4 POLLUTION LOADS

In this section, existing and future discharged pollution load into the lake is roughly estimated to know shear of pollution sources. Pollution sources for estimated pollution load are listed as follows.

- Domestic wastewater
- Commercial / Institutional wastewater
- Agricultural wastewater
- Livestock wastewater
- Leachated pollution load from non-collected solid waste
- Treated wastewater from sewerage treatment plant

Basically, pollution load is estimated multiplying unit pollution load by frame. Estimation method and precondition of calculation are described as below.

Frame

Using frames for estimation are summarized as follows, and details are shown in from *Table III.4.1* to *Table III.4.3*.

Domestic wastewater

	1998	2000	2008	2015	2025
Population (city area)	108,457	114,579	139,078	160,508	185.004
(other area)	1,564	1,564	1,564	1,564	1,564
Total population	110,021	116,143	140,642	162,072	186,568
Ratio of served population in population in city area	46 %	51 %	70 %	78 %	85 %

Agricultural wastewater

Total amount of fertilizer as T-N	19.0 kg/day*
Total amount of fertilizer as T-P	13.3 kg/day*

Note: * according to the questionnaire survey by JICA.

Livestock wastewater

No. of livestock (1998 – 2025)		
	Sheep	6,216 heads*
	Cow	871 heads*
	Alpaca	290 heads*
	Hog	311 heads*

Note: * according to the questionnaire survey by JICA.

Solid waste

Amount of illegally dumped solid waste

	1998	2000	2008 - 2025
	11,799 tons/year	11,799 tons/year	0 tons/year

Unit Pollution Load

Using unit pollution load is shown as below. (refer to *Table III.4.4.*)

Domestic wastewater from non-served population

	BOD	T-N	T-P
Graywater only	28.8 gcd	2.75 gcd	0.625 gcd

Sewerage treatment plant

	BOD	T-N	T-P
Inflow (gray + blackwater)	45 gcd	11 gcd	1.25 gcd
Removal efficiency	70 %	30 %	30 %
Discharged P. Load	13.5 gcd	7.7 gcd	0.875 gcd

Commercial wastewater

Pollution load (commercial) = Pollution load (domestic) x 15.1 %*

Note: * the ratio is acquired from PRONAP plan.

Livestock wastewater

Unit P.L. (g/ head-day)	BOD	T-N	T-P
Sheep	60	27	4.2
Cow	660	330	56.0
Alpaca	60	27	4.2
Hog	217	22	14.4

Solid waste

	BOD	T-N	T-P
Quality of leachate (mg/l)	2,500	800	80
Quantity of leachate		13,274 m3/year	

Run-off

	BOD	T-N	T-P
Domestic wastewater	0.6	0.6	1.0
Commercial / Institutional wastewater	0.6	0.6	1.0
Agricultural wastewater	-	0.3	0.2
Livestock wastewater*	0.55 – 0.3	0.55 – 0.3	0.55 – 0.3
Wastewater from Solid waste	0.6	0.6	1.0
Treated wastewater from treatment plant	1.0	1.0	1.0

Note: * According to development of inundation area, it assumes that the pastureland shifts from lake site to inland, and details are shown in *Table III.4.5.*

Results

Based on the results of estimation in the above calculation condition, the discharged pollution load into the lake is shown in *Figure III.4.1.* The transition of pollution load and share of each pollution source are summarized as follows.

- Existing discharged pollution load into the lake consists chiefly of sewage (domestic, commercial, institutional and others wastewater and treated wastewater from treatment plant) and livestock wastewater.
- Existing sewage account for 65 per cents of all pollution loads in T-P and the share of livestock wastewater is 31 per cents, respectively. (refer to *Figure III.4.2.*)
- While, solid waste and agriculture are unimportant in the composition of pollution load.
- In present condition, a ratio of increase in discharged pollution load between 1998 and 2025 is below.

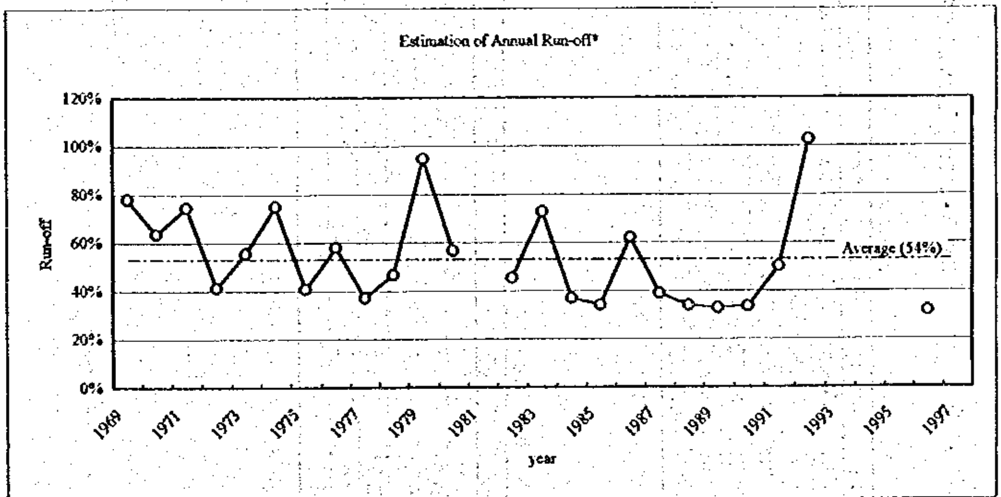
	BOD	T-N	T-P
2025 / 1998	1.14	1.67	1.28

As mentioned in the section of "Available Data of the lake" at Chapter III.2.1, it assumes that the deterioration of Puno Interior Bay became clear in 1980's. Similarly, discharged pollution load in 1972 and 1981 is roughly estimated as reference. (refer to *Table III.4.6*) Based on the above estimation, it found that discharged pollution load from 1972 to 1998 was increased quickly.

Table. III.2.1 The Estimation of Run-off Coefficient in The Study Area

Year	Water Level (m)	Precipitation (mm)	Evaporation (mm)	Water balance: (A) Rainwater in basin ($x10^6m^3/year$)	(B) Rainwater on lake ($x10^6m3/year$)	(C) Evaporation from lake surface ($x10^6m3/year$)	(D) Transition of water level ($x10^6m3/year$)	(E) B+C-D	Run-off (%) (-E / A)
1968	3,809.22	624.1	1,938.8	32.8	9.7	-30.1	-		-
1969	3,808.96	503.8	2,089.2	26.4	7.8	-32.4	-4.0	-20.6	78%
1970	3,808.76	566.0	1,986.3	29.7	8.8	-30.8	-3.1	-18.9	64%
1971	3,809.02	652.6	2,043.1	34.3	10.1	-31.7	4.0	-25.6	75%
1972	3,808.89	798.1	2,047.4	41.9	12.4	-31.7	-2.0	-17.3	41%
1973	3,809.28	797.0	1,912.7	41.8	12.4	-29.6	6.0	-23.2	56%
1974	3,810.06	750.8	1,877.5	39.4	11.6	-29.1	12.1	-29.6	75%
1975	3,810.38	951.6	1,939.7	50	14.7	-30.1	5.0	-20.4	41%
1976	3,810.64	758.0	1,984.9	39.8	11.7	-30.8	4.0	-23.1	58%
1977	3,810.38	742.4	1,938.6	39	11.5	-30.0	-4.0	-14.5	37%
1978	3,810.58	828.0	1,932.9	43.5	12.8	-30.0	3.1	-20.3	47%
1979	3,810.84	527.3	1,959.5	27.7	8.2	-30.4	4.0	-26.2	95%
1980	3,810.51	614.4	2,122.7	32.3	9.5	-32.9	-5.1	-18.3	57%
1981	3,810.71	-	2,002.9	-	-	-31.0	3.1	-	-
1982	3,810.64	794.0	2,082.8	41.7	12.3	-32.3	-1.1	-18.9	45%
1983	3,809.73	434.1	2,412.8	22.8	6.7	-37.4	-14.1	-16.6	73%
1984	3,810.64	1,290.6	2,003.0	67.8	20	-31.0	14.1	-25.1	37%
1985	3,811.03	1,072.5	1,923.1	56.3	16.6	-29.8	6.0	-19.2	34%
1986	3,811.98	927.4	1,927.5	48.7	14.4	-29.9	14.7	-30.2	62%
1987	3,811.35	630.7	2,095.6	33.1	9.8	-32.5	-9.8	-12.9	39%
1988	3,811.10	847.7	2,072.6	44.5	13.1	-32.1	-3.9	-15.1	34%
1989	3,810.58	684.6	1,966.4	35.9	10.6	-30.5	-8.1	-11.8	33%
1990	3,809.99	646.8	1,968.3	34	10	-30.5	-9.1	-11.4	34%
1991	3,809.67	596.8	1,934.0	31.3	9.3	-30.0	-5.0	-15.7	50%
1992	3,809.15	374.1	2,192.7	19.6	5.8	-34.0	-8.1	-20.1	103%
1993	3,808.92	759.2	-	39.9	11.8	-	-3.5	-	-
1994	3,809.22	803.6	-	42.2	12.5	-	4.6	-	-
1995	3,808.78	543.3	-	28.5	8.4	-	-6.9	-	-
1996	3,808.50	753.5	1,842.8	39.6	11.7	-28.6	-4.3	-12.6	32%
1997	3,808.97	908.9	-	47.7	14.1	-	7.2	-	-
Average	3,809.09	766.5	1,938.8	-	-	-	-	-	54%

Water surface of Lake 15.5 km2
Area of basin 52.5 km2



note: Annual run-off is estimated based on below calculation condition.
Assuming that the discharged rain water from basin balances with the evaporation.
run-off = ((Rain water on Lake) - (Evaporation) - (transition of water level))
/ (Rain water on basin)

Table. III.2.2 The Water Level of Titicaca Lake and The Monthly Precipitation in Puno

(The Water Level of Titicaca Lake) unit : monthly average (m)

	January	February	March	April	May	Jun	July	August	September	October	November	December	Average
1993	3809.070	3808.820	3808.720	3808.650	3808.680	3808.800	3808.910	3809.030	3809.160	3809.150	3809.170	3808.930	3808.924
1994	3808.940	3809.260	3809.460	3809.600	3809.560	3809.460	3809.340	3809.210	3808.980	3809.010	3808.930	3808.900	3809.221
1995	3809.000	3809.010	3809.190	3808.250	3809.140	3809.020	3808.890	3808.780	3808.550	3808.580	3808.480	3808.430	3808.777
1996	3808.500	3808.770	3808.840	3808.880	3808.780	3808.660	3808.520	3808.410	3808.170	3808.200	3808.140	3808.120	3808.499
1997	3808.290	3808.720	3809.180	3809.360	3809.330	3809.210	3809.100	3809.010	3808.915	3808.873	3808.836	3808.772	3808.966
1998	3808.807	3808.875	3808.979	3808.038	3808.915	-	-	-	-	-	-	-	-

source : SENAMHI

(The Monthly Precipitation) unit : monthly (mm)

	January	February	March	April	May	Jun	July	August	September	October	November	December	Total
1993	175.6	100.7	107.0	52.5	6.6	1.1	0.0	37.9	18.0	69.1	79.2	111.5	759.2
1994	180.0	183.1	113.3	116.2	29.9	0.4	0.0	0.0	18.3	36.6	52.6	73.2	803.6
1995	122.7	119.7	124.0	2.1	4.1	0.0	0.0	3.0	21.9	15.3	50.3	80.2	543.3
1996	252.7	130.5	60.8	76.3	0.0	0.0	2.9	12.8	0.8	10.4	88.3	118.0	753.5
1997	239.6	213.2	98.6	88.6	0.9	0.0	0.0	21.9	108.2	30.1	62.9	44.9	908.9
1998	196.4	-	-	-	-	-	-	-	-	-	-	-	-

source : SENAMHI

Table. III.3.1 Water Quality Parameters of Field Survey

Water Quality Parameter	Lake water quality survey	Lake sediment survey	Drainage channel survey	Sewerage treatment plant survey	Analysis Method
Temperature	o	o	o	o	Thermometer
Transparency	o				Secchi's disc
pH	o		o	o	pH meter (the glass electrode method)
ORP	o	o			ORP meter (the glass electrode method)
DO	o		o	o	DO meter
SS	o		o	o	Glass-fiber filter
BOD_5	o		o	o	Standard Method
COD_{Mn}	o		o	o	Japan Industrial Standard (JIS K0102)
Moisture content		o			Testing Method for Sediment (Environment Agency of Japan)
Ignition Loss		o			Testing Method for Sediment (Environment Agency of Japan)
T - N	o	o	o	o	T-N = Kj-N + NO3-N + NO2-N
NH_4 - N	o		o	o	Standard Method (Ammonia-Selective Electrode Method)
NO_2+NO_3 - N	o		o	o	HACH
Kj-N	o		o	o	Testing Method for Sediment (Environment Agency of Japan)
PO_4 - P	o		o	o	Standard Method (Ascorbic Acid Method)
T-P	o	o	o	o	Standard Method (Ascorbic Acid Method)
Total Coliform group	o		o	o	Simplified Filter Paper Method

Table. III.3.2 (1) The Results of Water Quality Survey (Puno Interior Bay : 2 Dec. 1998)

Items	Point No.	1	2	5	6	9	10	13	14	16	17	- 21	23
Location of Sampling Point	Longitude	69 - 57' 23"	69 - 57' 61"	69 - 58' 81"	69 - 59' 80"	69 - 59' 78"	70 - 00' 53"	70 - 00' 20"	70 - 00' 37"	70 - 00' 40"	70 - 00' 28"	69 - 59' 37"	69 - 59' 11"
	Latitude	15 - 51' 02"	15 - 50' 95"	15 - 50' 68"	15 - 51' 03"	15 - 50' 43"	15 - 50' 90"	15 - 50' 03"	15 - 50' 12"	15 - 49' 45"	15 - 49' 35"	15 - 49' 38"	15 - 50' 04"
Sampling Time (Start)		12:41	12.19	11:54	10:52	11:04	10:22	10:07	9:43	8:53	9:18	11:17	11:37
Air temperature (degrees C.)		16	16	16	17.5	17.5	17.5	17	17	17	17	17	17.2
Weather		F	F	F	F	F	F	F	F	F	F	F	F
Wind (direction)		N	East / G	East / G	East / G	East / G	East / G	East / G	East / G	East / G	East / G	East / G	East / G
Sampling Time (Finish)		12.54	12:32	12:00	10:58	10:09	10:35	10:14	9:51	9:07	9:32	11:22	11:45
Depth (m)		23.0	18.4	5.6	1.2	6.3	3.5	6.3	2.8	1.3	2.0	1.5	1.2
Transparency (m)		4.2	4.0	2.1	0.7	0.9	0.8	0.8	0.8	0.8	0.8	1.4	1.2
Sampling Depth (m)	Upper (20 %)	4.6	3.7	1.1	0.2	1.3	0.7	1.3	0.6	0.3	0.4	0.3	0.2
	Lower (80 %)	18.4	14.7	4.5	1.0	5.0	2.8	5.0	2.2	1.0	1.6	1.2	1.0
Upper Layer	Temperature (degrees C.)	16.3	16.3	15.9	17.2	16.5	17.3	17.1	17.5	17.3	17.6	15.3	16.7
	pH	8.9	11.9	8.9	9.3	9.2	9.2	9.2	9.2	9.0	9.1	8.8	9.2
	DO (mg/l)	6.5	6.8	6.9	7.3	10.4	8.0	9.3	11.0	13.2	10.9	6.4	7.4
	Conductivity (s/m)	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Lower Layer	Temperature (degrees C.)	14.4	14.6	14.3	17.3	14.8	16.5	15.3	17.3	16.0	16.9	14.5	14.8
	pH	8.9	9.0	9.0	9.2	8.6	8.9	9.0	9.2	9.2	9.2	8.5	9.1
	DO (mg/l)	5.1	5.4	6.2	12.4	3.7	9.5	11.0	11.3	8.3	11.1	5.3	7.4
	Conductivity (s/m)	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

Weather : F : Fine
C : Cloudy
R : Rain

Wind : N : no wind
G : gentle
S : slightly strong
SS : strong

Table. III.3.2 (2) The Results of Water Quality Survey (Puno Interior Bay : 21 Jan. 1999)

