EXECUTIVE SUMMARY

Preface

Background and Scope of The Study (See Chapter 1 in the Main Report)

1. The Cañete river is the second largest of the rivers that flow into the Pacific ocean in the Republic of Peru. Its estuary is located about 200 km south of the capital Lima. A numbers of glacial lakes are dotted in the Glacial/Alpine area of the upper reach at altitude over 3,500 masl, but no man-made reservoir has been constructed on the river. Water resources in the basin have not yet been well developed except for the irrigation in the coastal agricultural land, domestic water uses and rubber rafting tourism in the downstream river stretch. However, plans for large scale development of hydropower and irrigation have been proposed.

   The capital, Lima, which accommodates a population of over 7 million, about 30% of the national total in the area of coastal dry land, has always grappled with the problem of primary water supply to meet domestic and industrial demands.

   The Government of Peru therefore made a request to the Government of Japan for technical assistance to study an integrated water resources development of the Cañete river basin by paying due consideration to the conveyance of water from the basin to the capital Lima. The Japan International Cooperation Agency (JICA) and the Potable Water and Sewerage Service of Lima (SEDAPAL) agreed on the Scope of Work for the Study on the Integrated Water Resources Development in the Cañete River Basin in the Republic of Peru on November 22nd, 1996.

   The objectives of the Study are ‘to formulate an integrated master plan for the development of water resources in the Cañete river basin up to the year 2020, with priority to increase the water resources for the Lima water supply (Phase I), ‘to conduct a feasibility study of the priority project(s) to be identified and agreed upon by the two sides based on the master plan up to year 2003 (Phase II)’, and ‘to transfer technology to the counterpart personnel in the course of the Study.

   The Study area is shown on the map “The Study Area” and is composed of the area of the Cañete river basin for water resources development, the coastal band to Lima for water conveyance, and the southern area of the capital Lima for domestic and industrial water supply.

Implementation of the Study (See Chapter 1)

2. The Study was commenced in March 1999 by preparing an Inception Report. At the outset of the Study, it was agreed between JICA and SEDAPAL to extend the study horizon of the Phase I (master plan study) from 2020 to 2030.

The Study was carried out in Peru in collaboration with officials of SEDAPAL and by holding Joint Meetings among the concerned parties (Consultative group). A Progress Report (1) was submitted to SEDAPAL on October 18th, 1999.

The Study was continued in Japan and the Interim Report was completed on December 27th, 1999, by incorporating the outputs prepared up to that time.

On March 1st, 2000, JICA and SEDAPAL agreed that supplemental investigation of water use and water loss in the Rimac river (the main water source managed by SEDAPAL for domestic and industrial water supply in the capital Lima) would be carried out, and implementation of Phase II and contents of its TOR would be determined based on the results of the investigation.

The supplemental investigation was started in August 2001 and Progress Report (2) was submitted to SEDAPAL on September 28th, 2001.

On October 19th, 2001, JICA and SEDAPAL agreed that Phase II would not be implemented in the near future and the Draft Final Report would be submitted by December 2001, by finalizing the Interim Report and the Progress Report (2).

On December 13th, 2001, upon the acceptance of the Draft Final Report, JICA and SEDAPAL agreed that the Final Report would be submitted as soon as possible after obtaining comments of SEDAPAL by January 10th, 2002.

Socioeconomy in Peru and Study area

Socioeconomy in Peru (See Chapter 2)

3. The population of Peru was estimated to be 24.8 million in 1998 based on the population census of 1993 and growth rate of 2% per annum. Over 70% of the population is estimated to live in urban areas with a continuous trend of rural-urban migration. Judging from UNDP's human development index in 1997, Peru is categorized as nation of medium development ranked at 80th among the 174 nations of the world.

Although severe negative impact was experienced in 1998 by 'El Nino' together with the Asian economic crisis, average growth in GDP was 6.2% per annum for the period 1993-98. In 1998, investment in public works, which is US$1,897 million (or 18.8% of the public finance), was distributed by 47.6% to the Ministry of Presidency (in charge of development of water supply and sewerage systems, etc.), 26.1% for transportation, 6.4% for education, 5.2% for agriculture, 3.1% for energy and mining, and 11.6% for the rest. On the other hand, to materialize poverty alleviation, the government had allocated close to 9% of the public finance to the relevant program. Within the context of the structural reform program, the Peruvian government is proceeding with privatization for the purpose of consolidating bases for development of a competitive economy and re-composition of the roles of state and the private sector.

Socioeconomy in Study area (See Chapter 2)

4. The Study area covers the Cañete river basin and the coastal corridor to the south of Lima. Total population in the area in 1998 was estimated at 1.23 million, while that in the provinces (Canete and Yauyos) in the river basin was 191,000. The annual growth rate (1981-1998) was 1.9% for Cañete and – 1.5% for Yauyos, indicating the exodus of inhabitants from the hilly Yauyos to the coastal Cañete and the capital Lima.

In 1997, electricity service coverage was 25% in Cañete and 33% in Yauyos. Water supply coverage was 43% in Cañete and 24% in Yauyos. The proportion of roads that were paved was 45% in Cañete, whilst Yauyos had no paved roads.

The agricultural and livestock sector constitutes the mainstay of the basin area, playing an important role in the wholesale market of Lima. According to the census in 1993, the economically active population was distributed by sector to primary 46%, secondary 11% and tertiary 43%.

Water resources potential analysis

Cañete river basin (See Chapter 2)

5. The Cañete river is approximately 230 km long and has a catchment area of 6,189 km^2. The river basin shows an abrupt morphology with youthful V-shaped valley, which is being actively deepened at present. The average slope of the basin is 16.7%, whereas that of the riverbed is 1/53 (approximately 2%).

In view of the physiographic characteristics, the basin can be divided into three units, namely, the lower, middle and upper reaches. The lower reach extends from the river estuary to 70 km upstream consisting of Andean ridges, plain area and shore area. The middle reach is situated between 70 km and 170 km predominantly consisting of high mountain ridges, gorges with deep V-shaped valley. The upper reach is situated between 170 km and 230 km consisting of alpine and glacial areas.

Rainfall and surface runoff (See Chapter 2)

6. Annual rainfall is less than 50 mm in the coastal area of the lower reach and increases with altitude up to 1,000 mm in the upper reach higher than 4,000 m (see isohyet in Figure 1). The mean annual basin rainfall is about 437 mm (2,576 MCM/year). The basin runoff ratio is about 0.54 at the Socsi station (5,980 km^2). The annual basin runoff varied from 600 MCM/year (19.0 m^3/s) to 2,572 MCM/year (81.6 m^3/s) at Socsi, the mean being 1,385 MCM/year (43.9 m^3/s) during the period 1965 - 1997.

Daily discharge records from 1986 to 1997 are available at five stations (Tanta, Aguas Calientes, Tinco de Alis, Chavin and Socsi). Missing data are filled by means of correlation with nearby stations and monthly discharge data series are prepared for the water demand and supply balance analysis. Duration curves at gauging stations are shown in Figure 2. Estimate of discharge from rainfall records was tried by adopting the Tank Model, however, simulated daily discharge did not agree with the recorded data due to an insufficient number of rainfall stations, in particular, in the mountain area along the basin boundary higher than 3,000 m.

Groundwater (See Chapter 2)

7. The potential pumping volume of ground water is suggested to be about 150 MCM/year (about 4.75 m^3/s). However, the existing hydrological quantitative data and information are not sufficient to estimate hydrodynamic character and development potential of aquifers with appropriate accuracy. It is tentatively assumed at this stage that development potential of groundwater is about 130 MCM/year (about 4 m^3/s). The safe yield of the groundwater development must be determined through stepwise development with careful monitoring of groundwater level, water quality, effect of sea water intrusion and other potential adverse effects.

Water demand and supply balance analysis

Demand projection (See Chapter 3)

8. Domestic and industrial (D/I) water demand in the year 2030 is estimated to total 190 MCM/year (6.02 m^3/s) in the planned service area including the southern area of the capital Lima (5 m^3/s), lower reach of the Cañete River basin (0.87 m^3/s) and Concón-Topará (0.15 m^3/s). Locations are shown in Figure 3 and the supply system is assumed as shown in Figure 4. The growth of D/I water demand in the capital Lima toward 2030 is estimated as shown in Figure 5. The annual demand 1,018 MCM in 1998 (32.3 m^3/s) would be increased to 1,283 MCM in 2030 (40.7 m^3/s).

Water demand for agriculture is estimated to total 722 MCM/year (peak 43.4 m^3/s for 53,500 ha) in the irrigation area including the existing Valle de Cañete (peak 22.3 m^3/s for 24,000 ha), proposed Pampas Altas de Imperial (peak 1.7 m^3/s for 2,500 ha) and proposed Concón-Topará (peak 19.5 m^3/s for 27,000 ha). Cropping pattern in the Valle de Cañete and location of the existing and proposed irrigation areas are shown in Figures 6 and 7.

Electric power demand in the year 2030 is estimated at 9,700 MW for the National Interconnected System and 75 MW for the system in the Cañete basin. National grid and demand projection are shown in Figures 8 and 9 respectively.

