

Note \*): SUBCOMILAGO: Sub Comision Mixta para el Desarrollo de la Zona Integracion del Lago Titicaca

**Figure II.5.8 PELT's Organizational Structure (1999)**

(b) Office of Internal Audit as an organ of internal control in charge of supervising the technical performance, budget account and administrative management of the Project.

(c) Legal Advice Office and Budget and Planning Office, as advisory organs responsible for advising the Executive Director and other organs of the Project on the legal issues and on the formulation of development plans, international technical cooperation and rationalization of the Project.

(d) Administration Office and of Communication Office, as supporting organs in charge of supporting the Executive Director and other organs of the Project on matters related to the administration, supervision and control of human resources, economic, financial and materials of the PELT, as well as the conduction of the filing systems, documenting procedure, communication activities and public relationships.

(e) Other linear organs:

- Director of Studies, in charge of making the programs and carrying out the studies for the management and integrated exploitation of the resources of the basin of the Lake Titicaca.
- Director of Works, in charge of constructing the infrastructure of the projects consigned in the operative plans of the PELT.
- Director of Agricultural Resources, in charge of conducting the projects for the exploitation of the agricultural resources projected by the PELT.
- Director of Hydrobiological Resources, in charge of conducting the activities for achievement of rational use and integrated management of the hydrobiological resources of the basin of the Lake Titicaca.

In order to control the erosion, contamination and sedimentation of the Lake Titicaca, the PELT is conducting the Project of Decontamination of the Puno Bay, which composes the basic studies, definitive studies and plan of monitoring the contamination settled in the aquatic ecosystem. The study of the Plant Salcedo-Cancharani of pumping and treating sewerage water generated from Puno City's urban areas is also being conducted by PELT with the same purpose.

*Table II.5.7* shows the number of staff working in the PELT's organs.

**Table II.5.7 PELT's Personnel**

Name of the organ	Personnel	Total staff member
Executive Director	1 director 1 secretary	2
Office of Internal Audit	1 chief 1 engineer	2
Legal Advice Office	1 chief (lawyer)	1
Budget and Planning Office	1 chief 1 specialist of budget formulation and evaluation 1 specialist of planning 1 secretary	4
Administration Office	1 chief 1 accounting officer 1 specialist on provisions 1 specialist on personnel 1 accountant 1 integrador contable 1 accounting technician	7
Communication Office	1 chief 1 secretary	2
Director of Studies	1 director 2 engineers IV 5 engineers 1 system engineer 1 scientific specialist 1 biologist	10
Director of Works	1 director 2 supervisor IV 5 engineers 1 secretary	9
Director of Agricultural Resource	1 director 1 coordinator on agricultural technique 1 coordinator on socio- economic technique 2 agricultural specialists 1 coordinator on extension 1 administrative coordinator 1 programmer 1 investigating engineer	9
Section of Hidrobiological Resource	1 director 2 fisheries engineer 2 biologists 1 administrave technician	6
SEDE Center of INADE	1 secretary	1

## **MULTISECTORIAL COMMITTEE OF ECOLOGY AND ENVIRONMENT**

The formulation of the Multisectorial Committee of Ecology and Environment (Comite Multisectorial de Ecología y Medio Ambiente, hereinafter refer to as the 'Multisectorial Committee') is a result of the efforts of the relevant organizations in Puno Province, in order to obtain a better coordination for works aiming at the improvement of natural environment of this area.

The institutions participating in the Multisectorial Committee are:

- Municipality of Puno Province
- Transitory Council of Regional Administration (M.T.P)
- Binational Special Project of Lake Titicaca (PELT)
- EMSAPUNO
- Regional Department of Education
- National University of Altiplano, Faculty of Biology
- Andean Council of Ecological Management (CAME)
- APECO-PUNO
- Sub-region of Salud - Puno
- Regional Department of Agraria "JCM"-RNT
- College of Biologist Puno
- PRORRIDRE
- Center of Investigation, Education and Development (CIED)
- Rural Coordinator J.C.M
- PRONAMACHS
- INRENA- National Reserve of Titicaca
- XII Region PNP - Ecologic Policy
- And other organizations formed by Puno City's residents

The establishment of the Multisectorial Committee has not been formalized yet, but its members gather in the meetings every 3-month to push forward the projects which aim at "improving the Puno City's environment, in order to recover the Puno Interior Bay's water environment and its tourist potential, contributing also to the improvement of health and living condition of the Puno City's residents".

As presented in the Strategic Plan for the Improvement of Puno City's Environment (made in December 1995, with the former name "Comisión de Mejoramiento Ambiental

de la Ciudad de Puno”), the Multisectorial Committee works for the objectives which can be summarized as follows:

- (a) Develop the Puno City’s capacity to manage the environmental problems by itself;
- (b) Develop the projects for protecting the Puno Interior Bay from being contaminated by the human activities;
- (c) Develop the projects for recovering the Puno Interior Bay’s water environment once after the existing contamination process is interrupted.
- (d) Develop the projects for improving the socio-economic condition of Puno City’s residents in all aspects that contribute to the recuperation of this Bay.
- (e) Promote the results obtained by the implementation of the projects to other localities of the Titicaca Lake’s watershed, as well as to the localities of other countries that suffer the similar problems.

At the present time, the Mayor of the Municipality of Puno Province had been selected as the Committee’s chairman, and the PELT/Peru as the technical secretariat of the Committee.

Due to the lack of financial resource, the Multisectorial Committee’s plan of having a permanent office and a permanently working staff has not been realized yet. The Committee had published the annual report in May 1998, but it seems that the publication of the next report will be far late behind the schedule.

## 2) Financial situation of PELT

PELT receives fund from INADE. According to the 1998FY annual report, revenue was S/. 66,593 thousand and expenditure was S/. 65,259 thousand. The breakdown of the expenditure are as follows ;

a) General administration	S/. 12,468 thousand
b) Agriculture	49,506 thousand
c) Energy	640 thousand
d) Fishery	401 thousand
e) Health	1,852 thousand
f) Transportation	392 thousand
Total	<u>S/. 65,259 thousand</u>

### 5.3 MANAGEMENT OF SEWERAGE SYSTEM AND DRAINAGE SYSTEM

#### (1) Related Laws and Regulations

The major laws and regulations related to the management of sewerage system and drainage system in Peru are the followings.

- Law 17752 (24-07-69), General Law on Waters; additionally modified by 014-92-EM (03-06-92).
- Supreme ordinances 929-73-AG (12-09-73), 261-69-AP (12-12-69), 274-69-AP-DGA (30-12-69), 275-69-AD-DGAJ (30-12-79), 41-70-TO (20-02-70), 473-71-AG (23-11-71), 495-71-AG (01-12-71), 1098-71-AG (18-09-75), 158-81-AG (19-11-81), 007-83-INC (17-03-83), 939-73-AG (12-09-73), and 103-84-AG (17-11-84), regulations relating to the General Law on Waters and their modifications.
- Supreme resolution 006-90-VC-1200 (08-02-90), regulation on the Services of Drinkable Water and Sewer System.
- Decree Supreme No. 12-94-AG, defines the intangible areas such as the beds, the riversides and the marginal bands, etc. of the rivers, the streams, the lakes, the lagoons and water reservoirs, pub. 27-03-94.
- Ministerial Resolution No. 108-94-PR, on the creation of the execute agency for the projects handling the residual waters in Metropolitan Lima (PROMAR), pub. 14-04-94; modified by Ministerial Resolution No. 167-94-PR on 01-06-94 settles down that this project from now on will be denominated as "the Project for the Management of the Residual Waters in the Lima Metropolitan " (PROMAR).
- Law No. 26306, recognizes the ownership of the Corredor Ribereño that dominates the Costa Verda belong to many Municipal Districts of the Lima Province, pub. 13-05-94.
- Law No. 26338, Law on General Services of Sanitation, published on 24 July 1994.
- Decree Supreme No. 01-95-MTC, as an additional regulation of the Law No. 26306, recognizes the ownership of the terrestrial conformantes of the Corredor Ribereño that dominates the Costa Verda belong to many Municipal Districts, pub. 20-01-95.
- Ministerial Resolution No. 0284-96-AG, approves the Regulation of Organization and Functions of the Autonomous Authority of the Cuenca Hidrográfica Santa, pub. 04-04-96.

- Law No. 26620, Law of Control and Surveillance of the Activities on Marine, Fluvial and Lacustrine , pub. 09-06-96.
- Ministerial Resolution No. 397-96-PR, approves the new organization and the new regulation on the Organization and Functions of the Project Special National Program of Drinkable Water and Sewer System (PRONAP), pub. 22-09-96.
- Law No. 26737, disposes that the Authority of Waters are in charge of managing the exploitation of materials those are carried and deposited on the waters of their rivers or canals, pub. 05-01-97.
- Directorial Resolution 0127-97-DCG, dictates the definitions of different pollutants in the seawater and the approaches to identify these pollutants, pub. 11-06-97.

In particular, the Law on General Services of Sanitation (see attached Appendix) is considered to be the most important law which stipulates the basic matters on sanitation aspect in Peru. According to this Law, the following four types of sanitation services are defined as the basic services those should be provided to the peoples living in the cities or in the residential areas (characterized as the "urban areas") within the Peru territory.

- Potable Water
- Sanitary sewerage
- Rainfall sewerage (drainage)
- Sanitary excreta disposal

## (2) Relevant Organizations

### 1) General

According to the Law on General Services of Sanitation, the functions of the institution related to the sanitation sector are classified into:

- (1) The *management organism*, which is responsible for the administration and financing of the services;
- (2) The *regulating organisms*, which define the relevant regulations;
- (3) The *controlling organisms*, which control all relevant entities in accordance to the respective rules;
- (4) The *ruling organisms*, which are responsible for the control and the improvement of the sanitation sector in the national level.

Also according to this Law, the Ministry of Presidency performs the ruling competence, and is responsible of assuming all functions in the central government to improve the sanitation services in all areas in the country (Art.8°).

The Municipalities are responsible of providing services and grant the exploitation right to the appropriate public or private or public-private loaner entities.