Point No.	Items	Temp.	Transp. (m)	pH	DO (mg/l)	Conduct	Turb. (mg/l)	SS (mg/l)	BOD_5 (mg/l)	COD_{Mn} (mg/l)	NH_4-N (mg/l)	NO_2-N (mg/l)	NO_3-N (mg/l)	T-N (mg/l)	PO_4-P (mg/l)	T-P (mg/l)	Coliform
1	Upper layer	16.4	3.50	8.9	3.3	0.14	1	0.6	0.6	5.6	0.03	ND	0.44	0.47	-	-	2.0E+00
	Lower layer	15.2		8.6	2.2	0.14	3	0.5	0.3	6.0	0.01	ND	ND	1.67	-	-	ND
2	Upper layer	16.7	3.20	9.0	3.7	0.14	1	0.5	3.1	6.3	ND	ND	0.44	0.44*	-	-	ND
	Lower layer	15.5		8.8	3.9	0.14	2	0.5	0.2	6.4	0.04	ND	ND	0.42	-	-	1.0E+00
5	Upper layer	16.3	1.30	9.0	3.0	0.17	4	0.6	5.1	24.8	0.15	ND	0.44	1.25	-	-	3.0E+00
	Lower layer	15.6		9.0	2.6	0.17	8	10.7	3.6	20.4	0.15	ND	ND	2.50	-	-	1.0E+00
6	Upper layer	17.0	0.90	9.0	3.5	0.18	8	11.1	18.8	40.0	0.44	ND	0.44	1.67	-	-	2.0E+01
	Lower layer	16.7		9.3	2.9	0.18	14	22.9	14.0	30.4	0.50	ND	0.44	1.67	-	-	4.7E+01
9	Upper layer	16.2	1.15	9.2	3.4	0.18	7	8.0	20.8	43.2	0.08	ND	0.88	2.08	-	-	4.0E+00
	Lower layer	15.7		9.2	2.9	0.18	9	6.8	20.3	35.2	0.27	ND	ND	1.67	-	-	ND
10	Upper layer	17.3	0.95	9.3	4.2	0.18	12	9.2	19.5	30.4	0.15	ND	0.88	2.08	-	-	3.0E+01
	Lower layer	16.6		9.2	4.1	0.18	10	8.7	8.3	28.0	0.34	0.01	0.44	0.83	-	-	2.0E+00
13	Upper layer	17.8	0.85	9.2	2.9	0.18	12	36.4	37.3	43.4	0.28	0.01	0.88	1.67	-	-	5.0E+01
	Lower layer	17.4		8.9	2.3	0.18	12	10.2	16.3	30.4	0.29	ND	0.44	0.73*	-	-	4.0E+00
14	Upper layer	18.1	0.75	9.3	3.2	0.18	12	18.7	12.8	31.2	0.28	ND	0.88	3.75	-	-	1.0E+03
	Lower layer	18.1		9.2	3.3	0.18	12	11.2	19.0	30.4	0.34	0.01	0.44	2.08	-	-	3.7E+01
16	Upper layer	15.6	0.20	9.0	2.9	0.18	45	110	21.5	48.6	0.50	0.01	0.88	2.50	-	-	7.7E+02
	Lower layer	16.0		9.1	3.0	0.18	51	59.7	19.5	32.8	0.45	0.01	0.88	2.08	-	-	1.7E+02
17	Upper layer	16.6	0.65	9.0	3.2	0.17	19	19.0	11.3	31.2	0.14	0.01	0.88	1.25	-	-	7.0E+01
	Lower layer	16.7		9.2	2.7	0.18	22	20.0	25.8	34.4	0.27	ND	0.44	2.08	-	-	6.0E+01
21	Upper layer	15.6	0.75	8.9	2.8	0.18	12	16.2	6.2	22.2	0.28	0.01	0.44	0.73*	-	-	1.7E+01
	Lower layer	15.7		9.0	2.2	0.18	18	67.2	7.7	32.4	0.25	ND	0.44	0.69*	-	-	7.0E+00
23	Upper layer	15.0	1.00	9.3	3.6	0.16	5	10.0	10.9	21.8	0.05	ND	ND	0.83	-	-	2.0E+00
	Lower layer	15.0		9.4	3.7	0.16	5	40.0	6.3	22.4	0.18	ND	0.88	3.75	-	-	ND

Note * : Inorganic-N (NH_4-N + NO_2-N + NO_3-N)
NH_4-N, NO_2-N, NO_3-N, T-N were analyzed by HACH

Table. III.3.2 (3) The Results of Water Quality Survey (Puno Interior Bay : 28 Jan. 1999)

Point No.	Items	Temp.	Transp. (m)	pH	DO (mg/l)	Conduct.	Turb. (mg/l)	SS (mg/l)	BOD_5 (mg/l)	COD_{Mn} (mg/l)	NH_4-N (mg/l)	NO_2-N (mg/l)	NO_3-N (mg/l)	T-N (mg/l)	PO_4-P (mg/l)	T-P (mg/l)	Coliform
1	Upper layer	16.1	3.6	9.1	4.4	0.14	1.5	14.0	4.4	0.8	ND	0.01	ND	0.01*	0.03	-	5.0E+01
	Lower layer	15.6		8.7	3.3	0.14	1	12.0	-	2.0	0.01	ND	ND	0.01*	0.01	-	ND
2	Upper layer	16.3	3.0	9.1	4.6	0.14	1.5	19.0	4.9	1.6	0.01	0.01	ND	0.90	0.02	-	ND
	Lower layer	15.8		9.1	3.7	0.14	1	17.0	-	1.4	0.01	0.01	0.10	0.75	0.01	-	4.0E+01
5	Upper layer	15.3	1.3	9.2	3.6	0.17	10	22.0	14.0	10.6	0.25	0.01	ND	0.45	0.13	0.16	8.0E+01
	Lower layer	15.3		9.2	3.5	0.17	10	21.0	22.1	6.8	0.35	0.01	0.30	1.05	0.13	0.50	2.2E+01
6	Upper layer	15.9	1.1	9.2	2.7	0.18	10	15.0	20.4	17.1	0.63	0.01	0.10	0.90	1.14	-	2.6E+01
	Lower layer	15.9		9.1	2.7	0.18	9	54.0	36.8	25.7	0.72	0.01	0.30	1.03*	0.26	0.33	5.5E+01
9	Upper layer	15.9	1.0	9.4	5.2	0.17	16	20.0	35.4	21.2	0.19	0.01	0.10	0.75	0.15	0.23	ND
	Lower layer	15.3		9.3	3.6	0.18	12	22.0	25.3	18.8	0.29	0.01	0.30	0.60*	0.16	0.21	1.5E+01
10	Upper layer	16.0	1.0	9.2	3.5	0.17	14	19.0	25.6	20.4	0.19	0.01	0.10	0.60	0.34	-	1.0E+01
	Lower layer	16.0		9.2	3.2	0.18	13	24.0	21.6	-	1.01	0.03	0.30	1.04	0.37	-	2.0E+01
13	Upper layer	16.9	0.9	9.5	5.6	0.17	19	25.0	46.9	20.4	0.25	0.01	0.10	3.45	0.18	0.20	4.0E+01
	Lower layer	15.8		9.1	4.5	0.18	16	38.0	40.1	21.2	0.60	0.01	0.30	1.05	0.22	0.40	2.0E+01
14	Upper layer	17.2	0.9	9.3	5.2	0.17	19	26.0	26.3	20.4	0.75	0.02	0.10	2.40	0.21	-	1.5E+02
	Lower layer	17.2		9.4	5.9	0.18	18	45.0	23	19.6	0.35	0.01	ND	0.36*	0.20	0.20	1.3E+01
16	Upper layer	16.6	0.6	9.1	6.1	0.18	20	26.0	36.8	22.8	0.24	0.02	0.20	0.46*	0.21	0.29	3.5E+02
	Lower layer	16.6		9.2	6.1	0.18	19	28.0	32.3	18.4	0.34	0.02	0.30	0.75	0.24	0.32	1.6E+02
17	Upper layer	16.9	0.7	9.2	4.7	0.18	16	25.0	29.3	12.2	0.28	0.01	ND	3.00	0.16	0.26	2.0E+01
	Lower layer	16.8		9.1	4.4	0.18	18	-	15.2	9.0	0.27	0.01	0.20	0.48*	0.21	0.40	4.0E+02
21	Upper layer	15.0	0.6	9.2	3.6	0.18	16	34.0	29.1	17.1	0.33	0.02	ND	0.75	0.03	0.23	3.5E+01
	Lower layer	15.0		9.1	3.4	0.18	19	36.0	35.5	10.0	0.36	0.02	0.40	0.78*	0.05	0.33	5.5E+01
23	Upper layer	15.2	1.2	9.4	4.7	0.17	8	20.0	12.8	6.5	0.14	0.09	0.10	0.33*	0.07	0.18	ND
	Lower layer	15.1		9.4	5.1	0.17	9	44.0	24.6	8.4	0.22	0.01	0.10	1.35	0.07	0.14	ND

Note * : Inorganic-N (NH_4-N + NO_2-N + NO_3-N)
NH_4-N, NO_2-N, NO_3-N, T-N were analyzed by HACH

Table. III.3.2 (4) The Results of Water Quality Survey (Puno Interior Bay : 3 Feb. 1999)

Point No.	Items	Temp.	Transp. (m)	pH	DO (mg/l)	Conduct .	Turb. (mg/l)	SS (mg/l)	BOD_5 (mg/l)	COD_{Mn} (mg/l)	NH_4-N (mg/l)	NO_2-N (mg/l)	NO_3-N (mg/l)	T-N (mg/l)	PO_4-P (mg/l)	T-P (mg/l)	Coliform
1	Upper layer	-	4.0	-	-	-	-	0.5	1.7	4.6	0.03	0.01	0.00	0.04*	0.07	-	9.0E+00
	Lower layer	-		-	-	-	-	4.0	6.8	7.8	0.00	0.01	0.00	0.01*	0.08	-	ND
2	Upper layer	15.3	4.0	8.5	3.6	0.14	25	0.7	1.0	1.1	0.05	0.01	0.00	0.06*	0.07	-	2.0E+00
	Lower layer	14.6		8.6	3.7	0.14	24	-	3.7	6.6	0.00	0.00	0.00	1.65	0.08	0.09	2.1E+01
5	Upper layer	14.9	2.0	8.7	3.9	0.15	19	3.6	1.9	1.8	0.19	0.01	0.00	1.50	0.13	0.16	4.1E+01
	Lower layer	13.7		8.9	3.9	0.15	24	5.0	6.2	8.8	0.15	0.01	0.00	0.16*	0.17	0.27	3.2E+01
6	Upper layer	16.5	0.5	8.1	4.2	0.17	44	24.3	18.4	12.4	2.59	0.13	0.00	5.10	0.75	1.12	1.2E+02
	Lower layer	15.5		8.6	3.6	0.18	49	91.7	14.1	18.4	3.05	0.13	0.50	7.35	0.79	-	5.7E+01
9	Upper layer	14.9	1.0	8.9	4.4	0.17	36	26.0	4.5	7.6	0.57	0.02	0.00	1.80	0.24	0.25	5.6E+01
	Lower layer	14.1		9.0	4.1	0.17	34	13.3	3.7	3.2	0.50	0.02	0.00	1.35	0.29	0.30	5.3E+01
10	Upper layer	16.1	1.0	9.0	4.7	0.18	36	30.0	4.5	8.4	0.31	0.01	0.20	1.80	0.23	0.34	6.3E+01
	Lower layer	15.0		9.0	4.8	0.18	36	29.9	5.7	7.2	0.65	0.01	0.00	1.20	0.28	0.50	3.9E+01
13	Upper layer	16.7	1.0	9.0	4.9	0.18	34	17.0	3.8	2.8	0.16	0.01	0.10	1.35	0.30	0.31	3.8E+01
	Lower layer	15.8		9.1	5.7	0.18	36	23.0	7.0	6.8	0.34	0.01	0.00	1.05	0.28	0.38	4.7E+01
14	Upper layer	15.5	1.0	9.1	5.4	0.18	36	12.3	3.6	8.0	0.21	0.02	0.00	1.05	0.26	0.35	7.0E+01
	Lower layer	14.5		9.0	4.9	0.18	36	31.0	5.8	8.0	0.38	0.02	0.00	0.40*	0.26	0.30	1.2E+02
16	Upper layer	14.3	0.5	4.1	5.5	0.10	56	35.4	4.3	6.0	0.50	0.04	0.30	1.95	0.34	0.49	5.4E+02
	Lower layer	14.4		8.4	5.0	0.15	58	33.0	5.6	7.6	0.74	0.05	0.00	2.40	0.36	0.50	2.1E+02
17	Upper layer	14.6	0.4	8.2	4.0	0.12	56	34.4	2.9	4.0	0.85	0.04	0.10	0.99	0.37	0.41	4.3E+02
	Lower layer	14.3		8.2	3.6	0.13	56	27.0	10.4	15.2	1.04	0.06	0.00	1.20	0.38	0.38	1.0E+02
21	Upper layer	14.3	1.0	-	4.2	0.17	30	10.0	2.8	8.4	0.31	0.01	0.00	2.10	0.21	0.29	1.3E+02
	Lower layer	14.0		8.4	3.0	0.17	31	40.0	10.8	13.6	0.34	0.01	0.00	0.35*	0.20	0.24	1.8E+01
23	Upper layer	13.8	1.0	8.1	4.7	0.17	28	30.8	2.0	7.6	0.00	0.01	0.20	0.21*	0.17	0.31	3.6E+01
	Lower layer	13.3		8.5	4.4	0.17	29	28.8	9.5	9.6	0.10	0.01	0.00	1.20	0.17	0.23	1.0E+01

Note * : Inorganic-N (NH_4-N + NO_2-N + NO_3-N)
NH_4-N, NO_2-N, NO_3-N, T-N were analyzed by HACH

Table. III.3.2 (5) The Results of Water Quality Survey in The Interior Puno Bay (Date : 8 Jul. 1999)

Point No.	Items	Temp.	Transp. (m)	pH	DO (mg/l)	Conduct.	Turb. (mg/l)	SS (mg/l)	BOD_5 (mg/l)	s-BOD_5 (mg/l)	COD_{Mn} (mg/l)	s-COD_{Mn}	NH_4-N (mg/l)	NO_2-N (mg/l)	NO_3-N (mg/l)	T-N (mg/l)	PO_4-P (mg/l)	T-P (mg/l)	Coliform
1	Upper layer	11.2		8.7	6.4	0.14	6	8.0	9.7	-	4.4	-	0.02	0.00	0.00	4.00	0.04	0.11	-
	Lower layer	11.1	7.65	8.5	6.7	0.14	5.5	8.0	7.6	-	5.6	-	0.14	0.01	0.00	4.00	0.05	0.07	2.0E+00
2	Upper layer	11.3		8.4	6.7	0.14	5.5	9.0	4.0	-	4.6	-	0.06	0.00	0.00	3.00	0.04	0.08	1.0E+00
	Lower layer	11.1	7.15	8.3	6.8	0.14	4.5	9.0	6.9	-	5.6	-	0.04	0.00	0.00	-	0.04	0.08	2.0E+00
5	Upper layer	9.8		9.2	-	0.15	3	18.0	16.0	10.2	14.0	16.0	0.09	0.06	0.10	5.00	0.20	0.27	1.0E+00
	Lower layer	8.8	1.53	9.0	9.7	0.16	4.5	23.0	22.0	-	16.0	-	0.18	0.01	0.00	6.00	0.29	0.31	5.0E+01
6	Upper layer	10.8		9.0	7.0	0.16	7	46.0	40.2	17.5	23.6	34.8	1.92	0.01	0.30	8.00	0.28	1.05	9.0E+01
	Lower layer	9.7	1.26	8.5	2.2	0.16	13	63.0	50.4	-	34.8	-	2.68	0.07	0.40	5.00	1.76	0.39	1.0E+02
9	Upper layer	10.0		9.2	10.9	0.15	3	25.0	16.7	13.8	26.0	22.0	0.18	0.02	0.20	5.00	0.29	0.38	1.9E+02
	Lower layer	9.0	1.16	9.2	10.0	0.15	106	25.0	15.5	-	22.0	-	0.06	0.01	0.10	5.00	0.43	0.37	1.0E+00
10	Upper layer	9.6		9.1	8.2	0.16	6	19.0	32.2	-	22.8	-	0.50	0.01	0.20	4.00	0.43	0.54	2.5E+02
	Lower layer	9.5	1.85	9.1	7.6	0.16	6	15.0	9.6	-	15.6	-	0.25	0.01	0.10	7.00	0.58	0.35	2.0E+00
13	Upper layer	10.0		9.2	10.4	0.15	14	13.0	31.2	27.8	18.8	26.0	0.27	0.01	0.10	5.00	0.37	0.45	1.0E+01
	Lower layer	9.4	1.81	9.1	8.8	0.16	7	23.0	49.8	-	26.0	-	0.42	0.01	0.10	7.00	0.46	0.38	1.8E+01
14	Upper layer	11.1		9.2	9.4	0.15	4	14.0	4.7	-	22.0	-	0.28	0.01	0.10	6.00	0.38	0.48	9.4E+01
	Lower layer	11.1	1.76	9.2	9.1	0.15	4	23.0	10.8	-	17.2	-	0.41	0.01	0.20	8.00	0.58	0.45	-
16	Upper layer	9.2		8.8	6.4	0.10	3	11.0	22.5	20.2	22.0	22.8	0.38	0.01	0.10	4.00	0.35	0.42	6.1E+02
	Lower layer	9.5	0.90	8.6	5.1	0.10	5	30.0	24.6	-	22.8	-	0.50	0.01	0.20	7.00	0.56	0.06	-
17	Upper layer	9.5		9.0	7.9	0.16	2	21.0	26.9	-	23.6	-	1.23	0.01	0.10	6.00	0.52	0.54	1.7E+02
	Lower layer	9.3	1.71	8.9	7.5	0.16	2	14.0	31.5	-	20.4	-	1.68	0.01	0.10	6.00	0.94	0.44	3.0E+03
21	Upper layer	9.2		9.0	7.2	0.16	1.5	21.0	11.6	-	20.4	-	0.28	0.01	0.10	7.00	0.23	0.29	5.5E+01
	Lower layer	9.2	1.45	9.0	7.3	0.16	2	17.0	3.2	-	14.4	-	0.37	0.01	0.10	6.00	0.38	0.35	-
23	Upper layer	9.0		9.4	9.7	0.14	5	23.0	6.3	-	12.8	-	0.10	0.00	0.10	4.00	0.19	0.29	3.0E+02
	Lower layer	8.5	1.00	9.4	9.4	0.15	8	26.0	11.0	-	14.4	-	0.14	0.01	0.30	6.00	0.31	0.23	-

Table. III.3.2 (6) The Results of Water Quality Survey (Puno Interior Bay : 4 Aug. 1999)