Storage dams (See Chapter 4)

9. Four storage dams are considered for runoff regulation, from upstream to downstream, Paucarcocha (55 MCM), Morro de Arica (205-245 MCM), Auco (167-353 MCM) and San Jerónimo (132-350 MCM). The locations of the dam sites and principal features of the dams (typically Paucarcocha and Morro de Arica dams) are shown in Figures 10, 11 and 12. The Morro de Arica dam, in combination with the Paucarcocha and San Jerónimo dams as necessary, is able to bear the main role of runoff regulation. The Auco dam was finally discarded since its regulation efficiency is inferior to that of the alternative San Jerónimo dam.

Development scenario and demand & supply balance analysis (See Chapter 4)

10. Water resources development is contemplated with three principal scenarios;

- Senario-1 with first priority on D/I water supply, in particular, high weighting on the water conveyance to the south of the capital Lima,
- Senario-2 with high weighting on the irrigation (agriculture) development, and
- Senario-3 with equal weighting on the D/I water supply and the irrigation (agriculture) development.

In these scenarios, hydroelectric power generation is treated as in-stream water use while D/I and irrigation water use is treated as consumptive water use.

After extensive examination on various combinations of water demand and storages, the development scenarios are subdivided into seven (7) alternative cases of water resources development, as listed in Table 1 and as shown below in terms of the water demand.

Demand Category	Location	Scenario-1		Scenario-2		Scenario-3		
		Case 1.1	Case 1.2	Case 2.1	Case 2.2	Case 3.1	Case 3.2	Case 3.3
D/I water supply (m^3/s)	CB+CTP	1.03	1.03	1.03	1.03	1.03	1.03	1.03
	L	5.0	10.0	0	0	5.0	5.0	5.0
Irrigation (1,000 ha)	CV	24	24	24	24	24	24	24
	CLC	0	2.5	0	0	2.5	0	0
	CTP	0	0	27	13.5	27	13.5	27
Hydroelectric power (MW)		246	270	270	246	270	270	270
Maintenance flow (m^3/s)		4.3	4.3	4.3	4.3	4.3	4.3	1.0

. CB: Cañete river basin, CTP: Concón-Topará, L: South of the capital Lima, CV: Valle de Cañete, CLC: Pampas Altas de Imperial

Scenario-1 is composed of 2 different cases for D/I water supply to the south of Lima (5 and 10 m^3/s). Scenario-2 is composed of 2 different cases for irrigation in Concón-Topará (27,000 and 13,500 ha) and Scenario-3 assumes common amount of D/I water supply to the south of the capital Lima (5 m^3/s) but consists of 3 different cases for the combination of irrigation area (37,500, 51,000 and 53,500 ha) and amount of maintenance flow (4.3 m^3/s and 1.0 m^3/s). A typical system diagram (for the Scenario-2) is shown in Figure 13.

The result of water demand and supply balance analysis shows a probable water shortage at present and a large shortage (deficit) to the proposed maximum demands in the case without storage dams. The water utilization ratio, which is the ratio of the mean annual water demand to the mean annual runoff, will increase dramatically from 27.3% in 1999 to a maximum of 75.8% if the planned sectoral water resources development plans with dam(s) are implemented: 48.2% for Case 1.1, 62.2% for Case 2.1 and 75.8% for Case 3.1. The water resources development ratio, which is the ratio of total active storage capacity of the dam(s) to the mean annual runoff, will also increase from nil in 1999 to a maximum of 37.9%: 14.8% for Case 1.1, 21.7% for Case 2.1 and 37.9% for Case 3.1.

Screening criteria and development plan analysis

Screening criteria (See Chapter 4)

11. Screening criteria are set out for the plan formulation, by taking into consideration the legal priority of water use (including water right), national and regional policy, cost and benefit, clearance of EIA and policy of sustainable development.

The legal priority refers to the 1969 General Water Law, in which regional priority is first given to the water uses inside the Cañete river basin and sectoral priority is in the order of domestic water supply, animal breeding and livestock, agriculture, hydroelectric power and industrial water supply including mining, and others (navigation, tourism, etc.).

The concept of minimum river maintenance flow is introduced for sustainable development of the region. The existing minimum flow at the river mouth of the Cañete river is estimated at 1 m^3/s, while the 99% daily discharge is about 4.3 m^3/s at Socsi. The latter (4.3 m^3/s) is adopted as the maintenance flow in the downstream of Socsi in the development scenario, except for the Scenario-3/Case 3.3 with the former flow (1 m^3/s).

IRR of the alternatives and Sectoral development plan (See Chapters 4 & 5)

12. The economic and financial IRRs (internal rate of return) and NPVs (net present value) for the alternative cases of development are summarized as follows.

Scenarios/ Alternatives	IRR (%)		NPV at 12% (Million US$)	
	Financial	Economic	Financial	Economic
Case 1.1	17.1	14.2	156.1	56.4
Case 1.2	17.2	11.2	260.0	-24.8
Case 2.1	15.6	16.9	118.0	148.6
Case 2.2	15.8	15.9	87.8	81.5
Case 3.1	12.6	13.0	36.7	46.5
Case 3.2	15.0	14.3	137.3	83.8
Case 3.3	16.1	16.4	208.3	184.7

The above indicators show that all alternatives except for the Case 1.2 are both economically and financially feasible for their implementation.

Sectoral development in terms of D/I water supply, agriculture and hydropower is further assessed as follows.

(1) D/I water supply

A preliminary design of the Cañete River water conveyance to the south area of the capital (5 m^3/s) was prepared with a principal feature of a water intake at Zuniga on the Cañete river and a 206-km long mountain-side route conveyance canal (see location in Figure 14). An alternative canal along a coastal route allows shorter conveyer distance (165 km) but requires 110 m high pumping-up facility and longer pipes, resulting in a higher cost than the mountain route.

Comparison is shown below in terms of NPV of the capital and recurrent costs between the above Cañete river water conveyance scheme and the alternative Mantaro-Carispacha scheme, adopted in the 1998 SEDAPAL M/P, which plans to transfer water from the Mantaro river basin to the capital Lima via Rimac river (see location in Figure 14).

(Unit: million US $)

Source	Cañete River				Mantaro River
Cost allocation	S/P	D/P (Case 1.1)	M/P-1 (Case 3.3)	M/P-2 (Case 3.1)	Mantaro-Carispacha
NPV	304	254	239	333	176

S/P: single-purpose, D/P: dual-purpose, M/P: multi-purpose

In case the Cañete river water conveyance scheme is developed as a single-purpose D/I water supply, its NPV is much larger than the NPV of the alternative Mantaro river scheme. Development of a dual-purpose (D/I water supply and power production) or multi-purpose (D/I water supply, irrigation and power production) scheme will reduce the NPV of the Cañete river scheme, however it would remain expensive compared to the Mantaro river scheme.

It is further noted that the implementation of the Cañete river scheme would invite probable serious objection by the people in the river basin against the transfer of water to other basin.

(2) Irrigation and Power

A private firm, Cementos Lima, is promoting an integrated development for hydropower and irrigation. The hydroelectric power development (total 270 MW comprising 50 MW at Morro de Arica and 220 MW at El Platanal) is an attractive scheme to be put in the National Interconnected System. The agriculture development (27,000 ha at Concón-Topará) will enjoy an integrated effect of the hydropower development.

Rehabilitation and improvement of the existing agriculture land (24,000 ha at Valle de Cañete) is being implemented with co-finance by OECF (now JBIC) of Japan and the World Bank.

Implementation of the Pampas Altas de Imperial depends on the implementation of the D/I water supply to the capital Lima, since the irrigation intake is planned to be branched from the conveyance canal.

<u>Preferred option of development and Implementation schedule</u> (See Chapter 5)

13. The preferred option of the water resources development would be the Scenario-2/Case 2.1, for the following reasons (see the component on Table 1 and system diagram in Figure 13).

- D/I water supply to the capital Lima would preferably depend on the Mantaro river basin in terms of economic viability and legal priority of basin water use, therefore the Secenario-2/Case 2 would be more preferable option than the others.
- Case 2.1 shows higher value in economic and financial indicators than Case 2.2.

Storage for the river runoff regulation will be attributed to the implementation of the Morro de Arica dam followed by the Paucarcocha dam as needed according to the increase in water demand.

The implementation schedule of the Case 2.1 is shown in Figure 15.

- Expansion of D/I water supply in the Cañete river basin (0.87 m^3/s) will be carried out step by step to meet the demand growth by use of groundwater and/or surface water. D/I water supply to Concón-Topará (0.15 m^3/s) will be implemented over the period from 2003 to 2007 together with the implementation of the irrigation development therein.
- On-going rehabilitation of the existing Valle de Cañete irrigation system (24,000 ha) is assumed to be completed by 2004. Concón-Topará development (27,000 ha) is assumed to be realized over the period from 2003 to 2011.
- Hydropower development including Morro de Arica (dam and 50 MW power plant) and El Platanal (220 MW power plant) is planned to be realized over the period from 2003 to 2006.

