No.

LOCAL WATER UTILITIES ADMINISTRATION
(LWUA)
REPUBLIC OF THE PHILIPPINES

BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR IMPROVEMENT OF WATER QUALITY
IN LOCAL AREAS
IN
THE REPUBLIC OF THE PHILIPPINES

JUNE 2000

JAPAN INTERNATIONAL COOPERATION AGENCY
JAPAN TECHNO CO., LTD.

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PREFACE

In response to a request from the Government of the Republic of the Philippines, the Government of Japan decided to conduct a basic design study on the Project for Improvement of Water Quality in Local Areas in the Republic of the Philippines and entrusted the study to the Japan International Cooperation Agency(JICA).

JICA sent to the Philippines a study team from 23 August to 1 October 1999 for the 1st field survey and from 15 November to 24 December 1999 for the 2nd field survey. The team held discussions with the officials concerned of the Government of the Philippines, and conducted a field study at the study area.

After the team returned to Japan, further studies were made. Then, a mission was sent to the Philippines in order to discuss a draft basic design, from 6 March to 15 March 2000 as the 1st explanation of draft basic design, and from 26 June to 2 July 2000 as the 2nd explanation of draft basic design, and as a result, the present report was finalized.

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

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of the Philippines for their close cooperation extended to the teams.

June, 2000

Kimio FUJITA
President
Japan international Cooperation Agency

June, 2000

LETTER OF TRANSMITTAL

We are pleased to submit you the basic design study report on the Project for Improvement of Water Quality in Local Areas in the Republic of the Philippines.

This study was conducted by Japan Techno Co., Ltd, under a contract to JICA, during the period from 13 August 1999 to 30 June 2000. In conducting the study, we have examined the feasibility and rationale of the Project with due consideration to the present situation of the Philippines and formulated the most appropriate basic design for the Project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the Project.