The regulating and controlling competency is belong to the National Superintendence of Sanitation Services (Art.9°). In order to not burden the State budget, a part of the National Superintendence's budget is to be financed by the loaner entities, as stipulated by the Decree-Law N°25965 (Creation Law).

## **2) At the state level**

For many years in the past, the sanitary sector in Peru had been constituted separately of the urban sub-sector and the rural sub-sector. The rural sub-sector had been laid under the responsibility of the Ministry of Health, and the services of drinkable water and sewer system at the urban centers were managed by the Sub-bureau of Sanitary Works of the Ministry of Development and Public Works, with the exception of the Lima Metropolitan and at the small and dispersed communities. In 1969 the responsibility for the urban sub-sector were passed to the then recently created Ministry of Housing.

In 1991, the Law of Promotion of Private Investment came to affect to the sanitary sector, especially to the works relating to the contribution of services of drinkable water and sewerage, sanitary disposal of wastes and public cleaning.

In 1992, by means of the Law 25491 and 25738, the responsibility on sanitary sector was transferred to the Ministry of the Presidency through the Vice-Ministry of Infrastructure. The PRONAP (National Program of Potable Water and Sewerage System) was established in this year, as an organ belong to the Vice Ministry of Infrastructure.

Also, in respect to the requirements of leaving the sanitary sector open to the private investment, and in effort to normalize the regulations on institution, the General Law of Sanitary Services, and the General Law of the Superintendence of Sanitary Services are promulgated in 1994. They are, next to the laws referred to the citizen participation, taking the very important role in figuring out the institutional and organizational framework of the present sanitary sector in Peru.



Outlines of the organizations relevant to the management of water supply systems and sewerage systems in Peru are presented as follows.

## **MINISTRY OF THE PRESIDENCY**

The Ministry of the Presidency is the highest authority of the State that decides the policies on the matters related to the sanitation services; such as, to formulate the policy and to dictate the rules for the contribution of these services, to plan the strategic policies for the expansion of the national supply coverage, to evaluate the projects for external financed investment, to pursuit and to evaluate the programs of public investment, etc. That is to say, the Ministry of the Presidency assumes all functions of the State to facilitate the development of the sanitary sector.

In cases of emergency the Ministry of the Presidency coordinates with the Ministry of Health for the effect control of water quality. In addition, it approves the plans and budgets of the FONAVI, and coordinates the canalization of investment loans from the Inter-american Development Bank (IDB) and of the World Bank.

## **SUNASS**

The institutional reformation developed in the sanitary sector considers the Ministry of the Presidency as the headquarter of the organization, the National Superintendence of Services of Sanitation (SUNASS) as the regulator of the State, and the General Law on Services of Sanitation as the major regulation.

SUNASS is the organization in charge of regulating the contribution of the services, to supervise the execution of the regulations and to promote the development of the companies supplying the sanitary services. Under this charge, SUNASS issues the complementary rules relevant to the tariff system, the making of contracts of contribution of services, the sanction of offenders, the elaborating of the norms to evaluate the performance of the companies in charge of supplying the services. Its mission consists in ensuring the contribution of the sanitary services under the best conditions of quality, for improving the people's health and for the preservation of natural environment.

The SUNASS coordinates with the Ministry of the Presidency, through the Vice-Ministry of Infrastructure, to plan and make budget and regulations relevant to the

service, operation and management and the charges applied to the water supply systems and the sewerage systems in the whole country.

The SUNASS also acts as the inspector of the service of drinkable water and sewerage system, and it approves or disapproves the tariff that is proposed by the Services Providing Enterprises (Entidades Prestadoras Servicios, EPS).

There would be an apparent competition conflict between the SUNASS and the Ministry of Health regarding to the control of water quality. In accordance with the authority that indicates the norms, the SUNASS controls the quality of the service provided by the EPS, while the Ministry of Health controls the quality of water that consumed by the people, and is the authority who takes acts in the case of emergency.

In cooperation with the FONAVI, SUNASS gives the advise on the approval and the financing of the works of water supply, drainage and sewer system proposed by the EPS.

Coordination doesn't exist between the SUNASS and the municipalities. On the contrary, in some municipalities the existence of this highest level authority on sanitation is ignored.

## **FONAVI**

The National Housing Fund (FONAVI) was created by the government on June 30, 1979, with the purpose to satisfy the growing demand of the workers' housing. In recent years, the use of this Fund had been changed. Since 1986, an important part of the Fund was used for satisfying the demands of the population's services like electrification, water and drainage, besides the house connections. In addition, the benefit group was also expanded: Initially, the Fund's beneficiaries were only the specified workers who had contributed some parts of their salaries to the Fund, but this restriction was removed today, and even people who are not working as formal employees of a registered enterprise can also obtain the advantages provided by the Fund. Since then, a part of the Fund can be use to finance the sanitary programs which aim to improve the living condition even in the communities where there are few working residents.

In 1992, due to the epidemic of cholera, the Law on General Budget of the Republic had been modified to extend the percentage of the state budget dedicated to sanitary section

from 15 to 25%. In the same year, FONAVI was transferred to be a part of the Ministry of the Presidency, strengthening its activities on sanitary and electric field.

The Commission of Formalization of the Informal Property (COFOPRI) is the competent entity to identify and qualify the physical-legal sanitary facility at the residential areas regarding to the urban plan, and clarifying the facility's title and its registered specification, etc.

### **MINISTRY OF HEALTH**

The Ministry of Health whose competence reaches the aspects of environmental sanitation, should formulate the policies and dictate the norms of sanitary water quality for human consumption and of protection of the environment, as pointed out by the Law 26338.

In accordance with the Law of Health 26842, the Ministry of Health is responsible to watch over to the public entities those are authorized to have control on the sanitary and environmental aspects, by virtue of the Law on Organization and Functions.

Coordination doesn't exist between the Ministry of Health and the local governments for the control of the water for human consumption delivered by the lorry tanks.

### **MINISTRY OF AGRICULTURE**

The Ministry of Agriculture grants permits, authorizations, licenses for use of the waters with agricultural and not agricultural purposes; it controls, supervises and improves the use of waters served with irrigation purposes, and it authorizes the exploitation of the groundwater. In the reality, however, the ministry doesn't control well the water resource since it doesn't have an inventory of wells and it doesn't transfer to the municipalities the title of exploiting these wells.

### **SENAPA**

In 1981, a state enterprise called "the National Service of Supply of Drinkable Water and Sewer System (SENAPA)" was established as an agency belong to the former Ministry of Housing and Construction (MVC). At the end of the 1980 decade, a nationwide process of administrative decentralization had been undertaken in Peru, and it led to a remarkably institutional transformation in the sanitary sector. In April of 1990,

the organizational structure and the functions of the Ministry of Housing and Construction were modified in order to transfer the centralized enterprises to the provincial municipalities and district authorities, (except the Servicios de Agua Potable y Alcantarillado de Lima - SEDAPAL, and the operative units of the SENAPA), and the responsibility of the sanitary services was transferred to the urban and rural sectors.

At the end of 1991, the reorganization of the MVC began. In the middle of 1992, the MVC was merged to the Ministry of Communications and Transport, and the SEDAPAL was transferred to the Ministry of the Presidency (MP), and the SENAPA was nominated as an agency whose main function is to support the enterprises.

Due to fact that an appropriate legal and institutional system had not been prepared in advance of the sanitary sector's transformation, and the lack of an appropriate agency in charge of supervising the quality of the services provided by these enterprises,- it appeared numerous problems caused by the enterprises' institutional and financial weakness,. In 1992, with the support of the IDB and the WB, the Government of Peru undertook a process of establishing the legal and institutional system for the sanitary sector.

In the last years (1991-1994) , the most important change in the structure of the State was the transferring of the sanitary sector from the Ministry of Housing to the Ministry of Presidency.

## **PRONAP**

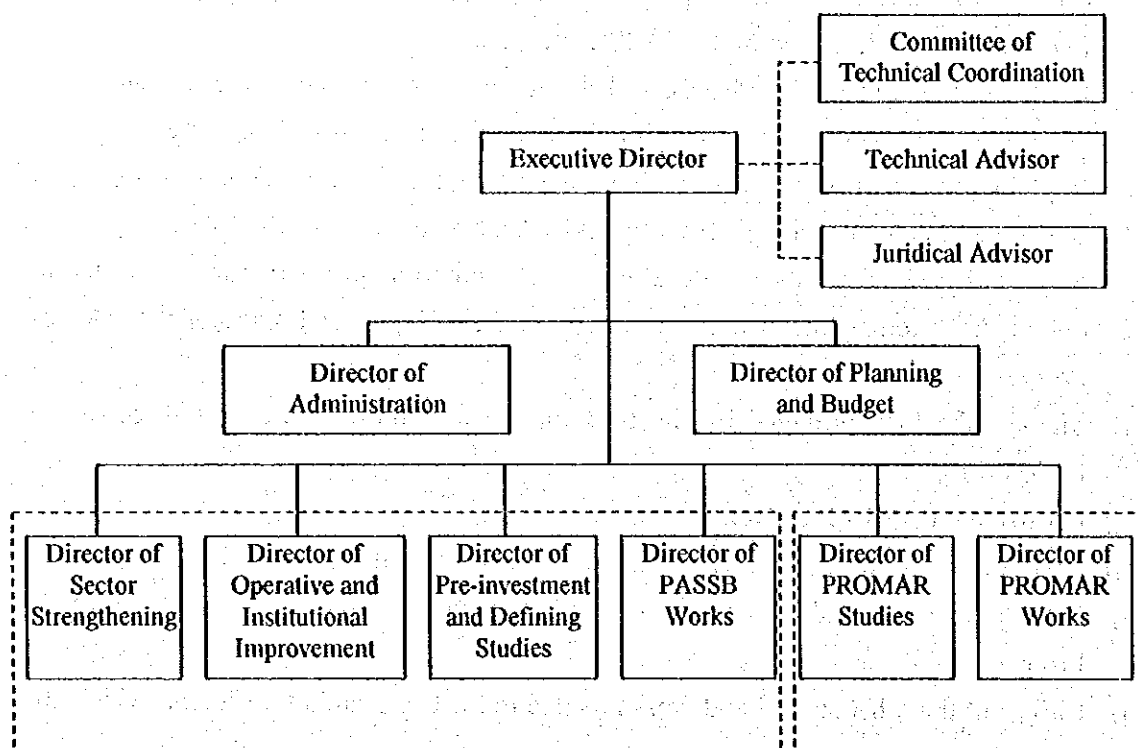
The PRONAP (*Proyecto Especial Programa Nacional de Agua Potable y Alcantarillado*, the National Program of Potable Water and Sewerage System) is belong to the Vice-minister of Infrastructure, a sub-organ of the Ministry of Presidency. The PRONAP was created in March 1992, and has the juridical autonomy on technical and managerial aspects.