Point No.	Items	Temp.	Transp. (m)	pH	DO (mg/l)	Conduct.	Turb. (mg/l)	SS (mg/l)	BOD_5 (mg/l)	COD_{Mn} (mg/l)	NH_4-N (mg/l)	$N0_2$-N (mg/l)	$N0_3$-N (mg/l)	T-N (mg/l)	$P0_4$-P (mg/l)	T-P (mg/l)	Coliform
1	Upper layer	11.7		8.5	6.8	0.15	1	3.0	7.8	4.1	0.04	0.01	0.00	5.00	ND	ND	3.0E+00
	Lower layer	11.7	5.50	8.3	7.2	0.15	1	7.0	6.8	3.9	0.04	0.00	0.00	5.00	ND	ND	5.0E+00
2	Upper layer	11.8		8.6	6.2	0.15	1	6.0	10.6	3.9	0.05	0.01	0.00	4.00	ND	ND	4.0E+00
	Lower layer	11.5	5.00	8.6	5.8	0.15	1	5.0	3.2	5.1	0.05	0.00	0.00	5.00	ND	0.06	3.0E+00
5	Upper layer	10.3		9.1	7.6	0.16	13	58.0	9.5	12.4	0.14	0.01	0.00	6.00	ND	0.86	3.7E+01
	Lower layer	10.1	1.50	9.1	7.2	0.17	15	21.0	12.1	16.5	0.18	0.00	0.00	6.00	ND	1.05	2.0E+01
6	Upper layer	10.2		9.2	9.2	0.16	10	30.0	17.8	21.0	5.43	0.02	0.20	12.00	2.66	4.91	1.4E+01
	Lower layer	9.7	1.50	9.2	8.3	0.16	14	29.0	28.1	29.0	5.38	0.02	0.00	13.00	2.84	3.65	7.2E+02
9	Upper layer	11.2		8.5	2.7	0.17	32	34.0	8.6	14.0	0.59	0.01	0.00	6.00	0.31	1.39	2.0E+00
	Lower layer	10.2	0.70	8.3	3.4	0.18	91	26.0	22.8	21.2	0.41	0.01	0.00	5.00	0.20	1.07	6.0E+00
10	Upper layer	12.6		8.9	7.2	0.17	7	21.0	12.9	13.2	0.59	0.01	0.10	7.00	0.31	1.41	3.8E+01
	Lower layer	12.5	1.20	8.9	7.2	0.17	8	32.0	10.8	18.8	0.57	0.01	0.00	6.00	0.51	1.52	1.4E+01
13	Upper layer	13.8		9.0	8.6	0.17	6	27.0	10.7	15.5	0.27	0.01	0.00	5.00	0.08	1.09	1.5E+01
	Lower layer	10.9	1.70	9.0	6.4	0.17	6	26.0	9.6	16.5	0.38	0.01	0.00	5.00	0.11	1.09	5.0E+00
14	Upper layer	12.6		9.0	12.3	0.17	6	24.0	13.2	13.2	0.28	0.01	0.00	7.00	0.11	1.25	1.6E+01
	Lower layer	11.7	1.40	8.8	3.9	0.17	8	27.0	8.9	19.6	0.55	0.01	0.00	7.00	0.32	1.32	1.8E+01
16	Upper layer	12.9		9.0	8.1	0.17	5	23.0	34.7	14.7	0.42	0.01	0.00	6.00	0.09	1.21	3.5E+01
	Lower layer	12.8	1.60	8.9	7.7	0.17	6	22.0	8.4	20.4	0.58	0.01	0.00	5.00	0.18	1.22	4.0E+01
17	Upper layer	12.6		9.0	8.2	0.17	6	19.0	38.0	14.0	0.24	0.01	0.01	6.00	0.08	1.01	1.5E+01
	Lower layer	11.5	1.80	8.8	6.8	0.17	6	120	8.3	16.5	0.34	0.01	0.00	3.00	0.16	1.10	3.4E+01
21	Upper layer	11.2		8.4	7.7	0.17	9	34.0	8.1	15.1	0.14	0.01	0.00	5.00	ND	0.84	7.0E+00
	Lower layer	9.9	1.50	9.0	7.7	0.18	10	28.0	7.1	16.5	0.26	0.01	0.00	4.00	ND	0.89	6.0E+00
23	Upper layer	11.5		9.0	8.1	0.17	10	35.0	17.8	12.0	0.15	0.01	0.00	5.00	ND	0.78	1.5E+01
	Lower layer	10.2	1.60	9.1	7.5	0.17	12	19.0	8.2	14.9	0.15	0.00	0.00	4.00	0.03	0.68	9.0E+00

Table. III.3.2 (7) The Results of Water Quality Survey (Puno Interior Bay : 18 Aug. 1999)

Point No.	Items	Temp.	Transp. (m)	pH	DO (mg/l)	Conduct	Turb. (mg/l)	SS (mg/l)	BOD_5 (mg/l)	COD_{Mn} (mg/l)	NH_4-N (mg/l)	$N0_2$-N (mg/l)	$N0_3$-N (mg/l)	T-N (mg/l)	$P0_4$-P (mg/l)	T-P (mg/l)	Coliform
1	Upper layer	12.0		8.3	6.8	0.15	1	5.0	3.0	3.8	-	ND	ND	-	0.15	ND	1.9E+01
	Lower layer	11.5	7.00	9.5	6.2	0.15	1	6.0	20.0	4.6	-	ND	ND	-	ND	ND	1.5E+01
2	Upper layer	12.3		8.2	5.9	0.15	1	6.0	21.4	4.2	-	ND	0.10	-	ND	ND	4.8E+01
	Lower layer	11.8	5.00	8.2	5.1	0.15	1	-	24.1	4.8	-	ND	ND	-	ND	Nd	5.0E+01
5	Upper layer	10.8		8.3	7.2	0.17	12	19.0	31.2	7.2	-	0.01	0.10	-	0.14	0.71	-
	Lower layer	10.5	1.35		7.7	0.17	14	28.0	79.0	16.8	-	0.01	0.10	-	0.23	0.63	7.0E+00
6	Upper layer	12.3		8.1	5.2	0.17	18	27.0	153.8	27.6	-	0.01	0.20	-	2.07	2.03	1.2E+02
	Lower layer	11.9	1.20	8.9	3.2	0.17	224	35.0	137.6	22.0	-	0.02	0.20	-	2.35	2.63	3.4E+01
9	Upper layer	12.1		8.8	9.6	0.17	12	23.0	130.5	23.6	-	ND	0.10	-	0.51	1.06	2.4E+01
	Lower layer	10.9	1.50	9.0	8.8	0.17	14	28.0	16.6	23.6	-	ND	0.20	-	0.37	0.91	3.0E+00
10	Upper layer	12.9		8.1	10.4	0.17	12	27.0	78.9	20.4	-	0.01	0.10	-	0.43	ND	1.3E+01
	Lower layer	12.0	1.50	9.0	5.9	0.17	87	27.0	121.3	22.0	-	0.02	0.20	-	0.66	ND	6.0E+01
13	Upper layer	13.0		9.1	10.4	0.17	10	21.0	50.9	22.8	-	0.01	0.20	-	0.42	0.73	4.0E+01
	Lower layer	12.0	1.50	9.1	8.9	0.17	12	23.0	75.1	20.4	-	0.01	0.10	-	0.53	0.68	3.0E+00
14	Upper layer	13.6		9.0	10.1	0.17	8	23.0	117.3	23.6	-	ND	0.20	-	0.43	ND	2.0E+00
	Lower layer	13.2	1.50	9.2	7.6	0.18	9	98.0	116.5	23.6	-	ND	0.10	-	0.59	0.93	7.0E+00
16	Upper layer	13.7		9.2	9.3	0.17	11	16.0	47.2	22.0	-	0.01	0.20	-	0.45	0.94	5.0E+00
	Lower layer	13.4	1.20	9.1	8.5	0.17	29	28.0	34.5	20.4	-	0.01	0.20	-	0.54	ND	2.0E+00
17	Upper layer	13.0		9.1	9.9	0.17	9	21.0	78.2	21.2	-	0.01	0.20	-	0.33	0.84	3.0E+00
	Lower layer	13.0	1.20	9.1	9.3	0.17	12	27.0	75.0	18.0	-	ND	0.20	-	0.43	0.73	2.0E+01
21	Upper layer	11.6		9.3	7.9	0.17	19	21.0	73.6	18.8	-	0.01	0.10	-	0.09	0.73	4.0E+00
	Lower layer	11.1	0.95	9.2	8.4	0.18	179	44.0	77.9	16.8	-	0.01	0.10	-	0.23	0.83	3.0E+01
23	Upper layer	10.5		9.0	7.4	0.17	13	17.0	70.9	15.2	-	0.01	0.10	-	0.06	0.55	2.0E+00
	Lower layer	10.7	1.20	9.1	7.4	0.17	18	24.0	77.9	14.8	-	ND	0.10	-	0.13	0.70	5.0E+00

Table. III.3.2 (8) The Results of Water Quality Survey (Puno Interior Bay : 7 Sep. 1999)

Point No.	Items	Temp.	Transp. (m)	pH	DO (mg/l)	Conduct	Turb. (mg/l)	SS (mg/l)	BOD_5 (mg/l)	COD_{Mn} (mg/l)	NH_4-N (mg/l)	$N0_2$-N (mg/l)	$N0_3$-N (mg/l)	T-N (mg/l)	$P0_4$-P (mg/l)	T-P (mg/l)	Coliform
1	Upper layer	12.9		8.5	6.4	0.16	6	5	9.9	4.8	0.13	0.01	1.10	1.51	ND	0.22	-
	Lower layer	12.4	5.00	8.4	5.8	0.16	3	7	6.8	4.0	0.08	0.01	1.10	1.46	ND	ND	-
2	Upper layer	12.8		8.4	6.6	0.16	5	5	4.0	5.0	0.12	0.01	1.00	1.29	ND	ND	-
	Lower layer	12.4	4.70	8.4	5.9	0.16	4	37	7.2	6.0	0.07	0.00	0.90	1.25	ND	0.24	-
5	Upper layer	11.8		9.1	7.7	0.17	15	45	16.9	14.3	0.10	0.01	1.10	2.05	0.08	0.55	-
	Lower layer	11.0	1.30	9.1	6.6	0.17	25	19	23.8	16.3	0.06	0.01	0.80	2.03	0.24	0.80	-
6	Upper layer	13.8		9.0	11.1	0.18	45	72	37.1	37.2	6.87	0.04	1.80	8.93	1.35	4.76	-
	Lower layer	13.2	0.80	8.6	12.4	0.18	130	86	40.7	27.6	3.16	0.02	0.90	6.17	1.18	2.83	-
9	Upper layer	13.0		9.1	8.7	0.17	21	-	20.0	26.0	0.17	0.01	1.20	2.79	0.62	5.81	-
	Lower layer	11.5	1.50	9.1	6.7	0.18	22	-	2.9	23.6	0.17	0.01	1.00	2.59	0.65	1.03	-
10	Upper layer	14.5		9.2	9.6	0.17	18	61	19.4	24.1	0.14	0.01	1.10	2.56	0.62	1.32	-
	Lower layer	13.7	1.15	9.2	10.1	0.17	19	61	8.2	26.0	0.15	0.01	0.70	2.58	0.63	1.04	-
13	Upper layer	13.9		9.2	9.9	0.17	18	31	21.6	22.3	0.11	0.01	1.30	6.13	0.50	1.12	-
	Lower layer	12.4	1.40	9.1	5.4	0.17	20	35	30.2	21.2	0.21	0.01	0.80	4.08	0.62	1.06	-
14	Upper layer	15.2		9.2	10.4	0.17	16	39	6.4	26.0	0.09	0.01	1.10	3.99	0.54	0.88	-
	Lower layer	13.7	1.15	9.1	10.2	0.17	16	47	12.9	25.2	0.16	0.01	0.90	5.15	0.53	0.84	-
16	Upper layer	13.6		8.9	8.2	0.17	21	118	17.2	25.2	0.70	0.01	1.20	4.35	1.31	1.83	-
	Lower layer	11.5	0.20	8.2	3.6	0.17	34	66	17.0	25.2	1.58	0.02	0.80	3.82	1.61	1.99	-
17	Upper layer	13.2		9.1	9.6	0.17	18	48	21.4	29.7	0.10	0.01	1.20	3.74	0.52	0.95	-
	Lower layer	12.5	0.65	9.1	9.2	0.17	22	-	54.0	22.0	0.11	0.02	0.80	3.35	0.41	2.75	-
21	Upper layer	12.2		9.0	7.9	0.17	18	-	7.9	19.6	0.09	0.01	1.20	3.53	0.55	0.78	-
	Lower layer	11.8	0.75	9.0	6.5	0.17	27	45	4.8	20.8	0.10	0.01	0.90	4.05	0.48	1.72	-
23	Upper layer	10.6		9.1	7.1	0.17	18	38	8.9	13.3	0.07	0.01	1.10	2.62	0.15	0.71	-
	Lower layer	10.3	1.00	9.1	7.5	0.17	18	36	5.0	16.4	0.09	0.01	0.80	1.98	0.15	1.05	-

Table III.3.3 The Distribution of Water Temperature in The Lake

unit : degrees centigrade

	21Jan.	28 Jan.	3 Feb.	9 Mar.	20 Apr.	36285	1 Jun.	8 Jul.	4 Aug.	18 Aug.	7 Sep.
Max.	18.1	17.2	16.7	16.9	16.0	15.4	13.2	11.3	13.8	13.7	15.2
Min.	15.0	15.0	13.3	13.4	12.5	12.3	10.0	8.5	9.7	10.5	10.3
Average	16.4	16.0	14.8	15.3	14.5	14.1	11.8	9.9	11.5	12.1	12.7

Table III.3.4 The Vertical Variation of Water Temperature in The Lake

unit : degrees centigrade

Point No.	21Jan.	28 Jan.	3 Feb.	9 Mar.	20 Apr.	36285	1 Jun.	8 Jul.	4 Aug.	18 Aug.	7 Sep.	Max.
1	1.2	0.5	-	0.6	0.3	0.5	0.0	0.1	0.0	0.5	0.5	1.2
2	1.2	0.5	0.7	0.2	1.7	0.8	0.0	0.2	0.3	0.5	0.4	1.7
5	0.7	0.0	1.2	0.8	0.4	0.1	0.1	1.0	0.2	0.3	0.8	1.2
6	0.3	0.0	1.0	2.4	0.7	1.0	1.0	1.1	0.5	0.4	0.6	2.4
9	0.5	0.6	0.8	0.7	0.6	1.8	0.8	1.0	1.0	1.2	1.5	1.8
10	0.7	0.0	1.1	0.4	0.9	1.0	0.2	0.1	0.1	0.9	0.8	1.1
13	0.4	1.1	0.9	1.0	1.2	1.7	0.4	0.6	2.9	1.0	1.5	2.9
14	0.0	0.0	1.0	1.1	0.8	0.4	-	0.0	0.9	0.4	1.5	1.5
16	-0.4	0.0	-0.1	0.0	0.1	0.0	1.0	-0.3	0.1	0.3	2.1	2.1
17	-0.1	0.1	0.3	0.7	0.7	0.3	0.4	0.2	1.1	0.0	0.7	1.1
21	-0.1	0.0	0.3	1.9	0.9	0.8	1.2	0.0	1.3	0.5	0.4	1.9
23	0.0	0.1	0.5	1.1	0.5	1.1	0.3	0.5	1.3	-0.2	0.3	1.3

note : Vertical variation = Upper layer - Lower layer

Table III.3.5 Transparency in The Lake (from January to September 1999)

unit : m

Point No.	Av.	Max.	Min.
1	5.1	7.7	3.5
2	4.7	7.2	3.0
5	1.6	2.7	1.0
6	1.1	1.5	0.5
9	1.4	2.3	0.7
10	1.4	1.9	1.0
13	1.4	2.0	0.9
14	1.3	2.4	0.8
16	0.9	1.8	0.2
17	1.2	2.2	0.4
21	1.2	1.9	0.6
23	1.3	1.8	0.9

Table III.3.6 Transition of pH in the Lake
(Observation from January to September 1999)

Point No.		Av.	Max.	Min.
1	Upper layer	8.6	9.1	8.0
	Lower layer	8.6	9.5	8.2
2	Upper layer	8.6	9.1	8.2
	Lower layer	8.5	9.1	8.2
5	Upper layer	8.9	9.2	8.3
	Lower layer	8.9	9.2	8.3
6	Upper layer	8.6	9.2	7.8
	Lower layer	8.7	9.3	7.8
9	Upper layer	8.9	9.4	8.4
	Lower layer	8.9	9.3	8.3
10	Upper layer	8.9	9.3	8.1
	Lower layer	9.0	9.2	8.1
13	Upper layer	9.1	9.5	8.4
	Lower layer	8.9	9.1	8.3
14	Upper layer	9.0	9.3	8.3
	Lower layer	9.0	9.4	8.1
16	Upper layer	8.9	9.2	8.3
	Lower layer	8.8	9.8	8.2
17	Upper layer	8.8	9.2	8.2
	Lower layer	8.8	9.2	8.2
21	Upper layer	8.8	9.3	8.2
	Lower layer	8.8	9.2	8.1
23	Upper layer	8.9	9.4	8.1
	Lower layer	9.0	9.4	8.2

Table III.3.7 Transition of DO in the Lake
(Observation from January to September 1999)

Point No.		Av.	Max.	Min.
1	Upper layer	5.1	6.8	2.7
	Lower layer	4.7	7.2	2.2
2	Upper layer	4.7	6.7	2.6
	Lower layer	4.4	6.8	2.0
5	Upper layer	4.5	7.6	2.7
	Lower layer	4.9	9.7	2.6
6	Upper layer	4.1	9.2	1.5
	Lower layer	3.1	8.3	1.0
9	Upper layer	5.0	10.9	2.7
	Lower layer	4.6	10.0	2.9
10	Upper layer	5.3	10.4	3.2
	Lower layer	4.8	7.6	2.9
13	Upper layer	5.9	10.4	2.9
	Lower layer	4.6	8.9	1.2
14	Upper layer	6.0	12.3	3.2
	Lower layer	4.7	9.1	2.1
16	Upper layer	5.3	9.3	2.9
	Lower layer	5.0	8.5	3.0
17	Upper layer	5.3	9.9	3.1
	Lower layer	5.0	9.3	2.7
21	Upper layer	4.9	7.9	2.8
	Lower layer	4.5	8.4	2.2
23	Upper layer	5.1	9.7	1.8
	Lower layer	4.9	9.4	1.6