Very truly yours,

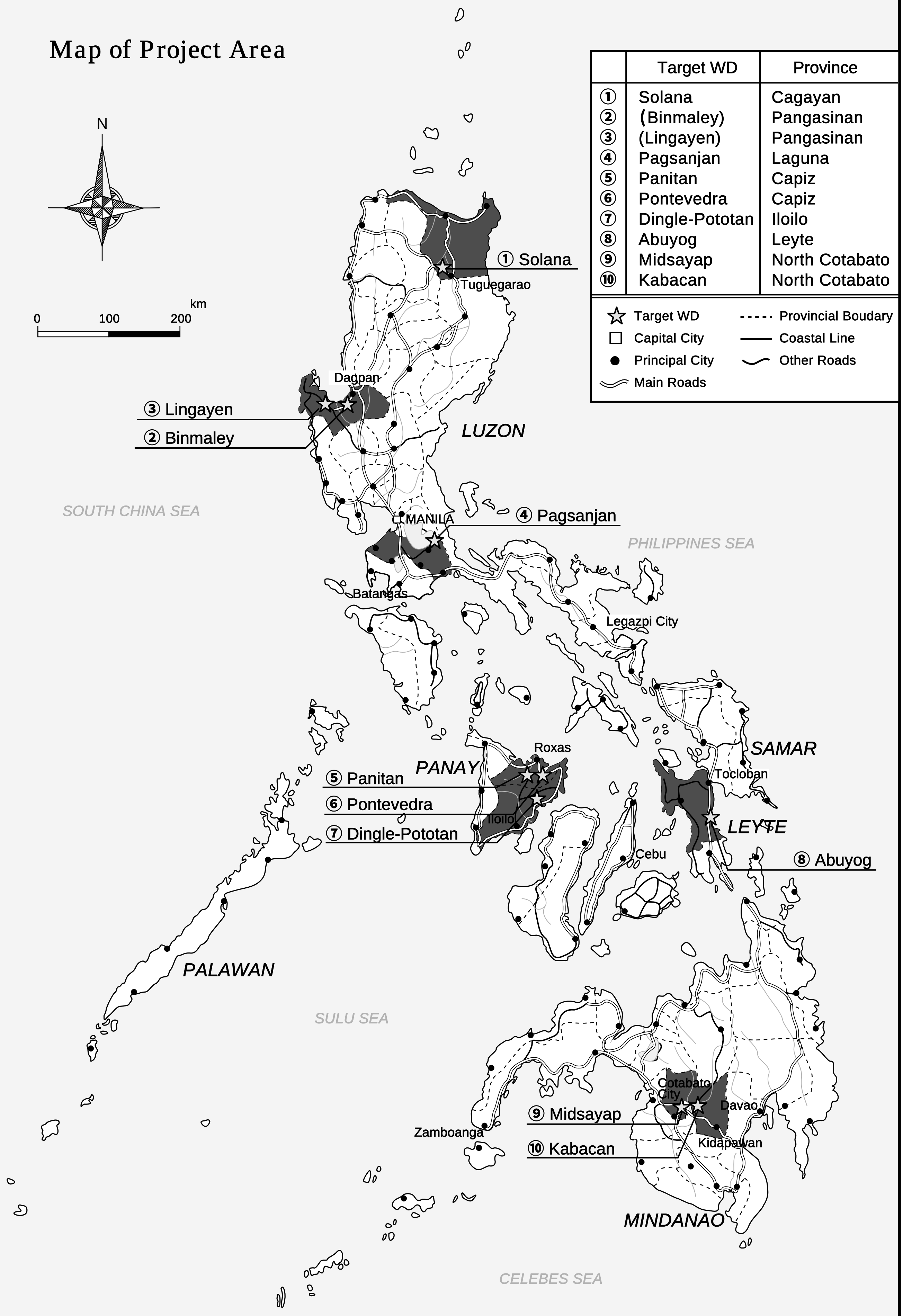
Kanji TAKAMATSU

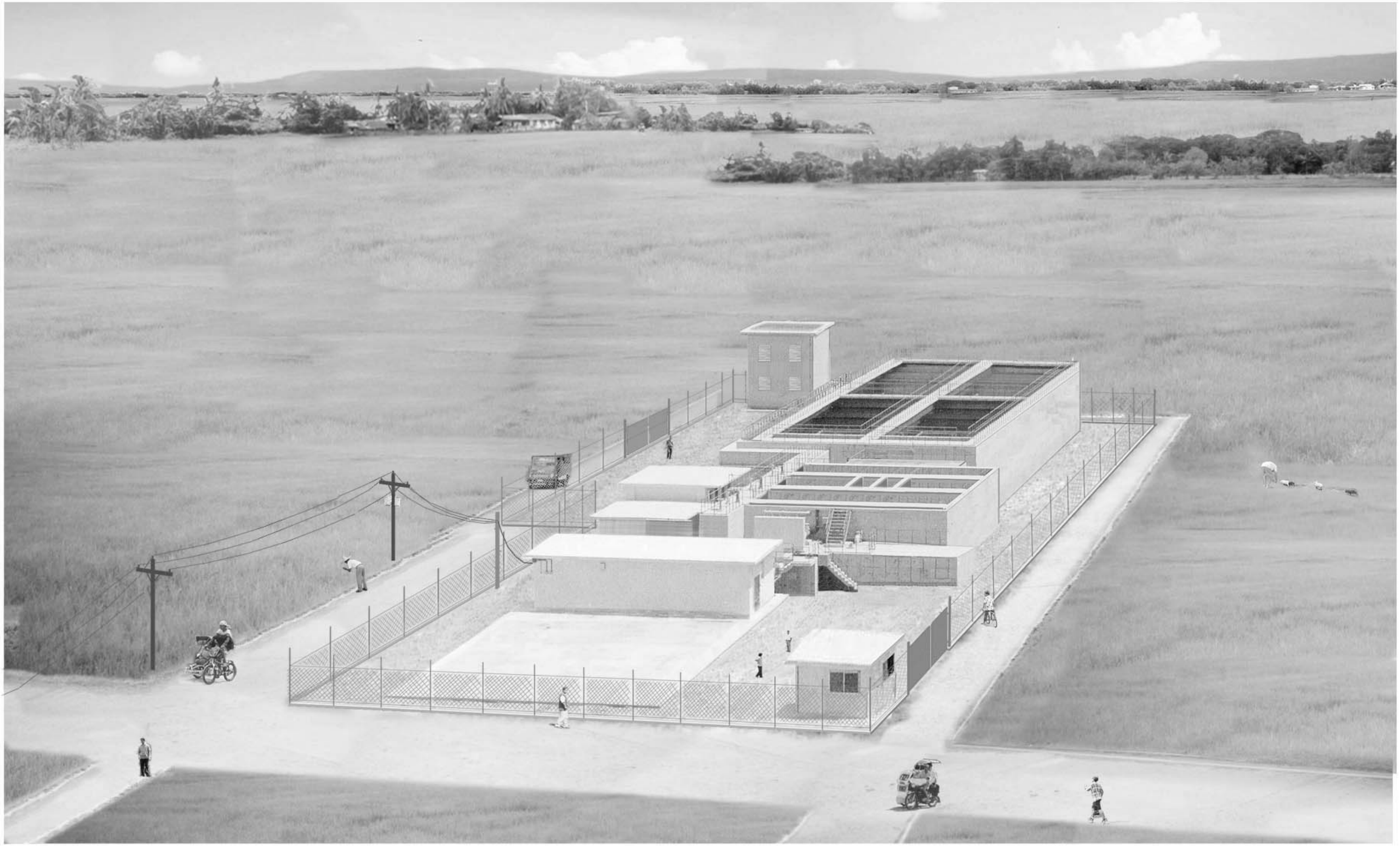
Project Manager
Basic Design Team on The Project for Improvement of Water Quality in Local Areas in the Republic of the Philippines