Assessment of water resources management

Environmental aspects (See Chapter 6)

15. Pollution of water is observed with heavy metals in the upper reach of the Cañete river and with fertilizer and pesticide in the lower basin. Severe erosion (Huaycos) takes place in the basin, particularly in the middle reach. Initial Environmental Examination indicates that implementation of the water resources development projects would induce environmental impact to some extent, in particular, a change of flow regime that may cause deterioration of the natural environment and resettlement issues at the sites of the engineering works (see Table 2 for screening and scoping). Further investigation is required to enable quantitative description of potential issues except El Platanal Integrated Project. The environmental impact study for the hydroelectric plant has been approved by the Ministry of Industry, Tourism and International Commercial Negotiations (MITINCI), with favorable opinion of the Ministry of Energy and Mines (MEM) and INRENA on August 23, 1999, after a previous public hearing in Cañete on July 29, 1999. The environmental impact study for the Concon-Topara Irrigation is in its final phase, and its final approval will be granted at the end of the first quarter of 2002.

Water resources management (See Chapter 7)

16. The water resources management in the Cañete River basin will require the following issues:
    1) Watershed management with respect to protection against natural disasters, in particular, flood, debris flow, and sediment control,
    2) Flood control in the flood prone areas,
    3) Water use management with respect to superintendency of multisectoral water use including legal and institutional arrangements,

4) Environmental conservation, in particular, maintenance of a healthy quantity and quality of water for the riparian and river ecosystems, and
5) Monitoring system.

In the Cañete river basin, damages due to the natural disasters, such as flood, debris flow and landslides are assessed to be fairly low compared to the other river basins. Injury of people and collapse of houses and roads were typical damages. Reports of death was low. Provision of a forecasting and warning system for flood and debris flow will be one of the practical non-structural measures.

The irrigation water and the D/I water have been the main water use inside the Cañete river basin. However, the existing water use is expected to compete with the water demand close to but outside the basin, such as the conveyance to Concón-Topará for irrigation in the near future. The integrated management of transboundary water resources and their multi-sectoral use are of great importance to riparian regions, provinces, districts and organizations.

A well-organized monitoring system will be required to achieve efficient integrated management of water resources, by providing the necessary data and information for project planning and implementation, for administration and superintendence and for operation and maintenance.

Institutional aspects (See Chapter 8)

17. The use of water in Peru is determined by the 1969 General Water Law. While the Ministry of Agriculture is responsible for water resources allocation and establishment of water tariffs, several government agencies are involved in water resources development and management (see Table 3). Responsibility for provision of the services of D/I water supply is distributed to 45 companies, among which SEDAPAL is the largest entity with approximately 1,600 personnel taking charge of water supply to the metropolitan area of Lima and Callao (see organization chart in Figure 16). Agricultural Investment and Promotion Law (1991) stipulates the establishment of regional inter-sectoral water management entities known as Autonomous Hydrological Basins Authority (AACH). An AACH exists in five river basins but one has not yet been established for the Cañete River basin. Establishment of AACH with various water user's participation was expected to contribute to better water resources management (see organization in Figure 17). AACH was replaced with the River Basin Authority Board in July 2001 prior to enactment of the new water law. The river administration organization for the local and national water authorities will be modified according to the new law. In addition, capacity building will be required in the National Environmental Council (CONAM) for addressing water pollution and in the National Service for Meteorology and Hydrology (SENAMHI) for hydrology data collection and transfer.

Supplemental investigation on Rimac river

Rimac river (See Chapter 9)

17. The Rimac river with its basin area of 3,583 km^2 and length of 143 km flows in the area of the capital Lima to the pacific ocean, discharging an average of about 21.3 m^3/s runoff gauged at Chosica station. The highest altitude of the river reaches to 4,850 masl and the river arises on the opposite side of the ridges that forms the Mantaro river basin, one of the upstream-most branch rivers of the Amazon river basin. The Rimac river has long contributed to the main role of D/I water supply to the capital Lima, by conveying the water of its own basin and, currently, water in the Mantaro river basin as well.

The 1998 SEDAPAL M/P assumed the loss of Rimac river runoff between the upper and lower reaches in the dry season to be 5%, or 0.67 m^3/s. However, runoff records used for several studies show notable discrepancies in quantity. A measurement conducted by SEDAPAL itself indicates that the loss may be ranged to be 25% in the maximum.

Besides, it is reported that since the1960's, that the water quality of the Rimac river has become significantly contaminated due to toxic chemicals, non-degradable materials, and microorganisms.

Loss of river runoff and impact to potable water supply to Lima (See Chapter 9)

18. River water loss between Chosica and Atarjea (intake site for D/I water by SEDAPAL) is estimated in this supplemental investigation between 3.5 and 9.1 m^3/s, say 6 m^3/s on average, which may be attributed chiefly to 'infiltration' by 2 m^3/s at the maximum and 'irrigation/industry water take' by 4 m^3/s (see Table 4). Loss rate amounts to 25% or more of the average river runoff, which is larger than the assumption of the rate (5%) adopted in the 1998 SEDAPAL M/P.

The identified water loss will not be resolved by construction of new water source facilities only. To maintain the balance of demand and supply of potable water to Lima, it would be required, probably before the early 2010's, to adopt either/or an adequate combination of structural and non-structural measures, such as reducing the water loss, managing the demand and developing new sources of water supply.

Development of new water sources would be sought preferably in the Mantaro basin (Mantaro-Carispacha scheme) from a view point of economy and legal priority of basin water use as discussed in paragraph 12.

Water quality and runoff regulation of the Rimac river (See Chapter 9)

19. Water quality in the Rímac river is currently an acute issue, in particular the discharge of toxic heavy metals from mining, sewage from residences, and

drainage water from agricultural lands and industries. The content of toxic materials in raw water (before treatment) exceeds the allowable limit of the Peruvian General Water Law: for example, the maximum 240,000 PMN/100 ml of Coliform (the limit 4,000 PMN/100 ml), the maximum 7.31 mg/l of BOD (the limit 5 mg/l) and the maximum 5.45 mg/l of Pb (the limit 0.05 mg/l) (see Table 5).

Water in the Rímac river is in multiple use for potable water production, hydropower generation and irrigation and industrial uses. The discharge operation rule is agreed between SEDAPAL and EDEGEL with coordination by COES for potable water and hydropower respectively. However, the agreement on water allocation between SEDAPAL and agricultural/industrial users, particularly during drought periods has not been formalized yet. Water resources management in the Rímac river basin would be a more acute issue compared to the Cañete river basin.

In view of the water loss discussed in paragraph 19, and the water quality discussed above, the Rimac river basin would require a water resources management study for alternative measures including (a) monitoring water quality and aquatic ecology, (b) institutional and legal arrangements and (c) alternative structural measures, in order to proceed the integrated management of surface water and groundwater with action programs of the study outputs.

Integrated Master Plan and Conclusions (See Chapter 10)

20. The integrated master plan for the water resources development of the Cañete river basin is concluded as follows in terms of ‘development of water resources’ and ‘management of water resources’:

(1) Development of water resources

Preference would remain with the Mantaro river basin, not the Cañete river basin, to convey new water to the capital Lima for D/I supply, as indicated by an economic assessment and other screening criteria.

Development of water resources would be realized, shown as Scenario-2/Case 2.1 on Table 1, by constructing the Morro de Arica dam supplemented with the construction of the Paucarcocha dam as needed with increase in demand;

- Development of D/I water supply (total of 1.03 m^3/s) including expansion in the Cañete river basin (0.87 m^3/s) and provision to the Concón-Topará area (0.15 m^3/s) to be accompanied by the implementation of agriculture development therein.
- Development of irrigation, total of 51,000 ha, including the rehabilitation and improvement of the existing Cañete Valley agriculture land (24,000 ha) and new development in the Concón-Topará (27,000 ha).
- Development of hydroelectric power, total at 270 MW including new development at Morro de Arica (50 MW) and at El Platanal (220 MW).

The implementation schedule for development is prepared as shown in Figure 15;

- Expansion of D/I water supply in Cañete river basin (0.87 m^3/s) will be carried out step by step to meet the demand growth by use of groundwater and/or surface water. D/I water supply to Concón-Topará (0.15 m^3/s) will be implemented over the period from 2003 to 2007 together with the implementation of the irrigation development therein.
- On-going rehabilitation of the existing Valle de Cañete irrigation system (24,000 ha) is assumed to be completed by 2004. Concón-Topará development (27,000 ha) is assumed to be realized over the period from 2003 to 2011.
- Hydropower development including Morro de Arica (dam and 50 MW power plant) and El Platanal (220 MW power plant) is planned to be realized over the period from 2003 to 2006.

Among the above, a private firm, Cementos Lima is carrying out the implementation of both the hydroelectric power (both Morro de Arica and El Platanal) and irrigation (Concón-Topará) with the construction of the Morro de Arica dam. Rehabilitation and improvement of the irrigation system for the existing agricultural land at the Valle de Cañete is being implemented with co-finance by OECF (now JBIC) of Japan and the World Bank.