Table III.3.8 Transition of SS in the Lake (Observation from January to September 1999)

Point No.		Av.	Max.	Min.
1	Upper layer	5.0	14	0.5
	Lower layer	5.5	12	0.5
2	Upper layer	6.0	19	0.5
	Lower layer	6.7	17	0.5
5	Upper layer	19	58	0.6
	Lower layer	16	28	5.0
6	Upper layer	23	46	10
	Lower layer	46	92	23
9	Upper layer	21	34	8.0
	Lower layer	20	28	6.8
10	Upper layer	19	30	9.2
	Lower layer	22	32	8.7
13	Upper layer	21	36	11
	Lower layer	22	38	10
14	Upper layer	19	26	12
	Lower layer	36	98	11
16	Upper layer	37	110	11
	Lower layer	42	95	22
17	Upper layer	22	34	12
	Lower layer	37	120	13
21	Upper layer	22	34	10
	Lower layer	36	67	17
23	Upper layer	21	35	9.0
	Lower layer	37	78	19

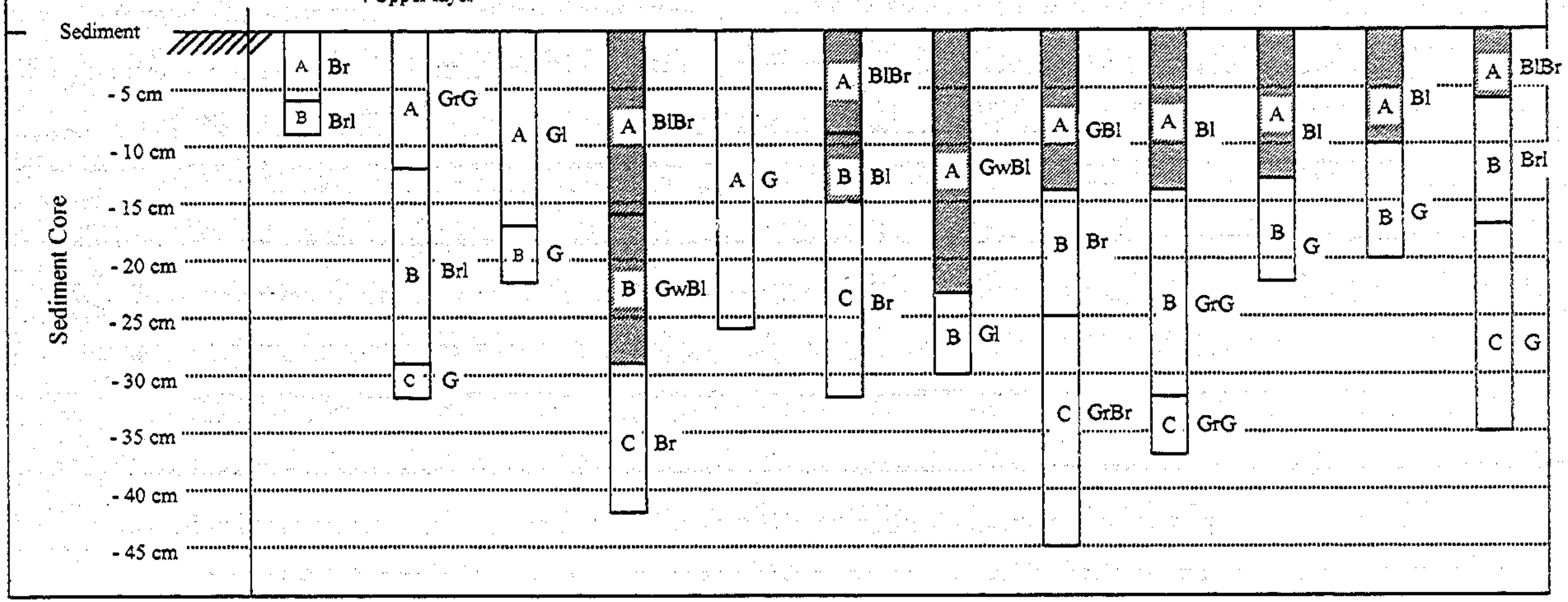
Table III.3.9 Transition of BOD_5 in the Lake (Observation from January to September 1999)

Point No.		Av.	Max.	Min.
1	Upper layer	4.1	9.9	0.5
	Lower layer	7.3	11.0	0.3
2	Upper layer	3.3	10.6	0.5
	Lower layer	5.2	9.0	0.2
5	Upper layer	7.4	16.9	0.9
	Lower layer	13.5	23.8	3.6
6	Upper layer	22.3	40.2	12.0
	Lower layer	26.5	50.4	14.0
9	Upper layer	12.1	35.4	1.5
	Lower layer	10.2	25.3	1.5
10	Upper layer	13.4	32.2	2.6
	Lower layer	8.4	21.6	4.0
13	Upper layer	16.2	46.9	1.7
	Lower layer	17.1	49.8	2.3
14	Upper layer	8.1	26.3	0.6
	Lower layer	9.5	23.0	1.4
16	Upper layer	15.1	36.8	0.6
	Lower layer	12.7	32.3	1.9
17	Upper layer	14.3	38.0	2.4
	Lower layer	19.8	54.0	5.8
21	Upper layer	7.6	29.1	0.4
	Lower layer	11.2	35.5	3.2
23	Upper layer	7.4	17.8	0.4
	Lower layer	10.7	24.6	5.0

Table. III.3.10 (1) The Results of Sediment Quality Survey (Date : 6. Feb. 1999)

Items \ Point No.		1	2	5	6	9	10	13	14	16	17	21	23
Sediment Temperature* (C.)		18	18	16	16	15	16	17	17	16	16	16	15
Oxidation reduction potential * (mV)		-75	-307	-16	-378	-325	-346	-389	-288	-321	-363	-32	-308
Moisture Content (%)	A	79	75	62	93	82	90	72	90	88	90	78	87
	B	74	74	38	76	-	66	43	83	89	89	74	78
	C	-	-	-	78	-	93	-	69	-	-	-	65
Ignition Loss (%)	A	13	13	10	48	22	66	66	77	24	27	43	26
	B	12	16	6	31	-	25	19	89	29	29	33	12
	C	-	-	-	23	-	-	-	27	-	-	-	18

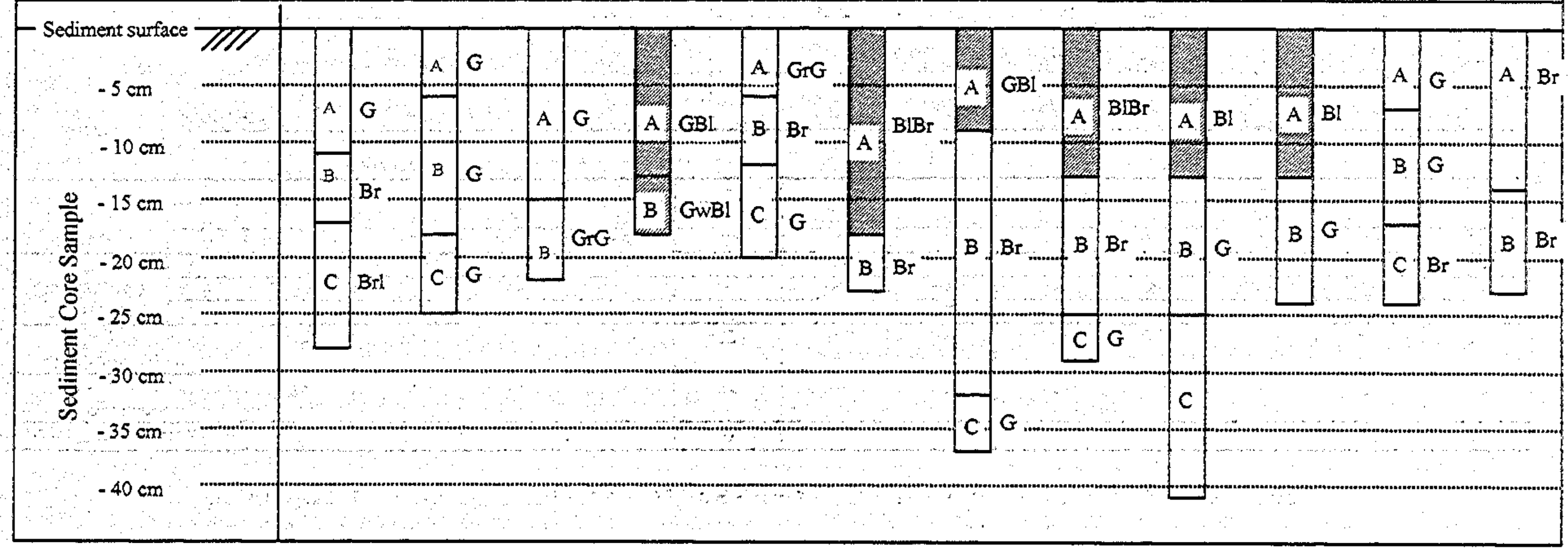
* : Upper layer



Color of sediment
Bl : Black
Br : Brown
Brl : Brown light
BlBr : Blackly Brown
G : Gray
GrG : Greenish Gray
Gl : Gray light
GBl : Blackly Gray
GwBl : Gray with Black
GrBr : Grayish Brown
(shaded) : Black / Blackly color

Table. III.3.10 (2) The Results of Sediment Quality Survey (Date : 5 Jul. 1999)

Items	Point No.	1	2	5	6	9	10	13	14	16	17	21	23
Sediment Temperature (C.)	A	13.7	13.3	13.5	13.9	13.9	14.4	13.8	14.3	14.2	15.0	14.7	14.1
	B	13.7	13.9	14.0	14.0	14.3	14.3	14.4	13.8	14.6	14.6	14.9	13.4
	C	14.2	13.9	-	-	14.8	-	14.9	15.9	14.7	-	14.9	-
Oxidation reduction potential (mV)	A	-209	-235	-191	-368	-271	-356	-355	-378	-333	-324	-310	-380
	B	-271	-86	-246	-354	-293	-340	-384	-370	-259	-247	-341	-323
	C	-37	-149	-	-	-343	-	-283	-357	-160	-	-194	-
Moisture Content (%)	A	64	74	63	87	84	87	88	84	76	92	85	88
	B	71	66	36	81	86	83	74	76	82	87	79	71
	C	58	30	-	-	80	-	49	75	76	-	68	-
Ignition Loss (%)	A	8	8	7	29	32	33	30	23	13	28	48	22
	B	12	9	4	21	25	26	20	19	19	27	33	22
	C	7	2	-	-	21	-	12	20	28	-	32	-
Total - N (mg/g-dry)	A	4.00	9.02	8.77	16.66	8.01	13.96	6.08	12.29	14.37	34.22	52.90	23.43
	B	4.04	1.76	3.34	26.89	20.73	23.04	14.68	6.75	22.40	21.97	33.44	9.28
	C	2.74	1.11	-	-	4.02	-	2.74	3.77	9.27	-	35.05	-
Total - P (mg/g-dry)	A	0.70	0.89	0.77	2.46	1.39	1.75	0.49	0.45	2.19	0.29	-	1.38
	B	1.01	0.32	0.95	0.75	1.07	0.85	1.03	1.19	1.13	5.10	1.65	1.25
	C	0.05	0.46	-	-	1.14	-	1.20	1.07	1.56	-	2.33	-



Color of sediment

Bl	: Black	BlBr	: Blackly Brown	Gl	: Gray light	GrBr	: Grayish Brown
Br	: Brown	G	: Gray	GBl	: Blackly Gray		
Brl	: Brown light	GrG	: Greenish Gray	GwBl	: Gray with Black		

(shaded) : Black / Blackly color

Table. III.3.11 (1) The Results of Water Quality Survey (Drainage Channels : 5 Jul. 1999)

Sampling time	Point No.	Sampling time	Flow (m^3/day)	Flow (m^3/sec.)	Temp.	pH	DO (mg/l)	SS (mg/l)	BOD_5 (mg/l)	COD_{Mn} (mg/l)	NH_4-N (mg/l)	$N0_2$-N (mg/l)	$N0_3$-N (mg/l)	T-N (mg/l)	$P0_4$-P (mg/l)	T-P (mg/l)	Coliform (n / ml)
from 8:00 to 9:00	1	8:34	3,974	0.046	-	8.5	4.4	3090	15.3	56.1	8.50	0.04	4.90	21.60	-	-	6.7E+03
	2	8:44	1,382	0.016	-	8.3	3.2	918	40.7	52.0	13.25	0.22	1.80	15.27*	-	-	2.0E+04
	3	8:56	8,122	0.094	-	8.4	4.4	2400	19.3	50.0	13.50	0.06	2.90	15.00	-	-	1.6E+04
	4	9:10	9,418	0.109	-	8.6	5.2	1750	12.3	38.3	6.00	0.03	3.50	15.90	-	-	1.1E+04
	5	9:27	11,750	0.136	-	8.5	3.8	552	26.3	42.3	4.00	0.22	1.40	5.62*	-	-	2.6E+04
from 13:00 to 14:00	1	13:10	1,382	0.016	-	8.1	4.2	520	118.7	53.0	3.00	0.24	1.40	4.64*	-	-	1.0E+04
	2	13:25	778	0.009	-	7.9	3.0	168	76.4	32.6	7.00	0.09	2.90	9.99*	-	-	5.0E+04
	3	13:35	518	0.006	-	8.2	3.8	133	15.3	32.6	4.05	0.03	2.70	11.70	-	-	7.5E+03
	4	13:50	4,061	0.047	-	8.3	3.9	237	19.7	46.9	5.25	0.05	2.40	13.05	-	-	1.1E+04
	5	14:00	17	0.0002	-	7.9	1.5	211	4.7	39.8	5.00	0.06	2.10	16.20	-	-	6.2E+03
from 18:00 to 19:00	1	18:45	2,678	0.031	-	8.4	4.7	154	14.8	16.3	4.15	0.05	1.40	5.60*	-	-	1.3E+03
	2	18:35	346	0.004	-	8.2	4.2	83.0	14	18.4	4.85	0.03	2.70	10.05	-	-	6.0E+03
	3	18:15	86	0.001	-	8.3	5.3	90.0	25	35.7	5.80	0.04	0.20	11.70	-	-	1.0E+04
	4	18:00	3,974	0.046	-	8.5	3.6	75.0	14.8	25.5	5.30	0.09	2.10	7.49*	-	-	4.9E+03
	5	17:50	17	0.0002	-	7.7	3.0	36.0	18	25.5	7.25	0.02	1.20	10.35	-	-	6.0E+03

Note * : Inorganic-N (NH_4-N + $N0_2$-N + $N0_3$-N)

Table. III.3.11 (2) The Results of Water Quality Survey (Drainage Channels : 1 Feb. 1999)

Sampling time	Point No.	Sampling time	Flow (m^3/day)	Flow (m^3/Sec.)	Temp.	pH	DO (mg/l)	SS (mg/l)	BOD_5 (mg/l)	COD_{Mn} (mg/l)	NH_4-N (mg/l)	NO_2-N (mg/l)	NO_3-N (mg/l)	Inorg.-N* (mg/l)	PO_4-P (mg/l)	T-P (mg/l)	Coliform (n / ml)
from 8:00 to 9:00	1	8:50	86.4	0.0010	11.2	8.2	ND	132	26.8	14.5	1.05	0.109	2.00	3.16	0.25	0.40	4.5E+02
	2	9:10	121.0	0.0014	13.6	7.5	ND	24.0	17.8	17.5	2.90	0.119	0.50	3.52	0.38	0.53	1.2E+03
	3	9:40	86.4	0.0010	14.0	8.0	3.5	296	49.6	47.5	13.88	0.096	3.20	17.18	0.54	0.61	1.1E+03
	4	9:55	1,641.6	0.0190	13.6	8.3	ND	31.0	27.8	29.5	11.50	0.060	2.10	13.66	0.46	0.60	9.0E+02
	5	10:10	1,900.8	0.0220	15.2	7.9	ND	200	130	53.5	32.25	0.084	1.80	34.13	0.69	-	1.3E+03
from 13:00 to 14:00	1	12:50	86.4	0.0010	12.8	8.3	ND	180	277	77.5	7.00	0.080	1.00	8.08	0.35	0.62	7.0E+02
	2	12:58	34.6	0.0004	14.8	7.4	ND	28.0	8.0	11.5	0.38	0.029	1.20	1.61	0.19	0.53	1.0E+03
	3	13:05	2,419.2	0.0280	13.8	8.0	3.4	108	43.3	25.5	6.13	0.046	2.90	9.08	0.41	0.76	9.9E+02
	4	13:25	1,468.8	0.0170	14.9	8.4	2.5	59.0	7.8	23.5	8.63	0.077	2.50	11.21	0.43	0.64	7.6E+02
	5	13:33	103.7	0.0012	18.2	7.7	0.7	54.0	39.0	33.5	19.63	0.107	1.70	21.44	0.52	0.73	2.7E+03
from 18:00 to 19:00	1	18:47	17.0	0.0002	12.2	8.3	4.3	176	55.0	32.0	4.63	0.050	4.50	9.18	0.41	0.65	1.5E+03
	2	18:33	86.4	0.0010	12.6	7.7	2.2	71.0	36.3	49.5	30.13	0.153	4.20	34.48	0.61	0.77	1.0E+03
	3	18:11	86.4	0.0010	12.5	8.0	3.5	74.0	17.1	28.0	7.00	0.090	3.40	10.49	0.43	-	1.2E+03
	4	17:49	259.2	0.0030	12.3	8.2	3.4	53.0	24.0	33.0	10.75	0.139	3.10	13.99	0.41	0.46	8.0E+02
	5	17:38	25.9	0.0003	14.8	7.6	2.9	94.0	5.0	41.5	6.50	0.230	3.80	10.53	0.44	0.53	6.4E+02