The main duties of the PRONAP is to execute a part of the PASSB (*Programa de Apoyo al Sector Saneamiento Básico*, Program for Supporting Basic Sanitation Sector, funded by the IDB); as well as to execute the PROMAR (*Proyecto Manejo de Aguas Residuales de Lima Metropolitana*, Lima Metropolitan Wastewater Management Project).

To perform these duties, the PRONAP has been assigned the following functions.

- a) Develop the activities for institutional consolidation and operative strengthening oriented to the EPS (Service Supplying Enterprise), and offer appropriate assistance to these EPS, as described in the PASSB Program.
- b) Carry out the studies, the advises, and the activities for strengthening the entities at central level, as well as for developing these entities' institutional capacity.
- c) Implement the works for rehabilitating the existing potable water supply systems and sewerage systems which are presently under the management of the EPSs;
- d) Formulate the programs for developing the sanitation infrastructure, in order to obtain the external financial sources necessary for the second stage of the PASSB Program;
- f) Manage the loan provided by the IDB for the execution of the first stage of the PASSP Program;
- g) Diffuse the PASSB Program;
- h) Carry out the studies and works related to the execution of the PROMAR Project;
- i) Propose for loan, and manage the granted loan, for the execution of the PROMAR Project;
- j) Carry out the other studies and works related to the basic sanitation sector, which are entrusted by the government, and differ to the projects mentioned in the previous articles.

*Figure II.5.9 shows the organization structure of the PRONAP.*



**Figure II.5.9 PRONAP's Organization Structure**

A part of the PRONAP's operational expenditure is financed by the UNDP, and others by the Ministry of Presidency. For carrying out the projects with low interests, the PRONAP obtain finance derived from the State budget, as part of the regional subsidies.

### 3) At the regional level

#### MUNICIPALITY

In accordance to the Law on General Services of Sanitation and the Law on Organization of Municipalities, the Municipalities are responsible for contributing the sanitation services to their residents. In consequence, all entities in charge of supplying drinkable water and operating the sewer systems of the former SENAPA (the National Service of Supplying Drinkable Water and Sewer System), are being on the process of transferring to the Municipalities. The case of Lima and Callao is an exception where

the relevant entities are not transferred to the concerned municipality, because they are subordinated to the Ministry of Presidency.

Taking this role, the Municipalities are responsible for contributing the sanitation services. The Municipalities can grant the right of contributing service to the EPS (Service Providing Enterprise), approve the tariffs proposed by the EPS in conformity to the relevant norms issued by the SUNASS.

Regarding to the water supply, the authorized Municipality should undertake the followings: (1) supervise the management of the wells and water reservoir to ensure its hygienic condition; (2) carry out the control and verification of the execution of technical norms for the cleanliness and disinfection of the public faucets and distributing lorry tanks for human consumption; (3) monitor the water quality to verify the effectiveness of the works of cleaning and disinfection; (4) supervise the quality of water produced and distributed by the concessionaire or the private enterprises responsible for the management of the water supply system. It should, in consequence, to check that the supply of the water is under appropriate methods conforming with the drinking water norms defined by the World Health Organization (WHO). Before putting in service the water supply system, it should test the residual chlorine and should take samples for the corresponding bacteriological analysis. Through the Direction of Health of the Municipal Secretary of Health and Social Welfare of Metropolitan Lima, or of the organ that takes this rule in the municipality, it should inscribe in the Registration of Public Faucets that provide water for human consumption.

In Puno Province, the right of supplying piped water and treating wastewater is transferred to the Enterprise of Basic Sanitation Services of Municipality of Puno Province (EMSAPUNO).

## **EMSAPUNO**

### **1) Structure**

The Enterprise of Basic Sanitation Services of Municipality of Puno Province (EMSAPUNO), is an enterprise established by mean of transferring the right of contributing service from the municipality to the EPS as stipulated by the D.S. No. 137 - 90-PCM. Before March 1991, it worked as a branch of the SENAPA under the name "SEDAPUNO "

The EMSAPUNO's main function is offering services of drinkable water and sewer system to the residents in the urban areas of Puno Province as the basic needs for the preservation of the public health.

The EMSAPUNO's capital is shared by 3 shareholders: the Municipality of Puno (79.07%), the Municipality of Collao (14.76%), and the Municipality of Chucuito (6.16%).

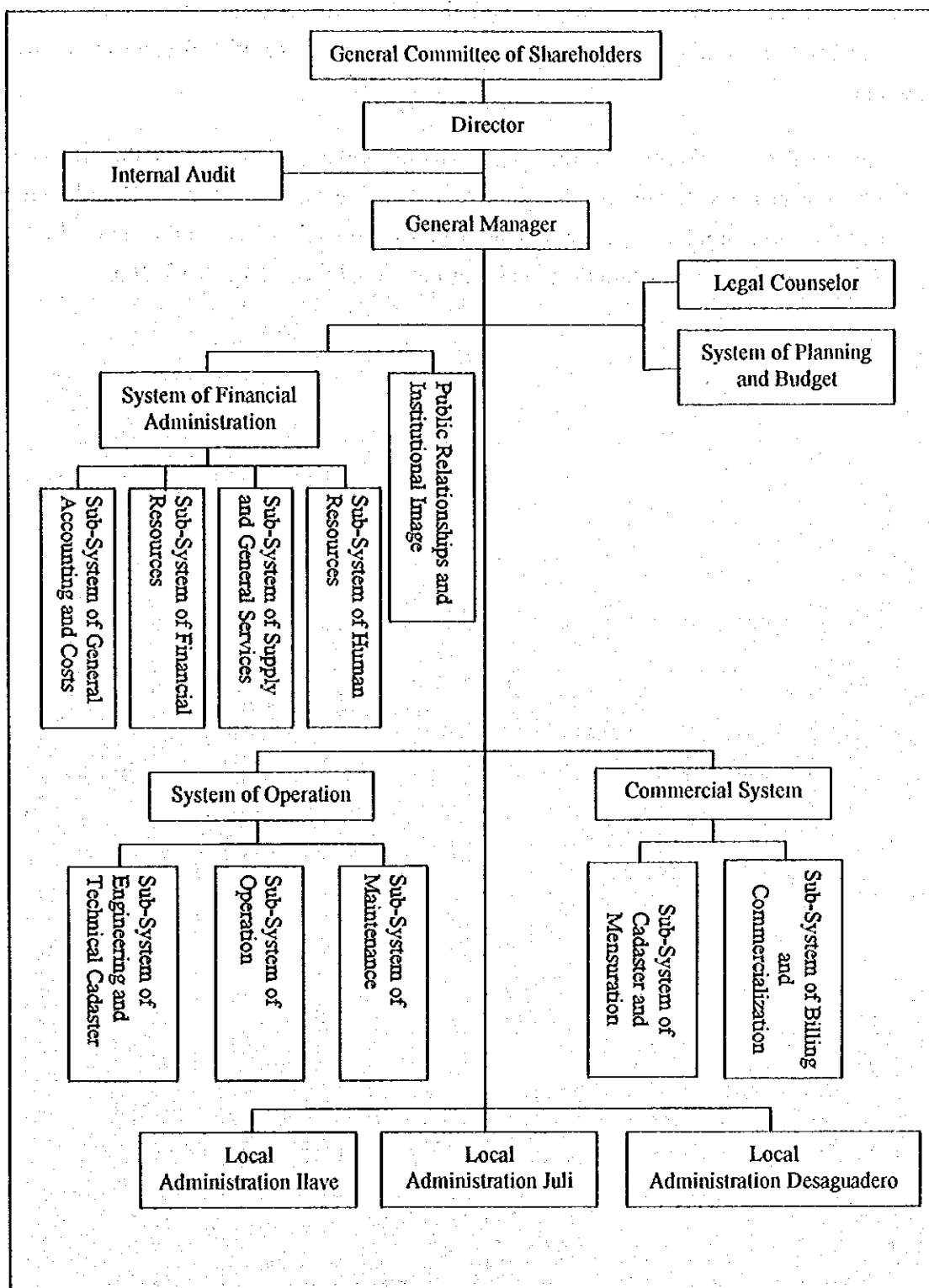
The EMSAPUNO's organization structure is presented in the *Figure II.5.10*.

The localities served by the EMSAPUNO are as described in *Table II.5.8*

**Table II.5.8 Localities Served by the EMSAPUNO in 1997**

Locality	Puno	Ilave	Juli	Desaguadero	Total
Population	98,596	15,907	6,919	4,892	126,014
Piped Water Connection					
- Number of connection	14,681	2,721	1,093	979	19,474
- Coverage (%)	74.68	85.53	78.98	94.00	
Sewer Connection					
- Number of connection	11,066	1,781	716	5	13,568
- Coverage	56.29	55.98	51.74	NA	
Distance from Puno City (km)	0	55.0	82.0	153.0	





**Figure II.5.10 Organization Structure of EMSAPUNO**

In December 1998, the EMSAPUNO has 90 workers, making administrative, commercial and operative works, what means a productivity of 130 connections for 1 worker.