(2) Management of water resources

The requirement for water resources management in the Cañete river basin, in respect of natural disasters, flood control, water use, water quantity and monitoring system, is not immediate at present. It would however be highlighted when the development of water resources will proceed and there are indications that there will be arguments on water allocation and contamination.

(3) Management of water resources in the Rimac river basin

The Rimac river basin currently faces more acute issues compared to the Cañete river basin in terms of water allocation and quality of the potable water supply to the capital Lima. Water in the Rímac river is in multiple use for potable water supply (in charge of SEDAPAL), hydropower generation (in charge of EDEGEL) and irrigation and industrial uses. Water use between SEDAPAL and EDEGEL is being coordinated by meetings. There is, however, no formal agreement on the water allocation between SEDAPAL and agricultural and industrial users, in particular during low flow period, which is deemed to be one of the causes of the appreciable loss to the potable water take. Water in the Rímac river is contaminated, particularly by the discharge of toxic heavy metals from mining, sewage from residences, and drainage water from agricultural lands and industries, with the results that the content of toxic materials in raw water sometimes exceed the allowable limit of the Peruvian General Water Law.

The Rimac river basin would require prudent consideration to prepare and implement guidelines and measures for water resources management including water quantity and quality monitoring, institutional arrangements and structural measures.

Table 1 Water Resources Development Scenarios and Alternative Cases

	Scenario-1		Scenario-2		Scenario-3		
	Case 1.1 *	Case 1.2	Case 2.1 *	Case 2.2	Case 3.1 *	Case 3.2	Case 3.3 *
Water Demand:							
1)D/I Water Supply	CB+L5	CB+L10	CB	CB	CB+L5	CB+L5	CB+L5
2)Irrigation Demand	CV	CV+CLC	CV+CTP	CV+CTP5	CV+CLC+CTP	CV+CTP5	CV+CTP
3)Maintenance Flow	Mf4.3	Mf4.3	Mf4.3	Mf4.3	Mf4.3	Mf4.3	Mp1.0
4)Total Demand (MCM)	667.7	855.55	861.4	685.73	1049.28	843.41	915.05
Dam: Active Storage							
1)Morro de Arica (MCM)	205	245	245	205	245	245	245
2)Paucarcocha (MCM)	Not Applicable	55	55	Not Applicable	Not Applicable	55	55
3)Capillucas (MCM)	2.8	2.8	2.8	2.8	2.8	2.8	2.8
4)San Jeronimo (MCM)	Not Applicable	Not Applicable	Not Applicable	Not Applicable	280	Not Applicable	Not Applicable
Power Station:							
1)Morro de Arica (MW)	46	50	50	46	50	50	50
2)El. Platanal (MW)	200	220	220	200	220	220	220
3)San Jeronimo (MW)	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
New Ground Water							3m3/s(94.6MCM)
Water Conveyance	L5=5m3/s	L10=10m3/s	Not Applicable	Not Applicable	L5=5m3/s	L5=5m3/s	L5=5m3/s
Irrigation Facilities	Not Applicable	Not Applicable	CTP Full Scale	CTP Half Scale	CTP Full Scale	CTP Half Scale	CTP Full Scale

Notes

*: The selectted scale for respective scensrios.

CB: D/I Water in Canete River Basin(34.22MCM), L5: Lima D/I Water Supply 5m3/s(157.68MCM), L10: Lima D/I Water Supply 10 m3/s(315.36MCM),

CV: Canete Valley Irrigation(340.20MCM), CLC: Alto Imperial Irrigation(30.17MCM), CTP: Concon-Topara Irrigation (Full Scale 351.41MCM),

CTP5: Concon-Topara Irrigation (Half Scale 175.71MCM)

Mf4.3: Maintenance Flow 4.3m3/s(135.60MCM), Mp1.0: Maintenance Flow 1.0m3/s(31.54MCM)

Table 2　　Overall Evaluation for Screening and Scoping

Check Items	Evaluation	Future Study Plan	Remarks
Impact on fishing industry	A	The fishing situation and fish species, i.e. trout and camarones (river prawns).	Trout is Non-endemic.
Change in flow regime	A	The water discharge pattern.	Monitor ecological minimum.
Change in the population distribution in the region	C	Land use, irrigation plans, and economic development plans in the Cañete River basin area.	More jobs!
Change in life-style	C	Sociological sketch of the life-style of residents near Auco, San Jerónimo and Zuñiga.	
Impact on agriculture and forestry	D	The irrigation plans and economic development plans in the entire Cañete River basin area.	
Additional use of agricultural chemicals and its accumulation	B	How to reduce the rampant use of pesticides and fertilizers.	Practice sustainable agriculture
Increased production and discharge of garbage and discharges	B	Economic development plans and incorporate them in the environmental management plan.	
Deterioration of sanitary condition during construction period	B	The sanitary condition in the project area.	
Draining area accretion	B	The influence of debris flow from the upper Cañete basin and the tributaries.	
Impact on downstream flow variations	D	Prediction of the water discharge pattern impact.	
Detrimental changes In water temperature	B	Impact prediction.	
Water contamination	B	The influence of debris flow into lower Cañete River basin.	
Change in sediment composition	B	The influence of debris flow into lower Cañete River basin.	
Exhaust fumes / offensive odors	B	Impact prediction (during construction period).	
Noise and vibration	B	Impact prediction (during construction period).	
Water rights, fishing rights, and rights relating to common use of trees	D	The vested rights and customs.	
Resettlement	B	Compensation and resettlement plan for 200 houses in the entire Cañete River basin.	
Conflict among local residents	C	The development plans in the project area must include provisions for public participation.	
Indigenous people, Minority groups, nomads	C	The settling zones in the upper Cañete basin of these groups.	
Widened income disparities	C	The development plans in the project area.	
Deterioration or destruction of historical and cultural heritages	D	The distribution of cultural heritage.	
Impact on induced earthquake	C	Geological risks.	
Slope failure	C	Observation of the weathering of mountain and study on the soil quality and history of 'Huaycos' in the area.	
Salt pollution	C	The salt accumulation and the Irrigation plans.	
Impact on precious species	C	Biodiversity survey.	

Note : A ; Serious,
B ; To some extent,
C ; Unknown (It is necessary to examine and there are possibilities that it turns out clearer as the study proceeds.),
D ; No (Since there is little impact it is not in the scope of IEE nor EIA).

Table 3 Summary of Tasks of Organizations related to Water Resources Development and Management

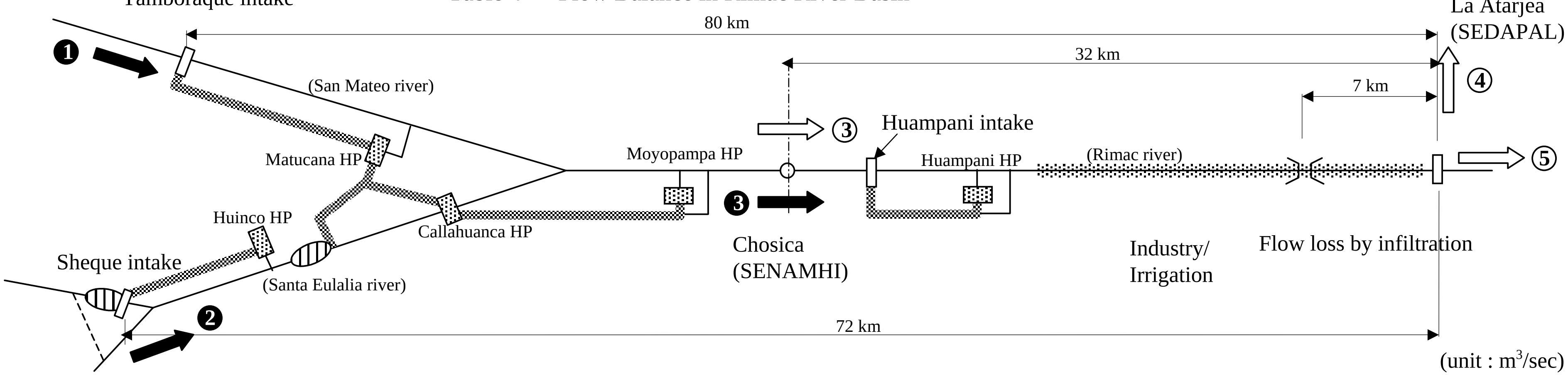
Dc : Data Collection Pl : Planning OM : Operation/Maintenance Mo: Monitoring
Re : Regulatory Coo : Coordination I: Implementation
N.B. 1. Contractors are not counted. 2. "Planning" role is to be assumed by the Government.
3.Though AACH does not exist in the Canete River Basin, included in the Table for reference.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	MIPRE			CONSEJO DE MINISTROS		MAG					MEM		MITINCI		MEF	MS	MD	LOCAL GOVERN-MENT		PRIVATE SECTOR			
Organizations	SEDAPAL	INADE	FONCODES	CONAM	INDECI	ATDR	INRENA	PRONAMACHS	PSI	AACH	DGE	DGAA	MITINCI	SDFEA	SUNASS	DIGESA	SENAHMI	LOCAL GOVERNMENT	EMAPA CANETE S.A.	OUA	ELECTROPERU	INDUSTRIAL ENTERPRISES	CEMENTOS LIMA
TASKS																							
I. Water Resources Development																							
1. Surface Water	I	DC,I				Pl, Re	Pl, Re	Pl, Re	I	Pl, Re	Coo	Coo	Coo	Coo			Dc				Dc		
2. Groundwater	I					Pl, Re	Pl, Re	Pl, Re		Pl, Re												I	
3. Forest management							Pl, Re	Pl, Re															
4. Sediment Control					Pl, I	I	I			I										I	Mo, I		Mo, I
5. Debris control				Coo	Pl, I											Mo		I					
Ⅱ. Water Resources Management																							
1. Water balance	Mo					Dc, Pl	Pl			Pl, Re							Mo			Dc, Pl			
2. Water allocation	Mo					Re	Pl, Re	Pl, Re		Pl, Re													
3. Water supply																							
3.1 Agricultural water		Pl, I	I			Pl,Re	Re	I	I	Pl, Pe										OM	OM	I	
3.2 Domestic water	I		I			Re	Re			Pl, Pe					Mo, Re	Re			I				
3.3 Industrial water	I					Re	Re			Pl, Pe									I			I	
3.4 River maintenance flow						Coo	Coo			Coo													
3.5 Hydro power generation						Re	Re			Re	Pl, Re	Coo									I		I
4. Flood control																							
4.1 Flood and disaster control		Pl			Pl, I		Coo,I			Coo								Dc, OM					
4.2 Flood forecasting		Pl			Pl, I													Dc, OM					
5. Water quality				Pl			Re		I														
5.1 River water	Mo			Co				Re	I	Re						Mo	Mo						
5.2 Waste water discharge	Mo			Co										Re				Mo					
6. River environment and Tourism																							
6.1 River and surrounding areas				Co				Re		Re			Pl										
6.2 Recreation around river areas				Co				Re		Re			Pl										
6.3 Biota in the river area				Co				Re		Re													

