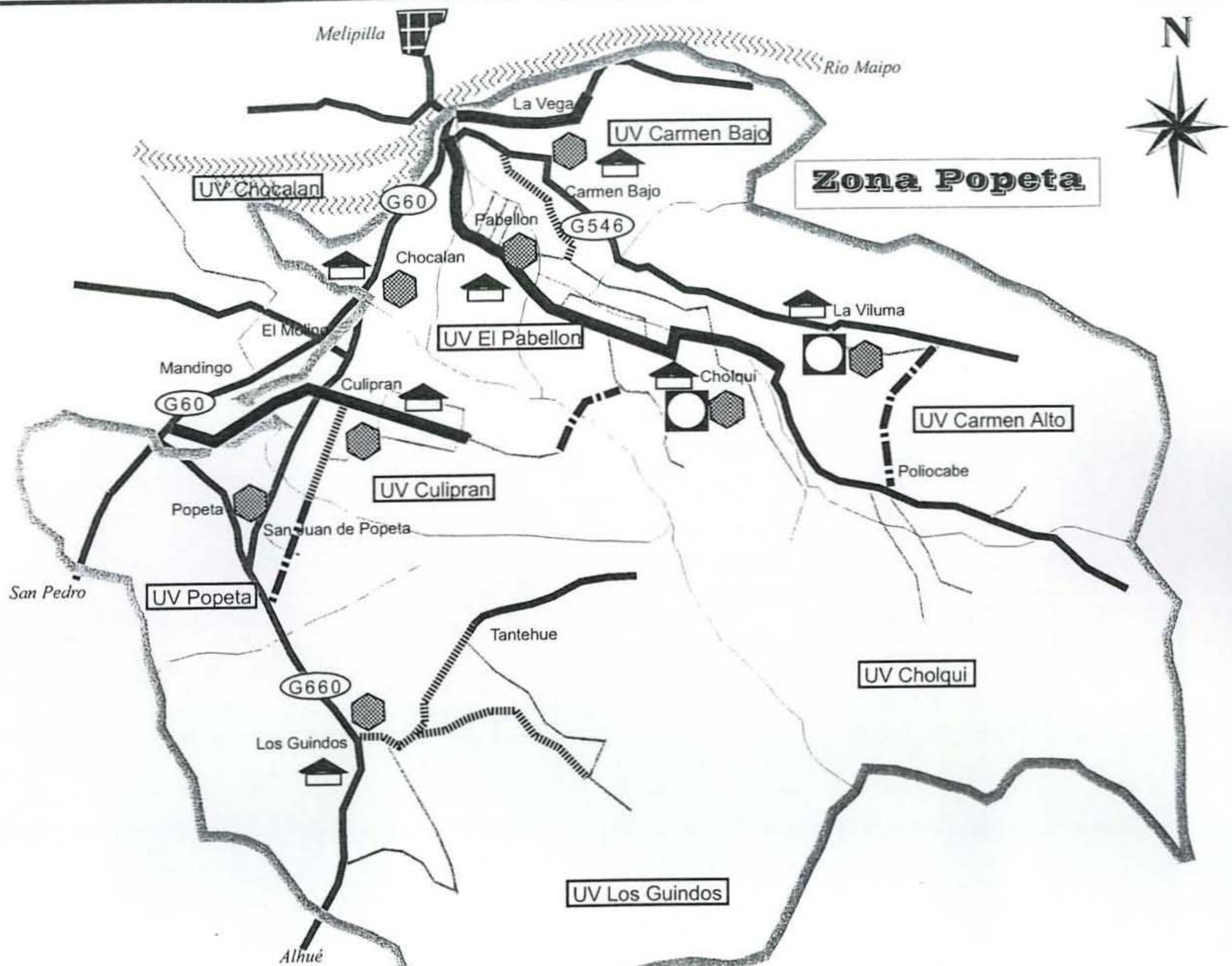
* Las superficies existentes fue calculado con los planos 1/10,000, planimetricamente.



DESARROLLO AGRICOLA Y MANEJO DE AGUAS DEL AREA METROPOLITANA (JICA - CNR)

Fig. 1.2.4

AGRICULTURAL PRODUCTION INFRASTRUCTURE DEVELOPMENT PLAN (POPETA AREA)



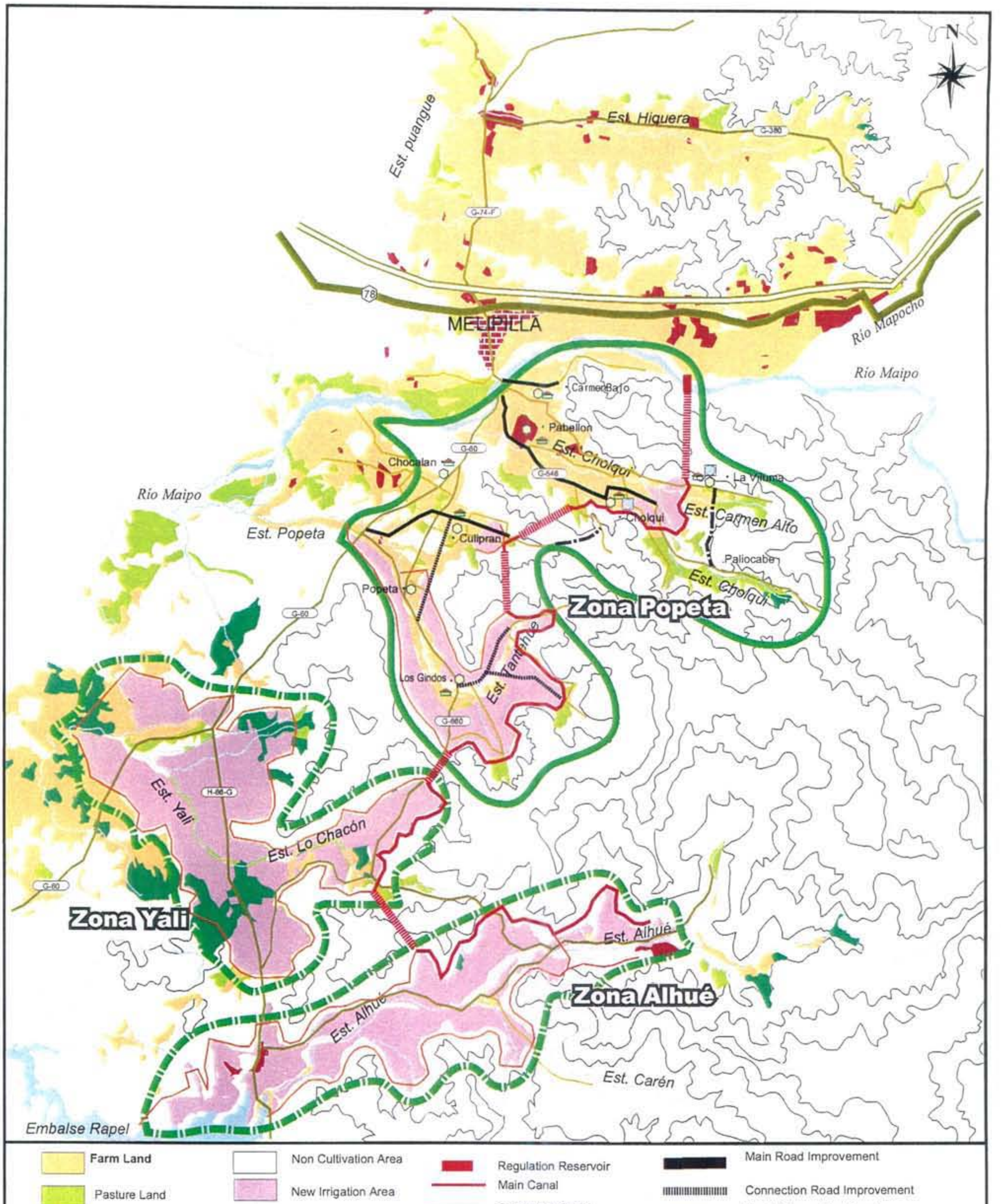
Main Road
Connection Road
Study Area
Boundary of UV
Main Road Improvement
Connection Road Improvement
Newly Connection Road
CECUV
Sewage Treatment System
Rural Water Supply

Fig. 1.2.5

RURAL INFRASTRUCTURE DEVELOPMENT PLAN

0 1 2 3 4 Km

DESARROLLO AGRICOLA Y
MANEJO DE AGUAS
DEL AREA METROPOLITANA
JICA - CNR



DESARROLLO AGRICOLA Y MANEJO DE AGUAS DEL AREA METROPOLITANA (JICA - CNR)

Fig. 1.2.6 Overall Development Plan (Popeta Area)

CHAPTER 2

AGRICULTURAL DEVELOPMENT PROJECT IN MALLARAUCO AREA

2 AGRICULTURAL DEVELOPMENT PROJECT IN MALLARAUCO AREA

2.1 Present Situation of Mallarauco Area

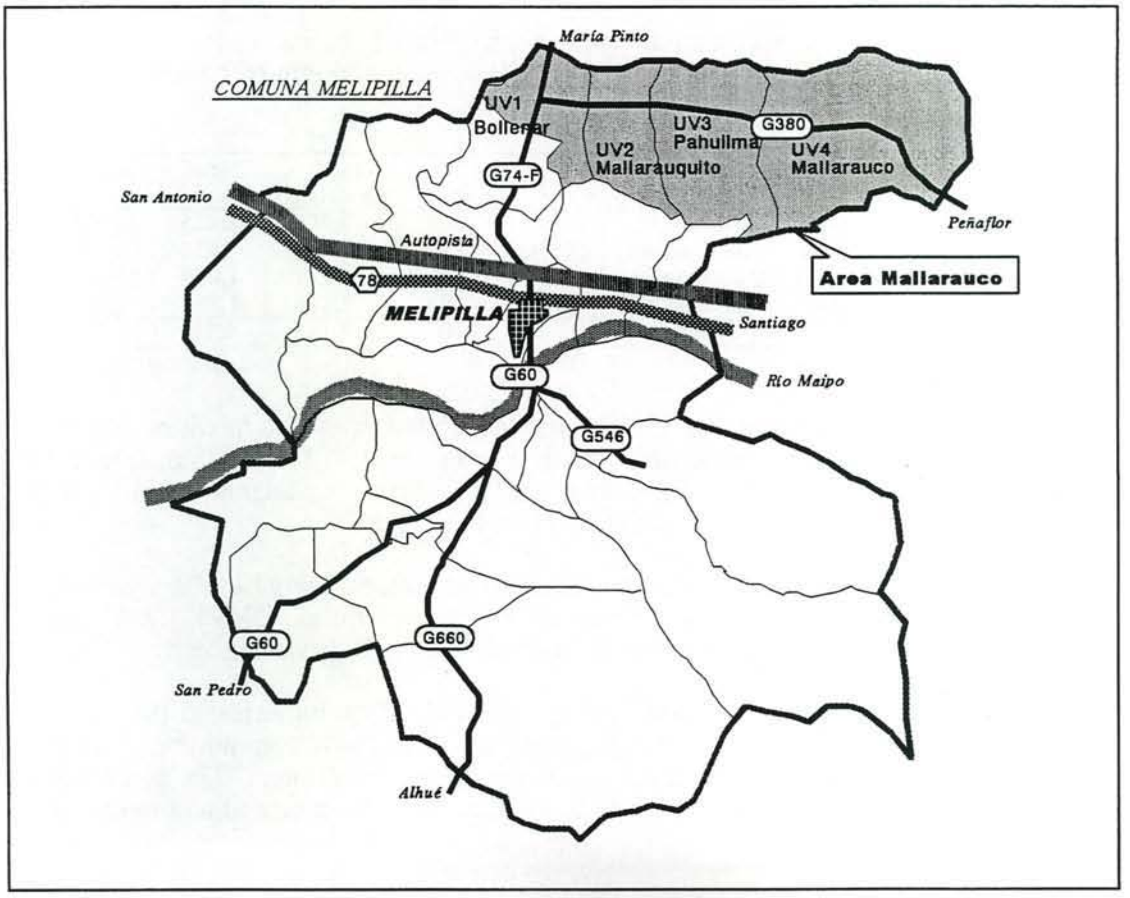
2.1.1 Present Social Situation

(1) Administrative Organization

Mallarauco area that belongs to *Comuna* Melipilla consists of 4 *Unidad Vecinal* (hereinafter referred to as the UV). Constitutions of UV in Mallarauco area are as follows.

Area	No.	*Unidad Vecinal*	No. of Council of Community
	UV1	Bollenar	3
Mallarauco	UV2	Mallarauquito	2
	UV3	Pahuilma	2
	UV4	Mallarauco	3

Allocation of UV in the study area is as follows.



(2) Population

Population of Mallarauco area is 8,145 heads according to the Census '92. Population of each UV are as follows;

Area	UV		No. of Households	Total population	Male	Female
Mallarauco	UV1	Bollenar	689	2,790	1,445	1,345
	UV2	Mallarauquito	250	986	523	463
	UV3	Pahuilma	480	1,871	1,008	863
	UV4	Mallarauco	688	2,498	1,335	1,163
		Total	2,107	8,145	4,311	3,834

Age composition of population in each UV is as follows.

Unit: %

Area	UV		Population constitution				
			0-15	16-30	31-50	51-60	61<
Mallarauco	UV1	Bollenar	31.7	27.8	24.1	5.7	10.8
	UV2	Mallarauquito	32.0	26.6	25.8	5.4	10.2
	UV3	Pahuilma	33.2	25.1	26.6	5.8	9.3
	UV4	Mallarauco	35.4	25.5	24.3	7.3	7.5
	Total		33.2	26.3	24.9	6.2	9.4
Comuna level			32.8	26.8	24.3	6.7	9.6
Nation level			29.0	25.1	27.9	8.1	9.8

Source: Melipilla-SECPLAC

(3) Rural society

About 77% of constituents of rural society in Mallarauco area are farmers. Among them, small scale farmers occupy about 90%. Breakdown of constituents is as follows.

Area	*UV*		No. of household	Total population	Men	Women
Mallarauco	UV1	Bollenar	689	2,790	1,445	1,345
	UV2	Mallarauquito	250	986	523	463
	UV3	Pahuilma	480	1,871	1,008	863
	UV4	Mallarauco	688	2,498	1,335	1,163
		Total	2,107	8,145	4,311	3,834

Source: REA-CIREN 95

Among the constituents of UV mentioned above, most of medium and large scale farmers carry out enterprise type of farm management. They do not live in the area and has become absentee landowners. Therefore, management of UV is undertaken by small scale farmers who settle down in the area.

As well as Popeta area, this area is divided administratively by UV, which is an integrated unit of *Junta de Vecino* (hereinafter referred to as JJVV). UV forms regional society and is recognized as a main body of local self-governance.

Minimum unit of the area as a group is JJVV. Communities in the area are extended into both sides of main roads, and shape so-called "row community." In case of row community, it is difficult to form the center of a community. The place where public facilities such as churches and schools are located is the center of a community at present.

(4) Rural organizations

UV is a core of rural society. As the other associations that form the rural society, there are JJVV, Center of Mother (*Centro de Madres*), Sports club (*Clubes Deportivos*), Aid committee (*Comités Allegados*), Young man's association (*Grupos Juveniles*), Culture club (*Centros Culturales*), and so on. Through activities of these associations, inhabitants of the area promote the activities of self-governance in the area with deepening solidarity by enhancing mutual friendship and help.

Distribution of various inhabitants' organizations in the area is as follows;

Area	*UV*		*Juntas de Vecinos*	Mothers' Center	Sports Club	Aid Committee	Young Man's Association	Culture Club
Mallarauco	UV1	Bollenar	3	2	3	1	-	1
	UV2	Mallarauquito	2	1	3	1	-	-
	UV3	Pahuilma	2	1	2	1	-	-
	UV4	Mallarauco	3	2	3	1	-	1
		Total	10	6	11	4	0	2
Comuna Melipilla			100	50	84	42	2	21

(5) Gender

According to the data of MIDEPLAN-CASEN 96 (Socio-economic Characterization Survey), the ratio of the extremely poor in *Comuna* Melipilla is high, compared to that in whole the Metropolitan Region. Yet, the ratio is 3.4% and is about 60% of the national average. That of the poor is also low, 17.5% and 76% of the national average. The other indicators also tend to be more improved, compared with the national average. Nevertheless, illiteracy rate is 1.5 times as much as the national average and 2.7 times as much as the Metropolitan Region's one, or 7.2%. The improvement of educational environment can be said the problem.

Indicators in *Comuna* Melipilla are summarized as follows;

Index			*Comuna*	Metropolitan	Nation wide
Illiteracy rate	Total	%	7.2	2.7	4.9
Poverty line	The extremely poor	%	3.4	2.7	5.7
	Non extremely poor	%	13.3	12.1	17.5
	Not extremely poor	%	83.3	85.2	76.8

Source; Casen96, MIDEPLAN

In many cases, the women's share of works in Mallarauco areas is also limited to housework and bringing up children as well as other rural areas. The concept that men work outside and women protect houses takes root. Therefore, women are isolated from the activities of JJVV and economic activities. The reason of this situation is that there are not enough training and education of skills for economic independence and of organized activities for women.

In Mallarauco area, there is not an organization which utilizes the program which supports independence of rural women (PRODEMU) by INDAP. Nevertheless, producers' organizations by rural women supported by PRODEMU are working in EL Bajo and San José areas around the area. Both of them produce and sell flowers. The organization in El Bajo area is managed by 15 housewives of farm households, and the other one in San José area is managed by 15 women.

Accordingly, the activities for improving rural women's status are taking root, gradually. So as to establish this tendency more effectively, forming organizations of women in community level is needed. For this, improvement and construction of the base facilities for interchange among rural women and the support system for forming organization are indispensable. Moreover, deepening interchange between the existing organizations by women and women in Mallarauco area has great meaning to promote forming organizations of rural women. Thus, it is important to establish this kind of interchange system.

2.1.2 Natural Resources

(1) Geology

Mallarauco area consists of a plain where old riverbed deposit and terrace deposit of Quaternary age cover the valley formed by impervious base rock. However, the surface layer is a tableland composed by Alluvial pumice volcanic ash. The rivers flow and erode the tableland at present. Diluvium aquifers is overlain by the volcanic ash deposit, and development of alluvial deposit along the existing river is poor.

(2) Climate

Mallarauco area, selected as the priority development area through the Master Plan study of the project, is located in the south-west of the objective study area. Melipilla meteorological station represents the climatic factors in the south-west of the study area. The station is located in the coastal mountainous areas and being observed the items to estimate the crop evapo-transpiration. Study on the meteorological items concerning the priority development areas will be made using the observed value at the Melipilla station. General climatic features on the Melipilla station are as follows;

Item	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Temperature (°C)													
Max.	32.2	32.4	31.1	29.0	25.2	21.8	21.9	23.8	26.8	28.4	31.1	32.5	28.0
Min.	7.4	7.2	5.3	2.9	1.2	0.4	0.0	0.2	1.4	2.7	4.4	6.3	3.3
Mean	19.1	18.9	17.7	15.1	12.6	10.7	10.1	11.0	12.6	14.5	16.5	18.4	14.8
Precipitation (mm)													
	0.1	0.2	3.0	17.8	76.1	94.7	107.4	57.6	25.4	10.9	6.0	1.3	400.6
Evaporation (mm)													
	206.3	165.9	124.9	70.7	34.9	20.1	21.8	36.2	62.2	112.5	154.8	202.0	1212.4
Relative Humidity (%)													
	60.1	62.5	66.3	70.9	77.5	80.7	80.1	77.1	72.9	67.2	62.5	58.7	69.7
Sunshine Hours (Hr)													
	10.5	9.6	7.7	6.1	4.2	3.4	3.6	5.0	5.8	8.0	8.9	9.9	6.9
Wind Velocity (km/month)													
	1599.5	1158.1	877.9	508.1	526.5	693.6	845.6	751.2	900.3	1158.6	1381.8	1641.8	1003.6

(3) Soils and land use

According to Agricultural Landholding Survey (REA : *Rol Extracto Agrícola*) in 1995, area of the study area is summarized in the table below. The present land use of Mallarauco area is shown in Figure. 2.1.1.