Japan Techno Co., Ltd.

Basic Design Study for the Project for Improvement of Water Quality in Local Areas in the Republic of Philippines

Map of Project Area





Basic Design Study for the Project for Improvement of Water Quality
in Local Areas in the Republic of Philippines

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ABBREVIATIONS

ADB	Asian Development Bank
AusAID	Australia's Agency for International Development
BHN	Basic Human Needs
CNC	Certificate of Non-Coverage
DANIDA	Danish International Development Agency
DENR	Department of Environmental and Natural Resources
DPWH	Department of Public Works and Highways
ECC	Environmental Compliance Certificate
EMB	Environmental Management Bureau
E/N	Exchange of Notes
GNP	Gross National Prouduct
ICC	Investment Coordination Committee
JICA	Japan International Cooperation Agency
KfW	Kreditanstalt für Wiederaufbau
LGUs	Local Government Units
LWUA	Local Water Utilities Administration
MDC	Municipal Development Committee

MWSS	Metropolitan Waterworks and Sewerage System
NEDA	National Economic and Development Authority
NWRB	National Water Resources Board
P	Peso
PDC	Provincial Development Committee
PDM	Project Design Matrix
RDC	Regional Development Committee
SIDA	Swedish International Development Agency
UNICEF	United Nations Children's Fund
WD	Water Districts

CHAPTER 1 BACKGROUND OF THE PROJECT

Chapter 1 Background of the Project

1-1 Details of the Philippines

The Republic of the Philippines (hereafter described as the Philippines) is situated on the west edge of the Pacific Ocean, and is composed of 7,100 islands. A total area of the country is about 300,000 km². The eleven large islands (such as Luzon, Mindanao, Samar, Cebu and Leyte) account for 96% of the total area of the country. The fifty-three percent of the total area is categorized as forests, and the 40% is arable land. The estimated population of the country in 1998 was about 75,000,000.

In the Philippines, the Aquino regime was established in 1986 after the Marcos regime which had continued for about 20 years from 1965. Afterwards, a gradual economic recovery proceeded with 3 different presidents. Meanwhile the U.S. military withdrew from the Philippines in 1992, and more diplomatic priorities are given to Japan and the ASEAN countries comparing with the past when those are exclusively given to the U.S. At the same time, the country is becoming more influential in the international arena.