Abbreviations :

AACH : Autoridad Autonoma de la Cuenca Hidrografica	Autonomous Hydrographic Basin Authority
ATDR : Administracion Tecnica de District de Riego	Technical Administration for Irrigation District
CONAM : Consejo Nacional del Ambiente	National Environment Council
DGAA : Direccion General Asuntos Ambientales	Directorate General for Environmental Affairs
DIGESA : Direccion General de Salud Ambiental	Directorate General for Environmental Health
DGE : Direccion General de Electricidad	Directorate General for Electricity
DGM : Direccion General de Minas	Directorate General for Mining
ELECTROPERU : Empresa de Electricidad del Peru	Peru Electricity Enterprise
FONCODES : Fondo Nacional de Compensacion y Desarrollo	National Fund for Compensation and Social Development
INADE : Instituto Nacional de Desarrolo	National Institute of Development
INDECI : Instituto Nacional de Defensa Civil	National Institute of Civil Defense
INRENA : Instituto Nacional de Recursos Naturales	National Institute of Natural Resources
MAG : Ministerio de Agricultura	Ministry of Agriculture
MD : Ministerio de Defensa	Ministry of Defense
MEM : Ministerio de Energia y Minas	Ministry of Energy and Mining
MIPRE : Ministerio de la Presidencia	Ministry of Presidency
MITINCI : Ministerio de Industria, Turismo, Integracion y Negociaciones Comerciales Internacionales	Ministry of Industry, Tourism, Integration and International Trade
MS : Ministerio de Salud	Ministry of Health
OUA : Organizaciones de Usuarios de Aguas	Water Users' Association
PRONAMACHS : Proyecto Nacional de Manejo de Cuencas Hidrograficas y Conservacion de Suelos	National Program for River Basin Management and Soil Conservation
PSI : Proyecto Subsectoral de Irrigación	Irrigation Subsector Project
SDFEA : Sub Dirección de Fiscalización y Evaluación Ambiental	Sub-Directorate for Supervision and Evaluation of Environmental Affairs
SEDAPAL : Servicio de Agua Potable y Alcantarillado de Lima	Potable Water and Sewage Service of Lima
SENAMHI : Servicio Nacional de Meteorogia e Hidrologia	National Service for Meteorology and Hydrology
SUNASS : Superintendecia Nacional deServicios de Saneamiento	National Superintendence of Sanitary Service

Table 4 Flow Balance in Rimac River Basin



(unit : m^3/sec)

	❶	❷	❶+❷	❸-❶-❷	❸ , ③	Industry / Irrigation	Infiltration	Others	Total	④	⑤
Monthly average (Jul.- Sep., 1991-92)	6.1 (EDEGEL)	8.4 (EDEGEL)	14.5	-0.3 -0.4	14.2 (SENAMHI) 14.1 (EDEGEL)	-1.6 -1.5	-2.0	---	-3.6 -3.5	10.6 *1 (SEDAPAL)	0.0 0.0
Monthly average (Jul.- Sep., 1993-95)	6.8 (EDEGEL)	12.1 (EDEGEL)	18.9	+0.5 -1.7	19.4 (SENAMHI) 17.2 (EDEGEL)	-4.3 -2.1	-2.0	---	-6.3 -4.1	13.1 *1 (SEDAPAL)	0.0 0.0
Monthly average (Jul.- Sep., 1996-97)	5.7 (EDEGEL)	10.0 (EDEGEL)	15.7	+5.3 +1.9	21.0 (SENAMHI) 17.6 (EDEGEL)	-7.1 -3.7	-2.0	---	-9.1 -5.7	11.9 *1 (SEDAPAL)	0.0 0.0
Daily average in Aug. 27 - Sep. 9, 2001	11.3 (JICA)	13.0 (JICA)	24.3	+2.5	26.8 (SENAMHI)	-6.8 *3	-2.0	---	-8.8	16.5 *2 (SEDAPAL)	1.5

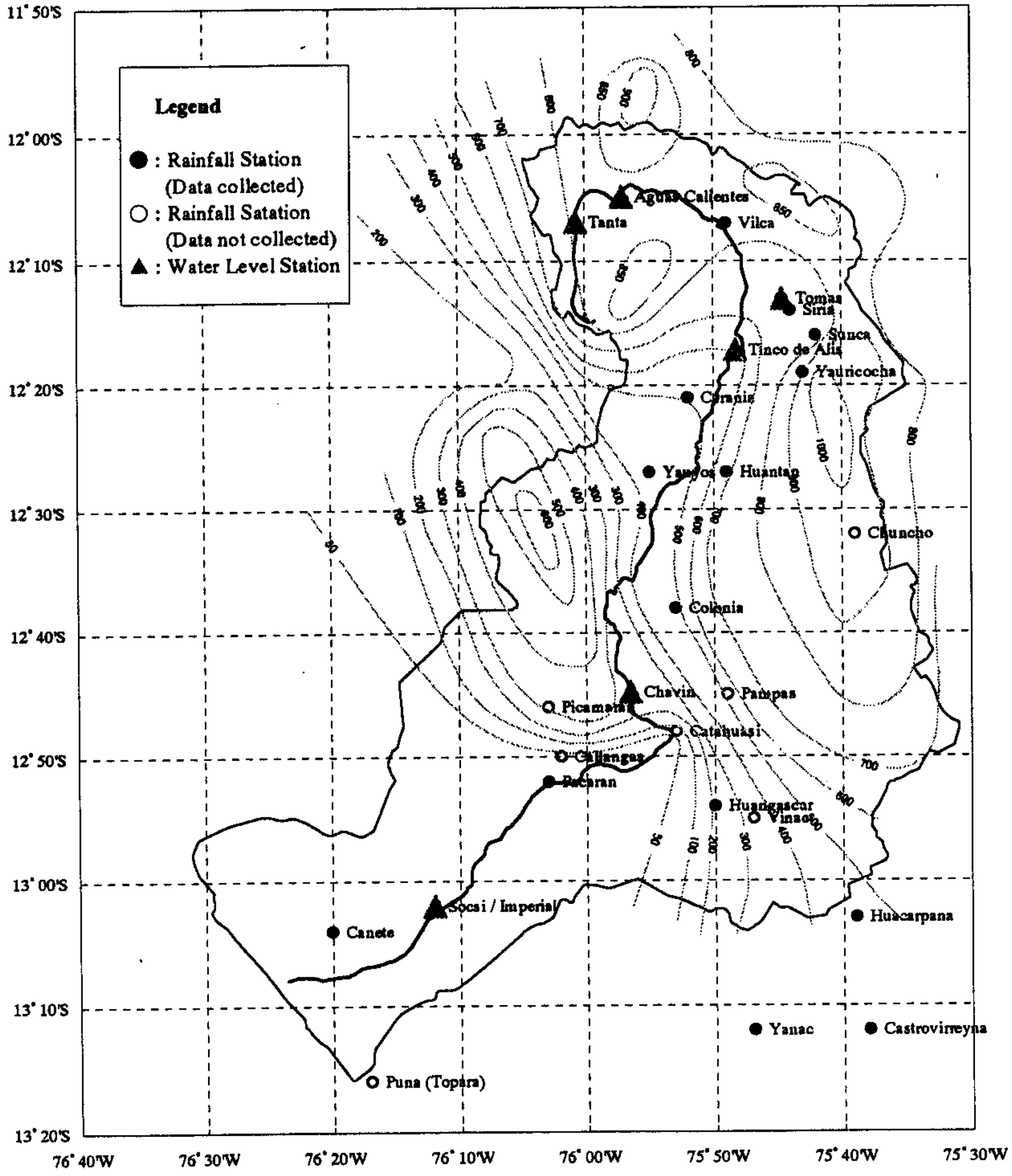
Source: *1 Production of Plant No. 1 and 2, La Atarjea (SEDAPAL)
*2 Discharge at Sediment trap basin (Desarenadores) No. 1 and 2 (SEDAPAL)
*3 Discharge measurement in Sep. 12 - 14, 2001 by JICA
Discharge data of EDEGEL at Chosica is observed at the Huampani intake. There is no intake between Chosica SENAMHI station and Huampani intake.