Unit: ha

Area	*UV*		Total area	Farmland	Others
Mallarauco	UV1	Bollenar	2,369.9	1,777.4	592.5
	UV2	Mallarauquito	2,952.6	1,535.4	1,417.2
	UV3	Pahuilma	5,379.4	1,882.8	3,496.7
	UV4	Mallarauco	9,622.4	4,041.4	5,581.0
		Total	20,324.4	9,237.0	11,087.4

For soil and land classification of the study area, the data of REA and the orthophoto which obtained from CIREN are used. Land productivity classification of the area is summarized as follows.

	Land productivity classification	Area by REA (ha)
I	(No limitation for cultivation)	0.0
II	(A little limitation)	134.2
III	(Necessary to select crops)	593.3
IV	(Serious limitation for cultivation)	315.0
V	(Difficult for farmland)	0.0
VI	(Impossible excluding pasture land)	0.0
VII	(Impossible for farmland)	0.0
VIII	(Impossible for whole land use)	0.0
	Total	1,042.5

Total benefited area by the project is to be 1,042.5ha. The area is existing irrigated land which belongs to between Class II and Class IV of the land productivity classification. 70% of total benefited area belongs to between Class II and Class III where is no limitation for agricultural use. Another 30% belongs to Class IV because of drainage aspects, and it is concentrated in farmland of Reforma area.

(4) Water resources

1) Surface water

Irrigation water for the farming plot in the Mallarauco area is conducted through the Canal Mallarauco. Intake facilities of the Canal Mallarauco is installed at the right bank of the Mapocho river. Monthly basis intake amount of the Canal Mallarauco is as follows;

Bocatoma Mallarauco — Unidad : m^3/s

Año	ENE	FEB	MAR	ABR	MAY	JUN	JUL	AGO	SEP	OCT	NOV	DIC
1988	-	-	-	-	-	-	-	1.40	4.59	7.75	7.69	7.54
1989	7.49	7.54	6.90	-	-	-	-	-	3.84	7.54	7.54	7.54
1990	7.54	7.60	7.32	7.54	-	-	-	3.02	6.00	6.63	7.02	7.70
1991	7.26	6.54	6.58	5.88	4.45	1.47	-	-	3.77	7.52	7.75	7.70
1992	7.89	8.06	7.45	6.35	3.10	-	-	-	4.54	7.42	7.75	7.80
1993	8.06	8.06	7.79	5.61	2.38	-	-	3.37	5.80	7.73	8.06	-
1994	7.80	8.06	7.09	6.63	4.37	2.32	-	1.20	6.04	7.30	8.06	8.06
1995	8.36	8.08	5.81	5.30	2.69	3.34	-	-	5.21	7.33	8.06	8.08
1996	7.67	6.62	7.53	6.22	5.12	3.73	-	2.79	3.98	3.84	3.68	7.80
1997	4.91	4.28	4.88	4.44	3.70	-	-	-	2.48	4.61	6.72	4.19
1998	8.00	8.06	6.98	5.75	4.79	2.88	-	4.70	4.97	5.50	6.84	7.99
Promedio	7.50	7.29	6.83	5.97	3.83	2.75	-	2.75	4.66	6.65	7.20	7.44

Water rights in the Mallarauco irrigation system are settled on 920 *Accións* at intake point. Available irrigation water of 1 *Acción* varies from 4.5 lit./s to 8.0 lit./s. Based on the maximum available irrigation water of 8.0 lit./s and water rights, total water requirement amount at headrace of canal counts at 7.36 m^3/s. Water requirement amount for peak demand of irrigation can be assured in comparison with the actual intake water amount shown in the above table.

Design discharge for the areas to be improved the water quality of irrigation will be settled multiplying total water rights by 8 lit./s of maximum available irrigation water per *Acción* because priority development areas locates in the Mallarauco irrigation system.

2) Groundwater

Mallarauco area is a whole basin of *Estero* La Higuera which is a branch of *Estero* Puangue.

a) Distribution and number of wells

According to the survey of DGA, distribution of wells in Mallarauco area is as follows.

Area	*Estero*	Number	For agriculture use	For domestic water supply	others
Mallarauco	Higuera	14	2	7	5 (5)

( ) was dig for irrigation use but is not utilized at present.

Compared the number of wells in 1984 with that surveyed by the study in 1999, it has increased from 8 to 14.

b) Number of wells for agriculture and irrigation area

According to the well register of DGA, 2 wells for agriculture are registered. The irrigation area by using groundwater is estimated 60ha from the average irrigation area (30ha/well).

c) Fluctuation of groundwater

Long term observation of groundwater fluctuation has been undertaken in Mallarauco area. The results of survey whose data is relatively good are shown below.

Basin	No.	Coordinate (South - North)	Coordinate (East - West)	No. of well	Use	Bore of well (inch)	Depth (m)	Date of digging	Natural water level (m)	Pumping volume (l/sec)	Pumping head (m)
Mallarauco	M-1	33□30□	71□00□	D1	RSU	10	82.5	1959.9	4.6	33	23,2
	M-2	33□30□	71□00□	B1	P	8	61.0	1967.2	6.2	10	40.2

Both M-1 (confined groundwater) and M-2 (free groundwater) in Mallarauco basin show a tendency to lower the water level. Therefore, change of water quantity caused by lowering the water level is worried.

2.1.3 Agriculture

(1) General feature

In Mallarauco area, under the extremely mild climate with highly productive soil, profitable fruits growing (mainly avocados and lemons) is carried out and occupies a half of the present irrigated farmland. The area is a pioneer of fruits plantation on the sloped land (*plantación en laderas*), and fruits are cultivated in 2,000ha of the sloped land.

One of the significant features of the area is dairy products. There are three large farms which produce and process milk in the area. They produce milk under the direct management and also purchase and process the raw milk which is produced in and around the area. These farms hold 1,000ha of land as a whole but purchase feed and raw milk from small scale farmers as well. The Pahulmo farm among them is famous for cheese production.

Some kinds of vegetables and cereals are cultivated by small scale farmers. Many kinds of vegetable have been produced in the past, and especially large quantity of melons for export, watermelons, pumpkins, onions and garlic were produced. The other vegetable such as lettuces, cabbages and cauliflower were also produced but small quantity. Production of export melons was drastically decreased by mosaic virus infection. Vegetables are not major cultivation crops any more in the area due to prohibition of their cultivation by using contaminated water after outbreak of cholera in 1990.

(1) Scale of farming

The farmers in the project area for water quality improvement are confirmed by the REA report and the Ortho-photography and are classified by farming scale. The results of this is shown in the table below.

Farming Size (ha)	No. of Farmers	Holding Area (ha)	Irrigation Area (ha)	Average Farming Area (ha)	Average Irrigation Area (ha)	Non-Irrigation Area (ha)
0.1 – 15	84	782.9	782.9	9.3	9.3	0
15.1 – 100	7	166.9	104.4	23.8	14.9	62.9
Over 100.1	3	791.1	155.2	263.8	50.9	638.3
Total	94	1740.9	1,042.5			701.2

Average scale of farmers' landholding in the project area is 9.4 ha for small scale farmers and 25.3 ha for large and medium scale farmers. Among beneficiaries of the project, 89% of the beneficiaries is small scale farmers and 11% of them is a large and medium scale farmer. The beneficiaries who hold land outside the projected area are only large and medium scale farmers. Most of their land is unirrigated area.

Small scale farmers in Mallarauco area have very wide farming experience and agricultural technology, compared with small scale farmers in the other areas. When export melons were produced in the area in the past, small scale farmers also cultivated them. Small scale farmers started to engage in milk production after quitting melon cultivation by the virus infection and the regulation on vegetable cultivation by contaminated irrigation water. Some of them produce quite high quality milk. Because the milk price decreased, small farmers had to quit milk production. Farming alternative for them is fruits growing but most of them cannot invest enough and remain small scale and low productivity farming.

(2) Present situation of cultivation crops

According to the information from Mallarauco canal association and the results of the survey on 25 farms in the study area, the present situation of cultivation crops is described in the table below

Crop	Grains			Vegetable *	Forage Crops	Fruit Trees			Sub total	Forage & Others	Total
	Maize	Wheat	Total			Avocado	Lemon	Total			
Area (ha)	164.7	22	186.7	99.1	225.2	31.3	20.9	52.2	563.2	479.8	1043
%	15.8	2.1	17.9	9.5	21.6	3.0	2.0	5.0	54.0	46.0	100

Note * : Basically indicate Pumpkin, Melon, Watermelon, zucchini and potato

Cultivation crops by scale of farming such as small scale farmers, and medium and large scale farmers are shown in the table below.

Crops	Grain Crops			Vegetables			Forage Crops	Fruits Trees			Sub total	Pasture & Others	Total
	Wheat	Maize	Sub total	Pumpkin	Watermelon	Sub total	Alfalfa	Avocado	Lemon	Sub total			
Small scale (9.4 ha)	0.28	1.2	1.48	0.4	0.41	0.81	1.83	0.06	0.12	0.18	4.3	5.1	9.4
(%)	2.7	13.0	15.7	4.2	4.4	8.6	19.5	0.67	1.16	1.9	45.7	54.3	100.0
Total Area (ha)	22	102.4	124.4	33.6	34.5	68.1	154.2	5.3	9.2	14.5	361.2	428.8	790.0

Crops	Grain Crops	Vegetables	Forage Crops	Fruits Trees			Subtotal	Pasture & Others	Total
	Maize	Melons	Alfalfa	Avocado	Lemon	Subtotal			
Large / Medium Scale (25.3ha)	6.2	3.1	7.1	2.6	1.2	3.8	20.2	5.1	25.3
(%)	24.5	12.3	28.1	10.3	4.6	14.9	79.8	20.2	100.0
Total Area (ha)	62.3	31.0	71.0	26.0	11.7	37.7	202.0	51.0	253.0

Crop cultivation of an average small scale farmer occupies over 54% of his landholding area with pasture or low profit crops. This cropping pattern reflects the history of crop cultivation in the area as mentioned before. Most of fruit growing is undertaken in small scale orchards, and only one exception is a commercial plantation of 5ha.

In case of large and medium scale farmers, pasture and low profit crops share 20.2% of total crop cultivation. The most important crop is forage crops and it shares 28.1 % of total crop cultivation..

(3) Farm income

Gross income of a typical farmer is shown in the table below.

Small Scale Farmer			Large / Medium Scale Farmer		
Crop	Farmland Area (ha)	Farm Income ($1,000)	Crop	Farmland Area (ha)	Farm Income ($1,000)
Wheat	0.28	70	Maize	6.2	2,480
Maize	1.2	360	Melons	3.1	4,650
Pumpkins	0.4	320	Alfalfa	7.1	4,970
Watermelons	0.41	533	Avocado	2.6	3,380
Alfalfa	1.83	732	Lemon	1.2	960
Avocado	0.06	48	Pasture	5.1	510
Lemon	0.12	48			
Pasture	5.1	510			
Total	9.4	2,621	Total	25.3	16,930

(4) Agro-processing

The table below shows agro-processing factories operating near the study area, María Pinto and Peñaflo. Melipilla, Talagante and Culacaví are located within 10km, 30km and 25 km from the study area, respectively. Buin, Paine, Linderos and Santiago are located within 60 km from the study area. Accordingly, it is possible for the study area to access easily all kinds of agro-processing facilities.

Type of Processing Facilities	No. of Facilities	Capacity
Nuts Processing Facility	1	45,000 kg/ day
Fruits Dehydration Facility	2	10,000 kg/day
Raw Milk Processing	3	N/A
Vegetable Freezing Facility	5	29,500 m^3
Packing Facility	16	135,500 kg/ day
Sterilizing Facility	3	31,000 kg/ day

2.1.4 Agricultural Support Services and Farmers' Organizations

All of agricultural support services in the study area are provided through INDAP-Melipilla. As farmers' organizations in the study area, there are three types of organizations; canal association, milk collecting cooperative and citrus group.

As water users' association, there is only one, Mallarauco canal association. This association distributes irrigation water fairly, and maintains canals in the area as a whole. The association can utilize INDAP service systems for improvement and construction of facilities, and also applies for and materializes the project. So that, the canal associations employ full-time advisers, and intend to promote their business and implement effective operation and maintenance of facilities.

Milk collecting cooperative and citrus group are producers' organizations and both of them are organized by INDAP services.

The milk collecting cooperative was established in 1987 and managed by 15 dairy farms. Its base is a milk collection center, which equipped with a fixed temperature storage by INDAP services. Based on the centers, the cooperative intends to control milk quality for maintaining the selling price through controlling animal raising, feed and milking of each farm. The selling destination is a large milk processor (SOPROLE). SOPROLE gives technical guidance for quality control. The quality is strictly controlled at the cooperative as well as among the members because the price is largely fluctuated by quality. The cooperative aims at construction of dairy processing facilities of original brand in the future. It receives financial support not only from public loan of FOSIS but also from OCAC (Farmers Support Association), NGO. It combines various financial sources effectively and utilize them.

Citrus group (*Groupo Citricola*) is organized by 17 small scale farmers through utilizing SAL program of INDAP. The group intends to increase productivity and control quality of lemons and oranges. This results in establishment of the productions' status in a market and maintenance of quality.

Although there are a few producers' organizations in the area as mentioned above, they have been achieved steadily the results and contribute largely to improvement of small scale farmers' status and stability of regional society. The ratio of forming organization is still very low. This is a big constraint on self-independence of small scale farmers.

The constraints on organizing small scale farmers are vigorous feeling for self-independence of themselves and mutual distrusts among them. On the other hand, there are lack of public relation on the support system, of basic motivation to form organizations. There is also lack of support organizations for them. In addition, it is also a big constraint that there are not enough places for reaching agreement through discussion of farmers themselves and for enlightening about and extending the support system. Therefore, solving these constraints and the way to establish the class of socio-economically independent small scale farmers are to be future subjects.

2.1.5 Agricultural Economy and Marketing

(1) Marketing of agricultural products

1) Production and distribution

Marketing of farm products in the study area can be (a) individual, in which the producer sells his/her products to an intermediary without a contract, generally obtaining low prices, but leaving the option open for good prices when market conditions turn favorable, and (b) group marketing, or through a trade association of the producers themselves, which not only improves marketing by replacing intermediaries, but permits access to credit and technical assistance.

As marketing channel, small producers in the priority study area mention intermediaries in the first place. Intermediaries bridge the gap between producers and wholesale markets in Santiago. Apparently there are two types of intermediaries: (a) those who pay before taking the products, and (b) those who combine transportation and sale services, paying the producer after selling the products, thereby making them more akin to consignees. Wholesale markets in Santiago are the main destination of most agricultural products, and serve as suppliers to regional consumption centers.

Concerning direct sale from producers to consumers, farmers who own land along a trunk road have the option of selling their produce in makeshift stands, which allow them to obtain better prices. Another marketing option is contract production, generally involving agroindustry or packing plants. To ensure the quality of agricultural products, these firms set a number of requirements, which are not always accessible or economically justifiable for the small producer.

Collective milk marketing is becoming a required step for small producers, due to the refrigeration requirement set by the milk buyers. The price differential between non-refrigerated and refrigerated milk can be as much as 50% ($40 against $60 per liter some time ago). A center for collective milk marketing can be set up by a group of dairy farmers who finance the necessary investments, but when there is surplus capacity it is usually open to non-members as well, paying a lower price than to members or charging around $2/liter as refrigeration service.

The purpose of quality control upon milk reception at the collective milk marketing center is to detect acidity and to prevent milk dilution with water. The milk price paid to producers is the same in some places, regardless of quality differences. However, better-organized collective milk marketing centers have all producers identified by individual codes, and their milk samples are analyzed in the laboratories of the final buyer who sets prices according to the milk quality. Milk quality requirements are defined by buyers, usually major dairy firms or local cheese factories, but small milk producers generally do not know what these requirements are.

Small collective milk marketing centers in the study area include Viña El Campesino, Santa Elena and Los Carrera.

2) Marketing facilities

Within the priority study area, there are facilities for the marketing of perishable products. These facilities consist of packing plants and cold storage, which permit value added to the produce, either through processing or through an improved inter-temporal distribution of the product.

(2) Price and quality of agricultural products

Agricultural products identified in the study area by the questionnaire survey were fruit like orange, avocado and lemon, melon, pumpkin, cucumber, water melon, corn, potato, alfalfa and natural pasture for cattle.

1) Farm gate price

The farm gate price received by the small producers appears to be influenced more strongly by the harvest time, rather than by the quality of the product. Farmers receive price information through 2 or 3 radio stations, and they are aware of the existence of such service. However, they argue that these radio stations broadcast price information during the morning when they need to be working in the field. The prestigious daily El Mercurio publishes an agricultural supplement on Mondays, with extensive information on prices of inputs and outputs. The Office of Studies and Agricultural Policy (ODEPA) of the Ministry of Agriculture provides price information by fax to interested farmers, and sends regional price information to the relevant local government office.

2) Wholesale price

The price recorded by ODEPA in wholesale markets specify the area where the product originates, three levels of prices (low, high, and common) by variety and quality of products, and the transaction volume per day. Price information is also available as weekly averages by variety and quality of products, and the transaction volume per week. Finally, price information is available as the monthly average between 1975 and 1998.

Wholesale price differentiation by quality of products indicates that some kinds of classification take place between the farm and the wholesale market. The tables below show examples of wholesale prices in two wholesale markets of Santiago, Lo Valledor and Mapocho, choosing the products originating in the Central Zone or in Santiago. Price differences can be noticed between the wholesale markets, prices being higher in the Mapocho market as a reflection of its convenient location in downtown Santiago, while Lo Valledor is located in the outskirts of the city.

3) Quality standards

The National Standards Institute (INN) defines quality standards for a variety of products, including some agricultural products. Quality standards for grapes, apples, pears, avocados and lemons are set for both the domestic market and export markets. In the case of Thompson Seedless variety of grapes, and taking the bunch weight as the criterion, standards for the domestic market and the export markets differ as follows:

Class	Domestic Standard (gram/bunch)	Export Standard (gram/bunch)	
		Thompson Seedless, Cardinal, Perlette	Other Varieties
1	225	250	300
2	180	200	250
3	115		
4	115		

Source: NCh1818.Of80, NCh1925.Of82

The quality standards set by INN are used by Agriculture and Livestock Service (SAG) to control the quality of agricultural products for export, through its regional offices located in Melipilla and Talagante within the priority area. On the other hand, in the case of domestic market, no control seems to exist for the enforcement of quality standards set by INN.

4) Marketing improvement

There are favorable factors that can enable producers in the study area to improve the marketing of their products. The favorable factors are the proximity to the main consumption centers of the country, and the relative abundance of information on prices and quality of agricultural products.

The long-term price trend can give an indication on promising products. The quality standards for the promising products will indicate market requirements, and therefore, the technology that will be required in the production of such products. Once the selected products are produced, recent or short-term price information will give the pattern to decide in which market to sell.

Small producers should set up their own trade associations in order to take over the role of intermediaries. Trade associations will give their members additional advantages, such as access to technical assistance and credit offered by government institutions. A trade association can rent a sale and exhibit module in the new Santiago Wholesale Market (MERSAN), to make it possible to sell directly to consumers. If the rental fee of a sale and exhibit module in MERSAN is out of reach of a trade association, a group of trade associations can share the same space. In this case, each trade association can directly sell to consumers a specific product, which should ideally be produced successively during the year, so as to permit an efficient rotation in the use of the sale and exhibit module.

(3) Farm income

Results from the questionnaire survey were analyzed with reference to small farms of less than 15ha. In the Mallarauco area, the survey included small farms and one medium size farm, but no large farm. The economic results from these farms in the Mallarauco area, as indicated by the questionnaire survey, are presented below.

Item	Small scale farmer Area (ha)	Income ($)	Expenses ($)	Result ($)	Medium scale farmer Area (ha)	Income ($)	Expenses ($)	Result ($)
Farm Area	8.14				18.5			
Used Area	4.39				17.0			
Gross Farm Income		3,164,032				12,133,456		
General Expenses			412,458				1,003,200	
Net Farm Income				2,751,574				11,130,256
Family Labor		75,000						
Off-farm Income		156,000						
Family Expenses			988,625				760,000	
Household Income				1,993,949				10,370,256

The economic results presented above indicate that the small farm is in a difficult situation, requiring off-farm income to make the farm viable.