Note * : Inorganic-N (NH_4-N + NO_2-N + NO_3-N)

Table. III.3.11 (3) The Results of Water Quality Survey (Drainage Channels : 15 Feb. 1999)

Sampling time	Point No.	Sampling time	Flow (m^3/day)	Flow (m^3/sec.)	Temp.	pH	DO (mg/l)	SS (mg/l)	BOD_5 (mg/l)	COD_{Mn} (mg/l)	NH_4-N (mg/l)	NO_2-N (mg/l)	NO_3-N (mg/l)	Inorg.-N* (mg/l)	PO_4-P (mg/l)	T-P (mg/l)	Coliform (n / ml)
from 8:00 to 9:00	1	10:40	9,590.4	0.111	13.0	8.1	4.4	490	10.1	22.0	9.35	0.130	2.70	12.18	0.258	0.314	4.4E+02
	2	10:51	1,468.8	0.017	13.2	7.9	3.5	103	36.3	31.0	6.20	0.220	3.10	9.52	0.536	1.600	6.3E+02
	3	10:25	3,196.8	0.037	12.0	8.0	4.0	1,992	49.8	34.0	2.90	0.320	5.00	8.22	0.560	1.540	6.0E+02
	4	10:10	0.9	0.00001	11.6	8.2	4.9	876	37.1	24.0	3.95	0.320	3.50	7.77	0.742	1.242	4.2E+03
	5	9:55	8,812.8	0.102	12.5	8.1	6.3	828	34.8	31.5	7.05	0.320	2.60	9.97	0.907	1.746	2.9E+03
from 13:00 to 14:00	1	13:45	7,344.0	0.085	20.1	7.7	4.4	227	36.8	31.0	12.05	0.190	4.20	16.44	0.477	0.734	5.6E+02
	2	13:51	1,814.4	0.021	14.6	7.8	2.2	131	50.0	52.0	10.15	0.340	3.90	14.39	1.096	2.274	4.5E+03
	3	14:10	2,160.0	0.025	14.1	7.9	3.4	146	36.4	23.0	3.25	0.310	4.50	8.06	0.807	1.554	1.1E+03
	4	14:24	2.6	0.00003	16.0	7.9	3.1	70	36.9	25.0	3.65	0.310	3.20	7.16	0.735	2.336	2.0E+03
	5	14:30	1,296.0	0.015	-	7.7	-	75	75.8	57.0	10.65	0.320	2.00	12.97	1.398	2.516	2.8E+03
from 18:00 to 19:00	1	17:30	7,084.8	0.082	16.0	7.8	3.7	75	36.1	21.8	2.22	0.160	4.10	6.48	0.656	-	6.1E+02
	2	17:23	950.4	0.011	14.0	8.1	3.4	65	44.3	33.0	7.45	0.250	3.40	11.10	1.029	2.322	1.2E+03
	3	17:12	1,382.4	0.016	13.0	8.1	3.4	1,275	35.8	23.5	3.25	0.260	4.20	7.71	0.898	2.128	7.8E+02
	4	16:59	1.7	0.000	13.6	-	3.4	35	56.8	60.0	3.35	0.330	3.20	6.88	0.810	1.644	3.0E+03
	5	16:49	2,851.2	0.033	15.2	-	3.3	169	11.8	40.0	13.50	0.240	2.50	16.24	1.574	3.056	4.7E+03

Note * : Inorganic-N (NH_4-N + NO_2-N + NO_3-N)

Table. III.3.11 (4) The Results of Water Quality Survey (Drainage Channels : 14 Jul. 1999)

Sampling time	Point No.	Sampling time	Flow (m^3/day)	Flow (L/sec.)	Temp.	pH	DO (mg/l)	SS (mg/l)	BOD_5 (mg/l)	COD_{Mn} (mg/l)	NH_4-N* (mg/l)	NO_2-N* (mg/l)	NO_3-N* (mg/l)	T-N* (mg/l)	PO_4-P (mg/l)	T-P (mg/l)	Coliform (n / ml)
from 8:00 to 9:00	1	-	-	-	-	-	-	35.3	82.0	35.9	27.00	0.04	0.30	116.00	-	1.77	5.5E+02
	2	-	-	-	-	-	-	126	42.8	70.6	29.38	0.24	1.40	52.00	8.53	0.28	1.1E+02
	3	-	-	-	-	-	-	82.0	3.7	50.2	12.15	0.20	1.30	24.00	3.64	1.41	2.0E+02
	4	-	-	-	-	-	-	304	165	132	24.13	0.04	0.60	7.00	6.83	0.38	4.2E+02
	4	-	-	-	-	-	-	61.3	7.8	31.8	12.42	0.03	0.10	27.00	4.29	2.06	2.4E+02
	6	-	-	-	-	-	-	45.0	3.6	17.5	0.18	0.01	-	7.00	0.24	0.07	1.5E+02
from 13:00 to 14:00	1	-	-	-	-	-	-	71.0	130	73.9	21.88	0.02	0.80	94.00	7.45	8.20	6.3E+02
	2	-	-	-	-	-	-	96.7	14.7	37.4	14.58	0.25	1.80	60.00	9.03	6.38	1.4E+02
	3	-	-	-	-	-	-	22.3	22.5	29.8	12.67	0.49	2.20	121.00	3.13	5.45	3.6E+02
	4	-	-	-	-	-	-	30.0	33.5	43.2	24.13	0.02	0.60	28.00	6.52	7.30	7.5E+02
	5	-	-	-	-	-	-	13.9	9.7	37.4	16.58	0.10	0.90	29.00	1.10	5.19	5.3E+01
	6	-	-	-	-	-	-	530	8.7	41.3	0.37	-	0.10	5.00	0.05	0.11	2.0E+00
from 18:00 to 19:00	1	-	-	-	-	-	-	59.0	51.9	66.4	11.87	0.01	0.90	109.00	2.72	7.34	5.1E+02
	2	-	-	-	-	-	-	129	45.1	31.9	11.13	0.41	1.90	24.00	5.67	6.85	7.8E+02
	3	-	-	-	-	-	-	52.2	55.3	43.4	15.88	0.03	1.00	24.00	7.00	7.01	7.2E+02
	4	-	-	-	-	-	-	36.6	19.7	30.0	9.00	0.42	1.80	17.00	3.53	2.52	3.2E+02
	5	-	-	-	-	-	-	11.0	22.5	22.3	10.88	0.03	0.80	22.00	2.87	3.58	5.2E+01
	6	-	-	-	-	-	-	22.1	20.7	33.8	-	0.01	0.30	6.00	0.02	0.05	ND

Note * : These parameters were measured by HACH.

Table. III.3.11 (5) The Results of Water Quality Survey (Drainage Channels : 11 Aug. 1999)

Sampling time	Point No.	Sampling time	Flow (m^3/day)	Flow (L/sec.)	Temp.	pH	DO (mg/l)	SS (mg/l)	BOD_5 (mg/l)	COD_{Mn} (mg/l)	NH_4-N (mg/l)	NO_2-N (mg/l)	NO_3-N (mg/l)	T-N (mg/l)	PO_4-P (mg/l)	T-P (mg/l)	Coliform (n / ml)
from 8:00 to 9:00	1	8:00	25.9	0.3	-	8.4	3.1	32	104	43.4	37.13	0.02	0.30	17.20	4.16	3.58	3.0E+05
	2	8:18	388.8	4.5	11.1	8.5	1.4	130	21.2	5.4	72.64	0.04	1.10	30.01	8.41	6.51	2.4E+06
	3	8:28	604.8	7.0	10.7	8.4	3.8	27	53.0	11.4	17.36	0.11	0.90	7.05	4.89	3.12	1.2E+06
	4	8:35	2,185.9	25.3	12.8	8.7	0.4	288	422	129.4	212.56	0.31	1.10	60.45	8.55	4.81	9.4E+05
	5	8:51	259.2	3.0	9.8	9.0	0.0	20	35.6	19.4	23.74	0.03	0.60	7.53	9.89	11.18	2.2E+07
	6	9:00	69.1	0.8	11.4	7.1	5.0	12	-	15.4	0.44	0.00	0.10	0.66	-	-	4.0E+02
from 12:00 to 13:00	1	12:05	25.9	0.3	18.8	8.4	3.1	19	39.4	27.4	17.36	0.64	1.80	14.78	8.96	4.89	3.0E+05
	2	12:18	518.4	6.0	14.8	8.3	1.7	55	81.3	43.4	27.15	0.02	0.70	20.91	6.33	3.32	2.9E+06
	3	12:24	691.2	8.0	16.2	8.7	3.8	20	38.7	27.4	32.47	0.19	0.80	5.40	5.84	6.41	4.0E+05
	4	12:35	17.3	0.2	21.5	8.1	0.2	36	150	49.4	58.08	0.03	1.20	50.60	3.70	4.27	1.1E+06
	5	12:40	6,912.0	80.0	13.0	8.8	0.0	38	27.0	33.4	22.70	0.23	0.90	6.18	4.23	13.55	8.0E+03
	6	12:50	3.5	0.04	20.0	9.0	5.6	10	36.0	27.4	0.42	0.00	0.10	0.51	-	-	4.0E+02
from 18:00 to 19:00	1	17:53	8.6	0.1	8.6	8.1	1.4	72	262	67.4	31.05	0.14	0.10	18.70	6.83	7.89	2.8E+05
	2	18:00	432.0	5.0	10.5	8.3	1.5	48	89.9	47.4	28.39	0.04	0.60	7.54	7.11	10.33	8.8E+05
	3	18:08	777.6	9.0	10.0	8.4	1.7	22	38.5	23.4	33.95	0.08	0.40	7.08	5.45	16.76	2.8E+05
	4	18:13	69.1	0.8	0.4	8.2	0.9	23	45.2	33.4	28.39	0.02	0.30	4.52	3.87	4.81	8.5E+05
	5	18:38	129.6	1.5	9.3	8.3	1.6	22	36.7	25.4	18.98	0.00	0.10	3.33	4.36	3.58	8.5E+04
	6	18:25	345.6	4.0	11.1	8.7	4.1	19	7.3	9.4	0.48	0.05	0.50	0.84	ND	ND	1.1E+03

Note * : Inorganic-N (NH_4-N + NO_2-N + NO_3-N)

Table. III.3.11 (6) The Results of Water Quality Survey (Drainage Channels : 24 Aug. 1999)

Sampling time	Point No.	Sampling time	Flow (m^3/day)	Flow (L/sec.)	Temp.	pH	DO (mg/l)	SS (mg/l)	BOD_5 (mg/l)	COD_{Mn} (mg/l)	NH_4-N (mg/l)	NO_2-N (mg/l)	NO_3-N (mg/l)	T-N (mg/l)	PO_4-P (mg/l)	T-P (mg/l)	Coliform (n / ml)
from 8:00 to 9:00	1	8:25	129.6	1.5	7.4	7.9	3.2	130	77.6	44.8	50.50	0.020	1.80	57.00	-	-	ND
	2	8:34	777.6	9.0	11.1	8.1	1.3	87	136.3	69.1	45.50	0.300	2.10	56.00	-	-	4.2E+02
	3	8:44	864.0	10.0	10.4	8.0	3.3	36	77.4	44.8	19.75	0.320	2.00	20.00	-	-	8.0E+01
	4	8:53	172.8	2.0	12.3	8.0	2.2	99	125.5	77.2	50.25	1.210	2.80	68.00	-	-	2.7E+03
	5	9:43	129.6	1.5	8.2	8.3	0.0	41	17.6	61.0	19.25	0.060	1.60	48.00	-	-	4.0E+01
	6	-	-	-	-	-	0.0	-	-	-	-	-	-	-	-	-	-
from 13:00 to 14:00	1	12:29	259.2	3.0	15.6	8.0	4.6	740	652.0	164.0	75.00	0.500	11.00	275.00	-	-	5.6E+03
	2	12:38	604.8	7.0	14.7	7.7	1.9	87	47.7	36.8	19.50	0.020	1.20	23.00	-	-	3.6E+03
	3	12:44	691.2	8.0	15.7	8.2	4.0	22	29.7	38.8	23.35	0.040	1.00	25.00	-	-	2.1E+03
	4	12:49	86.4	1.0	21.2	8.1	4.4	23	9.2	32.7	9.25	0.630	2.70	15.00	-	-	ND
	5	13:14	432.0	5.0	20.6	8.6	6.5	35	28.2	40.8	19.50	0.400	2.10	25.00	-	-	ND
	6	-	-	-	-	-	0.0	-	-	-	-	-	-	-	-	-	-
from 18:00 to 19:00	1	16:10	259.2	3.0	11.1	8.0	5.1	134	494.6	147.9	34.00	0.260	6.50	120.00	-	-	2.0E+03
	2	16:18	432.0	5.0	11.0	7.8	2.1	83	23.3	38.8	28.75	0.030	0.90	27.00	-	-	4.4E+04
	3	16:28	86.4	1.0	12.5	8.2	3.1	36	88.1	34.7	24.75	0.010	0.80	26.00	-	-	2.0E+03
	4	16:33	43.2	0.5	13.6	7.7	1.9	96	28.3	26.7	11.25	0.020	0.90	10.00	-	-	ND
	5	17:04	129.6	1.5	12.8	8.3	3.5	26	5.5	28.7	20.00	0.230	1.50	21.00	-	-	3.0E+03
	6	16:45	864.0	10.0	12.3	8.4	5.3	61	ND	20.6	0.06	0.010	0.70	4.00	-	-	ND

Table. III.3.12 Average Water Quality in the Channels

unit : mg/l

Channel	Rainy / Dry Season	Flow (m3/day)	SS (mg/l)	BOD_5 (mg/l)	T-N (mg/l)	T-P (mg/l)
Llavini	Rainy season 1)	3,583	631	28	8.8	0.5
	Dry season 2)	118	188	272	128.5	-
Floral	Rainy season	2,006	1,568	31	11.7	0.5
	Dry season	526	82	67	40.3	4.5
Carabaya	Rainy season	2,327	857	15	12.4	0.1
	Dry season	619	27	54	40.0	4.6
Ricardo Palma	Rainy season	965	168	12	16.6	2.1
	Dry season	429	94	130	24.2	3.4
Average	Rainy season	-	852	24	11.2	0.6
	Dry season	-	124	166	42.3	3.4

note: 1) Average of 3 surveys in the rainy season
2) Average of 2 surveys in the dry season

Table. III.3.13 (1) The Estimation of Discharged Pollution Load From Drainage Channels (Rainy Season)

Point No.	Date	Flow		SS		BOD_5		T-N		T-P	
		Q (m3/sec)	Q (m3/day)	C (mg/l)	L (kg/day)	C (mg/l)	L (kg/day)	C (mg/l)	L (kg/day)	C (mg/l)	L (kg/day)
1	26 Jan. '99	0.0310	2,678	1,255	4,471	49.6	88.3	38.85	74.3	-	-
	1 Feb. '99	0.0007	63	163	10	119.4	9.0	4.45	0.3	0.55	0.0
	15 Feb. '99	0.0927	8,006	264	2,299	27.7	207.7	2.45	19.3	0.50	3.7
	Average	0.0415	3,583	560	2,260	65.6	101.7	15.25	31.3	0.53	1.8
	Share (%)	37%	37%	-	29%	-	41%	-	26%	-	18%
2	26 Jan. '99	0.0097	835	390	476	43.7	40.0	52.73	55.3	-	-
	1 Feb. '99	0.0009	81	41	3	20.7	1.7	23.15	2.0	0.61	0.0
	15 Feb. '99	0.0163	1,411	100	150	43.5	62.0	9.30	13.3	2.07	2.7
	Average	0.0090	776	177	210	36.0	34.6	28.39	23.6	1.34	1.3
	Share (%)	8%	8%	-	3%	-	14%	-	19%	-	13%
3	26 Jan. '99	0.0337	2,909	874	6,523	19.9	55.7	12.80	43.0	-	-
	1 Feb. '99	0.0100	864	159	98	36.7	36.7	15.47	13.7	0.59	0.7
	15 Feb. '99	0.0260	2,246	1,138	2,815	40.7	95.7	5.65	13.7	1.74	3.7
	Average	0.0232	2,006	724	3,145	32.4	62.7	11.31	23.4	1.17	2.2
	Share (%)	21%	21%	-	41%	-	26%	-	19%	-	21%
4	26 Jan. '99	0.0673	5,818	687	5,914	15.6	85.0	11.30	74.3	-	-
	1 Feb. '99	0.0130	1,123	48	51	19.9	21.0	13.80	12.0	0.57	0.7
	15 Feb. '99	0.0005	40	327	22	43.6	1.7	4.65	0.0	1.74	0.0
	Average	0.0269	2,327	354	1,995	26.4	35.9	9.92	28.8	1.15	0.3
	Share (%)	24%	24%	-	26%	-	15%	-	23%	-	3%
5	26 Jan. '99	0.0002	17	36	1	18.0	0.0	10.35	0.0	-	-
	1 Feb. '99	0.0003	26	94	2	5.0	0.0	11.10	0.0	0.53	0.0
	15 Feb. '99	0.0330	2,851	169	482	11.8	34.0	16.95	48.0	3.06	9.0
	Average	0.0112	965	100	162	11.6	11.3	12.80	16.0	1.79	4.5
	Share (%)	10%	10%	-	2%	-	5%	-	13%	-	44%
Total	26 Jan. '99	0.1419	12,257	-	17,385	-	269.0	-	247.0	-	-
	1 Feb. '99	0.0250	2,157	-	164	-	68.3	-	28.0	-	1.3
	15 Feb. '99	0.1685	14,555	-	5,768	-	401.0	-	94.3	-	19.0
	Average	0.1118	9,656	805	7,772	34.4	246.1	15.53	123.1	1.20	10.2
Total (except No.2)	26 Jan. '99	0.1322	11,422	-	16,908	-	229.0	-	191.7	-	-
	1 Feb. '99	0.0240	2,076	-	160	-	66.7	-	26.0	-	1.3
	15 Feb. '99	0.1521	13,144	-	5,618	-	339.0	-	81.0	-	16.3
	Average	0.1028	8,881	852	7,562	23.8	211.6	11.21	99.6	0.99	8.8