Note: ⑤ Overflow discharge at La Atarjea intake was assumed to be negligible in the dry season from 1991 to 1997 because discharge observed at Chosica of 20.0 m^3/sec might diverted all for potable water production. While daily average discharge of 1.5 m^3/sec (or 6.0 m^3/sec presuming 6 hours overflow time) of overflow from flood gates was observed during Aug. 27 to Sep. 9, 2001.

Table 5 Water Quality at La Atarjea SEDAPAL Intake

Parameters	Limits of General Water Law	WHO Guidelines	Quality Record
Physical-chemical analysis			
pH	5 – 9	< 8	8.28
Suspended solids (turbidity)	0 mg/l	5	49.00 mg/l*
Dissolved Oxygen (DO)	> 3.0 mg/l	-	7.88 mg/l
BOD	5.0 mg/l	-	1.61-7.31 mg/l*
Coliform	8.8 N.M.P/100ml	No detectable	5,000-240,000*
Metal Analysis			
Aluminum, Al	only for class IV 1.0 mg/l	0.2 mg/l	1.53 mg/l*
Arsenic, As	0.1 mg/l	0.01 mg/l	0.04 mg/l*
Barium, Ba	0.1 mg/l	0.7 mg/l	0.13 mg/l*
Cadmium, Cd	0.01 mg/l	0.003 mg/l	0.004 mg/l
Zinc	5.0 mg/l	3.0 mg/l	0.53 mg/l
Copper, cu	1.0 mg/l	2.0 mg/l	0.07 mg/l
Chrome, Cr	0.05 mg/l	0.05 mg/l	0.008 mg/l
Iron, Ir	1.5 mg/l	0.3 mg/l	4.18 mg/l*
Manganese	0.1 mg/l	0.5 mg/l	0.19 mg/l
Lead, Pb	0.05 mg/l	0.01 mg/l	0.27-5.45 mg/l*
Cyanide	0.2 mg/l	0.07 mg/l	0.001 mg/l

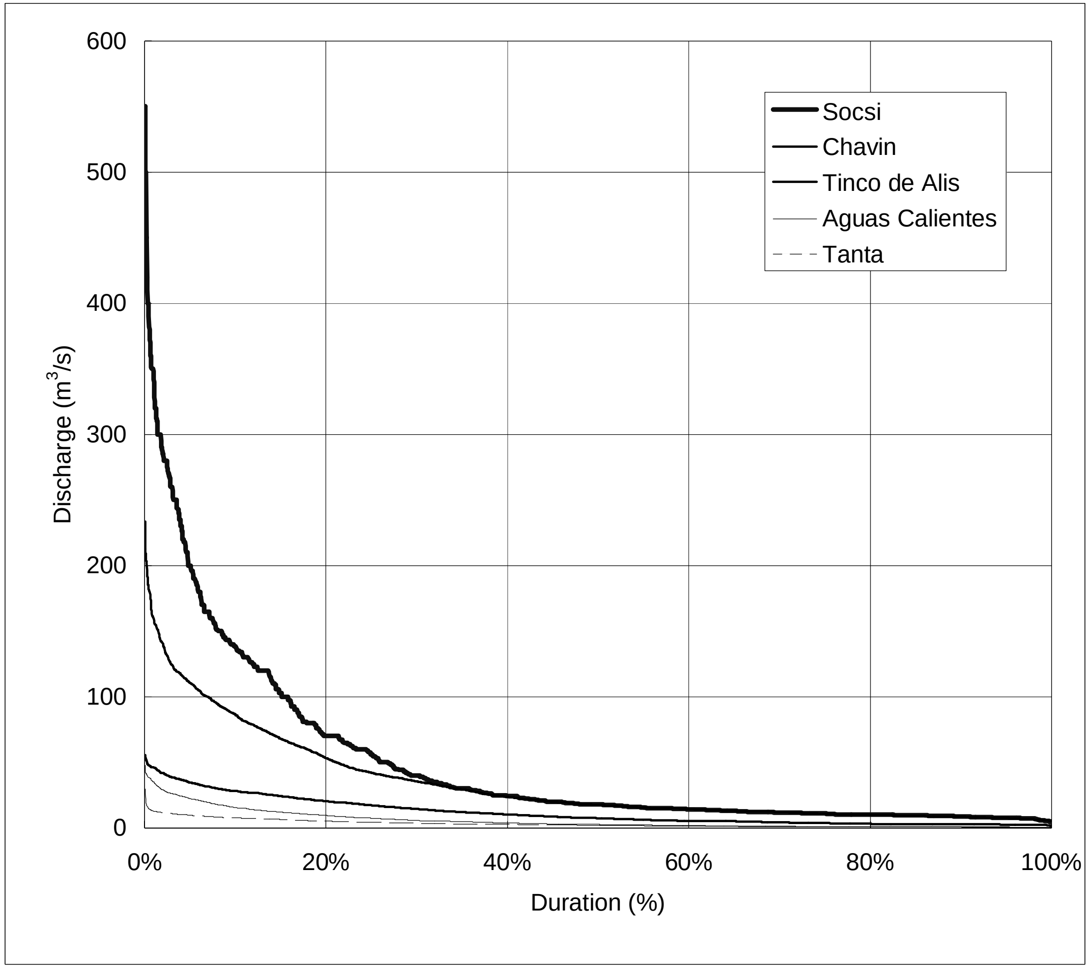
*: exceeding the limit of WHO guidelines



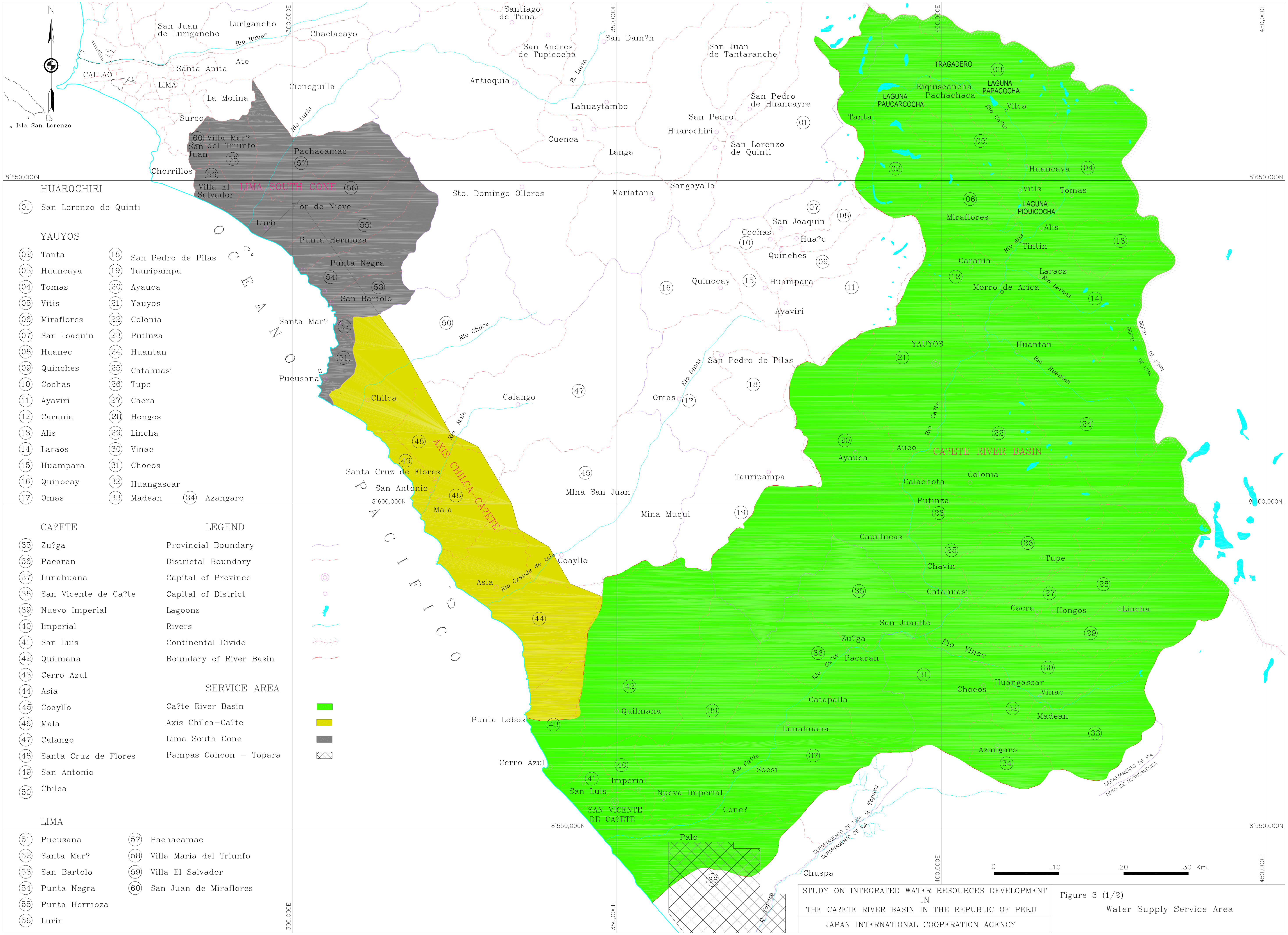
Note) Isohyet is cited from the "El Platanal Hydroelectric Power Plant Feasibility Study, 1987", ELECTROPERU