2.1.6 Agricultural Infrastructure

(1) Infrastructure on irrigation

Mallarauco area extends over 7,000ha of farmland and is irrigated by contaminated rive flow of the Mapocho river by urban sewerage. Irrigation water taken from the Mapocho river passes through Pervin and tunnel, then irrigation water is divided into seven irrigation systems (irrigation areas) in *Comuna* Mallarauco. The details on volume of water rights (*Acción*) and users (*Acciónistas*) are as follows.

Irrigation System	User	Water-Right	Discharge (m^3/sec)
1. Pervin	35	140,000	1.120 – 0.630
2. Norte	53	261,160	2.089 – 1.175
3. Sur	91	167,924	1.343 – 0.755
4. Higuerillas	95	193,890	1.551 – 0.872
5. Santa Ana	60	98,916	0.791 – 0.445
6. Italiano	61	107,364	0.858 – 0.483
7. Reforma	78	76,971	0.615 – 0.346
8. Retamo	21	8,000	0.064 – 0.036
Total	494	1,054,225	8.433 – 4.744

Note: Discharge is calculated from water right's discharge (1 *Acción*: 8~4.5 l/sec/ water right)

In Pervin area, 670ha or the section of about 6km ranged between intake facilities and a tunnel is irrigated by four diversion facilities. The Downstream Pervin, (after a tunnel of about 3km) is divided into three major systems (Norte, Sur and Higuerillas) and again divided into five systems (irrigation section). Number of water right (No. of *Acción*) at the intake facilities is 920 in the area as a whole. There is also *Acción* at the water source which uses return flow in the downstream basin. Sum of them is 1,054,225. Intake water volume is varied by season, the volume per *Acción* is changed between 8.0 and 4.5lit./sec, and distributed. Irrigation method in the area is mostly a furrow irrigation in the flat land including orchard. A drip irrigation method by pumping up is applied in the orchard of the sloped land.

(2) Drainage facilities

There are mountains in the north and the south and the Higuerillas river flows from the east to the west in the low flat of the center in the area. This river plays a role of a drain that collects rain and excess water of irrigation. However, the flow of river is dammed up at the downstream basin and utilized for irrigation. The river has a function as both irrigation and drainage canal.

There are poor drainage areas in the central lowland of the downstream basin. In the areas, although there are drainage canals per a branch irrigation canal, there is no organized drainage canal networks in the area as a whole. Moreover, the drainage canals are dammed up and become irrigation canal. This means that drainage and irrigation canals are mixed, there.

(3) Contamination of irrigation water

Irrigation water of Mallarauco area is taken from the Mapocho river. Water of the Mapocho river is already contaminated by the urban sewage at the intake point of the Mallarauco canal. Thus, the farmers must use contaminated water as irrigation water in the entire area. Accordingly, the problem of contaminated irrigation water is not solved in the area, otherwise sewage is treated in the Santiago city.

(4) Facilities and water management

Mallarauco canal association manages irrigation facilities from intake facilities to the secondary canals. Maintenance cost is paid according to number of water right (*Acción*) by a holder. The holders of water right are 494 and the maintenance cost per *Acción* is $63,000 annually. Main work of maintenance is canal repair, and the repair schedule is prepared every year. The management cost of the main canal is paid by users of the entire area. After the secondary, the management cost is paid by users concerned. The burden of canal repair cost is large in the canal system which passes through the slope of mountains.

Mallarauco canal association manages water and distributes *Acción* flow fairly at each diversion point according to intake water volume.

2.1.7 Rural Infrastructure

(1) Installation of basic infrastructure

The present situation of basic infrastructure in the Mallarauco area is shown in the table below.

Unit: %

Area		*UV*	Electricity	Water Supply	Sewage System
Mallarauco	UV1	Bollenar	84.9	89.6	10.9
	UV2	Mallarauquito	87.2	90.0	9.2
	UV3	Pahuilma	85.8	90.4	26.7
	UV4	Mallarauco	78.5	82.5	14.4
	Total		83.3	87.6	15.4

On the basic infrastructure in the study area, installation of electricity and water supply is almost completed. Electricity is supplied by the electric supply company and will be supplied to all households, soon. All drinking water is taken from groundwater. The water supply system is renewing in the entire area by the support of EMOS at present. All households will be able to obtain tap water by the water supply system. Accordingly, installation of electricity and water supply does not have problems at all.

On the other hand, installation of sewage systems has almost not proceeded, and there are no sewerage treatment facilities even in the communities where water supply facilities have already installed. Excreta is treated in the septic tank of individual houses and domestic sewage is directly discharged into drain canals.

Therefore, contamination of agricultural water and river flows by domestic sewage is getting noticeable in some places. Communities of Mallarauco area extend into the valley and the structure of communities is relatively gathered. Therefore, there are a few constraints on installation of a rural sewage system. It is necessary to promote installation of a rural sewerage system from the aspect of living and production environmental conservation for inhabitants.

(2) Road / Traffic facility

The road network in the area is formed by MOP managed road, Route G380 which runs from the East to the West in the central part of the area, and Municipality managed lateral roads which crosses Route G380 orthogonally. The area connects with Melipilla and Peñaflor by Route G380. Route G380 has been completely paved except the part of road to Peñaflor. Although lateral roads are not paved at all, they have already widen enough for passage of vehicle. Connection between lateral roads are very poor because most of lateral roads are arranged as comb-shape against trunk roads. According to the road situation mentioned above, connection between lateral roads should be promoted.

On the other hand, regarding public transportation facilities, there is a route bus service mainly on the trunk roads and connects with Melipilla city, the Peñaflo city and the Santiago city.

(3) Other facilities

As educational facilities, primary schools (*Básica*) are in Santa Elisa (Esc. Patricio Larrain, 10 teachers, 271 pupils) and Santa Victoria (Esc. Lidia Matte, 10 teachers, 273 pupils) and kindergarten is attached to each school. Normally they are going to high school and schools for professions in the Melipilla city.

As medical facilities, a health center (*Posta Bollenar*) is located in Bollenar community, the western end of the area. A nurse is always stationed. A medical doctor and a dentist make their rounds once a week. The Municipal hospital and the Red Cross hospital (*Policlinicos Cruz Roja*) in Melipilla city are used when high level treatment is needed or in case of emergency.

As a communication facilities, coin type public telephone of CTC which utilize cellular telephone networks is arranged in each community and it is possible to contact with outside by dialing. As telephone companies, NTEL and CTC provide various telecommunication services in Melipilla city.

2.1.8 Environment

(1) Designated area such as natural parks

There is no designated area in Mallarauco.

(2) Present condition of water contamination

Mallarauco area is irrigated by Canal Mallarauco taking water mainly from the Mapocho river. The table below shows the results of the water quality analysis in Mallarauco.

Date		22/7	11/8	8/12	11/12	Chilian standard	Chilian standard	Standard for growing	EMOS
Item	Unit	St.20	St.20	St.20	C11	for Irrigation	for Recreation	specified Vegetables	
Temperature	℃	11.0	12.8	23.4	21.5				
pH	-	7.4	7.1	7.7	7.4	5.5-9.0	6.5-8.3		
BOD	mg/l	96.0	59.0	38.0	110.0				
No. of Coliform Group	MPN/100ml	9.2E+06	1.1E+08	1.7E+05	9.2E+08				
No. of Fecal Coliform Group	MPN/100ml	1.7E+06	2.4E+07	3.5E+03	1.1E+07		1000	1000	1000
Cu^{2+}	mg/l	0.003	0.044	0.020	0.069	0.20			
$SO4^{2-}$	mg/l	405.0	381.0	324.0	326.0	250.00			
Cl^-	mg/l	257.0	275.1	204.4	224.2	200			

St.20:the Mapocho river at Canal Mallarauco C11:Canal Mallarauco(at outlet of tunnel)

The analyses were made three times at the intake point on Canal Mallarauco of the Mapocho river and once on the outlet point of the tunnel of Canal Mallarauco. Compared to the standard value shown in the table above, both points in all seasons meet the standard requirement of water for agricultural use as to pH and Cu^{2+}, while both points in all seasons exceed the standard as to $SO4^{2-}$ and Cl^-. Concerning fecal coliform, both points in all seasons exceed the standard value of water for recreation use and water for growing the specified vegetables. The analysis of well water in Mallarauco is shown in the table below.

Date		22/7	12/8	9/12	Chilian standard	Chilian standard	Standard forgrowing
Item	Unit	#6	#6	#6	for Drinking	for Irrigation	specified Vegetables
Temperature	℃	16.0	14.3	23.2			
pH	-	6.7	7.2	7.2		5.5-9.0	
BOD	mg/l	<10.0	<10.0	14.0			
No. of Coliform Group	MPN/100ml	7.9E+01	1.7E+01	2.4E+02			
No. of Fecal Coliform Group	MPN/100ml	1.1E+01	2.0E+00	4.9E+01			1000
Cu^{2+}	mg/l	0.003	0.002	0.002	1.0	0.20	
$SO4^{2-}$	mg/l	127.0	176.0	147.0	250	250.00	
Cl^-	mg/l	119.0	137.6	121.4	250	200	

#6:Well Bollenar (Hosteria Las Lilas II)

The analyses were made three times at the main well in Bollenar. Compared to the standard value shown in the table above, three analyses meet the standard requirement of drinking water as to Mg^{2+}, Cu^{2+}, $SO4^{2-}$, and Cl^-, and meet the standard of water for agricultural use as to pH, Cu^{2+}, $SO4^{2-}$, and Cl^-. Further, concerning fecal coliform, these analyses meet the standard value of water for growing the specified vegetables.

The table below shows the water analysis made in March 1995 on the Pervin Bridge on the Mapocho river and the Corta Bridge on the same downstream river.

Date		1/3	3/3	3/3	7/3
Item	Unit	P.Pervin	P.Pervin	P.Corta	P.Corta
pH	-	7.10	7.30	7.21	7.25
SS	mg/l	16	20	9	12
BOD5	mg/l	18	12	8	7.4
Total coliforms	MNP/100ml	4.9E+06	3.5E+06	1.1E+06	5.4E+05
Fecal coliforms	MNP/100ml	4.9E+05	3.9E+05	1.1E+05	1.7E+05
T-N (Kjeldahl)	mg/l	7.3	11.2	5.5	5.4
NH4-N	mg/l	5.4	6	3.3	4.3
Nitrate	mg/l	0.05	0.08	0.09	<0.02

Source: Asociación de Canalistas Mallarauco (Programa de Monitoreo de Calidad de aguas sistema río Maipo. Campaña monitoreo inicial) (CONAMA-CADE IDEPE)

The conclusion is that the contaminated water of the Mapocho river (including a part of Canal Esperanza Alto) is supplied in Mallarauco as irrigation water by way of Canal Mallarauco. Water contamination in the area including Mallarauco is a serious problem.

2.1.9 Problems and Development Approach

Present problems on agriculture is confirmed in the Master Plan of "Agricultural Development and Water Management in Metropolitan Area, Chile." They are involved in agricultural sector and are disparity caused by landholding scale regarded as a problem on the agricultural production structure, tightness and competition of water use as an agricultural condition, contamination of agricultural water, and decrease of farmland.

Mallarauco area is selected as the F/S area according to the standard that agricultural promotion from inside of the sector as the countermeasures to solve these problems, effective use of resources as an improving condition for its support, treatment of contaminated water and improvement of the existing irrigation facilities in accordance with contents of environmental conservation plans.

Following points can be listed by reviewing the present situation, according to the background of Mallarauco area.

- Contamination of irrigation water

  Using contaminated water limits kinds of cultivation crops under the regulation of vegetable cultivation and gives negative impact on farmers' health and sanitation. The reasons why water quality is not improved by farmers' side are that original cause of contamination is urban inhabitants, cost of improvement is high, and there are some crops which contaminated water use does not directly effect on farming income.

- Superannuation of irrigation facilities

  Existing irrigation system has been superannuated. Particularly, the main canals which run mountainsides have problems such as collapse with canals. Thus, cost of O & M has increased. In the terminal part of irrigation area, shortage of water is caused by leakage during dry season. There is about 7,000ha irrigated farmland, and cost of improvement should be paid by the beneficiaries. Thus, rehabilitation of the entire system is difficult.

- Unstable management bases of small scale farmers

  In case of small scale farmers in Mallarauco area, they can use irrigation water and farming technology reaches a certain level except a problem of landholding scale. The change of small scale farmers' cultivation crops in the past were melons, vegetables, dairy products and fruits in turn. It is recognized that the reasons of the change were disease and insect pest, contaminated irrigation water, decline of milk price and uneconomic farming scale. On the contrary, it can be said that the change is accumulation of experience of various crop cultivation or actual results of bearing difficulties on management. The problems of small scale farmers in Mallarauco area are different from hardware problems that are the problems of the small scale farmers who do not have farming infrastructure, but software problems that relates to farm management.

Based on the present problems in Mallarauco area, the measurements to solve these problems and to enjoy its advantage as a food supply base near the metropolitan area are recognized that improvement of production and living environment by improving quality of irrigation water, decrease of O & M cost and alleviation of water shortage at the terminal point of the irrigation system by rehabilitation of the existing irrigation facilities. Crop diversification which is resulted from water quality improvement brings about stabilization of farming base by more intensive agriculture and at the same time, the quality improvement of water contributes largely to maintaining favorable health and sanitary condition of farmers.

2.2 Agricultural Development Plan in Mallarauco Area

2.2.1 Basic Concept of Development

(1) General

The Master Plan on "Agricultural Development and Water Management in Metropolitan Area" targeted on the year 2010 was established with the frames of effective use of land and water, environmental conservation and agricultural promotion as countermeasures to solve the problems (disparity caused by landholding scale, decrease of farmland, contamination of irrigation water and tightness of water use) on agriculture in the Metropolitan area. Based on the Master Plan, Mallarauco area was selected as the priority area for carrying out the Feasibility Study where water quality improvement and rehabilitation of the existing irrigation facilities are to be undertaken.

Mallarauco area was formed by the Higuera river which is a branch of the Puangue river and flows in Melipilla Province. Irrigation water in the area is taken from the Mapocho river after the Zanjon de la Aguada canal, which sewage of Santiago city is concentrated in the Talagante province, joined the Mapocho river. The water reaches the top of the Higuera river after passing through Co. Los Erizos by tunnel canal. Afterward, it is conveyed by the three main canals in the right, left and central banks of the Higuera river to be used in approximately 7,000ha of farmland.

Contamination level of irrigation water taken from the Mapocho river shows extremely high, over 10^5MPN/100ml of coliform groups. However, water of the Mapocho river contaminated by urban wastes must be used continuously as irrigation water under the present situation of Mallarauco area where is no alternative water sources in and out of the area. Farming in the area is mainly cultivation of crops whose harvested products are not affected by contaminated water use. Main crops are perennial crops such as fruit trees in the upstream basin, and annual crops such as cereals, pasture and livestock in the middle and downstream basins. Recently, fruit growing on hillside of mountains has increased.

(2) Development approach

Contamination of water quality is to be reduced by step-by-step improvement of sewage treatment plants of EMOS, gradually. Nevertheless, it will take about 25 years until good irrigation water can be taken from the rivers by completing the plants. Positive measures for water quality improvement from agricultural section are required to establish sound agricultural production environment and recover the function as the base of perishable food supply which utilizes the characteristics of suburban agricultural area. These measures will also contribute to establishment of agricultural production environment which satisfies the demand of markets and achievement of sound health and sanitary environment for farmers who engage in agricultural production.

On the other hand, irrigation facilities in Mallarauco are well managed by canal associations, however the majority of facilities was constructed in 1800s. They have been repaired, repeatedly and used until now. The decrepit facilities has increased the maintenance cost and work. It is time to rehabilitate the entire irrigation system.

The plan for water quality improvement and rehabilitation of the existing irrigation facilities intends to have applicable contents to the other areas as a model project on improvement of deteriorated agriculture environment which metropolitan agriculture is facing at present.

On water quality improvement, either center type or block type is selected as the sewage treatment method according to sewage treatment capacity and capability. In case of Mallarauco, a block type treatment system is selected because a certain level of water quality is to be secured by operating EMOS's treatment facilities in the future, and large scale and high cost facilities are not favorable for model project. Treatment method is planned for each project area based on the conventional activated sludge method, considering treatment capacity and capability. The volume of sewage treatment corresponds to the amount of water determined by water right (Acción) in each area. On the canals in each project area, the existing canals are to be rehabilitated and used principally.

(3) Improvement area of irrigation water quality

Improvement area of irrigation water quality that F/S is to be implemented is selected according to the following standards which focus on appearing improvement effect, considering characteristics of water quality improvement project as a model.

1) Areas are independent on their irrigation and drainage systems
2) Easy diversification of crops by water quality improvement
3) Large number of beneficiaries including small scale farmers

From the point 1), proposed sites of water quality improvement areas are Pervin irrigation area where farmland extends from an intake point up to a tunnel, parts of Sur, Norte, Santa Ana and Higuerillas irrigation areas where irrigation areas extend on the place where canals pass through small valley and farm ditch, and Reforma irrigation area where surrounded by streams (Estero). Perennial crop cultivation such as fruits trees is mainly in the upstream Sur and Norte. From the point 2), irrigation areas which extend in the lower basin than middle basin can be selected. From the point 3), El Quillay irrigation area in the upstream Norte irrigation area, Los Carrera in Sur irrigation area, Reforma irrigation area and Santa Ana irrigation area can be proposed.

Five areas are selected according to criteria that areas are independent on their irrigation and drainage systems among the proposed water quality improvement areas mentioned above. Major indicators relevant to agriculture in each area are as follow.

Area	Irrigation Area	Area (ha)	No. of Farm household				Crop
			Large Scale	Medium Scale	Small Scale	Total	
Pervin	Pervin	676	4	5	26	35	Annual
El Quillay	Norte	248	-	-	18	18	Perennial
Los Carrera	Sur	196	-	-	24	24	Annual
Reforma	Reforma	716	-	17	53	70	Annual
Santa Ana	Mansano	531	3	10	25	38	Annual

Pervin and El Quillay areas are excluded from F/S areas because Pervin area is mostly occupied by farmland of large scale farmers, and in El Quillay area, although there are many small scale farmers, main cultivation crop is fruit tree at present. Accordingly, F/S on agricultural water improvement project in Mallarauco canal system is to be undertaken in Las Carrea, Reforma, and Santa Ana.

2.2.2 Agricultural Production Plan

(1) Cropping system

From agricultural view point, main purpose of water quality improvement plan in Mallarauco area is that producers, especially small scale producers can gain higher income from their farming through making intensive cropping system and crop diversification possible. The second important point in the plan is influence derived from the construction of sewage treatment plants. That is to say, as a result of sewage treatment plants' construction, introduction of technical irrigation systems such as drip irrigation and sprinkler irrigation can realize because water distribution is made by pressure conveyance method using pump facilities.

Crop diversification, in reality, boosts vegetable cultivation of prohibited kinds by using contaminated water mainly from the Mapocho river. Introduction of mechanized irrigation system is predominantly reflected in increase of orchards. This result enables small scale farmers to introduce high level intensive cultivation and highly profitable crops (vegetables which are prohibited to grow at present) as well as medium and large scale producers.

Considering distribution of water improvement areas and the purpose of the plan, expected effects of the plan must be important for small scale farmers, and proposed crop cultivation mainly focuses on expansion and diversification of vegetable cultivation. This is because vegetable would be the most profitable crop for small scale producers if water quality improvement is possible. Fruit tree growing requires capital and production scale which small scale farmers cannot afford. Actual prices of milk products cannot make high profit under management scale and technical level of small scale farmers. Based on the consideration above, a proposed cropping system for small scale farmers is shown in the table below.