Table. III.3.13 (2) The Estimation of Discharged Pollution Load From Drainage Channels (Dry Season)

Point No.	Date	Flow		SS		BOD_5		T-N		T-P	
		Q (L/sec)	Q (m3/day)	C (mg/l)	L (kg/day)	C (mg/l)	L (kg/day)	C (mg/l)	L (kg/day)	C (mg/l)	L (kg/day)
1	11 Aug. '99	0.23	20.1	41.0	0.7	135	2.0	106.3	2.00	5.77	0.00
	24 Aug. '99	2.50	216.0	335	81.3	408	102.3	150.7	36.33	-	-
	Average	1.37	118.1	188	41.0	272	52.2	128.5	19.17	5.77	0.00
	Share (%)	3%	3%	-	12%	-	12%	-	14%	-	0%
3	11 Aug. '99	5.17	446.4	77.7	33.7	64.1	29.7	45.33	20.33	4.50	2.00
	24 Aug. '99	7.00	604.8	85.7	52.3	69.0	48.3	35.33	23.33	-	-
	Average	6.08	525.6	81.7	43.0	66.6	39.0	40.33	21.83	4.50	2.00
	Share (%)	12%	12%	-	12%	-	9%	-	16%	-	11%
4	11 Aug. '99	8.00	691.2	23.0	15.7	43.4	29.7	56.33	39.33	4.62	3.33
	24 Aug. '99	6.33	547.2	31.3	16.3	65.1	32.0	23.67	12.00	-	-
	Average	7.17	619.2	27.2	16.0	54.2	30.8	40.00	25.67	4.62	3.33
	Share (%)	14%	14%	-	5%	-	7%	-	19%	-	19%
5	11 Aug. '99	8.77	757.4	116	211.0	206	309.3	17.33	5.33	3.40	0.33
	24 Aug. '99	1.17	100.8	72.7	7.7	54.5	8.0	31.00	4.33	-	-
	Average	4.97	429.1	94.2	109.3	130	158.7	24.17	4.83	3.40	0.33
	Share (%)	10%	10%	-	31%	-	36%	-	4%	-	2%
6	11 Aug. '99	28.17	2,433.6	26.7	90.3	33.1	67.0	26.00	70.0	3.61	12.33
	24 Aug. '99	2.67	230.4	34.0	7.7	17.1	5.0	31.33	6.67	-	-
	Average	15.42	1,332.0	30.3	49.0	25.1	36.0	28.67	38.33	3.61	12.33
	Share (%)	31%	31%	-	14%	-	8%	-	28%	-	69%
Total	11 Aug. '99	50.33	4,348.8	-	351.3	-	437.7	-	137.00	-	18.00
	24 Aug. '99	19.67	1,699.2	-	165.3	-	195.7	-	82.67	-	-
	Average	35.00	3,024.0	85.4	258.3	105	316.7	36.32	109.83	5.95	18.00
Total (except No.6)	11 Aug. '99	22.17	1,915.2	-	261.0	-	370.7	-	67.00	-	5.67
	24 Aug. '99	17.00	1,468.8	-	157.7	-	190.7	-	76.00	-	-
	Average	19.58	1,692.0	124	209.3	166	280.7	42.26	71.50	3.35	5.67

Table. III.3.14 Discharged Pollution Load into the Lake through Major Channels

unit : kg/day

Channel	Rainy / Dry Season	Flow (m3/day)	SS	BOD_5	T-N	T-P
Llavini	Rainy season 1)	3,583	2,260	102	31.3	1.8
	Dry season 2)	118	41	52	19.2	0.0
Jorge Basadre	Rainy season	(778)	(210)	(35)	(23.6)	(1.3)
	Dry season	-	-	-	-	-
Floral	Rainy season	2,006	3,145	63	23.4	2.2
	Dry season	526	43	39	21.8	2.0
Carabaya	Rainy season	2,327	1,995	36	28.8	0.3
	Dry season	619	16	31	25.7	3.3
Ricardo Palma	Rainy season	965	162	11	16.0	4.5
	Dry season	429	109	159	4.8	0.3
Chanu chanu	Rainy season	-	-	-	-	-
	Dry season	(2434)	88	67	66.3	12.3
Average	Rainy season	8,881	7,562	212	99.6	8.8
	Dry season	1,692	209	281	71.5	5.7
Rainy season/Dry season 3)		5.2	36.1	0.8	1.4	1.6

note: 1) Average of 3 surveys in the rainy season.
2) Average of 2 surveys in the dry season.
3) except Jorge Basadre and Chanuchanu.

Table. III.3.15 The Results of Water Quality Survey (Espinar Sewerage Treatment Plant)

(17-19 Feb. 1999)

Items	Water Quality of Discharged wastewater			
	17 Feb.'99	18 Feb.'99	19 Feb.'99	Average
Flow (m3/sec.)	22,234	24,941	36,403	27,859
Temperature	16.3	14.0	17.1	15.8
pH	7.8	7.7	8.7	8.1
DO (mg/l)	3.1	0.4	4.7	2.7
SS (mg/l)	463	231	365	353
BOD_5 (mg/l)	128	266	63	152
COD_{Mn} (mg/l)	87	50	70	69
NH_4-N (mg/l)	2.20	2.40	2.42	2.34
$N0_2$-N (mg/l)	4.68	4.05	4.03	4.25
$N0_3$-N (mg/l)	32.1	32.6	26.7	30.47
Inorg.-N* (mg/l)	38.98	39.05	33.15	37.06
$P0_4$-P (mg/l)	1.01	0.46	0.66	0.71
T-P (mg/l)	3.70	3.71	3.33	3.58
Coliform (n / ml)	5.5E+03	8.0E+02	1.6E+03	2.6.E+03

(14, 22-23 Jul. 1999)

Items	Water Quality of Discharged wastewater			
	25 May '99**	16 Jun. '99**	22 Jul.'99	Average
Flow (m3/sec.)	-	-	8,274	-
Temperature	12.4	10.0	-	-
pH	7.9	8.0	-	-
DO (mg/l)	4.5	6.8	1.9	-
SS (mg/l)	-	-	194	-
BOD_5 (mg/l)	173	81.0	183	-
COD_{Mn} (mg/l)	-	-	75	-
NH_4-N (mg/l)	5.92	3.43	4.15	-
$N0_2$-N (mg/l)	3.12	2.31	0.07	-
$N0_3$-N (mg/l)	4.85	3.0	0.40	-
T-N (mg/l)	13.99*	8.74*	36.61	-
$P0_4$-P (mg/l)	-	-	0.72	-
T-P (mg/l)	1.96	-	3.51	-
Coliform (n / ml)	-	-	6.0E+01	-

Note * : Inorganic-N
** : for reference data

Table. III 3.16 The Share of Discharged Pollution Load in The Puno Interior Bay

(Rainy Season)

	Date	Flow (m3/day)	Discharged Pollution Load (kg/day)					
			SS	BOD5	T-N	Inorganic-N	P04-P	T-P
Sewerage Treatment Plant	17.Feb.'99	22,234	10,294	2,846	-	867	23.0	82.0
	18.Feb.'99	24,941	5,761	6,634	-	974	11.0	92.0
	19.Feb.'99	36,403	13,287	2,293	-	1,207	24.0	121.0
	Average	27,859	9,781	3,924	-	1,016	19.3	98.3
	Share (%)	74%	56%	94%	-	90%	77%	91%
Drainage Channel	26 Jan.'99	16,168	19,547	372	-	154	-	-
	1 Feb.'99	2,808	291	152	-	46	1.3	1.7
	15 Feb.'99	16,024	7,912	513	-	180	11.3	19.0
	Average	9,656	7,772	246	-	110	5.8	10.2
	Share (%)	26%	44%	6%	-	10%	23%	9%
Total (average)		37,516	17,553	4,170	-	1,126	25.1	108.5

(Dry Season)

	Date	Flow (m3/day)	Discharged Pollution Load (kg/day)					
			SS	BOD5	T-N	Inorganic-N	P04-P	T-P
Sewerage Treatment Plant	18.Feb.'99	8,274	1,605	1,514	302.9	-	6.0	29.0
	Share (%)	73%	86%	83%	73%	-	30%	62%
Drainage Channel	11 Aug.'99	4,349	351	438	137.0	-	14.3	18.0
	24 Aug.'99	1,699	165	196	82.7	-	-	-
	Average	3,024	258	317	109.8	-	14.3	18.0
	Share (%)	27%	14%	17%	27%	-	71%	38%
Total (average)		11,298	1,863	1,831	412.7	-	20.3	47.0

Table. III 3.17 Estimation of Existed Pollution Load in Puno Interior Bay

			Western lake area	Northern lake area	Southern lake area	Eastern lake area	Total
Rainy Season	Lake Volume 1)	(x1000m3)	8,556	6,253	3,032	2,997	20,838
	Average water quality 2)	BOD	18.1	16.8	20.4	9.90	-
		T-N	2.85	1.14	2.95	1.22	-
		T-P	0.36	0.26	0.72	0.24	-
	Existed pollution load 3) (kg)	BOD	154,867	105,047	61,847	29,674	351,435
		T-N	24,385	7,128	8,944	3,657	44,114
		T-P	3,080	1,626	2,183	719	7,608
Dry Season	Lake Volume 1)	(x1000m3)	8,556	6,253	3,032	2,997	20,838
	Average water quality 2)	BOD	20.3	10.8	35.7	13.10	-
		T-N	5.22	4.66	8.85	4.22	-
		T-P	0.97	1.15	2.78	0.64	-
	Existed pollution load 3) (kg)	BOD	173,691	67,530	108,232	39,266	388,719
		T-N	44,663	29,138	26,831	12,649	113,281
		T-P	8,300	7,191	8,428	1,918	25,837

1) assumption : water level = 3,808 m
2) From the results of lake water quality survey by JICA and PELT(1999). (refer to Table 2.17 (2))
3) multiply lake volume 1) by average water quality 2).

Table III.4.1 Population in the Study Area

Zone	1998			2000			2008			2015			2025		
	Population	Served pop.	Ratio (%)	Population	Served pop.	Ratio (%)	Population	Served pop.	Ratio (%)	Population	Served pop.	Ratio (%)	Population	Served pop.	Ratio (%)
1	17580	10302	58.6%	17307	11596	67.0%	16718	16099	96.3%	15254	14949	98.0%	14160	14160	100.0%
2	11035	6467	58.6%	11076	7421	67.0%	11473	11048	96.3%	11385	11157	98.0%	11550	11550	100.0%
3	17624	10328	58.6%	17648	11824	67.0%	18132	17461	96.3%	17829	17472	98.0%	17925	17925	100.0%
4	18309	10729	58.6%	18409	12334	67.0%	19183	18473	96.3%	19160	18777	98.0%	19560	19560	100.0%
5	6886	1625	23.6%	7534	2034	27.0%	10023	6224	62.1%	12393	9914	80.0%	14985	13487	90.0%
6	10550	2490	23.6%	11391	3076	27.0%	14657	9102	62.1%	17699	14159	80.0%	21063	18957	90.0%
7	7937	2921	36.8%	8050	3381	42.0%	8637	5364	62.1%	8900	7120	80.0%	9354	8419	90.0%
8	3507	1291	36.8%	3627	1523	42.0%	4138	2570	62.1%	4527	3622	80.0%	5007	4506	90.0%
9	2843	534	18.8%	3201	736	23.0%	4555	2592	56.9%	5887	4415	75.0%	7320	6222	85.0%
10	7343	3018	41.1%	8901	4183	47.0%	14682	7385	50.3%	20526	11905	58.0%	25974	19481	75.0%
11	4531	172	3.8%	6863	295	4.3%	15363	983	6.4%	24117	10853	45.0%	30732	21512	70.0%
12	0	0	0.0%	79	0	0.0%	364	0	0.0%	673	471	70.0%	990	743	75.0%
13	0	0	0.0%	112	0	0.0%	516	0	0.0%	954	0	0.0%	1404	0	0.0%
14	312	0	0.0%	381	0	0.0%	637	0	0.0%	900	450	50.0%	1176	823	70.0%
15	0	0	0.0%	0	0	0.0%	0	0	0.0%	68	0	0.0%	856	0	0.0%
16	0	0	0.0%	0	0	0.0%	0	0	0.0%	236	0	0.0%	2948	0	0.0%
Sub-total	108457	49877	46.0%	114579	58403	51.0%	139078	97301	70.0%	160508	125264	78.0%	185004	157345	85.0%
17	1051	0	0.0%	1051	0	0.0%	1051	0	0.0%	1051	0	0.0%	1051	0	0.0%
18	200	0	0.0%	200	0	0.0%	200	0	0.0%	200	0	0.0%	200	0	0.0%
19	300	0	0.0%	300	0	0.0%	300	0	0.0%	300	0	0.0%	300	0	0.0%
20	13	0	0.0%	13	0	0.0%	13	0	0.0%	13	0	0.0%	13	0	0.0%
Sub-total	1564	0	0.0%	1564	0	0.0%	1564	0	0.0%	1564	0	0.0%	1564	0	0.0%
Total	110021	49877	45.3%	116143	58403	50.3%	140642	97301	69.2%	162072	125264	77.3%	186568	157345	84.3%

Table III.4.2 Number of Livestock in the Study Area

unit : head

Name of micro Cuenca		Sheep	Cow	Alpaca	Hog
1	Huaje	250	65	30	56
2	Dos de Mayo	50	6	12	20
3	Ventilla	700	153	50	50
4	Orkopata	20	0	0	30
5	Pucamayo	70	10	0	25
6	Chacarilla	70	0	0	0
7	Santa Rosa	60	0	0	15
8	San Martin	35	5	0	25
9	Alto manto	200	40	25	0
10	Huayna Pucara	45	10	5	25
11	Capullani	1,583	200	168	15
12	Jayllihuaya	1,500	302	0	20
13	Chimu	1,633	80	0	30
Total		6,216	871	290	311

source : Questionnaire survey by JICA (1999)

Table III.4.3 Fertilizer Consumption in the Study Area

Fertilizer	Consumption (kg/year)	Content (w/w %)		Amount (kg/year)	
		N	P	N	P
Guano de ovino	78,430	8.0	6.0	6,274.4	4,705.6
Fosfato Diamonico	116	18.0	46.0	20.9	53.4
Urea	1,329	46.0	0.0	611.3	0.0
Nutrifollaje	10	20.0	20.0	2.0	2.0
Guano de Isla	390	10.0	10.0	39.0	39.0
Nitrato de Amonio	48	33.5	0.0	16.1	0.0
Superfosfato triple	101	0.0	18.0	0.0	18.2
Potacio	22	0.0	0.0	0.0	0.0
Nitroforka	5	20.0	19.2	1.0	1.0
Fosfato	21	0.0	46.0	0.0	9.7
Cloruro de potacio	60	0.0	0.0	0.0	0.0
Guano llama	60	8.0	6.0	4.8	3.6
Bayfolam	2	11.0	8.0	0.2	0.2
Kurowanuchi	2	0.0	0.0	0.0	0.0
Ceniza	40	0.0	0.0	0.0	0.0
Total	-	-	-	6,969.7	4,832.7

source : Questionnaire survey by JICA (1999)

Table III.4.4 Assumption of Unit Pollution Load

pollution sources		BOD	T-N	T-P	note
Domestic wastewater	non-served population	28.8 gcd	2.75 gcd	0.625 gcd	graywater only
Commercial wastewater		Pollution load generation (domestic wastewater) x 15.1 %			the ratio is acquired from PRONAP plan.
Sewerage Treatment Plant	inflow	45 gcd	11 gcd	1.25 gcd	gray + blackwater
	Removal Efficiency (%)	70 %	30 %	30 %	
	Discharged Pollution Load	13.5 gcd	7.7 gcd	0.875 gcd	
Livestock wastewater	Sheep	60 g/head-day	27 g/head-day	4.2 g/head-day	
	Cow	660 g/head-day	330 g/head-day	56 g/head-day	
	Alpaca	60 g/head-day	27 g/head-day	4.2 g/head-day	
	Hog	217 g/head-day	22 g/head-day	14.4 g/head-day	
Solid waste	Quality of leachate	2.500 mg/l	800 mg/l	80 mg/l	
	Quantity of leachate	13,274 m3/year Assuming : quantity of solid waste 11.799 tons/year specific gravity 0.16 volume of solid waste 73,744 m3/year thicken 3.0 m assuming dumping site 24,581 m2 Intensity of precipitation 720 mm/year Run-off 0.75			

Table III.4.5 Assumption of Run-off Coefficient

Pollution Sources	BOD	T-N	T-P
Domestic wastewater	0.6	0.6	1.0
Commercial / Institutional wastewater	0.6	0.6	1.0
Agricultural wastewater	-	0.3	0.2
Livestock wastewater*	0.3 - 0.55	0.3 - 0.55	0.3 - 0.55
Solid waste	0.6	0.6	1.0
Treatment Plant	1.0	1.0	1.0

note : *

		run-off
Assuming :	area A: pastureland in lake site (inundation area)	0.8
	area B: pastureland in mountain area	0.3

Regional distribution of livestock in the Study Area

	area A	area - B
1998	50%	50%
2000	50%	50%
2008	25%	75%
2015	0%	100%
2025	0%	100%

Table III.4.6 Estimation of Discharged Pollution Load in 1972 and 1981

		Population		unit P. Load (gcd)	Domestic	Commercial	Treatment plant	Agriculture	Livestock	Solid waste	Total
1998		110,021	BOD	28.8	1,626.7	144.3	2,813.9	0.0	1,032.8	90.8	5,708.5
			T-N	2.8	155.3	35.3	687.9	19.0	477.0	29.1	1,403.6
			T-P	0.6	35.3	2.1	216.8	13.3	80.6	2.8	350.9