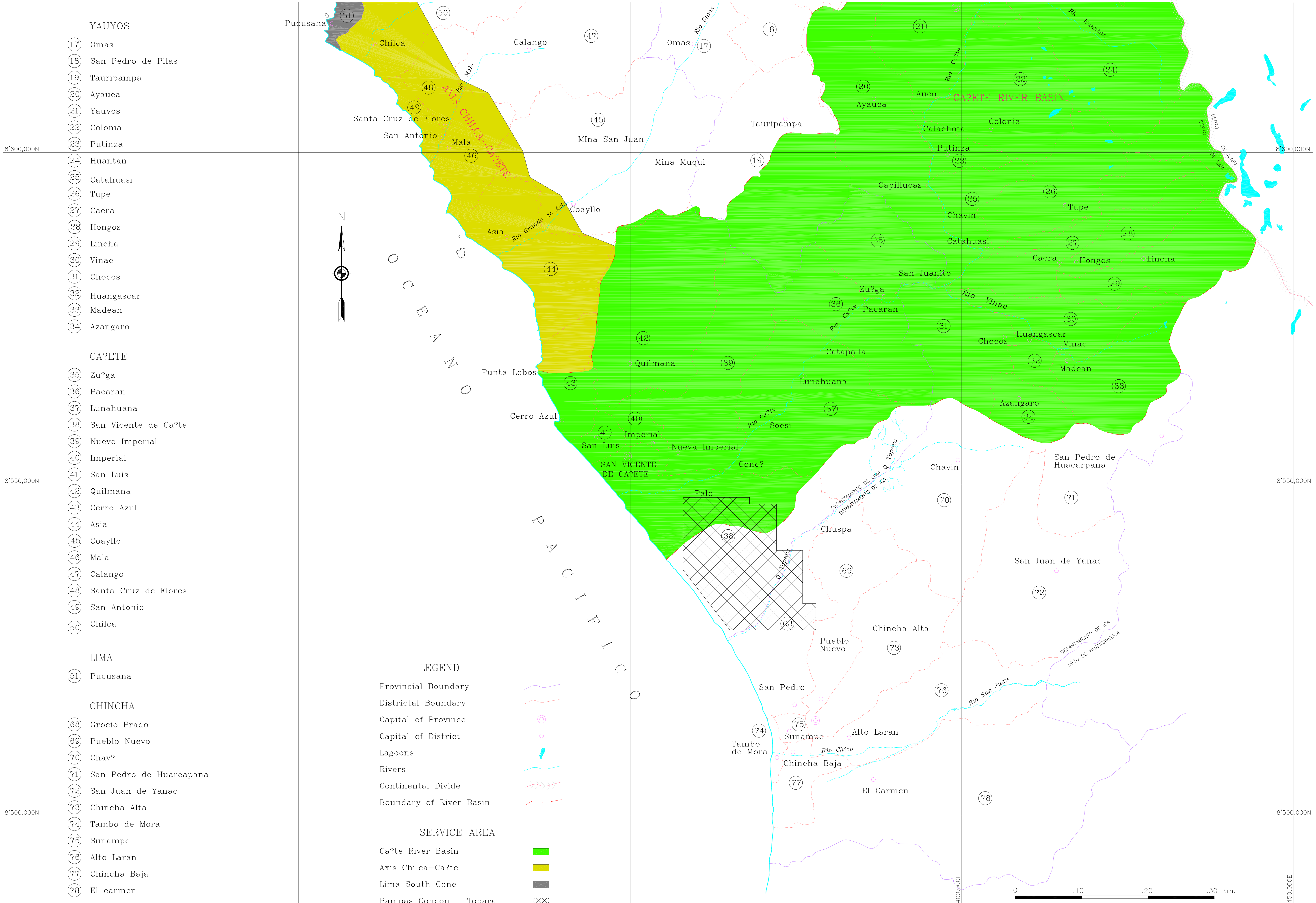
STUDY ON INTEGRATED WATER RESOURCES DEVELOPMENT IN THE CANETE RIVER BASIN IN THE REPUBLIC OF PERU	**Figure 1**
JAPAN INTERNATIONAL COOPERATION AGENCY	**Location of Meteorological and Hydrological Station**

Figure 2
Flow Duration Curve at the Gauging Stations in the Cañete River Basin



Duration (%)	Discharge (m^3/s)				
	Socsi	Chavin	Tinco de Alis	Aguas Calientes	Tanta
0.02%	550.0	233.8	55.5	47.8	29.9
5%	200.0	110.7	34.7	22.3	9.5
10%	138.0	86.7	28.1	15.6	7.6
15%	103.0	68.0	24.3	12.0	6.5
20%	70.0	53.1	20.4	9.4	5.1
25%	56.0	42.2	17.2	7.4	4.3
30%	40.0	35.4	14.4	5.7	3.7
35%	30.0	29.4	12.0	4.7	3.0
40%	24.5	23.7	10.3	3.8	2.6
45%	20.0	20.0	8.7	3.1	2.3
50%	18.0	17.6	7.4	2.6	2.0
55%	15.5	15.7	6.3	2.2	1.7
60%	14.0	14.5	5.5	1.8	1.4
65%	13.0	13.0	5.0	1.5	1.2
70%	11.7	12.2	4.3	1.3	1.1
75%	11.0	10.8	3.7	1.1	0.9
80%	10.0	9.9	3.2	1.0	0.8
85%	9.5	9.1	2.9	0.8	0.7
90%	8.8	8.5	2.8	0.7	0.6
95%	7.8	7.5	2.5	0.6	0.5
100%	4.6	5.4	1.2	0.2	0.2


HUAROCHIRI
01 San Lorenzo de Quinti
YAUYOS
02 Tanta
03 Huancaya
04 Tomas
05 Vitis
06 Miraflores
07 San Joaquin
08 Huanec
09 Quinches
10 Cochas
11 Ayaviri
12 Carania
13 Alis
14 Laraos
15 Huampara
16 Quinocay
17 Omas
18 San Pedro de Pilas
19 Tauripampa
20 Ayauca
21 Yauyos
22 Colonia
23 Putinza
24 Huantan
25 Catahuasi
26 Tupe
27 Cacra
28 Hongos
29 Lincha
30 Vinac
31 Chocos
32 Huangascar
33 Madean
34 Azangaro
CA?ETE
35 Zu?ga
36 Pacaran
37 Lunahuana
38 San Vicente de Ca?te
39 Nuevo Imperial
40 Imperial
41 San Luis
42 Quilmana
43 Cerro Azul
44 Asia
45 Coayllo
46 Mala
47 Calango
48 Santa Cruz de Flores
49 San Antonio
50 Chilca
LIMA
51 Pucusana
52 Santa Mar?
53 San Bartolo
54 Punta Negra
55 Punta Hermoza
56 Lurin
57 Pachacamac
58 Villa Maria del Triunfo
59 Villa El Salvador
60 San Juan de Miraflores
LEGEND
Provincial Boundary
Districtal Boundary
Capital of Province
Capital of District
Lagoons
Rivers
Continental Divide
Boundary of River Basin
SERVICE AREA
Ca?te River Basin
Axis Chilca–Ca?te
Lima South Cone
Pampas Concon – Topara
LIMA SOUTH CONE
AXIS CHILCA–CA?ETE
CA?ETE RIVER BASIN
OCEANO PACIFICO
CALLAO
LIMA
Isla San Lorenzo
0 10 20 30 Km.
STUDY ON INTEGRATED WATER RESOURCES DEVELOPMENT IN THE CA?ETE RIVER BASIN IN THE REPUBLIC OF PERU
JAPAN INTERNATIONAL COOPERATION AGENCY
Figure 3 (1/2)
Water Supply Service Area