Crop	Cereal	Traditional	Vegetable					Forage	Fruits Tree				Pasture & Others	Total
	Wheat	Potato	Swiss chard	Onion	Cabbage Melon	Broccoli Cauliflower	Total	Alfalfa	Avocado	Lemon	Total	Subtotal		
Small Scale Farmer (ha)	0.5	0.5	1	1	1	1	4 (6)	2	0.2	0.2	0.4	7.4	2.0	9.4 (11.4)
%	5.3 (4.6)	5.3 (4.4)	10.6	10.6	10.6	10.6	42.4 (52.6)	21.2 (17.5)	2.2	2.2	4.3 (3.5)	78.6	21.4	100

In case of two vegetable cultivation, for example, combinations of cabbage and melon, broccoli and cauliflower, double cropping is possible. This has same meanings with that new farmland area for one cropping is added to the present farmland. If there is this additional effect, it is shown in ( ) in the table above. In the present cropping system of small scale farmers, the ratio of vegetable cultivation increases from 8.6 % at present to 52.6 %. Potato is usually classified as *Chacra* or "the traditional crop," however in areas such as Mallarauco, it is an intensive cultivation crop as well as vegetable. Water quality improvement is required to reach this intensive level. Among proposed vegetables, three of them, Swiss chard, cabbage and cauliflower, are prohibited to cultivate under the present situation but have high marketability. The other three vegetables and potato are indirectly affected by water quality. On vegetable selection for Reforma area, there is a constraint against vegetable cultivation that drainage is relatively poor, compared with the other areas. Alfalfa is important in the meaning of that it can be included in land rotation and is a rational and highly profitable crop. Cereal crops which are represented in wheat is also important crop for completing the crop rotation and self-consumption for small scale farmers. In case of small scale farmers, fruit growing has an effect mainly as a kitchen orchard. For average small scale farmers, the area of pasture and the other relatively low profitable crops is to be reduced in the plan.

In case of average medium and large scale farmers in irrigation areas, orchards are given priority on water use, considering advantage of improved water quality. The proposed cropping system for medium and large scale farmers is described in the table below.

Crop	Cereal	Vegetable	Fruits tree			Seed production	Sub total	Pasture & Other	Total
	Maize	Melon	Avocado	Lemon	Total				
Large/ Medium Scale Farmers (ha)	2.0	3.0	9.0	7.0	16.0	2.3	23.3	2.0	25.3
%	7.9	11.9	35.5	27.7	63.2	9.0	92.1	7.9	100

Fruit growing in the cropping system is planned to occupy 63.2% of total farmland. In detail, avocado and lemon occupy 35.5% and 27.7%, respectively. Melon is cultivated in 3ha, and seed production occupies 2.3ha. On seed production, F1 hybrid vegetable seed which can be expected high profit is planned. Pasture and other relatively low profitable crops are planned to reduce from 20% to less than 8%.

(2) Farm income

Farm income on the proposed cultivation crops for average small, medium and large scale farmers is shown in the table below.

Small Scale Farmers

Crop	Farmland Area (ha)	Farm Income ($ 000)
Wheat	0.5	150
Potato	0.5	400
Swiss Chard	1.0	1,300
Onion	1.0	2,000
Cabbage-Melon	1.0	1,200
Broccoli-Cauliflower	1.0	1,500
Alfalfa	2.0	1,000
Avocado	0.2	200
Lemon	0.2	160
Forage	2.0	200
Total	9.4	9,710

Large/Medium Scale Farmers

Crop	Farmland Area (ha)	Farm Income ($ 000)
Maize	2.0	1,000
Melon	3.0	5,100
Avocado	9.0	11,700
Lemon	7.0	7,000
Seed production	2.3	4.600
Forage	2.0	200
Total	25.3	29.600

2.2.3 Agricultural Supporting Plan

In order to promote socio-economic self-independence of the area, establishment of organizations of farmers, who are beneficiaries, is indispensable. The base for regional agricultural development is established by realizing diversification of agricultural production through improvement of water quality for irrigation. Establishment of beneficiaries'organization is indispensable as a nucleus body to promote the materialization of project in the objective area and to use improved irrigation water effective and accelerative. For this, the consensus on improving the present situation should be achieved by inhabitant's participation.

Based on the consensus for improvement, following two organizations are required to be established as principal nucleus body of beneficiaries; 1) an organization for facilities on water quality improvement and 2) an organization for effective use of facilities (promotion of agricultural development by INDAP services and so on) A flow of the project promotion system is summarized as the figure below.

consensus of beneficiaries on the project

In the procedure on setting of mutual consensus among the beneficiaries, the most important part is the first part, "motivating." Because this part has been lacking in the agricultural support plan so far, sufficient consensus has not been formed and the plan has broken down.

The agricultural support plan in the project strengthens this part stated above. OMPC is regarded as the go-between organization between beneficiaries and the project plan. Based on the cooperation of external supporters (INIA, universities, private consultants and so on) employed by OMPC, the workshop for "motivating" will be held through JJVV and UV.

After 2) of the procedure on setting of mutual consensus is mainly carried out by beneficiaries and external support agencies concerned. Consulting fee is supported by OMPC and the beneficiaries will pay about 10% of it. The burden of the beneficiaries is clarified at the stage of "Motivating."

Based on the procedure of setting of mutual consensus mentioned above, two types of organization are to be established. One is for facilities on water quality improvement and another is for effective use of facilities.

(2) Organization for facilities on water quality improvement

In Mallarauco area, because whole irrigated area is managed by *Asc. Canalista Mallarauco*, it does not need to form new organization to promote the project. This canal association is utilized as the organization to promote the project. Nevertheless, as for operation and maintenance of facilities on water quality improvement, an independent section in the existing organization structure of canal association is established for smooth operation of facilities.

Concerned Project	Organization	Promotion Body
Water Quality Improvement for Irrigation	Section of O & M of Facility	Mallarauco Canal association

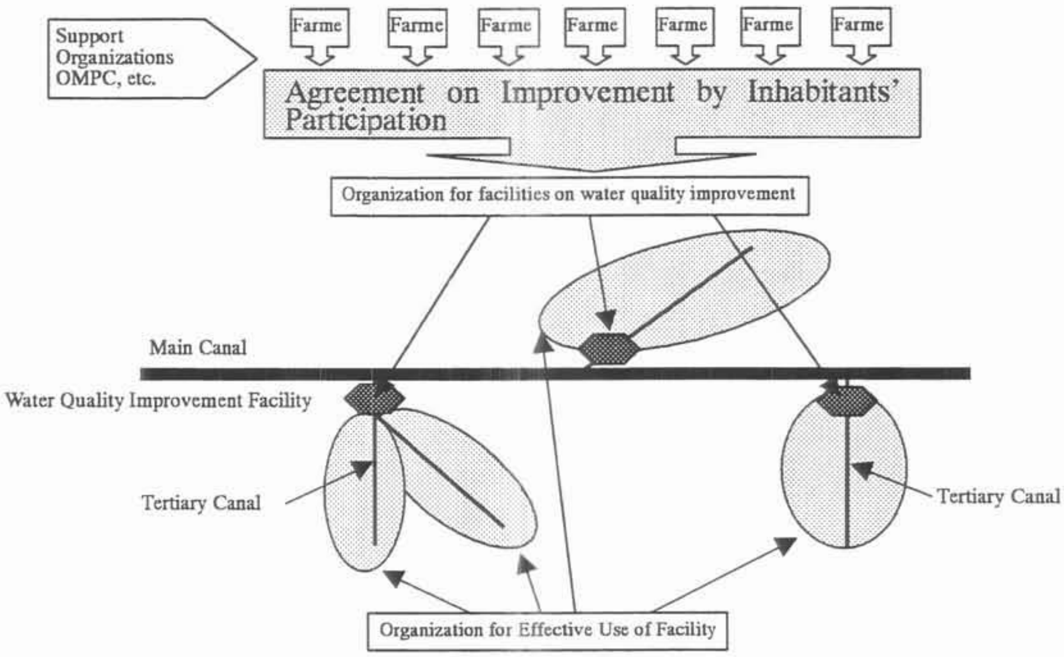
(3) Organization for effective use of facilities

Service system provided by the INDAP will be applied for technical and financial support services to the producers' groups for improvement of farming and for utilization of improved irrigation water at the field level. Various producers' groups are expected to be organized due to diversification of cultivation crops by water quality improvement. An advisor is to be employed through OMPC's arrangement for organizing producer's groups.

To accelerate the project implementation of INDAP, SAL, SAP or SAE is to be applied for elevation of function on production cooperatives.

Existing producers' groups and newly organized groups are as follow.

Groups	Name of Group
Existing Producers' Groups	Citrus Group Milk Collecting Organization
New Producers' Groups	Water Users' Association Grapevine Group Horticulture Group Avocado Group Cereals Group Multiple Production Group Rural Women Production Group



(1) Setting of mutual consensus

The beneficiaries of the project in the study area are mostly small scale farmers according to the structure of regional society. Participation of inhabitants as democratic procedure is indispensable at every stage of the project because the contents of the project directly connect with the interest of objective farmers. Participation of farmers is to be implemented in accordance with the purpose of each stage by following activities such as a conference with experts (INIA, universities, private consultants and so on), discussion among representatives of farmers, and a workshop among farmers and experts. Participation of formers in these activities leads to deepening farmers' understanding against the project and promoting the establishment of identity as the regional inhabitants. Moreover, this also creates derived effects such as growing regional leaders and providing accurate information for farmers.

In case of Mallarauco, improvement of the present situation will be accomplished through securing the sound irrigation water in quality and the release from the regulation of vegetable cultivation. Therefore, construction of facilities on water quality improvement and rehabilitation of irrigation facilities are set up as the principle projects. Accordingly, consensus on the project implementation of farmers are indispensable to promote these projects. The process on setting of mutual consensus is proceeded as follows;

1) Motivating: regarded the necessity of the project, the implementation system of the project, right and duty of beneficiaries based on the present situation
2) Problem finding: finding the problems to be changed, setting the purpose of the project, and then clarifying the subjects to be struggled for solving the problems
3) Analysis of the plan: analysis and appraisal of the project including alternatives to solve the problem or achieve the purpose
4) Determination of the plan: based on the comparative analysis of the alternatives, corresponding with the projects which are other projects such as water use plan at the terminal system, water management plan, and farming plan, determining the final plan, and then, setting of mutual

(4) Installation of base facility for agricultural support

Many of *UV* in Mallarauco area do not have base facilities for meeting and training. Thus, it is impossible to communicate smoothly among inhabitants, and this leads to difficult environment for establishment of fundamental organizations aiming at improvement of present agricultural situation. Thus, it is indispensable to construct the base facilities for vitalization of *UV* activities and smooth communication among regional inhabitants. This base facility is named as Communication Center for *Unidad Vecinal* (CECUV) and is constructed in each *UV*. Based on these facilities, beside promoting the activities for unity by small scale farmers, promotion of regional self-government, improvement of living environment, training and lectures on living and producing skills, and training of rural women for self-independence will be taken place. Through these activities, self-independence of *UV* will be promoted.

Functions of CECUV are promotion of communication, of support activities for farmers, and of self-independence of rural farmers. They are as follows;

- Promotion of regional communication
  1) Improvement of rural living environment
  2) Activation of communication among regional inhabitant
  3) Operate and maintenance of regional social infrastructure
  4) Participation of inhabitants in the plan for living environment improvement
  5) Providing the place for medical and health service
  6) Promotion of cultural activities for regional inhabitants and young generation
  7) Cooperation with OMPC

- Promotion of support activities for farmers
  1) Extension and enlightenment about agricultural and livestock farming's technology
  2) Extension and enlightenment about irrigation technology
  3) Promotion of uniting activities by small scale producers
  4) Providing the place for a training course of farming improvement
  5) Enlightenment about self-independence and promotion of rural women
  6) Providing an office for a producers' organization
  7) Interchange with producers' organizations in the other areas and exchange of information

Among agricultural support activities, promotion of uniting, enlightenment and technical guidance of agricultural support activities are undertaken by advisors organized by SECPLAC through cooperation with external support organizations (INIA, universities, private consultants and NGOs). These advisors make their rounds and give guidance in each CECUV, *Communa*. The contents of uniting promotion, enlightenment and technical guidance provided by SECPLAC are summarized as follow.

Agricultural Production	Economic Activity and Management	Living Improvement
- Guidance for organization	- Guidance of farm management	- Guidance & training on house works
- Guidance of cropping season	- Guidance of income generation	- Guidance of health control
- Guidance on problem of crops	- Guidance of group activity	- Guidance of group activity
- Guidance of irrigation	- Guidance on example of advanced area	
- Guidance of fertilization	- Guidance of business and finance	
- Guidance of marketing	- Guidance of merchandize	

Facilities of CECUV are planned as the table below.

Facility	Size (m^2)
Training room	48.6
Meeting Room	48.6
Administration office	12.2
Producers' Organization Office	72.9
Storage	12.2
Toilet	12.2
Total	206.7

Because Bollenar and Mallarauco *UV* in Mallarauco area have already had the Resident Center, agricultural support and living improvement are to be facilitated by using this center. Therefore, CECUVs which should be newly constructed are as follows.

UV	Population	Household	CECUV
Bollenar	689	2,790	-
Mallarauquito	250	986	1
Pahuilma	480	1,871	1
Mallarauco	688	2,498	-

2.2.4 Agricultural Infrastructure Development

(1) Proposed areas

Three areas, Los Carrera, Reforma and Santa Ana, are selected as the agriculture promotion areas by water quality improvement, and the improvement of existing irrigation facilities is also planned bringing about water quality improvement in the areas. Irrigation area, duty of water and irrigation methods of the proposed areas are as follow.

Area	Irrigation Area (ha)	Water-Right		Irrigation Method
		No. of *Acción*	Water requirement (l/sec)	
Los Carrera	135.2	15.6488	125.19	Furrow
Reforma	488.5	67.932	543.46	Furrow
Santa Ana	418.7	53.7163	429.73	Furrow
Total	1,042.5	137.2971	1,098.38	

Note: Irrigation Area is measured from 1/10,000, Water requirement is based on 8 l/sec/Right

Reforma area takes water by dam-up the Higuerillas canal, which is the drain of Mallarauco irrigation area and distributed irrigation water to three canals, Norte, Centro and Sur. Among these, a confluent section of the Sur canal is not included in the proposed area for water quality improvement because it joins with the other water system in the downstream reach. Irrigation area by canal system and number of water right (*Acción*) of the Reforma area are as follows, and their locations are shown in Figure 2.2.1.

Area		Irrigation Area	Water-Right	
		(ha)	No. of *Acción*	Water requirement (l/sec)
Reforma	Reforma Norte	172.8	24,816	198.53
	Reforma Centro	246.1	33,016	264.13
	Reforma Sur	69.8	10,010	80.80
Total		488.7		543.46

(2) Sites of water quality improvement facilities

Water treatment plants are basically to be constructed around the present intake facilities. Because the canals in Los Carrera and Santa Ana are located in higher elevation than the proposed irrigation area, the plant sites are selected according to the plan of treated water distribution by gravity method. In both Reforma and Santa Ana areas, because the canals are located in the lower elevation and irrigation areas are flat land, treated water needs to be conveyed to the existing canals by pumping up. The sites of water treatment plants in each area are planned as follow.

Area	Location		Planned Plant	Summary of Site
	Longitude (W)	Latitude (S)	Size (ha)	
Los Carrera	30° 52′ 00″	62° 79′ 50″	4.00	Right bank of Sur canal, High location in East of the area
Reforma	30° 26′ 00″	62° 83′ 40″	7.00	Reforma diversion, Right bank of Higuerillas canal
Santa Ana	30° 24′ 00″	62° 85′ 00″	7.00	Upstream of the target area, Left bank of Santa Ana canal

Geologically, treated water can be distribute by gravity method since the proposed site of treatment plant in Los Carrera area is located in the higher position of the irrigation area. Because treated water of Reforma and Santa Ana have the lower discharge level than the existing canals, it needs to be pumped up for irrigation use.

(3) Irrigation facility improvement

1) Treatment capacity and duty of water

Treatment capacity of the water treatment plant is determined by treatment capability. Thus, the treatment capacity is set by the discharge of water right mentioned above. Up to the degree of load on inflow discharge, it is adjustable to a certain level of discharge change by selecting number of treatment tanks.

Unit water requirement is calculated in accordance with the cropping pattern by farming scale proposed in the production plan of Mallarauco area. Preconditions of calculation are as follows;

Effective rainfall : estimated by SCS method using rainfall on 85% exceedance probability
Irrigation efficiency : field level; furrow irrigation 50 %, california type 60%, drip irrigation 90 %, canal level 80 %

According to the conditions mentioned above, the summary of unit water requirement by farm sizes at the intake point is as follows. Details are shown in Table 2.2.1

Type	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
9 ha	mm	107.69	79.06	52.10	32.60	3.41	0.02	0.00	25.30	91.88	170.57	208.08	192.10	962.80
50 ha	mm	136.30	98.61	70.70	45.89	4.11	0.00	0.00	21.02	75.85	142.37	171.24	165.17	931.27

2) Intake facilities and other related facilities

Intake facilities of the existing main canals are planned to be rehabilitated in connection with the construction of water treatment plants. The works include increase of intake capability. The detailed plan of major facilities is as follows.

Irrigation Area	Intake facilities Improvement		Pump Facility		
	Intake water volume (m^3/sec)	Diversion Gate Height x Width (m)	Pump Head (m)	Dia. of Pump (mm)	No. of Pump (unit)
Los Carrera	0.125	0.8 x 1.0	-	-	-
Reforma	0.543	1.2 x 1.5	7.0	300	2
Santa Ana	0.430	1.2 x 1.5	7.0	300	2
Total	1.098				4

Treated water at the water treatment plant is distributed through a regulation pond of canals for adjustment the time of treatment and irrigation. The capacity of a regulation pond is determined at 6 hours considering management of plant operation and irrigation.

Irrigation Area	Treatment Capacity (l/sec)	Pond Size Reservation Capacity (m^3)	Area (m^2)	Depth (m)
Los Carrera	0.125	3,000	1,000	3.0
Reforma	0.543	12,000	4,000	3.0
Santa Ana	0.430	10,000	3,500	3.0
Total	1.098	25,000	11,500	

3) Canal plan

Treated water can be conveyed to the field through existing canals. However, because the existing canals are earth canals, the main canal to the field is planned to be rehabilitated by a pipeline in order to reduce conveyance losses and to simplify the O & M of canals. The duty of irrigation water and the length of proposed pipeline in each irrigation area are summarized below.

Irrigation Area	Pipeline Extension by discharge (km) 0.05–0.1 (l/sec)	0.1–0.2 (l/sec)	0.2–0.3 (l/sec)	0.3–0.5 (l/sec)
Los Carrera	9.65	1.01	-	-
Reforma	11.05	3.65	2.15	0.96
Santa Ana	5.35	3.70	2.14	4.16
Total	26.37	8.36	4.29	5.06

The diameters of pipe are planned under the condition of $1.0 kg/cm^2$ of water head at the diversion points, considering conveyance losses to the irrigation areas. The required diameters of pipe are shown in the table below.

Irrigation Area	Pipe Diameter by Flow Scales (mm) 0.05–0.1 (l/sec)	0.1–0.2 (l/sec)	0.2–0.3 (l/sec)	0.3–0.5 (l/sec)
Los Carrera	ø150	ø250	-	-
Reforma	ø150	ø250	ø400	ø700
Santa Ana	ø150	ø250	ø400	ø600

4) Rehabilitation of existing irrigation facilities

Among the proposed areas for water quality improvement, the intake weir of Reforma area is required to be rehabilitated. Irrigation water for Reforma area is taken by dammed up the Higuerillas drain (the natural river). The weir of Reforma is planned to rehabilitate.

- Flood discharge of the Higuerillas river
  The Higuerillas river runs in the low flat plain of Mallarauco area, and rainwater in the basin flows into the Higuerillas river. Flood discharge at the weir site is estimated at $142 m^3/sec$ with 2% probability of exceedance.

- Structural design of the weir
  The Higuerillas river flowing in the low flat land is usually dammed up by wooden fixed gates, but when the flood is occurred, the gate is removed for release of excess water. The wooden gates is planned to be changed to the steel sluice gate in order to simplify O & M. The size of gate width (closing width), gate height and intake gate width is shown in the table below.

	Discharge (m^3/sec)	Gate Width (m)	Gate Height (m)	No. of Gate	Gate Structure
Higuerillas-Main: Gate-1	81.0	2.5	2.8	2	Steel Gate
Higuerillas-Main: Gate-2	67.5	3.0	2.6	1	Steel Gate
Intake Gate	0.55	1.0	1.5	1	Steel Gate
Intake Gate	0.30	0.6	1.0	1	Steel Gate

5) Plan for field irrigation

Treated water is to be conveyed by pipelines considering the high cost of treated water. Changing canal structure to pipeline is important because it can prevent inflows of contaminated water into canals at flood time. Drip and micro-sprinkler can be used in the field since 1.0 kg/m^2 of water head can be obtained from tap of the pipeline.