Of the total of workers, 43% the labor personnel that you/they work directly in the production process, treatment, distribution and maintenance conforms. Distributed by area, they correspond 45% to the Management of Production 22% to the General Office of Administration and 33% to the remaining functional areas. (see *Table II.5.9*)

**Table II.5.9a EMSAPUNO's Personnel**

Organ	Personnel	Number
1. General Committee of Shareholders		3
Total		3
2. Board of Director	Director	5
3. Internal Audit		1
4. General Management	Manager Secretary Chauffeur Porter	1 1 1 1
5. Legal Consultantship		1
6. System of Planning and Budget	Chief Secretary Specialist (Engineer Eco.)	1 1 1
7. Public Relationships and Institutional Image	Journalist	1
8. Administrative-Financial System	Manager Secretary	1 1
8.1 Sub-System of General Accounting and Costs	Cpc. Cpc. Cpc	1 1 1
8.2 Sub-System of Financial Resources	Cpc. Technician Collector	1 1 1
8.3 Sub-System of Supplies And General Services	Chief Technicians Auxiliary Porter	1 4 3 1
8.4 Sub-System of Human Resources	Manager Technician	1 1
9. Commercial System	Manager Secretary	1 1
9.1 Sub-System of Cadaster and Estimation of Consumption	Cpc. Technicians Operator	1 3 1
9.2 Sub-System of Billing and Commercialization	Chief Technicians Cpc Economist Social Worker Inspector Operator	1 2 1 1 2 1 1
10. Operation System	Manager Secretary	1 1
10.1 Sub-System de Engineering and Technical Cadaster	Chief (Inf. Civil) Engineer Civil Technician	1 1 1

**Table II.5.9b EMSAPUNO's Personnel (continues)**

10.2 Sub-System of Operation	Chief (Engineer Chemical)	1
	Technician	2
	Operators	7
	Chauffeur	3
	Reservoir Guardian	2
10.3 Sub-System of Maintenance	Chief	1
	Foreman	2
	Gasfitter	9
	Operator	4
	Chauffeur	2
	Mechanical Technician	1
	Auxiliary	1
	Operator	1
11. Local Administration Ilave	Administrator	1
	Auxiliary	1
	Operator	2
	Gasfitter	2
12. Local Administration Juli	Administrator	1
	Operator	1
	Gasfitter	1
13. Administration Local Desaguadero	Administrator	1
Total		101

## 2) Financial Situation

### (a) Operation profit / loss

According to the financial report as of December 31, 1998 and 1997, the EMSAPUNO recorded S/. 1,917 thousand net loss and S/. 5 thousand net profit respectively. But the revaluation gain of inflation ratio change S/. 718 thousand and S/. 517 thousand were recorded based upon the inflation accounting principle, so if the revaluation gain were not recorded based upon the GAAP in the world, the total operation loss would be S/. 2,635 thousand and S/. 512 thousand respectively.

### (b) Two department

There was not a separated accounting record for Agua Potable ( Water Supply ) department business and Alcantarillado ( Sewerage ) department business . The administration expenses including salary expenses ( for approximately 100 staff ), maintenance expenses, and so on were not allocated to the two departments business . So it is difficult to determine whether the Alcantarillado business is profitable or not.

### (c) Loan / Interest expense

The financial interest expense was S/. 1,205 thousand in 1998F/Y. EMSAPUNO borrows long a term loan from mainly FONAVI ( public fund for Peru citizen to his own house ). The loan has not been paid back to FONAVI and the current balance as of December 31 ,1998 was S/. 14,230 thousand including accrued interest.

In 1998 F/Y the interest expenses S/. 1,121,406 and loan principal S/. 981,976 should be paid back to FONAVI according to the payment schedule. But no payment has yet been made. In January of 1999, the legislation to permit 70% of EMSAPUNO 's debt about US\$ 4 M (S/. 11,826,219) to be capitalized and 30% to be cancelled was approved. Moreover, there are about US\$13M debts by Puno citizens to FONAVI for installation charges of water and sewage equipment. These debts was also cancelled by the above legislation. The reform seems to be related to the possibility of KfW loan arrangement. ( KfW , the finance source of Germany, will have a contribution 20 millions DM for EMSAPUNO's repair work.)

### (d) Bill collection

In 1997 F/Y report , 14% of produced water was not billed and the tariff of Alcantarillado was about 45% of water tariff. If produced water were billed completely, about s/500,000 additional income would be recorded.

### (e) Tariff

The tariffs of EMSAPUNO are controlled by government. The current tariff was approved in 1997 and is as follows ;

Category	Volume (m³)	Minimum tariff
Domestic	15	S/.13.70
	20	18.28
Commercial	30	43.47
Industry	60	131.00
State	50	48.00

1) Minimum tariff includes IGV

2) Source: Presupuesto Municipal 1999, Municipalidad Provincial de Puno

Tariff will be revised for EMSAPUNO reconstruction.

**PROFIT & LOSS STATEMENT as of December 31, 1998 ( unit : S/. 000 )**

<b>SALE</b>	(1) Agua Potable	S/. 3,223	
	(2) Alcantarillado	1,450	
	(3) Other	<u>303</u>	4,976
<b>COST</b>	(1) Agua Potable	1,367	
	(2) Alcantarillado	132	
	(3) Other	<u>1,697</u>	<u>3,196</u>
	Gross Margin		1,780
<b>EXPENSES</b>		<u>2,692</u>	
	Operation loss		912
<b>OTHER INCOME &amp; EXPENSE</b>	(1) Other income	354	
	(2) Financial expense	1,205	
	(3) Other expense	<u>873</u>	<u>1,724</u>
	Loss before inflation gain		2,636
	Inflation revaluated gain		718
	Net Loss		<u>S/. 1,917</u>

- **Sale increase**

Sale amount has increased by 38% in 1998FY. The customers' number of water supply department has increased from 19,474 in 1997FY to 20,863 in 1998FY. Also the number of sewerage has increased from 13,568 to 14,728.

- **Interest expense**

Long term debt from FONAVI was not paid back and accrual of interest expense S/. 1,121 thousand was recorded.

- **Inflation accounting**

According to Peru accounting standard, the revaluation gain of fixed asset should be recorded.

- **PRONAP donation & management skill support**

Donation S/. 15,840 thousand was offered by PRONAP and the fixed asset was acquired. Additionally PRONAP gave management skill support and the related expense was deferred and amortized over 10 years.

- May report in 1999FY  
Sale figure has increased 5% in 1999FY.

Cash Flow Statements as of December 31, 1998 and 1997 ( unit : S/. 000 )

Nature	1998FY	1997FY
<b>A : Operation</b>		
Net gain /(loss)	(1,917)	5
Depreciation	944	409
Social benefit provision	42	150
Other	(707)	3
Change of Asset/Liability	(286)	(28)
	(1,924)	539
<b>B : Investment</b>		
Fixed asset acquisition	(3,101)	(1,098)
	(3,101)	(1,098)
<b>C : Finance</b>		
Increase of long term debt	4,914	144
Other	0	533
	4,914	677
Cash increased/(decreased)	(111)	117
Cash at beginning of the year	113	3
Cash at ending of the year	2	120

Long term debt's increase S/. 4,914 thousand was absorbed by the acquisition of fixed asset and the offset of operation loss. ( Additionally PRONAP donated S/. 15,840 thousand for acquisition of fixed asset. )

#### **4) Civil Organization**

In the communities where any water supply system does not exist, a "water committees" is generally organized by the residents in order to preserve the supply of water.

The consultants and private companies, in this case, can work as contractors related to projects whose aims are to improve the basic infrastructure in the regional community, and are financed by the FONAVI.

Under such condition, the owners of lorry tank or spouts can work as the suppliers of water for human consumption after being registered to the concerned municipality and having a legal authorized license.

#### **5) Non-Government Organizations**

As promoters for the development of human-life condition, the non-government organizations (NGO) advise and supervise the execution of projects related to water supply and drainage, elaborate proposals on systems of cleansing, develop and promote the campaigns to promote public health in coordination with the social organizations (those are in charge of offering basic sanitation services).



## **5.4 MANAGEMENT OF SOLID WASTE**

### **(1) Relevant Laws and Regulations**

The main laws and regulations relevant to the management of solid waste in Peru are the followings:

- Law 13997 (09-02-62), Law of Rural Basic Sanitation.
- Law No. 697 (07-11-91), Law of Promotion of Private Investment in the Sanitary Field.
- Law No. 26338, Law on General Services of Sanitation, published on 24 Julio 1994.
- Law No. 26828, Law on the Penalty on the Import of Dangerous or Toxic Waste, pub. 30-06-97.
- Law No. 26842, Law of General Health, pub. 20-07-97.
- Ministerial resolution 535-97-SA/DM, approves General Principles on Hygiene Standards, pub. 02-12-97.

The Law No. 26338: "Law on General Services of Sanitation", promulgated on July 24, 1994 is the most important law relevant to sanitation sector which includes the management of water supply system and the management of solid waste in the urban areas. The outline of this Law is described in Appendix attached to this report.

### **(2) Relevant Organizations**

In 1992, by means of the Law 25491 and 25738, the responsibility on sanitary sector was transferred to the **Ministry of the Presidency** through the Vice-Ministry of Infrastructure. Also, in respect to the requirements of leaving the sanitary sector open to the private investment, and in effort to normalize the regulations on institution, the General Law of Sanitary Services, and the General Law of the Superintendence of Sanitary Services are promulgated. They are, next to the laws referred to the citizen participation, taking the very important role in figuring out the institutional and organizational frame of the present sanitary sector in Peru.

The Ministry of the Presidency is the highest authority of the State that decides the policies on the matters related to the sanitation services; such as, to formulate the policy and to dictate the rules for the contribution of these services, to plan the strategic

policies for the expansion of the national supply coverage, to evaluate the projects for external financed investment, to pursuit and evaluate the programs of public investment, etc.

The **National Superintendence of Services of Sanitation (SUNASS)** is the organization in charge of regulating the contribution of the services, to supervise the execution of the regulations and to promote the development of the companies supplying the sanitary services. Under this charge, SUNASS issues the complementary rules relevant to the tariff system, to the making of contracts of contribution of services, to the sanction of offenders, to the elaborating of the norms to evaluate the performance of the companies in charge of supply the services.

Besides, the **National Housing Fund (FONAVI)** also involves in the sector of sanitation, by mean of using a part of its fund to finance the sanitary programs in the local areas, which aim to improve the living condition in these communities.