Table 1-1 General data of the Philippines

Item	Indication	Item	Indication
Government	Republic	GNP per capita	US$1,050 (1998)
Sovereign	President Estrada	Inflation rate	9.0%
Capital city	Manila	Percentage of elementary education enrollment	99%
Racial composition	Malei, Mixed blood of Spanish, Chinese and small number of mountains races	Percentage of elementary education completion	Manila:100% Local:30%
Language	English and Tagalog	Literacy rate	95% (1995)
Religion	Rome Catholicism, Christianity, and Islam	Birth rate	29‰ (1997)
Area	300,176 km²	Mortality rate	6‰ (1997)
Population	75,100,000 (1998)	Infant mortality rate	32‰ (1997)
Population growth rate	2.2% (1990-1997)	Life span	68 (1997)
Unit of currency	Peso (P) (1999.7 US$1=P38.4)	Total fertility rate	3.7 (per)

The economic development plan in the Philippines is planned principally by NEDA (National Economic Planning Authority). The present development plan was announced by "Mid-Term, National Development Five-year Plan 1999-2004" in December 1999.

The aims of this plan are reduction of poverty, improvement of the standards of the living and making the country a part of the Newly Industrialized Economies. In addition, the improvement of the coverage of drinking water supply is described as the most important issue for the Basic Human Needs (BHN) in this plan.

1-2 Background of Water Sector

As for the water administration of the Philippines, NWASA, which had been founded in 1955 to take charge of nationwide water supplies and wastewater treatments, was divided into 3 sections (i.e., the metropolitan area, local cities and rural villages) in 1972. Metropolitan Waterworks and Sewage Systems (MWSS) is in charge of the Manila metropolitan area. Local Water Utilities Administration (LWUA) is in charge of local cities of 20,000 or more people. And the Department of Public Works and Highways (DPWH) and Local Government Units (LGUs) manage and supervise the rural areas of 20,000 or less people. Moreover, National Water Resources Board (NWRB) composed of the related ministries is responsible for the development and the maintenance of a nationwide water resource.

"Nationwide Water Supply, Sewerage and Sanitation Master Plan 1988-2000" was planned by the departments relating to the water sector such as NEDA, Department of the Interior and Local Government (DILG), DPWH, and NWRB in 1987. Setting the year 2000 as the target year, the nationwide water supply has been executed aiming at the following three points. The basic concept has been succeeded to the water sector in the Mid-Term, National Development Five-year Plan (1999-2004 years) planned by a present regime.

1) Safe water supply to a large number of households to be achieved in a short period
2) Improvement of the coverage of drainage and hygiene services
3) Reorganization of services

In this situation, LWUA, the responsible and implementing agency of this project, has been working with the focus on the higher coverage of water supplies. Yet, there are problems to be tackled. They are some groundwaters contain high concentrations of iron, manganese, color, taste and odors; the consumers hesitate to purchase the waters; and they tend to use the shallow wells instead, although these shallow wells might be contaminated more.

1-3 Background and Contents for the Request of the Project

Facing with the situation mentioned above, the Government of the Philippines planned "Project for Improvement of Water Quality in Local Areas" (hereafter described as "the Project") and requested grant aid assistance from the Government of Japan in July 1997.

LWUA examined 29 WDs under their affiliation whose water sources contain high iron and manganese concentration values than those of the Philippines National Standard for Drinking Water. Out of these 29 WDs, 10 WDs that met the 4 conditions mentioned below were selected as the target WDs of the Project. For these 10 target WDs, the construction of water treatment facilities and relating facilities was requested. The contents of the Request are shown below.

Table 1-2 Conditions of the Selection of requested 10 WDs

① WDs whose water qualities do not fulfill the Philippines National Standard for Drinking Water ② WDs which are unable to receive loans due to their limited scales ③ WDs which can secure the land necessary for the Project execution ④ WDs which are not requesting similar projects to other donors.