Agricultural infrastructure development plan is shown in Figure 2.2.1.

2.2.5 Rural Infrastructure Development Plan

In the rural infrastructure development plan is promoted through promoting regional agriculture and increasing comfort and safety of inhabitants in the area from the point of settlement. Accordingly, the parts of rural infrastructure where are not well proceeded will be mainly improved based on the analysis of present situation.

On road improvement, plan is put stress on the establishment of road networks in the area. Trunk roads are to be paved up to the center of each community. On lateral roads, new connection roads between lateral roads are to be constructed and improvement level is targeted for vehicle traffics. Community sewage treatment facilities are to be constructed mainly in the center of each *UV* for living and production environment conservation. As for the treatment facilities, high operation technique and special chemical treatment should be avoided because O & M of treatment facilities are to be handled by community members. Treated water is to be able to reuse for agriculture. The target of treatment level is less than 30 mg/lit. on BOD and less than 1,000 MPN on coliform groups.

CECUV is established for technical support on agriculture in the area, and providing the place for fostering agricultural successors, meeting of inhabitants, various subjects of lectures and rural women's activities and so on. Obtaining the space of each producers' group for technical support in the center expects to result in effective support services and technology transfer.

Based on the survey of the present situation and the improvement plan of irrigation facility, required items and quantity for improvement of rural living environmental are shown in the table below. General plan of rural infrastructure improvement is shown in Fig. 2.2.2.

Improvement Item		Mallrauco Area		
Road	Trunk road pavement	4 routes	L= 10.2 km	W= 6.0
	Lateral road improvement	1 route	L= 6.6 km	W= 5.0
	Construction of new lateral road	1 route	L= 9.4 km	W= 5.0
Rural sewage treatment facility		4 sites		
		Bollenar	2,790 persons	Ø150 L= 34 km
		Mallarauquito	986 persons	Ø150 L= 27 km
		Pahuilma	1,871 persons	Ø150 L= 35 km
		Mallarauco	2,498 persons	Ø150 L= 45 km
Community center (CECUV)		2 sites		
		210 m2 / site		
		Mallarauquito, Pahuilma		

2.2.6 Environmental Conservation Plan

(1) Water quality improvement plan

According to the construction plan of the sewage treatment plants in Santiago city by EMOS, three plants will be completed along the Mapocho river in 2024 and then the treated water of approximately 25 m^3/sec will be discharged into the Mapocho river. Consequently, water quality of the Maipo river joining the Mapocho river will be greatly improved. However, according to the predicted quality of water for irrigation in the priority project area in the target year of the project (2010), water quality of the Mapocho river will be more improved than the present, the BOD value predicted by EMOS will exceed 20mg/l in 2010 with the exception of the time at minimum discharge, despite the fact that a part of the construction of the EMOS treatment plants will be completed at that time.

The purpose of the water quality improvement project in Mallarauco is to improve the contaminated water for irrigation by means of the sewage treatment plants and to create the model area for agricultural development by improvement of the rural environment and diversification of crops. It is preferable to ameliorate water in the BOD and SS values, both of which are the index of water contamination, up to the lowest value as possible, and to discharge the water. The present project, however, the object values of BOD and SS are set as 20mg/l and 30mg/l respectively, both of which are the same as the planned values in the sewage treatment plant over the Metropolitan Region. The object group number of fecal coliform is set at 1000MPN/100ml as the domestic standard, though in this project, it is set at 23MPN/100ml which is the standard number for crops for export.

1) The sewage treatment plant

The supposed quality of water discharged into the treatment plant is set at 300mg/l of BOD and 300mg/l of SS. The planned quantity of water to be treated is supposed to the maximum volume of water rights in the proposed area. The treatment method is planned the conventional activated sludge method in the case where the quantity of water to be treated corresponds to 0.2m^3/sec or more, or the sequencing batch reactor process which is suitable for the middle- or small-sized plant in the case where water volume is less than 0.2m^3/sec. The disinfection method by chlorine or by ultraviolet rays is known as the method to disinfect coliform bacilli. In this project, adopted is the method by ultraviolet rays by which no chlorine is remained because the treated water is directly used for irrigation water. On the basis of the methods above, the sequence of sewage treatment and list of facilities are as follows:

<u>Flow of Treatment Process</u>

Conventional Activated Sludge Method:	Inflow- Sand Basin- Pump Well- Primary Settling Tank- Reaction Chamber- Final Settling Tank- Disinfection Chamber- Outflow
Sequencing Batch Reactor Process:	Inflow- Sand Basin- Pump Well- Batch Reactor - Disinfection Chamber- Outflow
Design inflow quality:	BOD 300 mg/l SS 300 mg/l (1.1E+07 MPN/100 ml of fecal coliforms)
Amount of sewage treated:	0.15 m^3/sec in Los Carrera (140 ha irrigated) 0.45 m^3/sec in Santa Ana (420 ha irrigated) 0.55 m^3/sec in Reforma (490 ha irrigated)
Design treated water:	BOD 20 mg/l SS 30 mg/l (23 MPN/100 ml of fecal coliforms)
Processing method:	Conventional activated sludge method in Santa Ana and Reforma Sequencing batch reactor process in Los Carrera
Disinfection method:	Method using ultraviolet rays
Site area	Los Carreras 1.5 ha Santa Ana 2.5 ha Reforma 5.0 ha

2) O & M of the plant

O & M of the sewage water plant is to be carried out by the Mallarauco canal association. Main works of O & M are as follows:

- Collecting screenings and transportation - Grit, sludge removal and transportation
- Water quality survey
- Maintenance of facilities including garden trees and weeding.

(2) Environmental management plan

1) Promotion of environmental education in a basin

After implementation of the project, facilities related to the project will be managed by the canal association. However, at the points where canals pass through communities, it may be considered that the canals will be damaged and irrigation water contaminated by wastes, domestic sewage, and stock-farming wastes.

UV, the smallest unit of the organization for administrative support in *Comuna*, has a role of promoting to obey the hygiene regulation, carrying out the activities for the environmental hygiene, promoting the environmental conservation, and keeping the balance of ecosystem. In this project, a campaign for enlightenment and public relations are planned on the-community-basis with respect to the environmental conservation to keep high quality of water. The promotion campaign of environmental education is also planned by recommending a member of the youth group of *UV* or other groups, and farmer's groups to have a qualification to be engaged in the environmental conservation.

2) Promotion of agriculture with environmental consideration

In order to prevent environmental pollution by agriculture due to expansion of fertilizer and pesticide use and to promote the sustainable farming, skill guidance and technology transfer to farmers concerning the reduction of fertilizer and pesticide use are executed by the public organizations such as INIA. These activities are carried out on the farmers' organizations formed to obtain the agricultural support services from INDAP.

(3) Environmental Impact Assessment (EIA)

EIA System in Chile, No. 35,731, established in April 1997 provides the projects to be assessed from the environmental view. The related items in the system to the EIA System selected as the priority project for development in Mallarauco is "in case of the sewage treatment plant construction."

Environmental assessment with regard to the EIA System is conducted by the Chile side when the implementation of this project is determined definitely as a project. In the process of the assessment, the environmental factors as to the conduction of the project are investigated and predicted based on the contents of the project including the alternative plan. The predicted results and designated goal for the environmental conservation are assessed, and then the goal is achieved by preparing the measures for the goal. If the goal is not achieved, the alternative plan is predicted and assessed instead, and the goal is achieved by making measures for the goal.

With respect to the environmental influence by the construction of the sewage plant, the following items are considered by the result of scooping as to the environmental factors to be the objects to be assessed.

Air pollution	: Generation of dust from vehicles during construction stage.
Contaminated water	: Water contamination of surrounding rivers and canals during construction stage.
Noise and Vibration	: Generation of noise and vibration from plants and pumping stations during construction and operation stage.
Offensive odor	: Generation of offensive odor by sewage treatment plant operation
Wastes	: Generation of construction wastes and generation of wastes, grit and sludge after construction.

As the evaluation standard, the influence of qualitative objects is set the minimum, while water quality and noise are set as follows:

Water quality	Turbidity 50-Silica, Color 100, Temperature 30℃, Transparency 1.2m, pH 6.5-8.3, Fecal Coliforms 1000MPN/100ml
Noise	45-55dB

2.2.7 Summary of Agricultural Development Plan in Mallarauco Area

Structural improvement in Mallarauco area relevant to the priority project proposed in the Master Plan of the Study is formed as following contents.

Project	Project component				
Water quality improvement project	Target area	Los Carrera	Reforma	Santa Ana	Total
	Treatment water volume (m^3/s)	0.13	0.54	0.43	1.10
	Treatment method	Sequencing batch reactor process	Conventional activated sludge method	Conventional activated sludge method	-
	Inflow quality	BOD 20 mg/l, SS 30 mg/l, 23 MPN/100ml of fecal coliforms			
	Facility area (ha)	2	6	6	14
Agricultural infrastructure development project	Irrigation area (ha)	135	488	418	1.043
	1. Improvement of irrigation canals (pipeline) (km)	10.98	17.75	15.35	44.02
	2. Improvement of intake facility (No..)	1	1	1	3
	3. Diversion facility (Nos.)	38	14	25	77
	4. Regulation pond (Nos.) (Volume m^3)	1 (3.000)	1 (12.000)	1 (10.000)	3 (25.000)
	5. Pump facility (unit)	-	Φ300 x 2	Φ300 x 2	Φ300 x 4
Rural infrastructure development project	1 Road				
	Pavement of main road (km)	4 routes 10.2			10.2
	Improvement of lateral road (km)	1 route 6.6			6.6
	Construction of lateral road (km)	1 route 9.4			9.4
	2 Rural sewage treatment facility (Nos.)	4			4
	3 Community center (Nos.)	2			2

General development plan in Mallarauco area is shown in Figure 2.2.3.

2.3 Project Cost

2.3.1 Basic Conditions of Cost Estimation

Project costs are estimated at the price level as of December 1998 based on the results of field survey regarding the costs of labor, construction materials and equipment. Basic conditions of cost estimation are as follows.

(1) Construction cost

Construction works is executed by the contractor with contract basis. Since contractor prepares construction materials and equipment, which are necessary to execute the works, costs of construction materials and equipment are estimated by depreciation cost. Referenced materials for construction costs are as follows.

- Cost of Corrales project which were executed by DOH (December/'98)
- Commodity price book published by ONDAC (December/'98)
- Prevailing costs in Chile is used on working ratio and depreciation cost of construction equipment, depreciation cost for temporary works.
- Cost for equipment of sewage treatment facilities is employed based on estimation results of manufacturers in Japan.

(2) Component of project cost and ratio applied for estimation

Component and ratio of indirect costs of the project against direct construction cost are assumed as follows.

- Project cost consists of preparation cost, direct construction cost, engineering and administration cost as well as physical contingency.
- Direct construction cost includes overhead and profits.
- Engineering and administration cost is assumed as 10% of direct construction cost.
- Each cost is divided into local and foreign currency portions. Labor costs and materials such as sand, aggregate, are assumed as local currency portion and others are foreign currency portion. Physical contingency is 10% of total costs from direct construction cost to engineering and administration costs.
- Price escalation is assumed as 5% of inflation index.
- Land acquisition and compensation costs are applied 600 to 1000 thousand pesos per ha based on kind of land.
- Operation and maintenance cost is estimated separately as the Operation and maintenance cost of canal association for water management.

2.3.2 Project cost

Project component consists of water quality improvement, rehabilitation of existing irrigation facilities, rural infrastructure improvement and installation of facilities for agricultural support. Entire project cost is estimated at 264 billion pesos as shown in the table below. Details of the construction cost is shown in Table 2.3.1. While, disbursement schedule of the project is shown in Table 2.3.2.

Unit: Thousand Pesos.

Component	F.C	L.C	Total
1. Preparation cost	590,845	360,008	950,853
2. Water quality improvement / Irrigation facility improvement cost			
Sewage treatment plant facilities	11,114,356	7,123,208	18,237,564
Irrigation facility improvement	692,540	276,956	969,496
3. Rural infrastructure and Agricultural support facility development cost	624,530	838,323	1,462,853
4. Land acquisition and compensation cost		15,442	15,442
5. Engineering and administration cost	861,169	1,416,907	2,278,047
6. O&M equipment cost	121,577	45,000	166,577
7. Physical contingency (10%)	1,391,470	1,007,279	2,398,743
8. Total	15,306,167	11,080,070	26,386,171

2.4 Implementation Schedule of the Project

2.4.1 Executive Agencies

Agricultural development project in Mallarauco area is defined as the project which farmers apply for. The project is executed within the government subsidy regulation system for irrigation project. Therefore, the executive agencies of the project are divided into two based on the project scale. Water quality improvement project is executed by DOH in accordance with Government ordinance No.1123 and the rehabilitation project of irrigation facilities is executed by CNR in accordance with Law No.18450. Regarding construction of sewage treatment plants, proposed standard of water quality and structure, and water quality examination after completing the construction works are managed and implemented under the guidance of CONAMA.

2.4.2 Burden of the Project Cost (Source of Funds)

Among these projects, in case of water quality improvement, maximum 70% of the project cost is paid by national government subsidy under Government ordinance No. 1123 and the rest of it is paid by beneficiaries. However, the burden of Santiago City, which is the cause of pollution and also the nation, should be examined. On the other hand, in case of rehabilitation project of existing irrigation facilities, maximum 75% of the project cost is paid by the national government subsidy under the Law No. 18450. Beneficiaries pay the rest of it.

2.4.3 Process of the Project Implementation

(1) Agreement on the project of beneficiaries

DOH examines the project implementation after *Consejo de Riego* approved the project. DOH carries out questionnaire survey on approval or disapproval of the project for expected beneficiaries, and then confirms if more than 50% of the benefiting farmland area agrees with the project (consensus on the repayment of the project cost). DOH usually explains and collects agreement sheets directly.

(2) Implementation schedule

DOH employs consultants to execute the detailed design (D/D) with cooperation of CONAMA after confirmation of beneficiaries' agreement on participation of the project. Then, DOH promotes the project from the contract by competitive bidding among contractors to commencement of construction works. In case of tertiary canals (terminal facilities), Mallarauco canal association employs a consultant company and submit the implementation program to CNR. After approval of the project, they procure fund and implement the project.

1) Works to be carried out by consultant

DOH will entrust topographic survey, geological survey, survey for structural design and the survey relevant to the construction planning for detailed design to a consultant company. The consultant company restudy and examine the general issues on the project implementation such as the project plan and sewage treatment plants, the detail design of canals, the cost estimation, the bidding, the contract documents, and quality control of the construction. The inspection of design and execution methods of sewage treatment plants is guided by CONAMA.

2) Preparation works

Preparation works consist of the topographical survey for the detailed design, the geological survey for regulation reservoirs, and acquisition of land for facilities.

Topographical survey
- Longitudinal section, cross section and plan of site for proposed sewage treatment facilities in Los Carrera, Reforma, and Santa Ana areas (Scale: 1/500)
- Longitudinal section, cross section and plan of proposed rehabilitation canal route in Los Carrera, Reforma, and Santa Ana areas (Scale: 1/1,000)

Geological survey
- Geological survey of site for proposed sewage treatment facilities
- Drilling at 2 places of each proposed plant site
- Drilling at 3 proposed regulation reservoirs (each depth is 30m, total 90 m) and soil analysis

Required facilities for the supervision of the project implementation are prepared by the consultant and the constructor before before commencement of construction works.

3) Land acquisition

The land for construction of the sewage treatment facilities, canals, regulation reservoirs and so on is acquired by the consultant through the procedure of land acquisition under the consignment of DOH. Estimated land area is as follows.

Components	Area of land acquisition (ha)
Sewage treatment facility	11.0 (3 places)
Canals	4.0
Los Carrera	1.2
Reforma	1.9
Santa Ana	1.6
Regulation reservoir	3.0 (3 places)
Total	18.0

(3) Construction planning

Implementation schedule of the project is planned to meet the effects of sewage treatment facility construction and canals rehabilitation at the same time.

Construction works of sewage treatment facility

In the plan, 3 sewage treatment facilities in Los Carrera, Reforma, and Santa Ana are constructed. Construction works of three sites are not executed at the same time. Construction works commence from Los Carrera whose treatment volume is small, and then Reforma and Santa

Ana. It is possible to construct the sewage treatment plants all the year round. Rehabilitation of canals is executed during winter season which requirement of irrigation is low.

- Civil works
  Civil works are treatment tank of the sewage treatment plant, headrace from canals, and buildings. Main civil works are foundation excavation and concrete placing. No specified problems can be considered for execution of the works. Required equipment are mainly backhoe for foundation excavation, dump truck for conveyance of sediment, batching plant and truck crane for concrete placing.

- Installation of the sewage treatment plant
  As most of materials and equipment for the sewage treatment plant is foreign made, therefore, training of equipment method, operation of equipment, and operation technique should be considered.

Canal works

The pipes are set up on a flank wall of canals at the parts where canals are utilized at present and the existing canals which are remained as a drainage canal. Concrete placing for concrete structure such as diversion facilities and so on are executed by manpower directly from the agitating truck.

Regulation pond works

Regulation ponds are constructed next to the sewage treatment facilities. A dam body is constructed by concrete wall. Concrete placing is executed by concrete mixer and truck crane.

(4) Implementation schedule of the project

Commencement of the project is scheduled at 2003 taking into account arrangement of the funds, confirmation of beneficiaries' agreement on project participation, establishment of the O & M system of Mallarauco canal association. Total implementation period is 4 years up to 2006. In the period, project evaluation and preparation for budget by the government of Chile, the enhancement of management section in the canal association, farmers' agreement on the burden of the project cost, the detailed design and the construction works will be carried out. The implementation schedule of the project is shown in Table 2.4.1.

2.4.4 Operation and Maintenance Plan

(1) O & M of water improvement facilities

1) Items of O & M

Mallarauco canal association is carried out the O & M of the projected sewage treatment plants. Main works of O & M are as follows:

- Management of operation & maintenance of plants - Clerical work
- Collecting screenings and transportation - Grit, sludge removal and transportation
- Water quality survey – Maintenance of facilities including garden trees and weeding.

2) Personnel

The organization for O & M of the plants is divided into four sections, operation, maintenance, water quality and clerical work. Among them, one full-time staff who is in charge of operation and one full-time staff who is in charge of water quality are stationed at each facility. Regarding staffs being in charge of maintenance, and clerical work, two for each section are stationed and cover three plants in shift. Private companies are entrusted to dump waste and sludge. The contents of service are as follows:

Items of Management	Descriptions	Los Carrera (0.15m3/s) No. of persons	Mallarauco (0.45m3/s) No. of persons	Santa Ana (0.55m3/s) No. of persons	Total (No.of persons)
Operation	Inspection, monitoring, operation and recording work in water and sludge treatment facilities.	1	1	1	3
Maintenance	Repairing work and environmental control of machines, electric facilities and buildings.	1*	2*	2*	4
Water quality	Periodic analyses of sewage and sludge and instruction of change of operation of treatment processes.	1*	1*	1*	2
Clerical work	Budget, supply of materials, machine parts, vehicles, general affairs, etc.	1*	1*	1*	2

Note : Asterisk (*) means the persons who hold the position concurrently.

3) Management of sludge

The amount of sludge generated from three plants is estimated at 133 tons of sludge cake (the dry solid sludge about 26.7t/day) whose maximum water content rate is 80% per day. The sludge cake is dumped to landfill by the external private companies entrusted.

4) Analysis of water quality

Analysis of water quality is executed on water discharged into the plant, water in process of treatment, and the treated water to be discharged in order to manage water quality. The data is used for the best operation of the plants and achievement of the best quality of water for irrigation, and submitted to the related organizations.