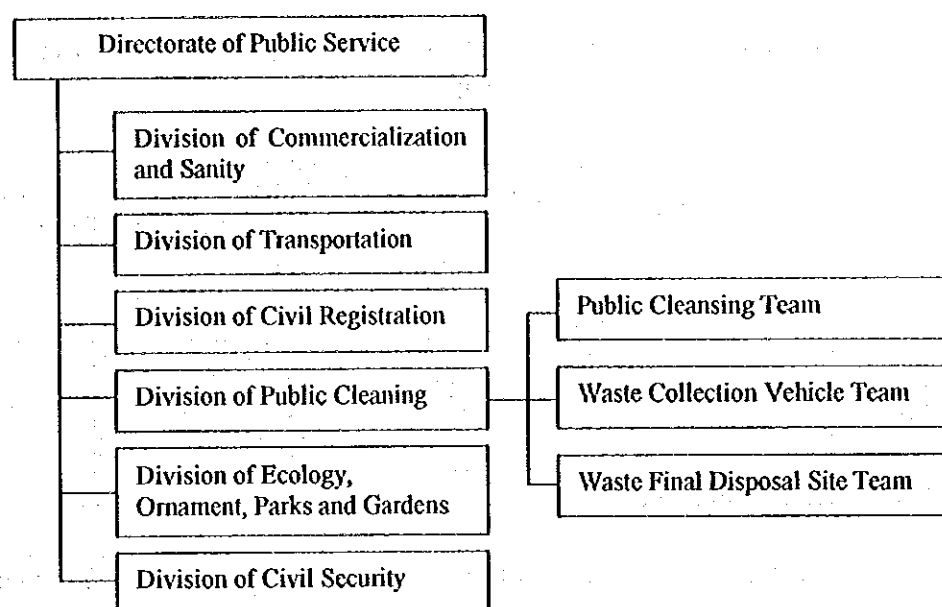
The **Ministry of Health**, whose competence reaches the aspects of environmental sanitation, is responsible to watch over the public entities those are authorized to have control on the sanitary and environmental aspects, in accordance with the Law of Health 26842.

### **(3) Municipality of Puno Province**

According to the Law of Municipality Organization No.23853, the municipality is the sole agency being responsible of public cleaning which includes: the collection, transportation, and disposal of solid wastes, sweeping of streets and avenues. The Municipality can grant the right of contributing these services to the EPS, approve the tariffs proposed by the EPS in accordance to the relevant norms issued by the SUNASS.

In the Puno Province Municipality, the **Division of Public Cleaning**, a sub-organ of the Directorate of Public Service (see *Figure II.5.3*), is in charge of performing the public cleaning service. *Figure II.5.11* shows the sub-organs of the Directorate of Public Service which had been reorganized in January 1999, and *Table II.5.10* shows the personnel assigned in these organs.

The **Division of Public Cleaning (DPC)** is responsible of technical and administrative issues relating to the management of solid wastes. Its operational finance is derived from the municipal revenues.



**Figure II.5.11 Sub-organs of the Division of Public Cleaning**

**Table II.5.10 Staff Members in the Community Service Directorate**

(in September 1999)

Organs		Total	Permanent Staff	Temporary Staff
Directorate of Public Service		2	0	2
Division	Division of Commercialization and Sanity	21	17	4
	Division of Transportation	11	10	1
	Division of Civil Registration	6	6	0
	Division of Public Cleaning	95	21	74
	Division of Ecology, Ornament, Parks and Gardens	12	11	1
	Division of Civil Security	34	13	21
Total		181	78	103

Source: Puno Province Municipality, Directorate of Public Service, Sep. 1999.

Table II.5.11 presents the staff members working at the Division of Public Cleaning in 1998, and their monthly remuneration.

**Table II.5.11 Staff Members in the Division of Public Cleaning in 1998**

Position	Permanent staff		Contracted staff		Total employees and workers
	Quantity	Remuneration (S/. per month)	Quantity	Remuneration (S/. per month)	
Driver	2	875	4	400	6
Driver Assistant	8	875	13	400	21
Guardman	2	875	1	400	3
Wheelbarrow worker	3	875	25	400	28
Road sweeper	3	875	24	400	27
Collector of papers	3	875	7	400	10
Total	21		74		95

Source: Puno Province Municipality, Directorate of Public Service, Sep. 1999.

In the sanitary landfill, there is a member of the sweeping group working as a watchman in rotary turns.

*Table II.5.12* describes the education level of the contracted employees working in the Department of Public Cleaning.

**Table II.5.12 Education Level of the Contracted Employees in the Division of Public Cleaning**

Education level	Number of employees
Professionals	1
Finished high school	3
Elementary school	18
Total	22

Source: Staff division – Municipality of Puno

The remained 73 hired staff members have reached elementary education. Seven of them are women. However, it is unable to collect information on these hired staff members' age.

And *Table II.5.13* describes these contracted staff members' age ranks. As showed by this Table, a major part of these staff members (15 persons) are older than 45-year old.

**Table II.5.13 Contracted Staff Members Classified by Their Ages**

Age	Number of employees
35-45 years old	7
45-65 years old	11
Older than 56 years old	4
<b>Total</b>	<b>21</b>

Source: Staff division- Municipality of Puno province

It is clear that the public cleaning service is not efficient, due to the lack of necessary equipment, financial resources, and professional and well-trained staff member.

Regarding to the financial condition, *Table II.5.14* presents the budget account of the Directorate of Public Service and the Division of Public Cleaning in the past 3 years.

**Table II.5.14 Budget Account of the Municipal Service Directorate**

(Unit: 1000 /S.)

Year	1996		1997		1998	
Items	Estimate	Execute	Estimate	Execute	Estimate	Execute
<b>Revenue</b>						
- Total	15,712	11,218	20,591	18,759	15,892	-
- Public Cleaning	325	356	464	362	392	-
<b>Expenditure</b>						
- Total	15,712	11,105	20,591	18,832	15,892	-
- Public Cleaning	325	-	464	686	392	-

Source: Municipalidad Provincial de Puno, Direction de Servicios Municipales, Nov. 1998.

As showed by the previous Table, the income and expenditure relevant to the public cleaning service seem to be varied from year to year. However, the information on the financial condition of the Division of Public Cleaning are different by their sources, and their accuracy are hardly verified.

*Table II.5.15* shows the annual ranks of tariff charges determined by the Puno Province Municipality as one financial resource for performing public cleaning service in the Municipality.

The public cleaning tariff charges are determined according to the values of the properties (houses and business facilities) sited in the Municipality. These charges are determined without any support technical criterion. The Division of Tax Collection and Taxpayer Orientation is in charge of collecting these tariff charges.

**Table II.5.15 Public Cleaning Tariff Charges**

Tariff charges	Annual rank (S/.)
Houses	1.65 ~ 5.70
Commerce and central government	2.75 ~ 17.20
Restaurants and hotels	2.75 ~ 27.50
Private enterprises	64.60

Source: Puno Province Municipality, Directorate of Generation of Resources and Rents.

Table II.5.16 presents the incomes from collection of public cleaning tariff charges in the Municipality in the last five years.

**Table II.5.16 Public Cleaning Tariff Charges Collected in the Past Five Years**

Year	No. of taxpayers	Collecting (S/.)
1993	-	178,193
1994	11,308	163,394
1995	11,197	282,423
1996	11,342	355,774
1997	11,276	361,974

Source: Puno Province Municipality, Directorate of Generation of Resources and Rents.

The number of taxpayers is about 50% of the number of existing properties (23,500 properties according to 1993 Census) in the Municipality. This low rate of tariff collection may be caused by the passive collecting: only the voluntarily-paying taxpayers are the subjects of the tariff collection.

As showed by the previous Table, the average tariff charge paid by one taxpayer in 1997 was S/. 32.00 (or S/. 2.70 per month). It is worth to notice that this average is

considerably high compared with the tariff charge determined by the Municipality as showed in *Table II.5.15*. The reason is unknown and should be studied in future.

*Table II.5.16* presents the expenditures for public cleaning service in 1997. It is hard to obtain such detailed information on this expenditure for the previous years.

**Table II.5.17 Public Cleaning Expenditures in 1997**

Item	Quantity	Expenditure (S/.)
<b>Staff and social obligations (contracted staff)</b>	22	<b>268,271.08</b>
- Repayment and complementary things		243,405.78
- Contributions		24,865.30
<b>Goods and services</b>		<b>460,860.00</b>
- Fuel		49,920.00
- Oil		5,200.00
- Dump car rent		46,440.00
- Maintenance		9,300.00
- Other tertiary services (hired employees SNP)	87	350,000.00
<b>Total</b>		<b>729,131.08</b>

Source: TYPASA-TUBSA-GMI.S.A Association

The expenditures described in the above-mentioned table were estimated based on the information obtained provided by INADUR in the same year and information provided by accounting unit of the Municipality. Data in both documents are different and doubtful. The indirect expenses and depreciation were not included in these expenditures.

*Table II.5.17* shows the deficit in the account for public cleaning service in the Municipality.

**Table II.5.18     Deficit in the Account of Public Cleaning Service in 1997**

Item	Amount (S/.)
Income	361,974
Expenditure	729,131
Balance	- 367,157

Source: TYP SA-TUBSA-GMI SA Association

It can be observed that only about 50% of total expenditures can be recovered by the tariff charge collection, and the Municipality has to make up the remained 50% of this total expenditure by the Municipality budget.



**CHAPTER – III**  
**ENVIRONMENTAL CONDITIONS OF PUNO**  
**INTERIOR BAY**



## CHAPTER - III

### ENVIRONMENTAL CONDITIONS OF PUNO INTERIOR BAY

#### 1. GENRAL

The organic pollution and eutrophication in Puno Interior Bay has been deteriorating from the 1970's, and significantly deterioration of lake became clear in 1980's. Especially, the western shoreline is affected mainly by domestic and commercial wastewater, which is discharged from the urbanized area of Puno. This chapter deals with the pollution of Puno Interior Bay. Based on results of survey and data collection, the main features of Puno Interior Bay are summarized below.