		Population		unit P. Load (gcd)	Domestic	Commercial	Treatment plant	Agriculture*	Livestock	Solid waste*	Total
1972	Served area	0	BOD	45	0	0	0	0	0	0	0
			T-N	11	0	0	0	0	0	0	0
			T-P	1.25	0	0	0	0	0	0	0
	non-served	40,500	BOD	28.8	1166.4	176.1	0	0.0	2987.0	33.4	4362.9
			T-N	2.75	111.4	16.8	0	7.0	1434.8	10.7	1580.7
			T-P	0.625	25.3	3.8	0	4.9	237.1	1.0	272.1
	Total	40,500	BOD	-	1166.4	176.1	0.0	0.0	2987.0	33.4	4362.9
			T-N	-	111.4	16.8	0.0	7.0	1434.8	10.7	1580.7
			T-P	-	25.3	3.8	0.0	4.9	237.1	1.0	272.1
1981	Served area	20,288	BOD	45	0	137.9	913.0	0	0	0	1095.9
			T-N	11	0	33.7	223.2	0	0	0	267.9
			T-P	1.25	0	3.8	25.4	0	0	0	30.45
	non-served	47,340	BOD	28.8	1363.4	205.9	0	0.0	3086.4	55.8	4711.5
			T-N	2.75	130.2	19.7	0	11.7	1437.4	17.9	1616.9
			T-P	0.625	29.6	4.5	0	8.2	232.5	1.7	276.5
	Total	67,628	BOD	-	1363.4	205.9	913.0	0.0	3086.4	55.8	5624.5
			T-N	-	130.2	19.7	223.2	11.7	1437.4	17.9	1840.1
			T-P	-	29.6	4.5	25.4	8.2	232.5	1.7	301.9
Efficiency			BOD	-	-	-	70%	-	-	-	-
			T-N	-	-	-	30%	-	-	-	-
			T-P	-	-	-	30%	-	-	-	-
Run-off			BOD	-	0.6	0.6	1.0	-	0.3	0.6	-
			T-N	-	0.6	0.6	1.0	0.3	0.3	0.6	-
			T-P	-	1.0	1.0	1.0	0.2	0.3	1.0	-
Discharged Pollution Load	1972		BOD	-	699.8	105.7	0.0	-	896.1	20.0	1,721.6
			T-N	-	66.8	10.1	0.0	2.1	430.4	6.4	515.8
			T-P	-	25.3	3.8	0.0	1.0	71.1	1.0	102.2
	1981		BOD	-	818.0	123.5	315.3	-	925.9	33.5	2,216.2
			T-N	-	78.1	11.8	179.8	3.5	431.2	10.7	715.1
			T-P	-	29.6	4.5	20.4	1.6	69.8	1.7	127.6

note : * (Pollution Load)i = (Pollution load)$_{1998}$ x ((Pop)i / (Pop)$_{1998}$)

where; P.Load : Discharged Pollution Load
i : year (1972 or 1981)
Pop : Population
1998 : the year 1998

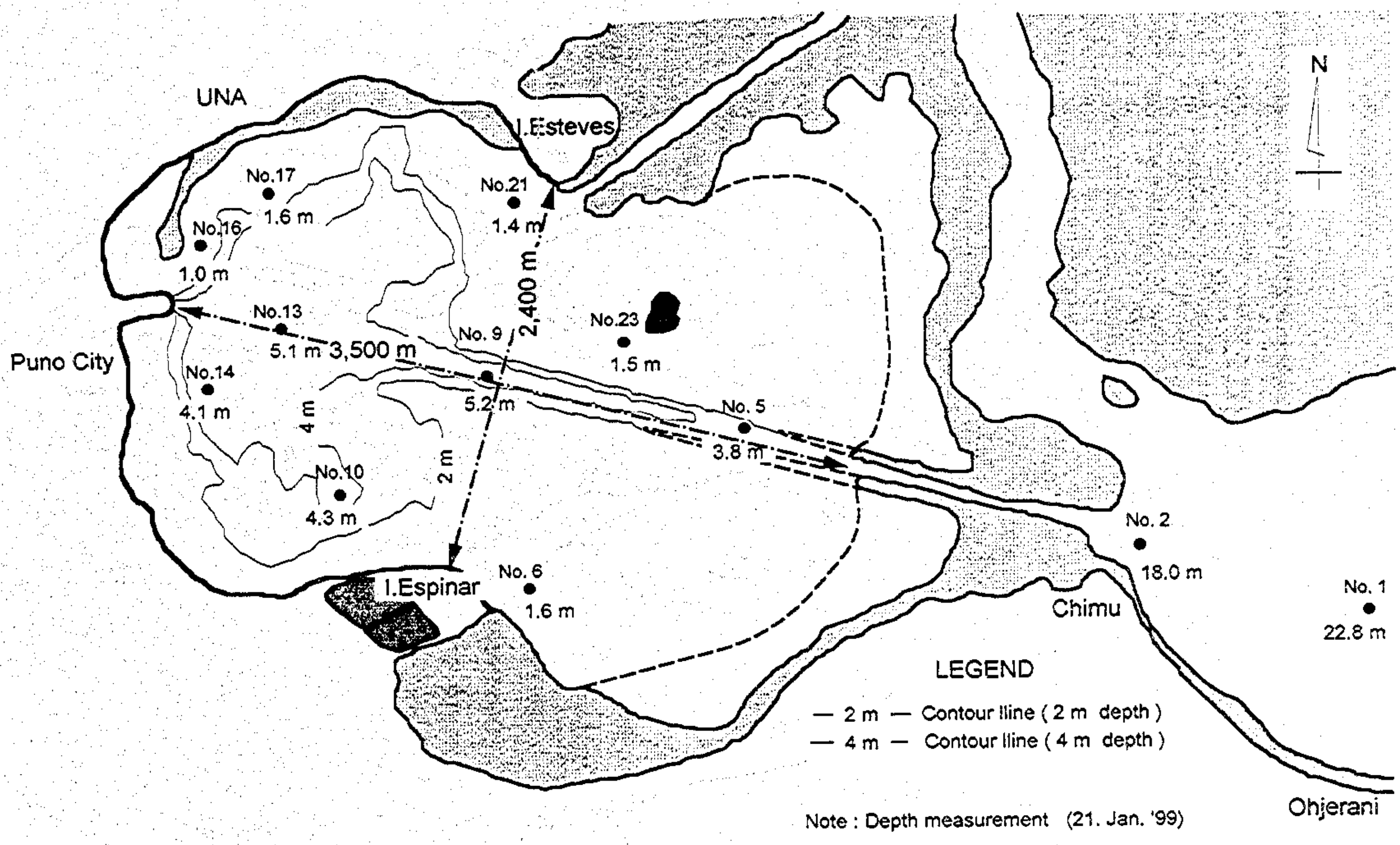


Figure III.1.1 The Shape of Puno Interior Bay

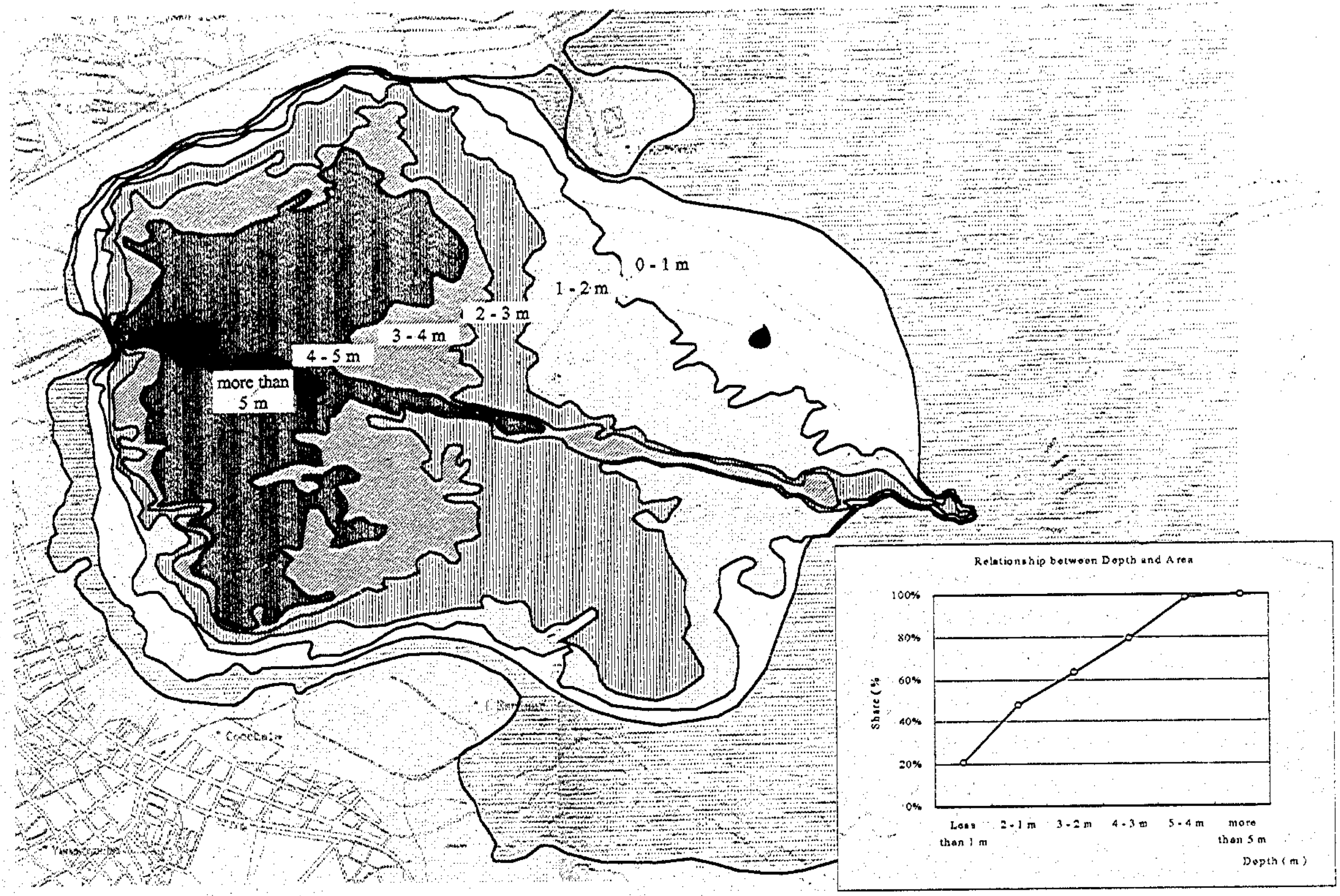
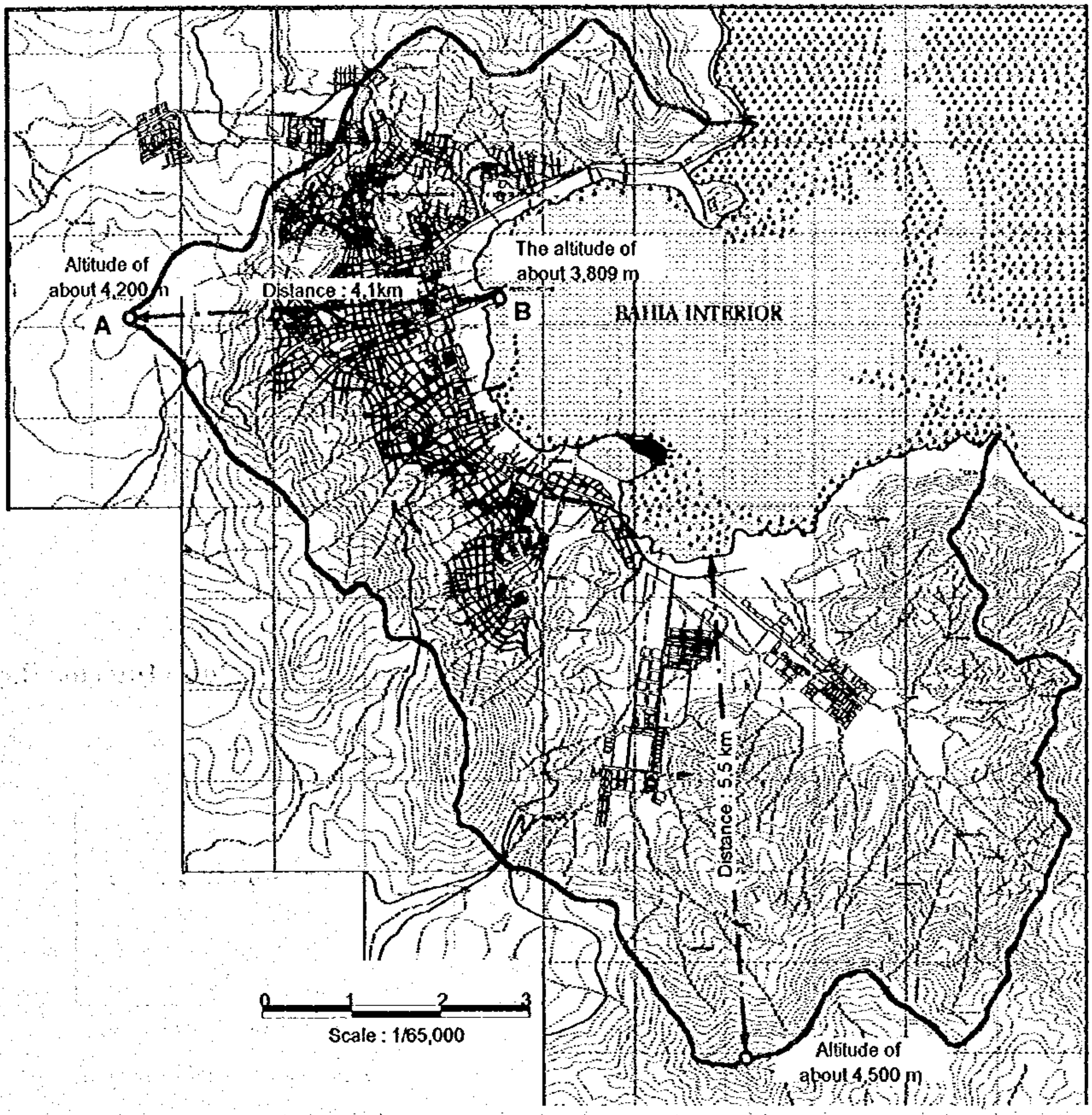


Figure III.1.2 The Depth of Puno Interior Bay



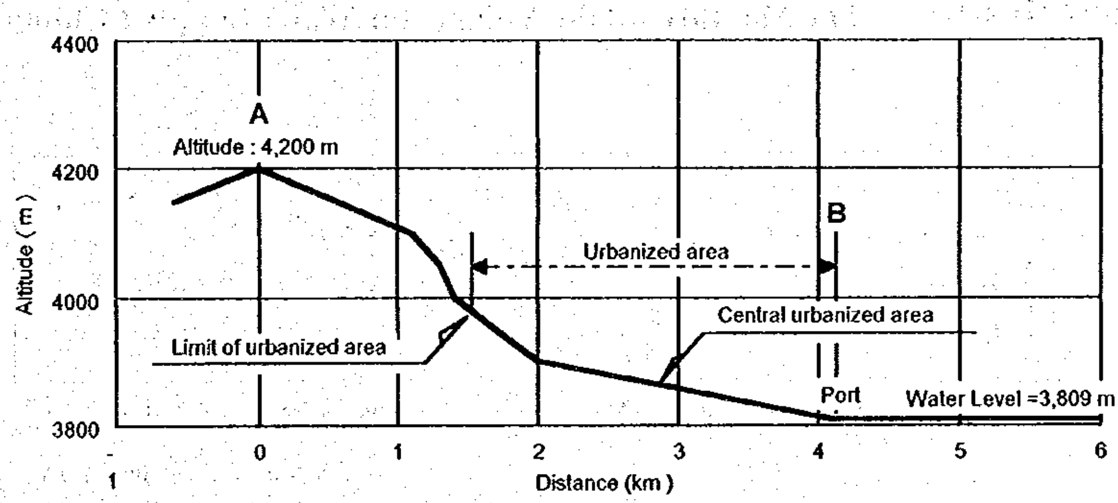
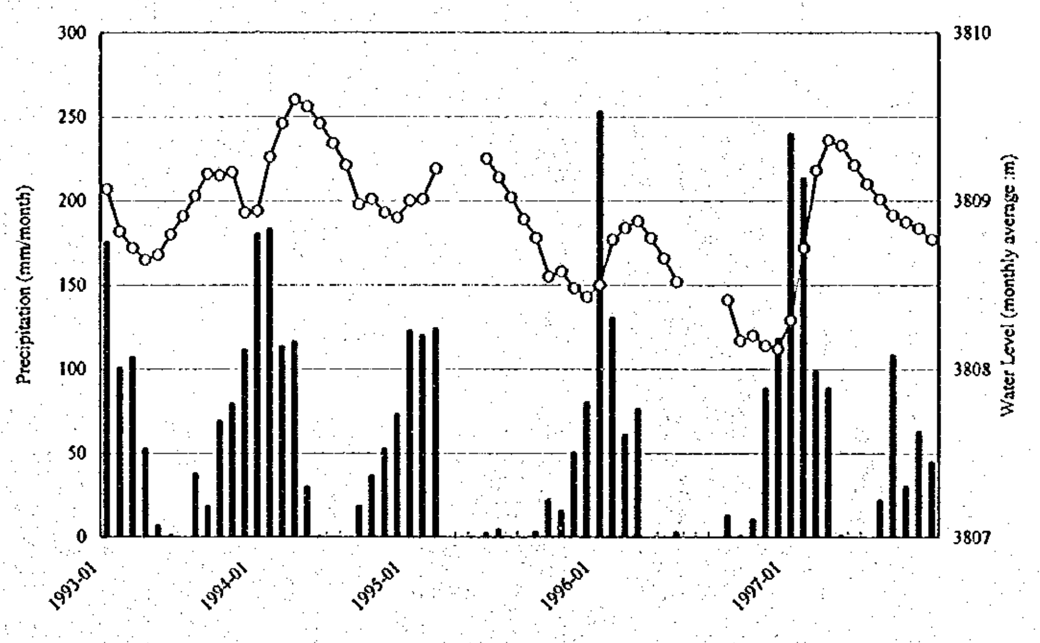
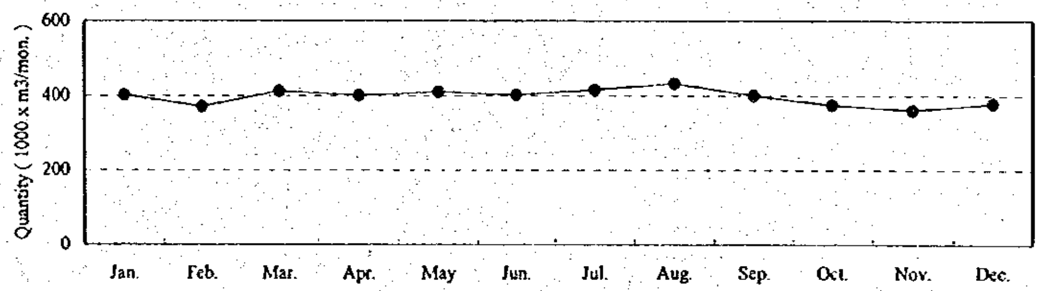