5) Electric power for operation and management

The electric consumption for operation and maintenance of the plants is estimated for each plant based on sewage treatment capacity as follows:

Contents	Los Carrera (0.15m3/s)	Mallarauco (0.45m3/s)	Santa Ana (0.55m3/s)
	Electric consumption (MWH/d)	Electric consumption (MWH/d)	Electric consumption (MWH/d)
Aerator, Pumps and Disinfection facilities by ultra violet.	3.2	5.5	6.7

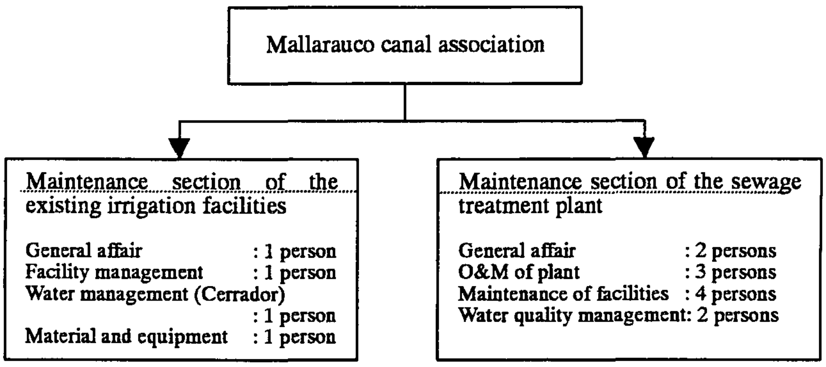
(2) O & M of rehabilitation canal

Because the canal is pipeline, water is distributed by pumping irrigation system. Therefore, those who hold water right have to submit annual planting schedule to canal associations as O & M of pump operation, and water distribution is planned based on the farming scale. O & M of canals and a pump are carried out by Mallarauco canal association. Water management will be carried out by the present Cerrador as it is. O

& M of irrigation pump is included in the O & M works of sewage treatment plant.

(3) O & M organizations

O & M of canals and water management are carried out by Mallarauco canal association. The present works and roles of Mallarauco canal association are management of canal structures and diversion, but O & M of the plant facilities and water quality management mentioned above are added. Therefore, the organization of canal association will be expanded as follows.



(4) O & M cost and it's burden

O & M of the existing irrigation facilities and water management in Mallarauco area are carried out by Mallarauco canal association. Its O & M cost is collected based on unit of *Acción*, and 1 *Acción* is 63,000 pesos. O & M cost of the sewage treatment plant facilities is summarized as follows.

Items of expense	Items of O&M	Expense (pesos)
Personnel expense	11 persons: permanent	70,380,000
Electric charge for operation	15.4MWH/hr. (Full operation for 6 months, Half operation for 3 months)	174,636,000
Maintenance cost of facilities	Repair of machine etc.	103,000,000
Sewage treatment cost	Maximum daily treatment volume 26 ton	12,150,000
Total		360,166,000

Number of water right or *Acción* of Mallarauco area is 137. Total O&M cost is estimated at 360,166,000 pesos and per 1 *Acción* as 2,628,000 pesos.

2.5 Development Impact and Evaluation

2.5.1 Project Evaluation

(1) Basic assumption

1) The economic life of the facilities is 30 years after completing them. Replacement costs for gates and machinery will be appropriated after 20 years from when the project works are completed.
2) All prices are shown in 1998 prices in Chilean pesos.
3) Evaluation is made on financial and economic aspects. Market prices and economic prices are used for financial evaluation and economic evaluation, respectively.
4) Economic evaluation of the project requires conversion of market prices to economic prices. For this purpose, adjustment factors provided by the Chilean Planning Ministry consisted of the following:

Foreign currency	1.06	Skilled labor	1.00
Semi-skilled labor	0.65	Unskilled labor	0.85
Social Discount Rate	12%		

In addition, tariff of 11% and value added tax of 18% are excluded as transfer expenditure.

(2) Benefits

1) Quantified benefits in the Mallarauco project area include increase of agricultural production and environmental benefits, the latter consisting of BOD reduction.

2) Agricultural benefits in the Mallarauco project area is the incremental benefits of $692,777/ha stemming from changes in cultivation crops.

3) Transformation of agricultural benefits to economic prices is made by applying the standard coefficient of transformation. Production cost is classified into foreign and local currency portions. Coefficient of transportation for foreign currency applies to foreign currency portion after excluding tariff and value added tax. On the other hand, in case of local currency portion, coefficient of transportation applies to personnel expenses excluding value added tax, and ratio of personnel expenses is 25% of local currency portion. The rest of local currency portion, 75% is cost of input material and equipment, and coefficient of transportation applies to it after excluding value added tax.

4) Benefits from BOD reduction are estimated as follows:
   - The sewage treatment plants in Mallarauco area are planned to reduce BOD for irrigation water of $1.15m^3/sec$ from 300mg/l to 20mg/l. This means that present BOD concentration is to become 1/15.
   - In other words, 15 times water for dilution requires against the present Mallarauco irrigation water.
   - Because water required for irrigation is estimated at 1liter/sec/ha, the water required for dilution ($15m^3/sec$) has the potential to irrigate 15,000 ha.
   - The present benefit of agricultural production in Mallarauco is estimated at $373,407/ha. If it multiplies by 15,000 ha, the potential agricultural benefit of water for dilution is $5,601.1 Million. If the treatment plants were assumed to operate at 80% annually, the potential agricultural benefit is $4,480.9 Million.

5) In case of transforming the items which cannot be classified into foreign or local currency portion into economic prices, standard coefficient of transformation, 0.96 which is used in Chilean foreign trade data is applied.

Accordingly, the benefits in market prices and economic prices are shown in the table below.

Benefits	Market Prices	Economic Prices
Agriculture	$692,777/ha	$1,112,724/ha
Environment	$4,481 million	$4,302 million

(3) Costs

Project cost in market prices is the cost which was estimated in the previous chapter, “Project Cost.” For transformation of the project cost into economic prices, the project cost is divided into foreign currency portion and local currency portion. The project cost is classified into foreign and local currency portions. Coefficient of transportation for foreign currency applies to foreign currency portion after excluding import tariff and value added tax. In case of local currency portion, coefficient of transportation applies to personnel expenses excluding value added tax. The ratio of personnel expenses is 20% of local currency portion. The rest of local currency portion, 80% is cost of input material and equipment, and coefficient of transportation applies to it after excluding value added tax. Land acquisition cost is excluded from economic prices.

Accordingly, the project cost in market prices and economic prices are shown in the table below.

	Market Prices ($ Million)	Social Price ($ Million)
Project cost	25,318	19,777

(4) Evaluation

The results of evaluation indicates net present value(NPV), benefit cost ratio (B/C), internal rate of return (IRR) at social discount rate of 12% are shown below.

Evaluation	IRR (%)	NPV (12%) $ Million	B/C (12%)
Financial	15.2	3,629.4	1.2
Economic	20.5	8,030.6	1.7

(5) Sensitivity Analysis

Sensitivity analysis is made about the case that cost increases by 10% and the benefits decreases by 10%, simultaneously. As shown in the table below, even in case that increase of cost and decrease of benefit are occurred at the same time, internal rate of return (IRR) of the project exceeds 12% of social discount rate.

Sensitivity Analysis	Internal Rate of Return (IRR)	
	Economic	Financial
1. Base Case	20.5%	15.2%
2. Cost Increase: + 10%	18.8%	13.8%
3. Benefit decrease: -10%	18.6%	13.6%
4. 2 + 3	17.0%	12.2%

2.5.2 Financial Analysis

The effects of the project are examined from improvement of farms' income and expenditure brought about agricultural development, and repayment and O&M cost of the project cost relevant to each farm based on farm income and expenditure of typical farmers, seeing the table below. The repayment of the project cost by farmers is estimated in cases of that they did not receive subsidy for the project, that they received 75% subsidy, and that they received 90% subsidy. Repayment condition is set up that repayment term is 20 years and interest rate is 12%. Annual O&M cost does not depend on subsidy.

Item	9ha	25ha
Mallarauco area		
Landholding area (ha)	9.4	25.3
Number of farms	84	10
Project cost	$19,021,665,452	$6,094,834,548
O&M cost	$344,967,197	$110,532,803
Project cost/farm	$226,448,398	$609,483,455
O&M cost/farm	$4,106,752	$11,053,280

to be continued

Item	9ha	25ha
Farm income and expenditure		
Gross income	$22,410,773	$52,767,116
Production cost	$12,700,773	$23,167,116
Net income	$9,710,000	$29,600,000
Living expenses	$1,800,000	$2,400,000
Agricultural revenue	$7,910,000	$27,200,000
Without subsidy		
1. Repayment of project cost /year/farm	$30,316,635	$81,596,901
2. O&M cost/year/farm	$4,106,752	$11,053,280
3. 1+2/year/farm	$34,423,387	$92,650,181
4. Agricultural revenue/year/farm	$7,910,000	$27,200,000
5. Surplus/year/farm	($26,513,387)	($65,450,181)
With 75% Subsidy		
1. Repayment of project cost /year/farm	$7,579,159	$20,399,225
2. O&M cost/year/farm	$4,106,752	$11,053,280
3. 1+2/year/farm	$11,685,911	$31,452,505
4. Agricultural revenue/year/farm	$7,910,000	$27,200,000
5. Surplus/year/farm	($3,775,911)	($4,252,505)
With 90% Subsidy		
1. Repayment of project cost /year/farm	$3,031,664	$8,159,690
2. O&M cost/year/farm	$4,106,752	$11,053,280
3. 1+2/year/farm	$7,138,416	$19,212,970
4. Agricultural revenue/year/farm	$7,910,000	$27,200,000
5. Surplus/year/farm	$771,584	$7,987,030

In case of Mallarauco area, it is impossible to repay if subsidy for the project cost is 75%. Annual deficiency of 9ha holding farmers and 25ha holding farmers are $3,775,911 and $4,252,505, respectively. If subsidy for the project cost is 90%, annual surplus of 9ha holding farmers and 25ha holding farmers are $771,584 and $7,987,030, respectively. Accordingly, in case of Mallarauco area, if farmers receive 90% subsidy for the project cost, farmers who hold any scales of farmland would have the ability to repay the burden of the project cost and pay for O&M cost.

2.5.3 Other Development Impact

By the project implementation, following socio-economical impacts is expected in addition to the benefit estimated by financial and economical evaluation. The effect of the project implementation will be borne by following condition;

- Inhabitants' will to improve the present situation
- Promotion of the project by participation of inhabitants
- Support organization system for realizing the will of improvement
- Improvement of irrigation water quality and advancement of land use
- Activation of agriculture by improvement of irrigation water, advancement of land use and improvement of farming technique
- Advancement of product marketability and promotion of diversification
- Activation of the area based on the community center (CECUV)
- Establishment of sustainable operation of the area and agricultural system considering environment.

Main expected socio-economical impact by the project implementation is as follows;

(1) Creation of the solidarity among inhabitants

In the process of the project, the beneficiaries themselves are to participate the plan for improvement of the present situation, and consensus on the goal of better improvement is formed. As a result, solidarity of inhabitants is created. Based on the solidarity of inhabitants, it is expected that mutual confidence of farmers, who are easy to be isolated, is created and then motivation of creating various organizations such as producers' cooperation is formed.

(2) Diversification of agricultural products

Water quality improvement of irrigation water is expected to bring about diversification of agricultural products such as fruits and vegetables and that small scale farmers can carry out high profitable intensive cultivation, and then to contribute to economic independence of small scale farmers. In addition, implementing water quality improvement of irrigation water is expected to result in that improvement of recognition against safety of agricultural products brings about increasing marketability and quality of agricultural products. Furthermore, diversification of agricultural products is expected to bring about promotion of forming production organizations against the diversification and growth of motivation to organize among small scale farmers.

(3) Effects of water quality improvement

Water quality improvement of irrigation water by farmers themselves promotes diversification of agricultural products and contributes greatly to agricultural improvement in the area. Furthermore, efforts for water quality improvement is to be appreciated domestically and internationally, and then marketability of agricultural products is to become high. Moreover, safety, healthy and comfortable agricultural and rural environment is created and the basic condition for the promotion of regional socio-economic independence is established.

(4) Increase of job opportunity

During the construction period of the project, job opportunity is created because most of construction workers are to be recruited from farmers in and around the project area. The technique which the employed farmers achieve through the construction works is expected to be useful for operation, management and maintenance of the constructed irrigation system and roads.

After implementation of the project, activated agricultural production activities in the area crate job opportunities. Creation of job opportunity for non-farm houses can be also expected because increased farm work by irrigation and intensive land boosts the demand of labor force in and around the project area.

These created job opportunity alleviates out flow of rural population to cities such as Santiago, and contributes to well balanced development of the country.

(5) Increase of intention for working

Compared to the limited agricultural production under water contamination at present, improvement of farm economy by diversification of agricultural products and its result, improvement of living standard after the project implementation give the farmers satisfaction and sufficiency in the area. This raise farmers' intention to increase the productivity, and accelerates development of the area.

(6) Activation of socio-economic activities

The activities of the community center (CECUV) promote integrated interchange in the area as a whole. The integrated interchange results in the motive power of activating and developing the area. Moreover, quality improvement of irrigation water and construction of rural sewage treatment plants makes an appeal for safety of agricultural products to outside of the area beside environmental conservation in the area. It is also expected that the effort of environmental conservation arouses public response everywhere and contributes to improving socio-economic status of the area.

(7) Development of regional economy

It is expected that increase of agricultural products brings about increase of farmers' income after the project implementation. Increases of farmers' purchase power can contribute largely to development of regional economy and also stable national economy of Chile

(8) Fostering of human resource

Establishment of the community center (CECUV) is expected to be a base of manpower development by conducting social education and technical training such as living improvement, irrigation method, agriculture technique, operation and maintenance of various machinery, environment and so on. The center is expected to contributes to the future development in rural areas as well as the nation. The activities of the center are expected to promote women's participation in the project and to improve their social status.

(9) Effect on environment

Quality improvement of irrigation water by farmers themselves contributes largely to alleviating the burden of environment and conserving natural environment. The effort against environmental improvement by farmer themselves is to be a model for the other areas where have same problems, and a stimulus for improvement of present situation. The construction of rural sewage treatment facility is expected to contribute largely to not only living environment but also environmental conservation of the area as a whole. Moreover, environmental education at the community center (CECUV) clarifies the relation between agriculture and environment, and between human activities and environment. This creates motive power of promoting practical activities for environmental conservation.

2.5.4 Justification of the Project

The objectives of the project implementation are providing the support for farmers' will to improve the present situation and realizing safe and comfortable rural areas. On the other hand, as the precondition of the project, development for accomplishment of the objective has to be carried out under participation of inhabitants.

In the development plan, agricultural production increases through promoting diversification of agricultural products by amelioration of quality of irrigation water and of agricultural infrastructure based on the purpose and precondition of the project. As a result, income growth of farmers is reflected not only household expenditure but also improvement of farmers' quality of life as a whole with development of rural infrastructure and improvement of knowledge and technique. Then, breakaway from the present situation is promoted for the farmers living in the area.

As living environment in rural area, improvement of the basic living condition satisfies the condition of settlement. At the same time, through the activities of farmers in the community and of production, lively socio-economic interchange such as human communication among inhabitants in the area activates the area as a whole.

In view of economic aspects, implementation of the proposed development plan can be evaluated at 20.5% with the index of economic internal rate of return (EIRR).

With these stand points, the implementation of the project is justified.

2.6 Conclusion and Recommendation

2.6.1 Conclusion

To formulate the agricultural development plan in Mallarauco area, study and examination on the present situation, facing problems and development potentials has been carried out. Following is obtained as a conclusion.

(1) The source of irrigation water in the proposed project area is the Mapocho river, but contamination level of water taken from the Mapocho river shows extremely high, over 10^5MPN/100ml of coliform groups. However, water of the Mapocho river contaminated by urban wastes must be used continuously as irrigation water under the present situation of Mallarauco area where is no alternative water sources in and around area. On the other hand, major irrigation facilities in Mallarauco were constructed in 1800s. The decrepit facilities have increased the maintenance cost and work. Farming in the area is mainly cultivation of crops whose harvested products are not affected by contaminated water use. Main crops are perennial crops such as fruit trees in the upstream basin, and annual crops such as cereals, pasture and livestock in the middle and downstream basins. Recently, fruit growing on hillside of mountains has increased.

As the development plan in the Mallarauco area, the quality improvement of irrigation water by construction of sewage treatment plants and rehabilitation of existing irrigation facilities are proposed at the three irrigation blocks of about 1,000ha among the Mallarauco irrigation system of about 7,000ha. Implementation of these development measures will attain improvement of production and living environment, reduction of O & M cost and alleviation of water shortage at the terminal point of irrigation system. As for the water quality improvement project, ameriolation of deteriorated environment on water which agriculture in metropolitan area faces at present is undertaken by agricultural sector itself. Implementation of the project, therefore, has the meaning of the pilot project.

(2) From the point of views above, the structural improvement plan, which consists of following contents, is proposed as structures to be improved in the Proposed Project.

Contents	Unit	Quantities
Water quality improvement		
Project area	site	3
Treatment volume	m^3/sec	1.10
Irrigation facilities improvement project		
Irrigation area	ha	1,043
Improvement of canals	km	44.02
Improvement of intake facilities	site	3
Diversion facilities	site	77
Regulation pond	site	3
Pumping facilities	site	4

To be continued

Contents	Unit	Quantities
Rural infrastructure development project		
Road improvement		
Pavement of main road	km	10.2
Improvement of lateral road	km	6.6
Construction of lateral road	km	9.4
Rural sewage treatment facilities	site	4
Community Center	site	2

(3) Total investment for implementing the project above is estimated at 26,386 million pesos (local currency portion: 11,080 million pesos, foreign currency portion: 15,306 million pesos). Required period of works is proposed at 7 years including the period of the detailed design.

(4) The economic internal rate of return of the project is 20.5% according to the required costs and expected benefits. Socio-economic effects of the project implementation are to be expected intensive utilization of land and water, diversification of crop cultivation, improvement of consciousness on environmental conservation, improvement of health and sanitary environment for the farmers, creation of job opportunity and so on.

2.6.2 Recommendation

(1) The project implementation benefits directly to the improvement on farming and farming condition of the farmers in the projected area. Because the sanitary environment surrounding production of perishable food has become international interest, infrastructure improvement for agricultural production is an urgent problem in order to expand agricultural export. The water quality improvement project is recommended as a pilot project based on the understanding stated above. On the other hand, required cost of water quality improvement is large and it is hard to be established as the project in the range of direct benefit which usually can be measured. From the results of financial analysis of farmers, subsidy of 90% on investment costs is required to promote the project execution. Taking these condition into account, the burden of Santiago City, which is the cause of pollution and also the nation, should also be examined. Accordingly, it is recommended for early implementation of the project that subsidy methods for initial investment should be established in the frame of existing or new subsidy system of government, considering the project advantage.

(2) As Government ordinance No.1123 is applied to the project under the frame of the present subsidy system, close cooperation between CNR and DOH is necessary at each stage such as adoption of the project by DOH, approval of the project and execution of the project. Guidance of CONAMA is required at the stage of the project promotion because the project includes water quality improvement relevant to environmental issues. Therefore, it is recommended that a project promotion committee which consists of CNR, DOH, and CONAMA should be established.

(3) The main body of the beneficiary of the project is the Mallarauco canal association. As operation and O & M of sewage water facilities handed by the association, it is proposed that the section of O & M for sewage treatment facilities should be established in the present Mallarauco canal association.