Table 1-3 Target WDs

Island	Water Supply Area LWUA / 1999	Province	Name of WDs	Region
Luzon	Area 1	Cagayan	1.Solana	Region-2
	Area 3	Laguna	2.Pagsanjan	Region-4
		Batangas	3.Balayan	Region-4
	Area 4	Sorsogon	4.Matnog	Region-5
Panay	Area 5	Capiz	5.Panitan	Region-6
			6.Pontevedra	Region-6
		Iloilo	7.Dingle-Pototan	Region-6
Leyte	Area 6	Leyte	8.Abuyog	Region-8
Mindanao	Area 8	North Cotabato	9.Midsayap	Region-12
			10.Kabacan	

Table 1-4 Requested Facilities and Equipment

① Construction and installation of water treatment facilities
② Rehabilitation of the existing well pumps
③ Rehabilitation of the existing facilities for disinfection
④ Rehabilitation and construction of pump houses
⑤ Installation of pipes and electrical equipment for the relating facilities mentioned above
⑥ Procurement of laboratory equipment for water analyses

1-4 Change of the Target Water District

At the beginning of the 1st Field Survey, the Philippines side suggested that Balayan WD and Matnog WD in Luzon Island are removed from the target WDs because it was found that the qualities of water in these WDs fulfill the country's water standards.

On the other hand, it has been reported that other 16 WDs have problems of color, odor and objectionable taste which seem to be due to humic substances. And thus, 2 WDs, Binmaley WD and Lingayen WD in Luzon Island which satisfy 4 conditions of the selection in Table 1-2 are newly requested as target WDs.

As this result, the number of target WDs remains 10. The target WDs in the Project are shown in Table 1-5 below.

Table 1-5 Target WDs (1999)

Island	Water District LWUA	Province	Target WD	Total Population	Barangay Population	Served Population	Water Supply (m3/day)
Luzon	Area 1	Cagayan	1.Solana	68,994	8,207	6,834	750
		Pangasinan	2.Binmaley	66,832	45,479	22,626	2018
			3.Lingayen	82,819	36,416	16,782	1537
	Area 3	Laguna	4.Pagsanjan	31,679	25,020	17,568	1603
Panay	Area 5	Capiz	5.Panitan	31,737	10,508	2,322	232
			6.Pontevedra	41,742	20,800	8,500	721
		Iloilo	7.Dingle-Pototan	97,157	30,042	14,934	2094
Leyte	Area 6	Leyte	8.Abuyog	56,410	15,703	5,258	522
Mindanao	Area 8	North Cotabato	9.Midsayap	147,255	34,218	10,254	1119
			10.Kabacan	71,152	17,069	15,942	1902
Total				695,777	243,462	121,020	12498

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CHAPTER 2　CONTENTS OF THE PROJECT

Chapter 2 Contents of the Project

2-1 Objectives of the Project

The Government of the Republic of the Philippines undertakes "Water supply, Sewerage, and Sanitation Master Plan (1988-2000 years)" which has been advanced aiming at 2000 year, with this concept, is planning the target concerning the water sector in “The Mid-Term Development Five-year Plan (1999-2004 years) ” planned in December, 1999. Under this situation, the Government of the Republic of the Philippines is putting her importance on the improvement of water coverage rate in the basic living standard of the people. To fulfill safe and stable water supply to the large number of the households in the shortest period, the Government is encouraging efficient, decentralized and autonomous operation of water companies. Under the above mentioned governmental policy, this Project is to construct water treatment facilities and related facilities for the 10 Water Districts (WDs) supervised by the Local Water Utilities Administration (LWUA), which is the implementing agency as well as responsible agency of the Project. The target 10 WDs are facing with such problems as the deterioration of water supply service level, the difficulty of establishing an appropriate water tariff, the tendency of the customers avoiding water supplied by WDs, and the failure to expand water coverage rate caused by the quality of water from the existing water sources. The purpose of the Project is to increase volume and coverage of water supply by improving the water quality, and subsequently to improve water-supply service level and the operational status of the WDs.

In addition to resolving water quality problems of target 10 WDs, LWUA also hopes to have spin-off effect to the other WDs which have similar water quality problems by transferring technology of water treatment under the Project.

To realize this Project purpose, water treatment facilities complying with the water quality improvement objectives for the water sources at each of the 10 WDs are to be constructed. Since one of these WDs uses two wells as water sources, the number of water treatment facilities are eleven in total.