The shape of Puno Interior Bay and its catchment area are mentioned below.

##### 1) The shape of Puno Interior Bay

Puno Interior Bay is characterized by shape as described below.

- Puno Interior Bay is elliptic in form and measures 2.4 km from I.Estives to I.Espinar by 3.5 km from port to the mouth of channel. (refer to *Figure III.1.1.*)
- The surface area of the lake is approximately 16 km<sup>2</sup>.
- The average depth of water in Puno Interior Bay is approximately 2.4 m, and the maximum depth of water is from 5 m to 6m. The surface area of less than 2-m depth account for 50 % in the entire interior bay. (refer to *Figure III.1.2.*)
- Two channels link Puno Interior Bay and Puno Exterior Bay.
- The bigger one which measures approximately 50 meters wide and 1,700 meters length, opens into the external bay directly.
- The smaller one links to the external bay through the other (River Willy) channel.

It can be said from the above that Puno Interior Bay is a closed water body.

## 2) The characteristic of catchment area in Puno Interior Bay

The catchment area of Puno Interior Bay is approximately 40 km<sup>2</sup>. The distance from the port to the boundary of the basin is approximately 4,100 m, and the altitude of the boundary point is nearly 4200 m. The average slope from the top to the lake is 9.5 %, and the slope in the urbanized area is reduced with the decreasing distance to the lake.

The longest distance from the lake to the boundary of the basin is approximately 6 km, and the highest point in this catchment area is approximately 4,500 m. The catchment area of Puno Interior Bay is characterized by being small and steep. (refer to *Figure III.1.3*.)

The basin of Puno Interior Bay has no permanent rivers. There are 13 drainage channels in the urbanized area of Puno City, of which 5 channels constantly discharge domestic and commercial wastewater into Puno Interior Bay.

## 2. PHYSICAL CONDITIONS

### 2.1 THE WATER BALANCE IN PUNO INTERIOR BAY

#### (1) Estimation of run-off coefficient

Generally, the water balance of a lake can be expressed by:

$$dQ = Q_p + Q_{in} + Q_g - Q_{out} - Q_{ev} - Q_{int}.$$

where;

$dQ$  : water volume of variation of water level in the lake,

$Q_p$  : water volume of precipitation on the lake,

$Q_{in}$  : water volume of inflows to the lake through river and drainage channel,

$$Q_{in} = P_{cat} \times R + q_w$$

where;

$P_{cat}$  : water volume of precipitation in the catchment area,

$R$  : Run-off coefficient from precipitation,

$q_w$  : wastewater volume from the basin,

$Q_g$  : water volume of inflows to the lake through ground,

$Q_{out}$  : outflow from the lake,

$Q_{ev}$  : Evaporation from the lake surface,

Q<sub>int</sub> : water volume of intake from the lake.

However, complete data concerned with the actual water balance are not available to estimate the water balance. Therefore, in this section, it is considered concerning run-off coefficient of rainwater. It assumes that estimation conditions for run-off coefficient are follows.

$$R = (Q_p - Q_{ev} + dQ) / (Q_{inall})$$

Where;

R, Q<sub>p</sub>, Q<sub>ev</sub>, dQ are same as above mentioned.

Q<sub>inall</sub> : Q<sub>inall</sub> = Q<sub>in</sub> + Q<sub>g</sub>

Assuming that;

Q<sub>out</sub> = 0.0

q<sub>w</sub> = 0.0

In above condition, a run-off coefficient is estimated 0.54 as average in from 1969 to 1996. (refer *Table III.2.1*) The estimated run-off coefficient means that inflow water volume and precipitation on lake water balance with the evaporation and variation of water level of lake. On the other hand, it was reported that the mean run-off coefficient over all the gauged catchments in Peru is 0.252, with a maximum of 0.383 in Coata catchment and minimum of 0.196 in the Zapatilla catchment<sup>9</sup>. Therefore, the estimated run-off coefficient is larger than one in other basin of Titicaca Lake. It can be said that the outflow from Puno Interior Bay is small volume in annual balance.

Source 1) "Lake Titicaca" C. Dejoux and A. Ittis

The specific catchment area, which is estimated by land catchment area and surface of lake, are shown as follows. The specific catchment area of Puno Interior Bay is smaller than the whole area of Titicaca Lake and Puno Exterior Bay.

Water body	Catchment area (A) km <sup>2</sup>	Surface of lake (B) km <sup>2</sup>	Specific catchment area (A / B)
The whole Titicaca lake	49,010	8,490	5.77( 1.00 )
Puno Exterior Bay	4,650*	552	8.42( 1.46 )
Puno Interior Bay	40	16	2.50( 0.43 )

note \*: Catchment area of Coata river

Source : "Lake Titicaca" C. Dejoux and A. Ittis

## **(2) RELATION BETWEEN PRECIPITATION AND WATER LEVEL OF LAKE**

The seasonal variation of water level in Puno Interior Bay is in the range of 0.5 m to 1.0 m. The seasonal variation of precipitation, intake volume for water supplies in Puno and evaporation is shown *FigureIII.2.2* and *FigureIII.2.3*. There is no significant seasonal variation of intake volume and evaporation, while the precipitation is characterized by two distinct seasons. (refer to *FigureIII.2.1* and *TableIII.2.2*)

As evident from *FigureIII.2.1*, the water level in the lake is positively related to the precipitation, and a time lag between both patterns was found. Therefore, the relationship between variation of water level and precipitation is estimated as shown in *FigureIII.2.4*. There is a high correlation between both parameters, and it can be said that the variation of water level in Puno Interior Bay is affected by precipitation of the previous two months. This means that the water level of the lake is affected by rivers, which have large catchment area as Coata River.

The above mentioned concerning water balance of lake, it came to the conclusion that Puno Interior Bay is characterized closed water bodies by its shape and water balance.

## **2.2 WATER MOVEMENT IN THE LAKE**

The factors concerning flow formation in the lake are as below.

- Inflow
- Variation of water level in the external bay
- Wind
- Variation of water temperature

From among the above factors, it seems that the inflow and variation of water level are not effective factors in to producing flow in the interior bay. This is because there is no river to produce flow in catchment area of Puno Interior Bay, and the variation of water level is small. Therefore, it seems that wind is the factor of consequence in flow formation of Puno Interior Bay.

The features of the wind in Puno Interior Bay from July 1995 to June 1996 are summarized below. (refer to *Figure III.2.5*.)

Morning ( 7:00 ) : the wind during the morning is gentle and unstable in its direction. (percentage of calm day was 66 %)

Daytime ( 13:00 ) : the wind direction is stable. ( percentage of wind from east in 1995 was 75 % )

Evening ( 19:00 ) : the wind direction is unstable.

The features of the wind are characterized by the wind during the middle of the day (13:00). It seems that the flow in Puno Interior Bay is caused by wind. (refer to *Figure III.2.6* )

Therefore, JICA Study Team and PELT carried out the water movement survey in July 1999. The outline of the survey is summarized as follows.

- Survey method : use of a buoy. (refer to *Figure III.2.7*)
- Confirmation of location : utilization of GPS
- Target of the water layer : layer at 1.5-m depth
- Survey location : 3 points and central channel (refer to *Figure III.2.8*)

The results of survey are summarized as below.

- At the 3 points in the Interior Puno Bay, the water movement is not identified.
- The water movement of the surface water in the channel was caused by the wind, while it was found that no water movement in the bottom water.

However, the slow-water movement from east to west in the lake is assumed based on the following circumstantial evidence.

- The feature of wind is the eminent east wind during afternoon in all the year round.
- The movement of the *LEMNA*.
- Distribution of water quality in the lake.

### 3. CHEMICAL CONDITIONS

#### 3.1 AVAILABLE DATA OF THE LAKE ( THE TRANSITION OF THE WATER QUALITY IN THE LAKE )

The water quality records in Puno Interior Bay are available from 1970 to 1996 as summarized below.

( 1970 ) <sup>1)</sup>

pH value was recorded from 7.5 to 8.6 in 10 points of Puno Interior Bay and Chimu in 1970. It seems that the little high pH value was caused by the activity of photosynthesis.

( 1993 – 1996 ) <sup>2)</sup>

The water quality in Puno Interior Bay and Chimu during 1993 to 1997 is shown *Figure III.3.1*, and the regional variations on 12 June 1996 are shown in *Figure III.3.2*. As evident from *Figure III.3.1* and *Figure III.3.2*, the main features of water quality conditions are summarized below.

- The over 9.0 of pH value was above 9.0 in Puno Interior Bay.
- Supersaturating of dissolved oxygen was recorded in Puno Interior Bay.
- Seasonal variation of transparency was found.
- $\text{NH}_4\text{-N}$  value was observed ranging from 0.01 mg/l to 1.57 mg/l, and  $\text{PO}_4\text{-P}$  value was ranged from 0.018 to 0.41 with a wide range of seasonal variation.
- Based on the concentration of  $\text{NH}_4\text{-N}$  and  $\text{PO}_4\text{-P}$ , eutrophic level of Puno Interior Bay in the middle of 1990's ranged from Meso-eutrophic to hyper-eutrophic condition. (refer to *Figure III.3.3*.)

Source 1) "Pollution in Lake Titicaca, Peru",

T.G.Northcote, P.Morales S., D.A.Levy and M.S.Greavmen.

2) "Lake Titicaca" C.Dejoux and A.Iltis

It seems that water environment of Puno Interior Bay in 1970's was not deteriorated. However, actual transition of water quality is unknown because of no continuous observation as monitoring. Therefore, related data of water environment as situation of Puno City and its topics shown in *Figure III.3.4*.



According to *Figure III.3.4*, It assumes that the deterioration of water quality in the interior Puno Bay became clear in 1980's. It can be said the deterioration of the lake was caused by the following factors.

- The rapid increase of population in Puno city
- Insufficiency of sewerage system

Additionally, The sewerage treatment plant was submerged from 1986 to 1992, and the all of the wastewater in Puno City was discharged into the lake without treatment. Consequently, it assumed that the further deterioration of Puno Interior Bay was brought.