STUDY ON INTEGRATED WATER RESOURCES DEVELOPMENT
THE CA?ETE RIVER BASIN IN THE REPUBLIC OF PERU
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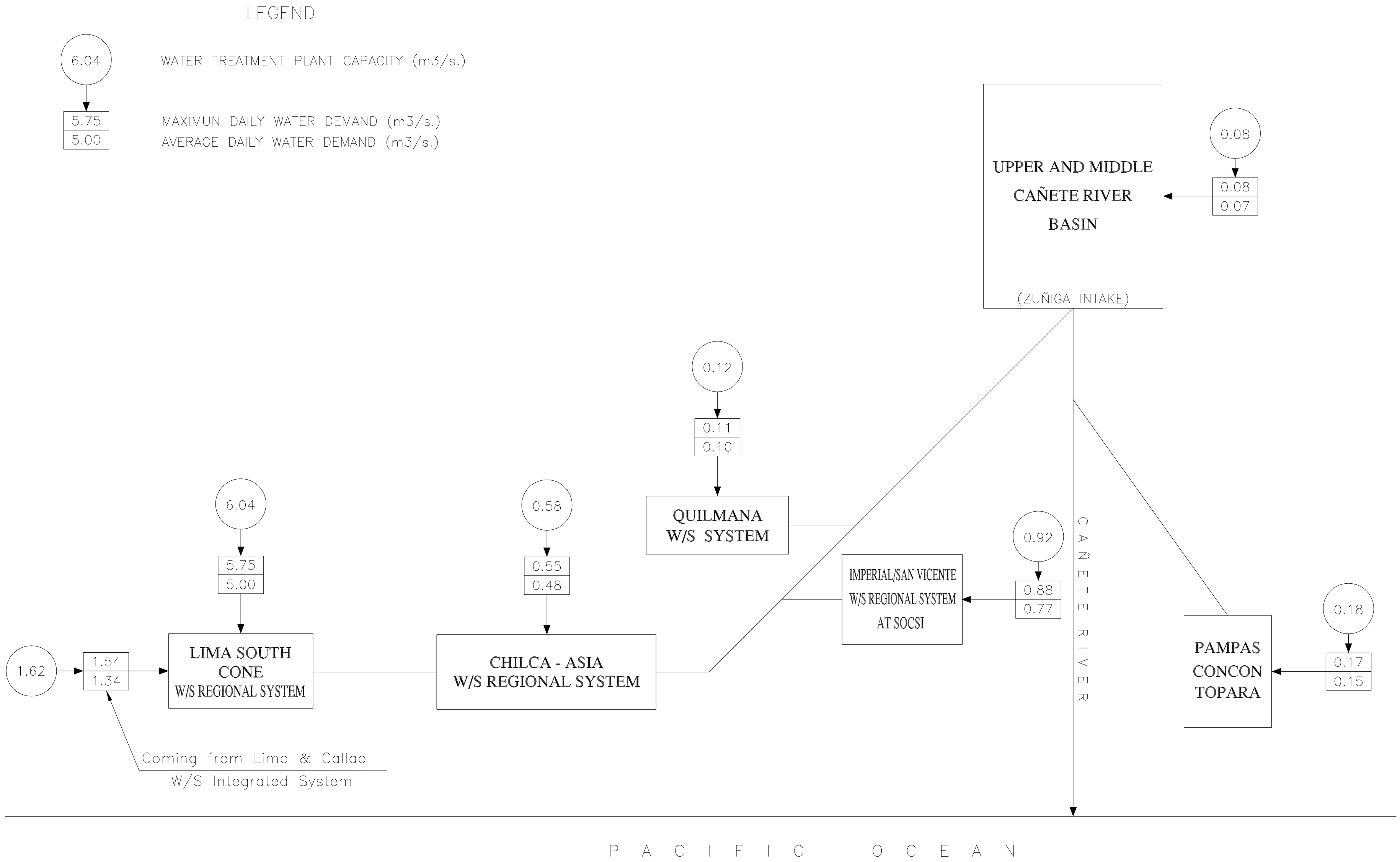
Figure 3 (2/2)
Water Supply Service Area

STUDY ON INTEGRATED WATER RESOURCES DEVELOMENT
IN
THE CAÑETE RIVER BASIN IN THE REPUBLIC OF PERU
JAPAN INTERNATIONAL COOPERATION AGENCY

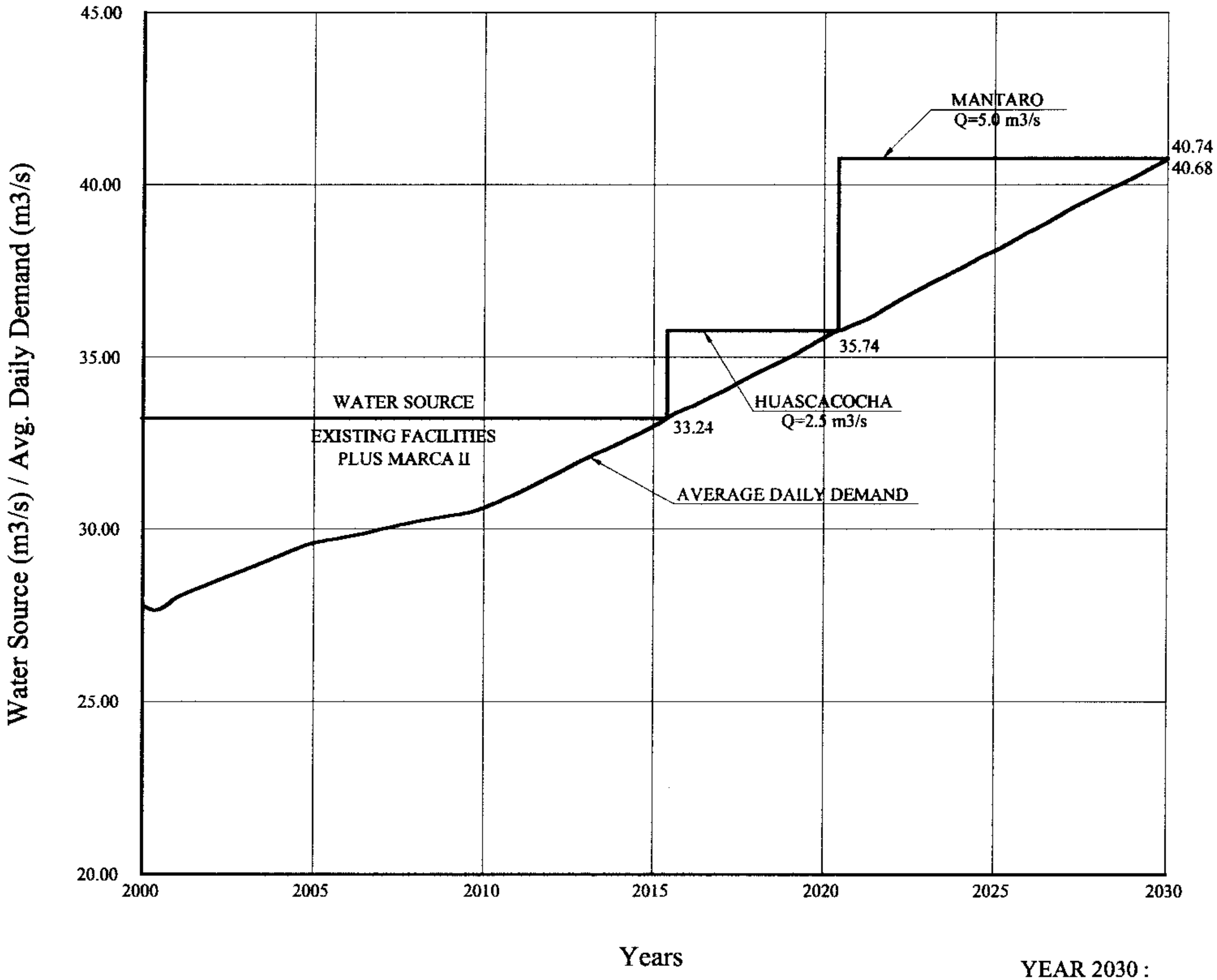
Figure 4

PROPOSED WATER SUPPLY SYSTEM



STUDY ON INTEGRATED WATER RESOURCES DEVELOPMENT
IN
THE CAÑETE RIVER BASIN IN THE REPUBLIC OF PERU

THE JAPAN INTERNATIONAL COOPERATION AGENCY



YEAR 2030 :

WATER SOURCE : 40.74m3/s
AVERAGE DAILY DEMAND : 40.68m3/s

Figure 5
Demand – Supply Balance and Proposed Expansion System for Metropolitan Lima Water Supply System

Figure 6 **Existing Cropping Pattern in the Valle de Cañete (24,052 ha)**

CROP ha	LAND AREA ha	CROP AREA ha
1 Cotton	10,726	10,726
2 Starchy maize / Potato	2,745	4,118
3 Yellow maize for feed / Starchy maize	1,965	3,930
4 Yellow maize for feed	1,965	1,965
5 Cotton in the submerged area	1,811	1,811
6 Horticulture	868	868
7 Citrus	819	819
8 Fruit trees (apple, grape, etc.)	1,710	1,710
9 Pasture (alfalfa, etc)	667	667
10 Starchy maize	776	776
Total	**24,052**	**27,390**