Figure III.1.3 The Catchment Area of Puno Interior Bay



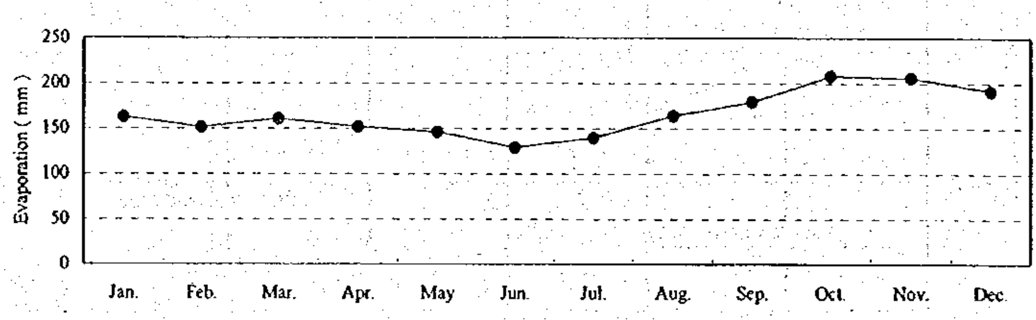
Source : SENAMHI (average 1993 - 1997)

Figure III.2.1 The Water Level and the Precipitation of Puno Interior Bay



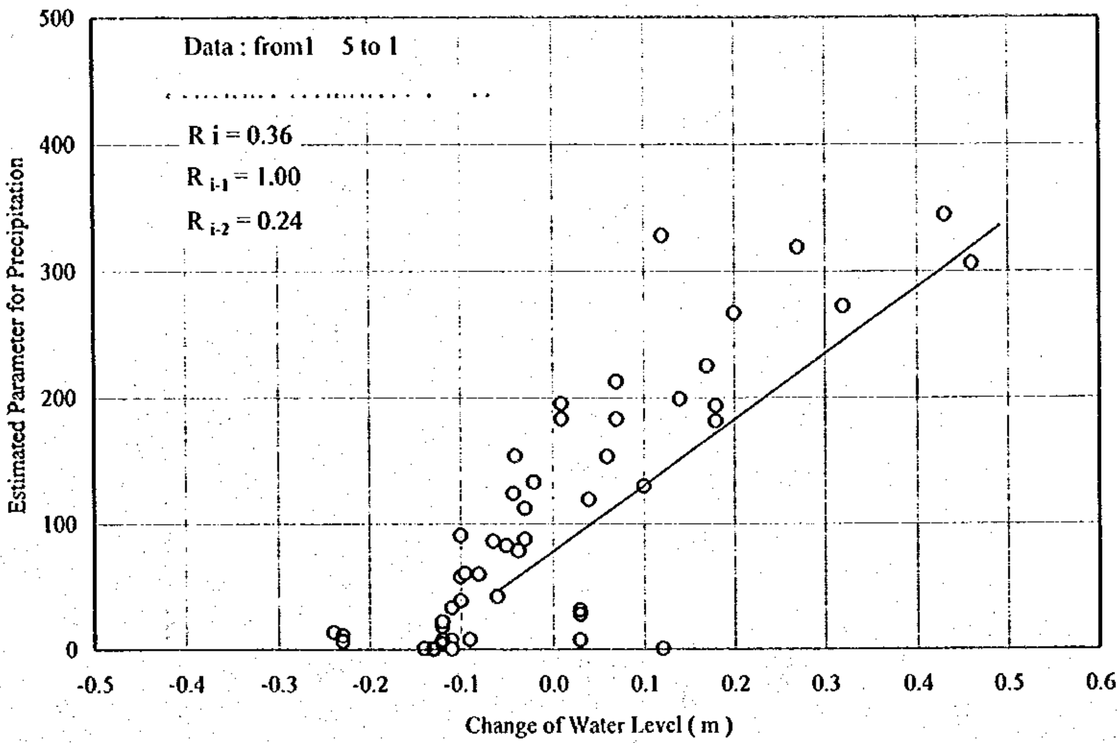
Source : Ensa-Puno (Chimu, 1998)

Figure III.2.2 The Monthly Intake Volume for Water Supply (Chimu, 1998)



Source : SENAMHI (average 1967 - 1997)

Figure III.2.3 The Seasonal Variation of Evaporation

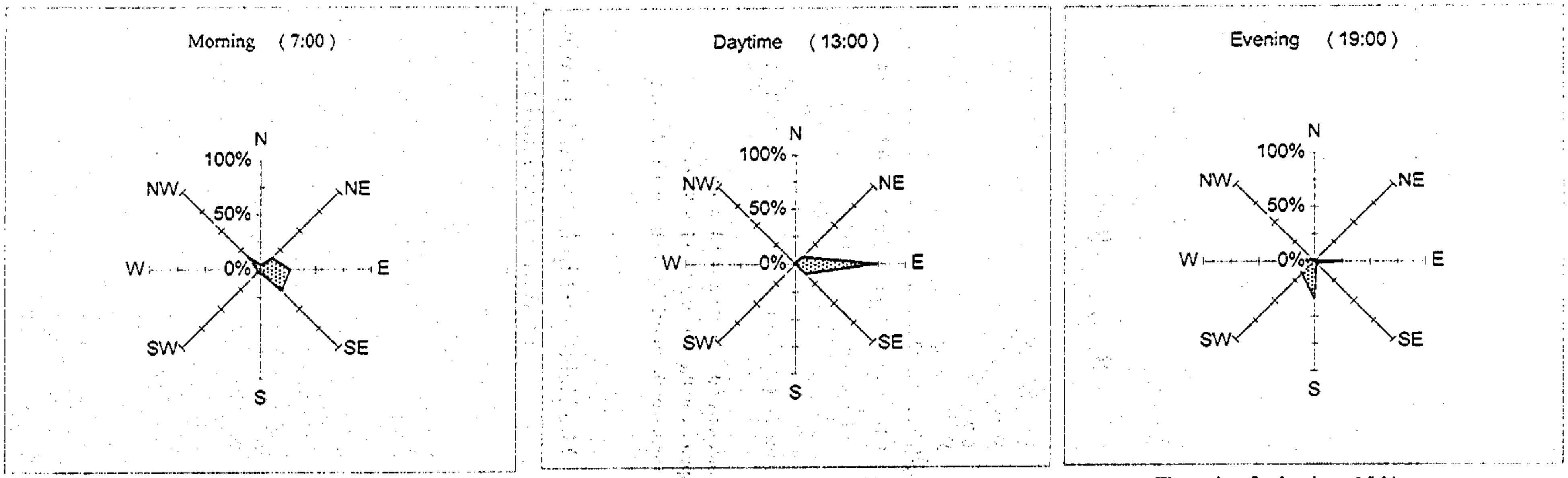


Estimated parameter for precipitation = $(P_i \times R_i) + (P_{i-1} \times R_{i-1}) + (P_{i-2} \times R_{i-2})$

Where;

P_i, R_i	: Monthly precipitation of this month and itsRun-off
P_{i-1}, R_{i-1}	: Monthly precipitation of the last month and its Run-off
P_{i-2}, R_{i-2}	: Monthly precipitation of the month before last and its Run-off

Figure III.2.4 The Relationship between Variation of Water Level and Precipitation



The ratio of calm day : 66 %

The ratio of calm day : 1 %

The ratio of calm day : 15 %

Data : from July 1995 to June 1996
Source: SENAMHI

Figure III.2.5 The Features of Wind Direction in Puno City

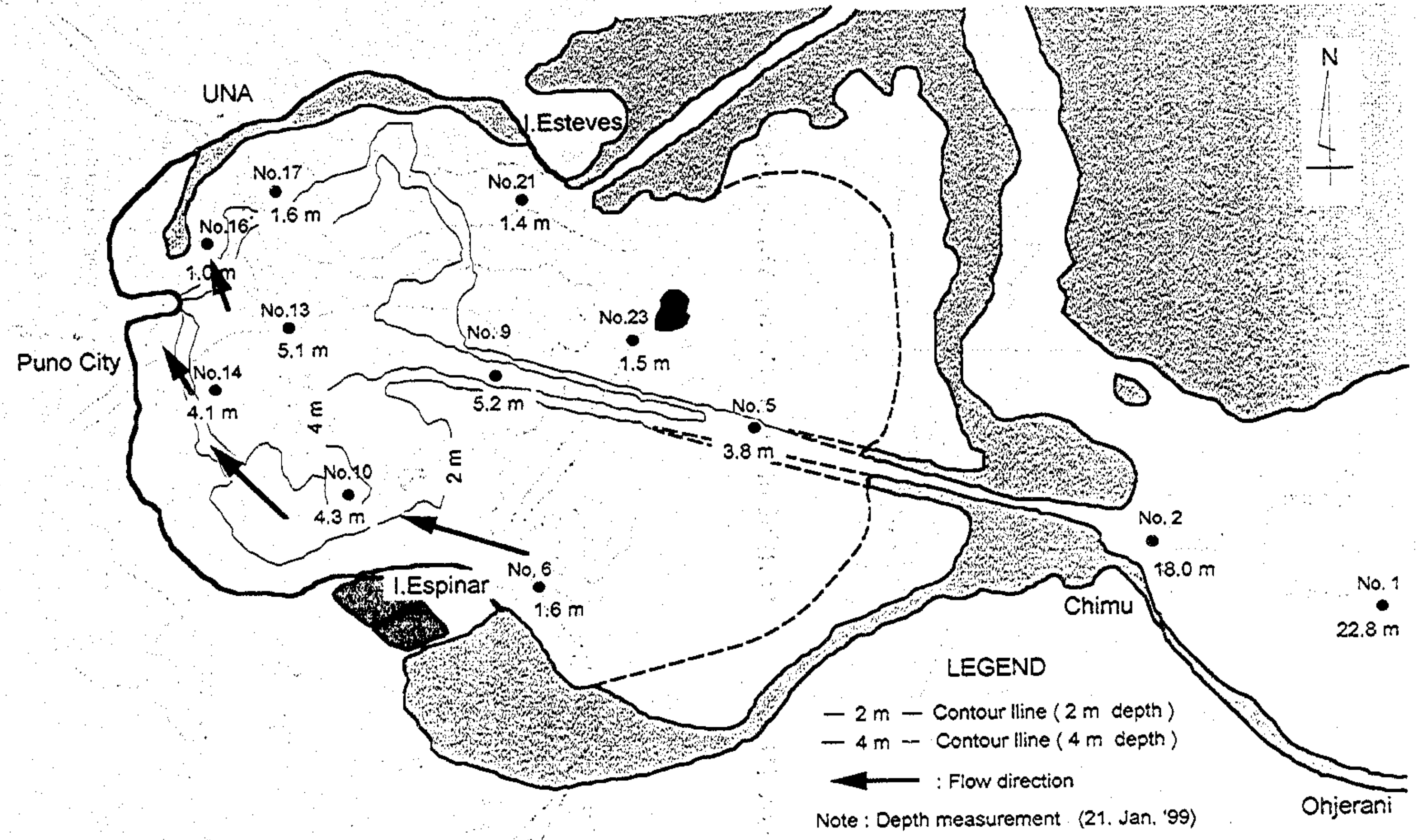


Figure III.2.6 The Water Movement of Puno Interior Bay

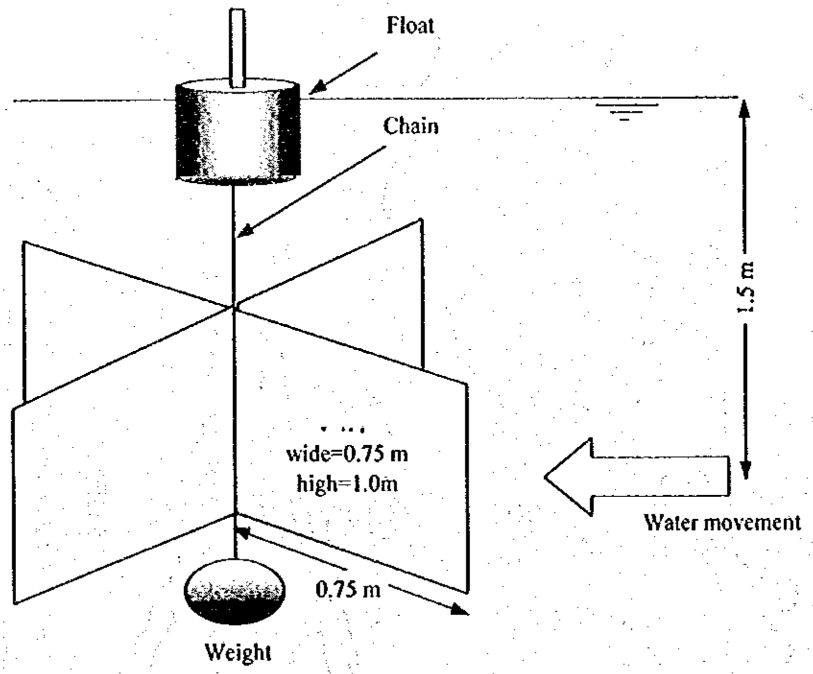


Figure III.2.7 Outline of Buoy (Water Movement Survey)

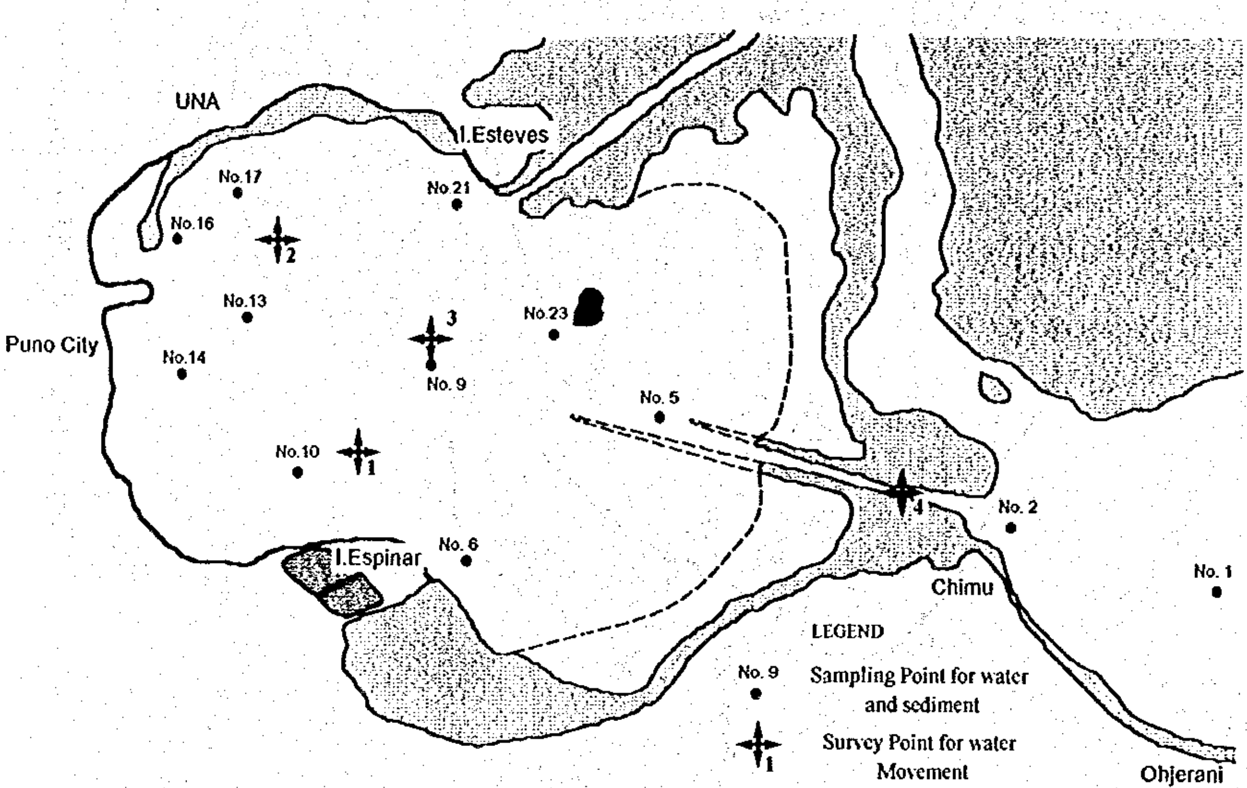


Figure III.2.8 Survey Points of Water Movement Survey