### 3.2 EXISTING ENVIRONMENTAL CONDITION

JICA Study Team and PELT conducted three field survey, namely, Lake water quality survey, Lake sediment survey and Drainage channels / Espinar sewerage treatment plant survey. The results of field survey are summarized as follows.

#### (1) Existing Water Quality in the lake (Results of Lake Water Quality Survey)

The JICA Study Team and PELT conducted eight (8) lake water quality surveys at 12 points in the lake in the rainy season and dry season.

The surveys are conducted from December 1998 to February 1999 as the rainy season and from July to September 1999 as dry season.

Rainy season	2 Dec. '98
	21 Jan. '99
	28 Jan. '99
	3 Feb. '99
Dry season	8 Jul. '99
	4 Aug. '99
	18 Aug. '99
	7 Sep. '99

The weather in the period of survey in the rainy season is shown *Figure III.3.5*. The rainfall is observed almost everyday, and the rainfall is characterized short

time and high intensity. While, it had no rain in the period of survey in the dry season.

Based on the results of survey, the characteristic of water quality condition in Puno Interior Bay is obtained as described below.

#### **(The Contents of Survey)**

The outline of water quality survey in the lake is summarized below.

The survey points are selected 12 points in the interior and exterior bay based on the previous monitoring program which was carried out by PELT from 1993 to 1997. (refer to *Figure III.3.6*)

The sampling time is one time a survey. The water samples for analysis were obtained at the upper layer (20% of the depth) and the lower layer ( 80% of the depth) in the lake. The observed and analyzed water quality parameters are shown in *Table III.3.1*.

#### **( The Results of Survey )**

The results of lake water quality survey are shown from *Table III.3.2(1)* to *Table III.3.2(8)*. Based on the results of survey, it was found that Puno Interior Bay could be classified into five water bodies as described below. ( refer to *Figure III.3.6*.)

**Water body-A**: Heavy polluted water body, which is affected mainly by directly discharged wastewater from the urbanized area of Puno.

**Water body-B**: Significantly polluted water body, which is caused by treated wastewater from the Espinar treatment plant.

**Water body-C**: Slightly polluted water body, which has undergone a kind of purification and dilution.

**Water body-D**: Clean water body, which has no external pollution source.

**Water body-E**: Clean water body, which has the same water quality level as Puno Exterior Bay.

The reasons of the above mentioned water quality condition are assumed as below.

The location of the discharged pollution load into the lake is concentrated the western shore from the University of Altipulano (UNA) to the Espinar wastewater treatment plant.

It seems that the diffusion of discharged wastewater in the western water bodies of the interior bay is disturbed by the wind during the daytime.

The characteristic of the water quality on each parameter is summarized as below.

#### **Water Temperature**

The average temperature in the Interior Puno Bay ranged from 10 degrees to 16 degrees in January to September. The water temperature in the western water bodies is higher than eastern water bodies. It seems that the water temperature rising is caused due to the discharged wastewater from Puno urbanized area. The vertical distribution, which measured at 20 % depth and 80 % depth, was less than 3 degrees. (refer to *Figure III.3.7, Figure III.3.8, Table III.3.3 and Table III.3.4*)

#### **Transparency**

The transparency in the interior bay was recorded from 0.2 m as the lowest to 2.7 m as the highest with average of 1.3 m. The minimum value was observed in the western water bodies. The transparency in the exterior bay is still good with from 3.0 m to 7.7 m.. (refer to *Figure III.3.9 and Table III.3.5*)

#### **pH**

The pH value was observed ranging from 7.8 as the lowest to 9.5 as the highest in the interior bay and from 8.0 to 9.5 in the exterior bay. It seems that the Puno Bay undergo activity of photosynthesis. (refer to *Figure III.3.10 and Table III.3.6*)

#### **Conductivity**

The conductivity value was observed ranging from 0.10 s/m to 0.18 s/m in the interior bay and from 0.14 s/m to 0.16 s/m in the exterior bay. The wide range in the Interior Puno Bay was caused by rainfall and wastewater.

### **Dissoluble Oxygen**

The DO value was observed ranging from 1.0 mg/l to the supersaturated condition in the interior bay and from 2.0 mg/l to 7.2 mg/l in the exterior bay. It seems that the high value was caused by activity of photosynthesis with the same trend of pH. A minimum DO value was observed at the point of near the Espinar Treatment Plant with 1.0 mg/l. The second was found at the central point (No.13) of the western water body with 1.2 mg/l. (refer to *Figure III.3.11* and *Table III.3.7*)

### **Suspended Substance**

The SS value was observed wide ranging from 0.6 mg/l to 110 mg/l with average of 27 mg/l. High values were found in the western water bodies in the interior bay. This water bodies was affected mainly by discharged rainwater from the urbanized area in Puno city. (refer to *Table III.3.8*)

### **BOD**

The average of each points were ranged 7 mg/l at No. 5, 21 and 23 in the eastern water bodies to 27 mg/l at the point of near the Espinar Treatment Plant. High values were found in the western water bodies, namely, at the front of the Port, the Espinar wastewater Treatment and University of Alutipurano. This water bodies was affected mainly by discharged wastewater and rainwater from the urbanized area in Puno city and treated wastewater from the treatment plant. (refer to *Figure III.3.12*, and *Table III.3.9*)

### **Total Nitrogen / Total Phosphorus**

The average total nitrogen of 10 points in the Interior Puno Bay were ranged 2 mg/l to 6 mg/l. The average total phosphorus of 10 points in the Interior Puno Bay were ranged 0.2 mg/l to 1.6 mg/l. The higher concentration of both parameters was observed in the western water bodies and near the Espinar Treatment Plant. (refer to *Figure III.3.13* and *III.3.14*)

The regional distribution of pollution trend in the interior bay was almost the same as BOD. Based on the concentration of total nitrogen and total phosphorus, the eutrophication level is hyper-eutrophic ( $>0.1$  mg/l Total P).

### Total Coliform

The number of total coliform was observed wide ranging from N.D. to 1000 n/ml. High values were found in the western water bodies in the interior bay. This water bodies was affected mainly by discharged wastewater and rainwater from the urbanized area in Puno city and overflow from sewerage system.

## (2) LAKE SEDIMENT SURVEY

The JICA and PELT conducted a lake sediment survey on February and July 1999. Sampling points are selected 12 points as same as the water quality survey. Sediment sample is taken by core sampler, and divided into two or three parts according to its color for analyzed sample. The analyzed parameters are shown in *Table III.3.1*.

Based on the results of survey, the feature of core sediment sample and the regional distribution of the sediment quality are shown *Table III.3.10(1) and (2)*.

The sediment quality in Puno Interior Bay is characterized by as below.

- Color of surface sediment is black, except No. 1, 2 point at Puno Exterior Bay and No. 5, 9 under the sailing route. It means that the sediment color is changed by ferrous sulfide (H<sub>2</sub>S), and this reaction is explained by the following reaction formula.  
$$\text{Fe}_3(\text{PO}_4)_2 + 3\text{S}^{2-} \rightarrow 3\text{FeS} + 2\text{PO}_4^{3-}$$
- Above formula shows a mechanism of phosphorus release from sediment, namely, Insoluble phosphorus as Ferrous Sulfide changes to phosphorus-ion in anaerobic condition.
- ORP, Ignition loss and sediment color is showing anaerobic condition of sediment. The regional distribution of above three parameters is showing the same tendency as the sediment in the western part of lake is anaerobic condition. (refer to *Figure III.3.15*)
- The average contents of nutrients of the sediment in the Puno Interior bay were 16.1 mg/ g-dry solid as total nitrogen and 1.4 mg/g-dry solid as total phosphorus.
- The total contents of nutrients in the sediment are estimated 13,389 tons of nitrogen and 1,164 tons of phosphorus under the below condition. These

amounts of nutrients are equal with the discharged pollution load from :  
Puno City from for 20 years to for 40 years. (refer to the following  
Assumption )

- It seems that the sediment at the point of Espinar (No.6) and western part  
( No. 10, 13, 14, 16, 17) is formed by external pollution load from Puno  
City. While, in case of point 23, it can be said the sediment formed by  
macrophytes according field survey.

#### Assumption:

The average contents of sediment	Total nitrogen = 16.1 mg/g-dry solid
	Total phosphorus = 1.4 mg/g-dry solid
Moisture content	76 %
Specific gravity	2.2
Subject area	525 ha (the western part of Puno Interior Bay:inside the line which links Hotel Estives with Espinar wastewater treatment plant )
Sediment thickness	0.3 m thickness
Discharged Pollution Load	Total N = 865 kg/day Total P = 142 kg/day (refer to Chapter III 4. Pollution Loads)

#### Estimation :

Total volume of sediment	$831,600 \text{ tons} = 5,250,000 \text{ m}^2 \times 0.3 \text{ m}$ $\times (1.0-0.76) \times 2.2$
Total content	N: $13,389 \text{ tons} = 831,600 \text{ ton} \times 16.1 \text{ mg/g-DS}$ P: $1,164 \text{ tons} = 831,600 \text{ tons} \times 1.4 \text{ mg/g-DS}$
Equivalent Discharged P. L.	42 years = $13,389 \text{ tons} / (865 \text{ kg/d.} \times 365 \text{ d.})$ 22 years = $1,164 \text{ tons} / (142 \text{ kg/d.} \times 365 \text{ d.})$

### **(3) Discharge of Pollution Load to the lake ( Drainage Channel and Treatment Plant Survey)**

The pollution load, which is generated in the city of Puno, is discharged into the lake through drainage channels and the sewerage system. The JICA Study Team and PELT conducted a drainage channel survey at 5 points and the Espinar wastewater treatment plant in rainy and dry season.

#### **( Drainage Channel )**

The observed drainage channels are as follows.

- Rainy season : Llavini, Jorge Basadre, Floral, Carabaya and Ricardo Palma.
- Dry season : Llavini, Floral, Carabaya, and Ricardo Palma

The five (5) observed drainage channels were selected with the following points of view. (refer to *Figure III.3.16*.)

constantly discharge domestic and commercial wastewater into Puno Interior Bay.