Table 2.2.1 Irrigation Water Requirement (Mallarauco)

	Item	Area (ha)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
9 ha														
	Wheat	0.110	0.00	0.00	0.00	0.00	0.00	0.00	0.00	48.98	148.78	217.31	159.68	44.25
	Potato	0.110	0.00	0.00	0.00	0.00	0.00	0.00	0.00	48.98	142.24	250.74	291.18	247.80
	Pumpkin(1)	0.055	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.90	111.40	191.04	169.45	86.45
	Pumpkin(2)	0.055	90.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	62.12	176.71	244.22	191.58
	Onion	0.110	0.00	0.00	0.00	0.00	0.00	0.00	0.00	32.18	110.32	189.05	229.61	221.25
	Broccoli-Melon	0.055	0.00	0.00	0.00	43.74	20.53	0.22	0.00	0.00	0.00	0.00	0.00	0.00
		0.055	117.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.74	133.33	221.78	250.75
	Cabbage-Cauliflower	0.055	0.00	0.00	0.00	0.00	0.00	0.00	0.01	15.20	14.31	0.00	0.00	0.00
		0.055	193.37	144.56	37.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	48.22	128.50
	Alfalfa	0.230	278.54	240.41	172.35	102.92	6.95	0.00	0.01	18.81	75.37	159.20	234.83	265.50
	Unused Land	0.110												
	Total	1.000	86.15	63.24	41.68	26.08	2.73	0.01	0.00	20.24	73.50	136.46	166.46	153.68
50 ha														
	Wheat	0.100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	48.98	148.78	217.31	159.68	44.25
	Melon	0.100	117.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.74	133.33	221.78	250.75
	Alfalfa	0.100	278.54	240.41	172.35	102.92	6.95	0.00	0.01	18.81	75.37	159.20	234.83	265.50
	Avocado	0.280	113.48	97.94	70.22	47.17	4.63	0.00	0.00	15.16	45.78	79.60	95.67	108.17
	Lemon	0.280	113.48	97.94	70.22	47.17	4.63	0.00	0.00	15.16	45.78	79.60	95.67	108.17
	Seed Production (Hybrid)	0.080	73.53	0.00	0.00	0.00	0.00	0.00	0.00	19.34	119.47	229.25	272.40	193.92
	Unused Land	0.060												
	Total	1.000	109.04	78.89	56.56	36.71	3.29	0.00	0.00	16.82	60.68	113.90	137.00	132.14

Table 2.3.1 Agricultural Development Project Total Construction Cost in Mallarauco Area

(Unit : Thousand Pesos)

Description		F.C	L.C	Total
1 Preparation Cost				
(1)	Water Quality Improvement and Irrigation Facilities	590,845	360,008	950,853
(2)	Rural Infrastructure	31,226	41,916	73,142
	Sub-total	622,071	401,924	1,023,995
2 Water Quality Improvement and Irrigation Facilities Improvement Cost				
(1)	Water Quality Improvement Facilities Construction Cost			
	1) Civil Facilities	2,704,208	7,113,566	9,817,774
	2) Plant Facilities	8,410,148	9,642	8,419,790
	Sub-total	11,114,356	7,123,208	18,237,564
(2)	Irrigation Facilities Improvement Cost			
	1) Pipe Lines	596,461	226,178	822,639
	2) Related Facilities	96,079	50,778	146,857
	Sub-total	692,540	276,956	969,496
Total		11,806,896	7,400,164	19,207,060
3 Rural Infrastructure Construction Cost				
(1)	Rural Sewage Treatment Facilities	481,763	268,887	750,649
(2)	Rural Road	115,784	481,492	597,276
(3)	Community Centers (CECUV)	26,983	87,945	114,928
	Sub-total	624,530	838,323	1,462,853
4 Land Acquisition and Compensation Cost				
(1)	Water Quality Improvement and Irrigation Facilities	0	14,616	14,616
(2)	Rural Infrastructure	0	826	826
	Sub-total	0	15442	15442
5 Engineering and Administration Cost				
(1)	Water Quality Improvement and Irrigation Facilities	798,716	1,333,075	2,131,762
(2)	Rural Infrastructure	62,453	83,832	146,285
	Sub-total	861,169	1,416,907	2,278,047
6 O & M Equipment		121,577	45,000	166,577
7 Total (1-5)		13,914,697	10,072,791	23,987,428
8 Physical Contingencies (10%)		1,391,470	1,007,279	2,398,743
9 Total (6+7)		15,306,167	11,080,070	26,386,171
10 Price Contingencies		2,813,288	4,100,753	6,914,041
11 Grand Total		17,306,414	11,675,715	28,982,129

Table 2.3.2 Disbursement Schedule (Total Construction Cost in Mallarauco Area)

(Unit : Million Pesos)

Year	F.C	L.C	Total
2000	0.0	0.0	0.0
2001	319.5	473.9	793.4
2002	609.8	692.9	1,302.7
2003	1,259.3	1,568.8	2,828.1
2004	3,795.3	2,319.1	6,114.4
2005	8,318.9	4,764.3	13,083.2
2006	2,893.8	1,966.4	4,860.2
Total	17,196.6	11,785.4	28,982.0

Table 2.4.1 Project Implementation Schedule in Mallarauco Area

Development Items	Quantities	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008
1. Project Evaluation by the Government of Chile											
2. Provision of Fund by the Government of Chile											
3. Agricultural Development Project in Mallarauco Area											
(1) Preparation Works for the Implementation of the Project											
Contract with Consultant Company	1.0	unit									
Detail Design Study	1.0	unit									
Land Acquisition and Compensation	1.0	unit									
Selection and Contract of Construction Company	1.0	unit									
(2) Water Quality Improvement Project	12.0	Places									
Las Carrera	0.13	(m^3/sec)									
Civil Works	1.0	unit									
Construction of Plant Facilities	1.0	unit									
Reforma	0.54	(m^3/sec)									
Civil Works	1.0	unit									
Construction of Plant Facilities	1.0	unit									
Manzano	0.43	(m^3/sec)									
Civil Works	1.0	unit									
Construction of Plant Facilities	1.0	unit									
(3) Agricultural Production Development Project											
Rehabilitation Work of Canals											
Las Carrera	14.1	km									
Reforma	17.2	km									
Manzano	16.5	km									
(4) Rural Infrastructure Development Project											
Construction of Road	26.2	km									
Construction of Rural Water Supply Facilities	4.0	Places									
Construction of Rural Sewage Treatment Facilities	2.0	Places									

Table 2.5.1 Project Evaluation (Mallarauco Area)

<Financial Evaluation of the Project : Mallarauco>

Year	Costs			Benefits			Cash	Cost	Benefit	Cost + 10%
	Investment	O & M	Total	Agriculture	Environment	Total	Flow	[+10%]	[-10%]	Benefit-10%
2000			0.0			0.0	0.0	0.0	0.0	0.0
2001	793.4		793.4			0.0	-793.4	-872.7	-793.4	-872.7
2002	1239.8		1239.8			0.0	-1239.8	-1363.8	-1239.8	-1363.8
2003	2571.2		2571.2			0.0	-2571.2	-2828.3	-2571.2	-2828.3
2004	5245.3	45.6	5290.9		0.0	0.0	-5290.9	-5820.0	-5290.9	-5820.0
2005	10864.9	136.7	11001.6	144.5	896.2	1040.7	-9960.9	-11061.1	-10065.0	-11165.1
2006	3611.3	318.9	3930.2	216.8	1344.3	1561.1	-2369.2	-2762.2	-2525.3	-2918.3
2007		455.5	455.5	505.8	3136.6	3642.5	3187.0	3141.4	2822.7	2777.2
2008		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1
2009		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1
2010		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1
2011		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1
2012		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1
2013		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1
2014		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1
2015		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1
2016		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1
2017		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1
2018		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1
2019		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1
2020		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1
2021		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1
2022		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1
2023		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1
2024		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1
2025		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1
2026	992.1	455.5	1447.6	722.6	4480.9	5203.5	3755.9	3611.1	3235.6	3090.8
2027		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1
2028		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1
2029		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1
			$15,139.6			$18,770.6				
						IRR=	15.21%	13.75%	13.60%	12.20%
						NPV(12%)=	$3,630.9	$2,116.9	$1,753.9	$239.9
						B/C=	1.24			

<Social Evaluation of the Project : Mallarauco>

Year	Social Cost			Social Benefits			Cash	Cost	Benefit	Cost+10%
	Foreign	Local	Total	Agriculture	Environment	Total	Flow	[+10%]	[-10%]	Benefit-10%
2000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2001	247.2	358.9	606.1	0.0	0.0	0.0	-606.1	-666.7	-606.1	-666.7
2002	449.3	501.3	950.6	0.0	0.0	0.0	-950.6	-1045.6	-950.6	-1045.6
2003	885.8	1097.0	1982.7	0.0	0.0	0.0	-1982.7	-2181.0	-1982.7	-2181.0
2004	2538.9	1545.2	4084.1	0.0	0.0	0.0	-4084.1	-4492.5	-4084.1	-4492.5
2005	5451.4	3041.8	8493.2	232.1	860.3	1092.4	-7400.7	-8250.1	-7510.0	-8359.3
2006	1804.4	1228.9	3033.3	348.2	1290.5	1638.7	-1394.6	-1697.9	-1558.5	-1861.8
2007	95.9	255.0	350.9	812.4	3011.2	3823.6	3472.7	3437.6	3090.3	3055.2
2008	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0
2009	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0
2010	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0
2011	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0
2012	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0
2013	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0
2014	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0
2015	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0
2016	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0
2017	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0
2018	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0
2019	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0
2020	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0
2021	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0
2022	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0
2023	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0
2024	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0
2025	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0
2026	863.4	255.0	1118.4	1160.6	4301.6	5462.2	4343.9	4232.0	3797.6	3685.8
2027	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0
2028	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0
2029	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0
			$11,673.4			$19,703.9	$8,030.6	$6,863.2	$6,060.2	$4,892.8
						IRR =	20.47%	18.76%	18.58%	16.96%
						NPV =	$8,030.6	$6,863.2	$6,060.2	$4,892.8
						B/C =	1.7			

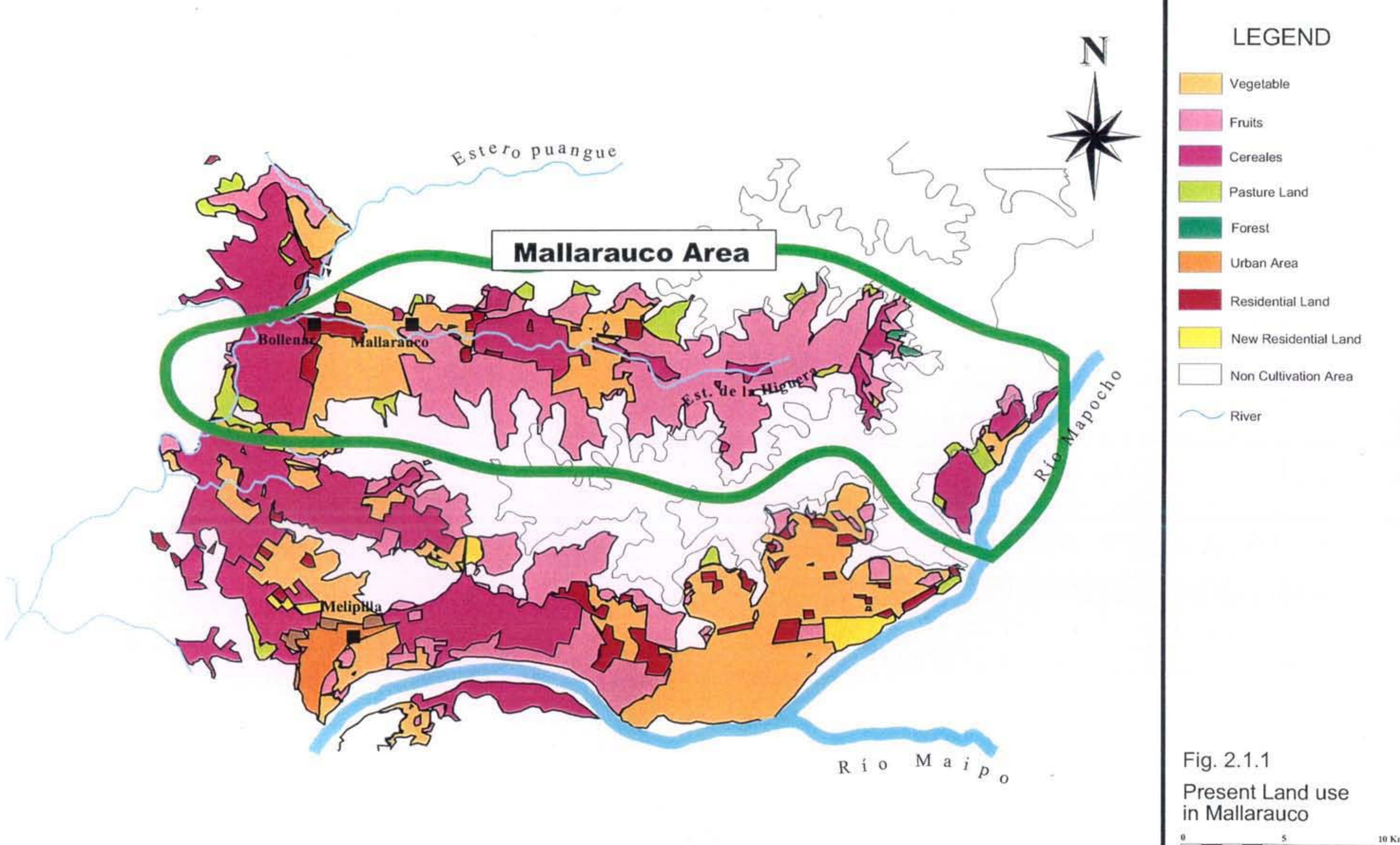


Fig. 2.1.1
Present Land use in Mallarauco

DESARROLLO AGRICOLA Y MANEJO DE AGUAS DEL AREA METROPOLITANA
JICA - CNR

LEGEND

Main Irrigation Pipeline

Secondary Irrigation Pipeline

Sewage Treatment Plant

Irrigation Area

P.T.C Sewage Treatment Plant in Los Carrera

P.T.R Sewage Treatment Plant in Reforma

P.T.M Sewage Treatment Plant in Manzano

Fig. 2.2.1
AGRICULTURAL PRODUCTION INFRASTRUCTURE DEVELOPMENT PLAN (MALLARAUCO)

0 0.5 1.0 2.0km

DESARROLLO AGRICOLA Y MANEJO DE AGUAS DEL AREA METROPOLITANA JICA - CNR

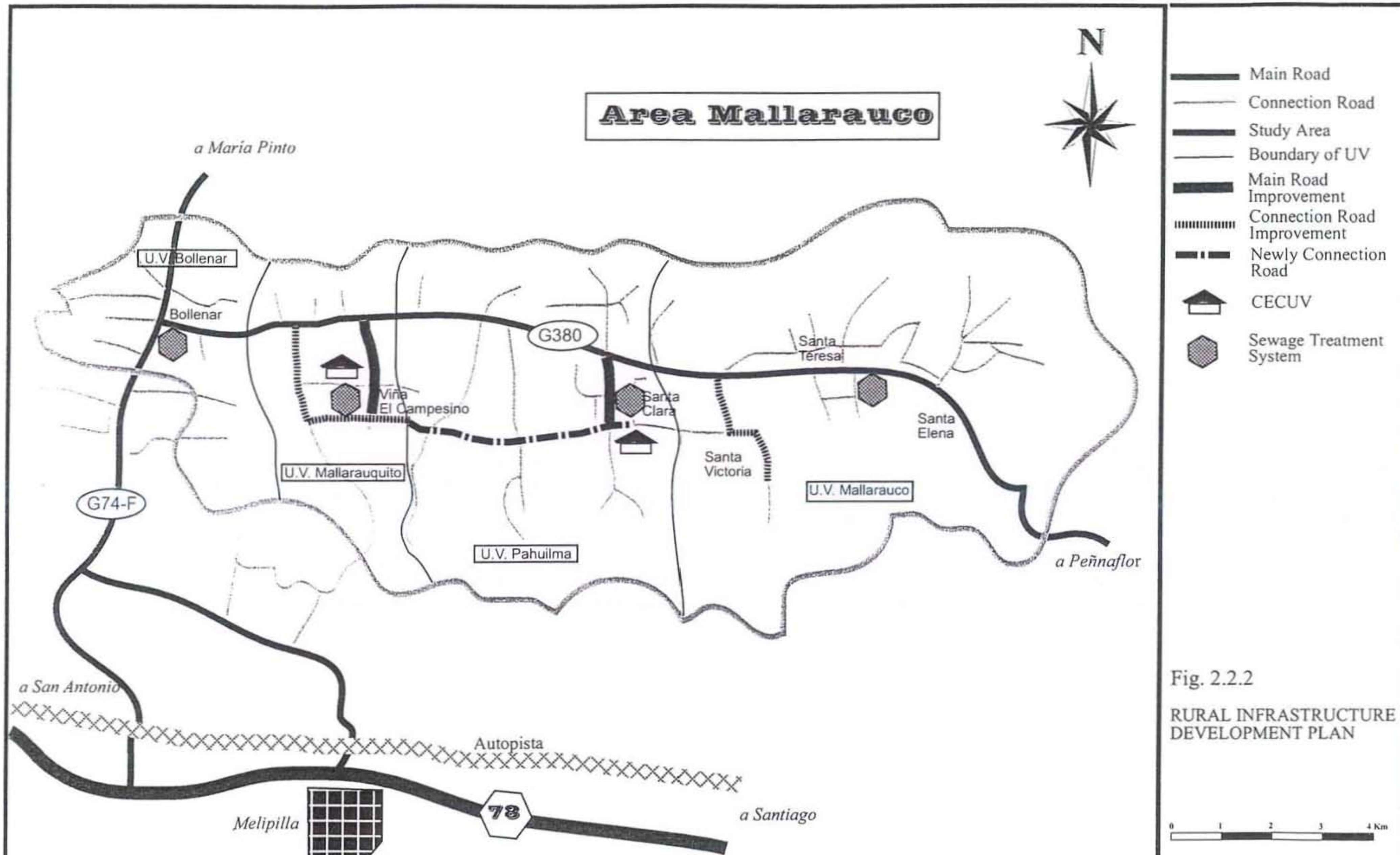


Fig. 2.2.2

RURAL INFRASTRUCTURE
DEVELOPMENT PLAN

DESARROLLO AGRICOLA Y
MANEJO DE AGUAS
DEL AREA METROPOLITANA
JICA - CNR

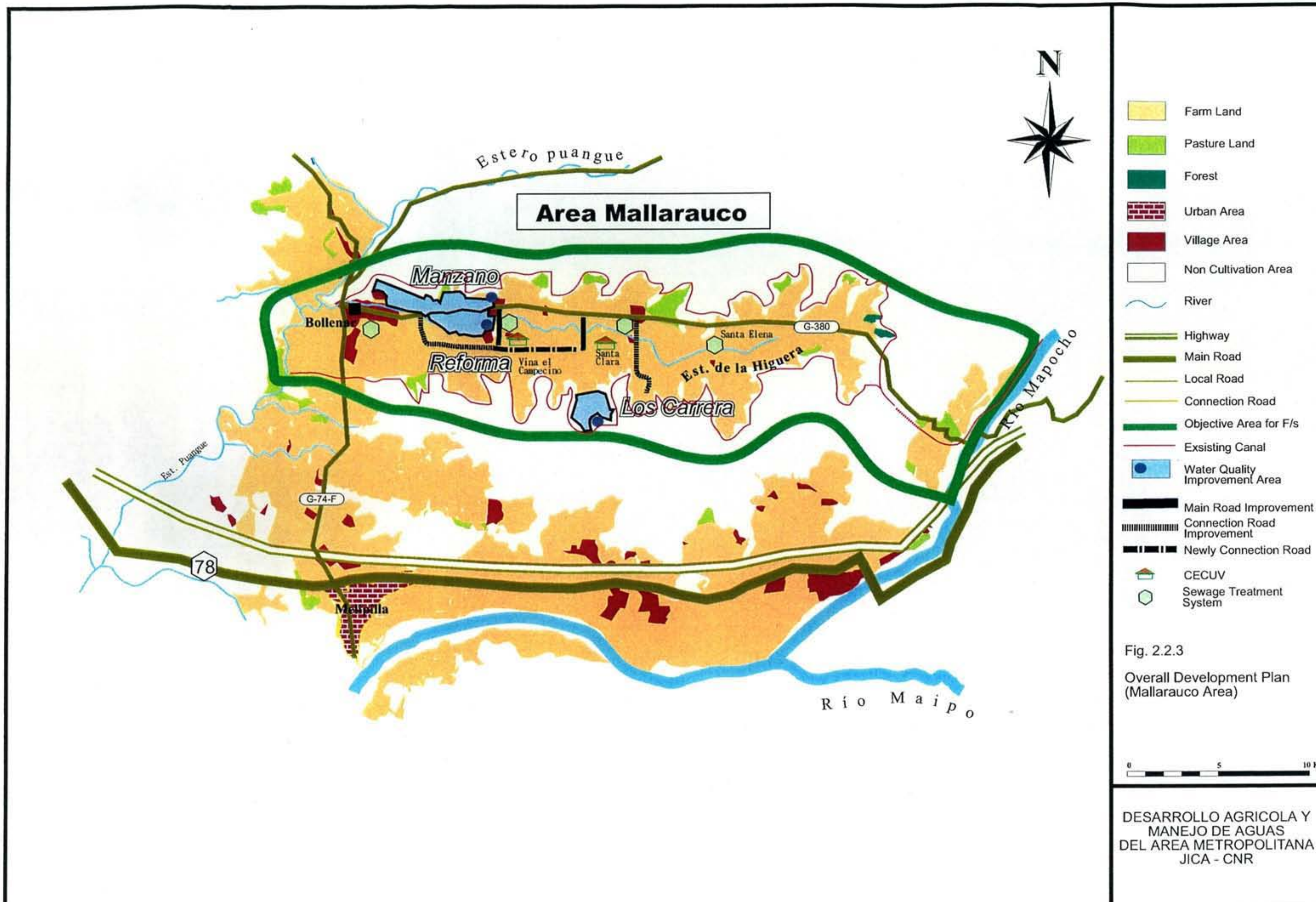


Fig. 2.2.3

Overall Development Plan (Mallarauco Area)

DESARROLLO AGRICOLA Y
MANEJO DE AGUAS
DEL AREA METROPOLITANA
JICA - CNR

ATTACHMENT

SCOPE OF WORK
FOR
THE STUDY
ON
AGRICULTURAL DEVELOPMENT AND WATER MANAGEMENT
IN
METROPOLITAN AREA , CHILE

AGREED UPON BETWEEN
NATIONAL IRRIGATION COMMISSION
AND
THE JAPAN INTERNATIONAL COOPERATION AGENCY

Santiago, November 13 , 1997

Mr. Ernesto Schulbach B. Executive Secretary National Irrigation Commission	Mr. Germán Quintana P. Intendant Metropolitan Region	Mr. Shigenari Koga Leader, Japanese Preparatory Study Team Japan International Cooperation Agency

Witnessed by

Mr. Francisco Vio G.
Executive Director
International Cooperation Agency
of Chile

I. Introduction

In response to the request of the Government of the Republic of Chile (hereinafter referred to as "the Government of Chile"), the Government of Japan has decided to conduct the Study on Agricultural Development and Water Management in Metropolitan Area, Chile (hereinafter referred to as "the Study"), in accordance with the relevant laws and regulations in force in Japan.