- a drainage channel has a large point-source, namely, slaughterhouse.
- major drainage channel in the city of Puno.

#### **(Sewerage Treatment Plant)**

The observed treatment plant is Espinar Sewerage Treatment Plant. (refer to *Figure III.3.16*.)

#### **(Frequency of sampling time and Analysis parameters )**

The frequency of sampling time is determined as follows;

- |                           |         |              |
|---------------------------|---------|--------------|
| - Drainage Channel        |         | 3 times /day |
| - Espinar treatment plant | inflow  | 3 times /day |
|                           | outflow | 1 time / day |

The observed and analyzed water quality parameters are shown in *Table III.3.1*.

## Survey Results

### Drainage Channel :

Based on the results of survey in the rainy season and the meteorology data, the observed channel flow in the rainy season was affected by rainwater. (refer to *Figure III.3.5 and Table III.3.11.(1)-(6)*) The estimated channel flow in four channels, namely, Llavini, Floral, Carabaya and Ricardo Palma, was as follows.

	Date	Channel Flow
Rainy season:	26 Jan. '99	11,400 m <sup>3</sup> /day
	1 Feb. '99	2,100 m <sup>3</sup> /day
	15 Feb. '99	13,100 m <sup>3</sup> /day
Dry Season:	11 Aug. '99	1,900 m <sup>3</sup> /day

The channel flow in the rainy season and the dry season significantly differ. However the channel flow on 1 February in the rainy season was not significantly affected in comparison with above two surveys in the rainy season.

While, average water quality of drainage channel in the dry season was higher than rainy season, except suspended solid. (refer to *Table III.3.12*)

According to the calculation of discharged pollution load through the channels, it is found as below.

- According to the estimation of share of discharged pollution load from channels, the largest channel in the rainy season is Llavini, and the next channels are Floral and Carabaya. While, in the dry season, Ricardo Palma and ?? are major channels. (refer to *Table III.3.13(1) and (2)*)
- It seems that a pollution load run-off in the above channels is characterized by a large amount of accumulated pollution load in the channel bed or overflow from sewerage system.
- The discharged pollution load into the lake through major channels in the rainy and dry season is as follows. It is noted that suspended substance was increased extremely and Nutrients were tended to increase.



	Rainy season	Dry season	Ratio of rainy / dry season
Flow (m <sup>3</sup> /day)	8,881	1,692	5.2
SS (kg/day)	7,562	209	36.2
BOD (kg/day)	212	281	0.8
T-N (kg/day)	99.6	71.5	1.4
T-P (kg/day)	8.8	5.7	1.6

(refer to *Table III.3.14*)

#### **Espinar Sewerage Treatment Plant :**

Based on the results of survey, average inflow of the treatment plant in the rainy season is 28,000 m<sup>3</sup>/day. The inflow is too large compared with the intake volume for water supply in Chime, which is approximately 13,000 m<sup>3</sup>/day. It seems that the inflow in the treatment plant contains a large amount of rainwater.

While, the average inflow in the dry season is approximately 13,000 m<sup>3</sup>/day.

Treated wastewater quality in the treatment plant is as follows. It seems that no difference of treated water quality between the rainy season and the dry season is found. (refer to *Table III.3.15*)

	Rainy season <sup>1)</sup>	Dry season <sup>2)</sup>
SS	353	194
BOD	152	183
NH4-N	2.34	4.15
T-N	37.06 <sup>3)</sup>	36.61
PO4-P	0.71	0.72
T-P	3.58	3.51

1) Average (from 17 Feb. to 19 Feb. 1999)

2) Results of survey on 22 July 1999.

3) Inorganic Nitrogen

### Discharged pollution load into the lake :

According to the results of treatment plant and channel survey, it was found that a shear of discharged pollution load is as follows.

unit : kg/day

		Treatment Plant	Drainage Channels	Total
Rainy Season	BOD <sub>5</sub>	3,924 (94 %)	246 (6 %)	4,170
	Inorg.-N	1,016 (90 %)	110 (10 %)	1,126
	T-P	98.3 (91 %)	10.2 (9 %)	108.5
Dry Season	BOD <sub>5</sub>	1,514 (83 %)	317 (17 %)	1,831
	T-N	303 (73 %)	110 (27 %)	413
	T-P	29.0 (62 %)	18.0 (38 %)	47.0

As evident from the above, it was found that a share of discharged pollution load from the Espinar wastewater treatment is more than 90 % in the rainy season. In the dry season, a share of discharged pollution is from 60 % to 80 per cent in the dry season.

It seems that the treatment plant is a major external pollution source in Puno Interior Bay, and the pollution load in the rainy season is approximately three times on the amount in the dry season (refer to *Table III.3.16.*)

### 3.3 EVALUATION OF PRESENT CONDITIONS

#### (1) Regional Distribution of Existing Water Quality in the Interior Puno Bay

The regional distribution of water quality in Puno Interior Bay is characterized by as follows.

- The outlet of the wastewater, namely, drainage channels from Puno City and Espinar treatment plant, is concentrated in the western shore of the lake.
- The diffusion of the wastewater is preventing by the east wind during the daytime.

Consequently, the water body in the western part of the Interior Puno Bay is significantly deteriorated.

## (2) Eutrophic Level

Based on the results of water quality survey, it found that the nutrient concentration is high. Judging from the concentration of nutrient, it assumed that the eutrophic level of the interior Puno Bay is reached hyper-eutrophic ( $>0.1$  mg/l as total Phosphorus). (refer to *Figure III.3.17*).

		unit : mg/l		
		Median	Maximum	Minimum
Rainy Season	T-N	1.2	7.35	0.16
	T-P	0.3	1.12	0.14
Dry Season	T-N	3.07	8.93	1.25
	T-P	0.39	4.76	0.06

In general, nitrogen or phosphorus lists as a limiting nutrient in the lake. Based on the balance of the existed whole pollution load in the lake, ratio of nitrogen / phosphorus is approximately 5. Based on the existed pollution load, it can be said that nitrogen is assumed as the limiting nutrients in the Interior Puno bay.

	Existed Pollution Load in the Lake		Ratio of
	T-N (ton)	T-P(ton)	N/P
Rainy season	44.1	7.6	5.8
Dry season	113.3	25.8	4.4
Average	-	-	5.1

(refer to *Table III.3.17*)

The other side, it is assumed that nitrogen and phosphorus participate with limiting nutrient in view the relationship with total nitrogen and total phosphorus of water quality in the lake. (refer to *Figure III.3.18*)

## (3) External Pollution Sources

As above mention, the deterioration of the Interior Puno Bay is caused by discharged wastewater through drainage channels and the treated wastewater from Espinar sewerage treatment plant. Based on the results of survey, the shear of discharged pollution load from treatment Plant and five (5) drainage channels is calculated as below.

unit : %

		BOD <sub>5</sub>	T-N	T-P
Rainy Season*	Treatment Plant	94	90	91
	Drainage Channels	6	10	9
Dry Season**	Treatment Plant	83	73	62
	Drainage Channels	17	27	38

Note \* : The observed channels are Llavini, Jorge Basadre, Floral, Carabaya, and Ricardo Palma.

\*\* : The observed channels are Llavini, Floral, Carabaya, Ricardo Palma and Chanu chanu.

As evident from the above, it assumed the treatment plant is a major pollution source in the water environment of the interior Puno Bay.

#### (4) Existing Condition of Lake Sediment

Based on *Table III.3.10* and *Figure III.3.15* as the results of survey, the polluted sediment, namely, high organic content and anaerobic condition is located in water body-A and B as the classified water quality bodies.

The average contents of nutrients in the sediment in the Puno Interior bay were 16.1 mg/ g-dry solid as total nitrogen and 1.4 mg/g-dry solid as total phosphorus.

The total contents of nutrients are estimated 13,389 tons of nitrogen and 1,164 tons of phosphorus. These amounts of nutrients are equal with the discharged pollution load from Puno City from for 20 years to for 40 years.

### 3.4 IDENTIFICATION OF PROBLEMS

The existing water environment problems in Puno Interior Bay are identified as below. These problems are identified by the field survey and interview of residents.

#### (1) Occurrence of odor

It is presume that the occurrence of odor from the lake is cased from the anaerobic lake sediment, but JICA member in this survey does not confirm this problem. The sediment in the west part of the interior bay was observed high value in ignition loss and black color, which is shown anaerobic condition. It can be reasoned the required conditions for occurrence of odor problem are satisfied as below.

- A source of occurrence  
According to the sediment survey , the anaerobic sediment was observed.
- A source of pollution load for formation of sediment  
Puno urbanized area and Espinar treatment plant.
- Anaerobic atmosphere  
The west part of Puno Interior Bay is polluted water body and less water movement.
- A carrier  
The direction of wind during daytime is from east to west, namely, from lake to Puno City.
- A affected subject  
The port and residence area is near the lake.

## **(2) Obstruction of ship navigation (activity) by *Lemna***

*Lemna* covers a part of surface of Puno Interior Bay. *Lemna* come near the west shore of the lake by the wind during daytime. The density of *Lemna* will be reaches 10 to 15 cm thick depending on the direction and the force of the wind. Consequently, the obstruction of the small ship activity is occurred by the thick and heavy of *Lemna*.

The harvest of *Lemna* as countermeasure for above mention was conducted by the Multi-Sector Committee for the Environmental Improvement of Puno Interior Bay in 1998. The harvest of *Lemne* is efficacious against obstruction of ship activity and also participates with improvement of below:

- Removal of nutrient in the lake
- Protection for formation of sediment by *Lemna*
- Improvement of the view which is depreciated by *Lemna* and Solid waste.

## **(3) Depreciation of tourism resources**

An affluent in ecosystem in the Titicaca Lake is important as the tourism industry in this area. However, the existing ecosystem in the lake will be depreciated by the water pollution. Actualized depreciation are made up a list as below:

- Occurrence of odor from the lake
- Deterioration of water quality
- Extraordinary floating *Lemna*
- Eutrophication (water color will be change green by the photosynthesis)
- Depreciation of natural environment (weakening "Totorá" as the view characteristic of the Titicaca Lake)