Accordingly, Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of technical cooperation programs of the Government of Japan, will undertake the Study in close cooperation with the authorities concerned of the Government of Chile.

The present document sets forth the scope of work with regard to the Study.

II. Objectives of the Study

The objectives of the Study are :

1. To formulate a master plan for agricultural development and water management reflecting upon environmental conditions in metropolitan area, Chile.
2. To conduct a feasibility study for the agricultural development plan(s) in the priority project area(s).
3. To carry out technology transfer to the Chilean counterpart personnel through on-the-job training in the course of the Study.

III. Study Area

The Study covers the Metropolitan Region and the Province of San Antonio in the Fifth Region, and the total area for the master plan is about 3,200 square kilometers which consists of actual and potential irrigated areas. (ANNEX I)

IV. Scope of the Study

In order to achieve the above objectives, the Study will consist of the following two phases:

1. Phase I (Master Plan)

1.1. To collect and analyze existing data and information and to carry out field survey including the following components:

(1) Natural conditions

(2) Socio-economic conditions

(3) Soil conditions and land use

(4) Crop production

(5) Livestock and pasture

(6) Agricultural and rural infrastructure

(7) Irrigation and drainage

(8) Operation and maintenance of irrigation and drainage facilities

(9) Agricultural supporting systems (farmers organization, research, training and extension services, etc.)

(10) Marketing system

(11) Water demand and system of water resources management for the various sectors

(12) Domestic waste water from urban areas

(13) Environmental aspects

(14) Legal aspects

(15) Others

1.2. To review the existing development plan(s) and project(s) in the Study Area.

1.3. To identify potential of water resources, problems and constraints.

ok

1.4. To implement Initial Environmental Examination (IEE).

1.5. To prepare the water optimization plan for the various sectors.

1.6. To formulate a Master Plan for the agricultural development and water management reflected upon environmental conditions in the Study Area.

1.7. To identify the priority project area(s) through the Master Plan study.

2. Phase II (Feasibility Study)

2.1. To collect data and information in the selected project area(s) through additional survey.

2.2. To conduct the feasibility study for the priority project area(s) including the following components:

(1) Agricultural development plan

(2) Groundwater resources development plan, if necessary

(3) Irrigation and drainage plan

(4) Operation and maintenance plan of irrigation and drainage facilities

(5) Environmental conservation plan

(6) Preliminary design of infrastructure

(7) Farmers' organization and its supporting plan

(8) Implementation schedule

(9) Estimation of the project costs and benefits

(10) Evaluation of the project

(11) Conclusions and Recommendations

V. Study schedule

The Study will be carried out in accordance with the attached tentative work schedule.(ANNEXII)

VI.Reports

JICA will prepare and submit the following reports in English and Spanish to the Government of Chile.

1. Inception Report

Twenty (20) copies at the commencement of the Phase I study (Spanish version only).

2. Progress Report (1)

Twenty (20) copies at the end of the work in Chile of the Phase I study (Spanish version only).

3. Interim Report

Twenty (20) copies at the commencement of the Phase II study (Spanish version only).

4. Progress Report (2)

Twenty (20) copies at the end of the work in Chile of the Phase II study (Spanish version only).

5. Draft Final Report

Twenty (20) copies at the end of the Phase II study. The Government of Chile will provide its comments on the Draft Final Report to JICA within forty(40) days after receiving the Draft Final Report.

6. Final Report

Fifty (50) copies in Spanish and English (only Main Report) within two (2) months after the receipt of comments on the Draft Final Report.

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In case any doubt arises in interpretation, English text shall prevail.

VII. Undertakings of the Government of Chile

1. To facilitate smooth conduct of the Study, the Government of Chile shall take necessary measures:

(1) To secure the safety of the Japanese study team,

(2) To permit the members of the Japanese study team to enter, leave and sojourn in for the duration of their assignment therein, and exempt them from foreign registration requirements and consular fees,

(3) To exempt the members of the Japanese study team from taxes, duties, fees and any other charges on equipment, machinery and other materials to be brought into and out of the Republic of Chile for the conduct of the Study,

(4) To exempt the members of the Japanese study team from income tax and charges of any kind imposed on or in connection with any emoluments or allowances paid to the members of the Japanese study team for their services in connection with the implementation of the Study,

(5) To provide necessary facilities to the Japanese study team for the remittance as well as the utilization of the funds introduced into the Republic of Chile from Japan in connection with the implementation of the Study,

(6) To secure permission for entry into private properties or restricted areas for the implementation of the Study,

(7) To secure permission for the Japanese study team to take all data and documents (including photographs and maps) related to the Study out of the Republic of Chile to Japan by the Japanese study team, and

(8) To provide medical services as needed.

2. The Government of Chile shall bear claims, if any arises, against the members of the Japanese study team resulting from occurring in the course of, or otherwise connected with, the discharge of their duties in the implementation of the Study, except when such claims arise from gross negligence or willful misconduct on the part of the members of the Japanese study team.

3. National Irrigation Commission (hereinafter referred as "CNR") shall act as a counterpart agency to the Japanese study team and also as a coordinating body in relation to other Chilean organizations concerned for the smooth implementation of the Study.

4. CNR shall, at its own expense, provide the Japanese study team with the following, in cooperation with other Chilean organizations concerned:

(1) available data and information related to the Study,

(2) counterpart personnel,

(3) suitable office space with necessary equipment and furniture in Santiago and

(4) credentials or identification cards.

VIII. Undertakings of JICA

For the implementation of the Study, JICA shall take the following measures:

(1) To dispatch, at its own expense, the study team to Chile,

(2) To pursue technology transfer to the Chilean counterpart personnel in the course of the Study.

IX. Consultation

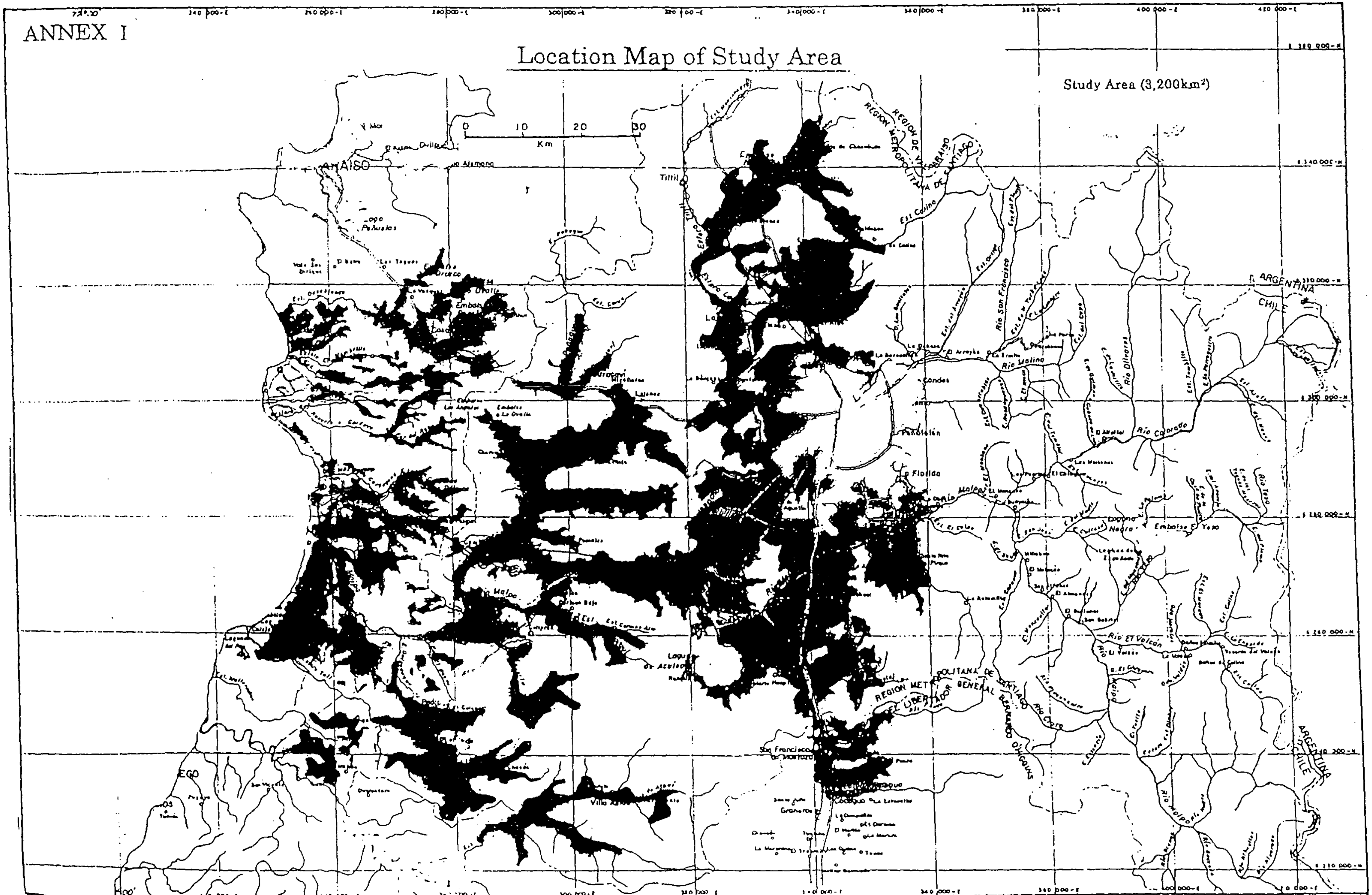
JICA and the Government of Chile shall consult with each other in respect of any matter that may arise from or in connection with the Study.

X. Others

The Scope of Work is prepared both English and Spanish. In case of any discrepancy of translation arises in interpretation, the English text shall prevail.

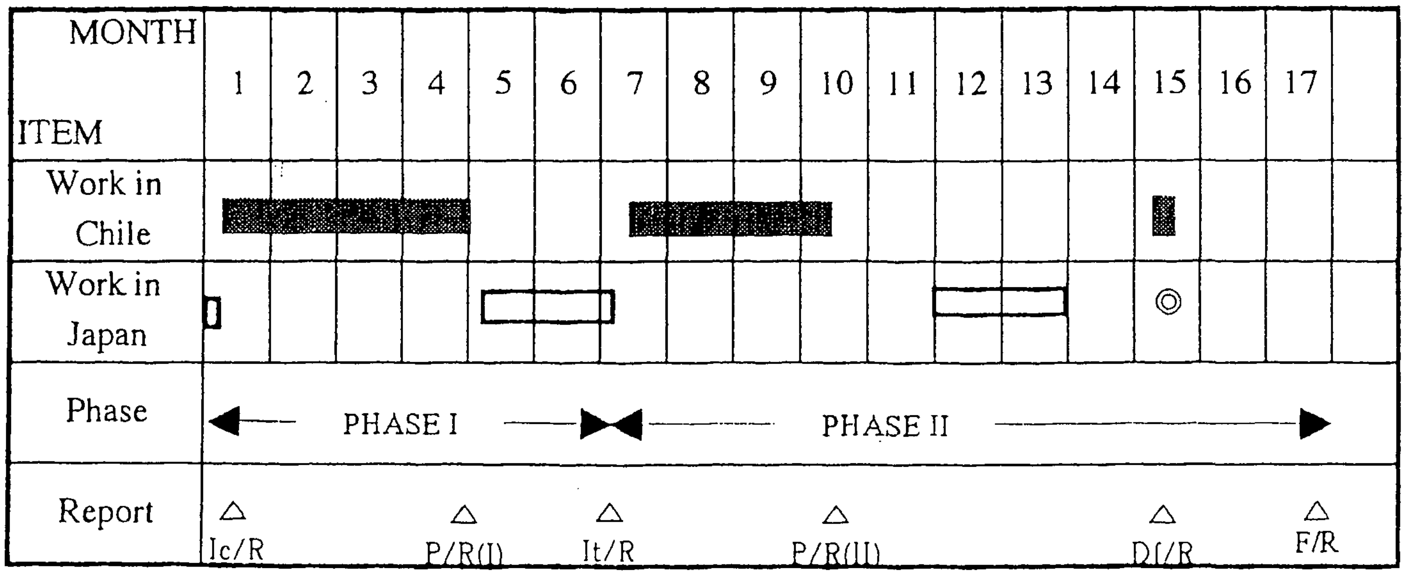
ANNEX I

Location Map of Study Area



ANNEX II

TENTATIVE WORK SCHEDULE



(Remarks)

Ic / R	: Inception Report
P / R(I)	: Progress Report(1)
It / R	: Interim Report
P / R(II)	: Progress Report(2)
Df / R	: Draft Final Report
F / R	: Final Report
◎	: Comments on Df /R by Chile side

MINUTES OF MEETINGS
ON
SCOPE OF WORK
FOR
THE STUDY
ON
AGRICULTURAL DEVELOPMENT AND WATER MANAGEMENT
IN
METROPOLITAN AREA , CHILE

AGREED UPON BETWEEN
NATIONAL IRRIGATION COMMISSION
AND
THE JAPAN INTERNATIONAL COOPERATION AGENCY

Santiago, November 13 , 1997

Mr. Ernesto Schulbach B.
Executive Secretary
National Irrigation Commission

Mr. German Quintana P.
Intendant
Metropolitan Region

Mr. Shigenari Koga
Leader, Japanese
Preparatory Study Team
Japan International
Cooperation Agency

Witnessed by

Mr. Francisco Vio G.
Executive Director
International Cooperation Agency
of Chile

The preparatory study team (hereinafter referred to as "the Team") organized by the Japan International Cooperation Agency (hereinafter referred to as "JICA") and headed by Mr. Shigenari Koga visited the Republic of Chile from November 3 to November 22, 1997 for the purpose of discussing and exchanging views in relation to the Study on Agricultural Development and Water Management in Metropolitan Area, Chile (hereinafter referred to as " the Study") with the officials concerned of the Government of the Republic of Chile (hereinafter referred to as " the Government of Chile ").

As a result of the discussions, the Government of Chile and the Team mutually agreed to the Scope of Work for the Study .

The following Minutes have been prepared to confirm the main issues discussed and matters agreed upon by both sides in connection. The list of participants in a series of meetings is attached as ANNEX.

1. The Study will be carried out mainly aiming at the agricultural development taking into account environmental conditions in metropolitan area.

2. For the smooth and effective implementation of the Study in terms of technical and administrative aspects, it was mutually agreed to establish a Steering Committee which shall be comprised of various organizations concerned with the Study. The chairperson of the Committee shall be National Irrigation Commission (hereinafter referred to as " CNR "). Basically, the Committee will be held each time when the Japanese study team explains the Reports and/or if necessity arises. The Committee shall be formed by the following institutions:

National Irrigation Commission (CNR)
Metropolitan Region Government (IRM)
Ministry of Agriculture (MA)
Ministry of Publics Works (MOP)

3. The Team requested that counterpart personnel for each field to the Japanese study team, necessary for smooth and effective implementation of the Study, be assigned during the Study period. The Government of Chile promised to be responsible for the assignment.

4. The Government of Chile requested to prepare an operational simulation model for the

hydrological system, on condition that the Government of Chile provides the practical groundwater model based on the existing data and its analysis of CNR's survey without additional survey by the study team about this.

The Team promised to convey the request to the JICA headquarters.

5. The Summary report will be separated from Main volume of Final Report in Spanish.

6. The Government of Chile requested one hundred(100) copies of reports in Spanish for the summary of Final Report.

The Team promised to convey the request to the JICA headquarters.

7. The Government of Chile requested that the draft final report will be submitted to the CNR one(1) month before the explanation in the Joint Committee meeting, on condition that the Government of Chile will provide its comments on the Draft Final Report to JICA within ten (10) days after the explanation.

The Team promised to convey the request to the JICA headquarters.

8. The Government of Chile requested the counterpart training in Japan.

The Team promised to convey the request to the JICA headquarters.

9. The Government of Chile promised to provide the Study team with desks, chairs and the exclusive use of one telephone line, telephone with facsimile function, one personal computer and secretary in the office.

10. The Government of Chile agreed that the Final Report would be available to any person who has interests in the Study.

11. The Minutes of Meetings is prepared both English and Spanish. In case of any discrepancy of translation arises in interpretation, the English text shall prevail.

ANNEX

List of Participants

Chilean Side

National Irrigation Commission

Mr. Marcial Gonzalez S.	Director, Department of Survey
Mr. Mario Fajardo R.	Agricultural Engineer, Department of Survey
Mr. Cesar Arriagada A.	Civil Engineer, Department of Survey

Metropolitan Region Government

Mr. Fernando Cacho A.	Chief, Department of Environment

Ministry of Agriculture

Mr. Rolando Nunez H.	SEREMI
Ms. Pilar Matamala E.	Agricultural Engineer, SEREMI
Mr. Mario Gallardo P.	Agricultural Engineer, SAG
Mr. Carlos Barrientos	Agricultural Engineer, INDAP
Mr. Carlos Weber	Regional Director, CONAF

Ministry of Public Works

Mr. Alberto Calatroni	Geographer, SEREMI
Mr. Edgardo Lara	Agricultural Engineer, Irrigation Directorate

International Cooperation Agency of Chile

Mr. Ivan Mertens	Coordinator, Sectorial
Ms. Adriana Lagos	Coordinator, Asia Pacific
Mr. Mitsuo Oba	JICA Expert in AGCI

Japanese Side

Preparatory Study Team

Mr. Shigenari Koga	Leader
Mr. Haruyuki Sato	Member
Mr. Atsushi Mori	Member
Mr. Kazuya Suzuki	Member
Mr. Yoshinori Kanetsuna	Member
Mr. Yoshimi Sugano	Member

JICA Chile Office

Mr. Kiyotaka Otsuki	Assistant Resident Representative

Embassy of Japan

Mr. Kanehiko Shindo	First Secretary