2-2 Basic Concepts of the Project

The 10 WDs for this project have conducted the feasibility study (F/S) or the corresponding technical study as scheduled for the plan year of 2010 under the support of LWUA, and have improved and expanded the undertakings on the basis of the project. However, it is difficult to develop new good quality water as well as to improve the water quality for the financial reason. The increase in water supply volumes is impossible because the boreholes that were drilled once have been abandoned due to their bad water quality. Those WDs are facing many operational problems including water loss volumes in discharge through pipeline inside scales, in particular, due to bad water quality.

Some WDs having multiple boreholes can obtain good quality raw water, but their production volumes are low. Therefore, the increase of water supply volumes would not be expected unless new boreholes with quality water are developed or unless the water quality of the existing boreholes is improved under the project. At present, those WDs are forced to supply water from the existing boreholes with bad water quality. Under this situation described above, the supply of groundwater of improved quality from the boreholes in each WD under the project have large significance.

As to water volumes, even if volumes of quality water supplied from the planned boreholes are increased after implementation of the project, those volumes could not satisfy the volumes planned for 2010 on the basis of the F/S that has been conducted by each WD in the past. However, it is necessary to preferentially solve many problems which are resulted from supply water of inferior quality through improving the water quality as early as possible. Thus, it is planned to set up water treatment facilities and associated facilities in order to improve the inferior water quality due to the problems of each WD's boreholes.

2-2-1 Target WDs

The target 10WDs of this Project are water district in local cities which lie six regions over four islands as shown in the table 2-1.

Table 2-1 Target Study Site (1999)

Island	Water Supply Area LWUA	Province	Target WD	Barangay * Population	Served Population	Water supply (m3/day)
Luzon	Area 1	Cagayan	1.Solana	8,207	6,834	750
	Area 2	Pangasinan	2.Binmaley	45,479	22,626	2,018
			3.Lingayen	36,416	16,782	1,573
	Area 3	Laguna	4.Pagsanjan	25,020	17,568	1,603
Panay	Area 5	Capiz	5.Panitan	10,508	2,322	232
			6.Pontevedra	20,800	8,500	721
		Iloilo	7.Dingle-Pototan	30,042	14,934	2,094
Leyte	Area 6	Leyte	8.Abuyog	15,703	5,258	522
Mindanao	Area 8	North Cotabato	9.Midsayap	34,218	10,254	1,119
			10.Kabacan	17,069	15,942	1,902
Total				243,462	121,020	12,498

(*) Unit of administrative boundary in the Philippines.

Each WD has relied upon water supply from its boreholes of bad quality water formerly since 1929 and lately from 1992 though water supply demand has been increasing with a increase of population. The water supply undertakings have faced many difficulties due to this problem and are not in a position to accomplish the expansion of water districts and increase in water supply contracts that should contribute to good operation. Some WDs could not meet the demand for water supply by the marine product processing industry that will turn out a large number of big users within those WDs though it is operationally profitable for the water supply undertakings.
At the same time, WDs are facing with a worsening state of operation due to low income from individual connection charge and water charge and increasing operational cost for chlorine to disinfect water. In order to remove obstructions caused by the slime generated in the pipelines from reactions with the chlorine, frequent back wash of the pipelines are required and this increases un-accounted-for-water. Thus WDs with water quality problems are urgently required to improve their water quality. Most of these WDs are small scale, and it is not easy for them to receive financing from LWUA for new undertakings.

At the present, 29 WDs affiliated with LWUA have problems with iron and manganese, and 16 WDs have problems with coloring, odor and/or taste. Under the Project, 8 of the former and 2 of the latter have been chosen by LWUA on the basis of the four conditions for selection set forth in the time of the request.

2-2-2 Per Capita Supply Rate (Capacity of water treatment facility)

The project is aimed at setting up water treatment facilities to improve the raw water quality of main boreholes under operation in 10 WDs that have large production volumes, but problems in quality.

The target water volumes will, therefore, depend upon the capacity of each of water treatment facilities, namely the production volume of each main borehole. The production volume of each planned borehole is shown in the next Table. The water supply capacity is equal to the balance of subtraction of the water volume for operation of the water treatment facilities from the production volumes.

Table 2-2 □Production Volume of Target Well

No	Target WD	Target Well	Production Volume m^3/d
1	Solana	Basi	1,296
2	Binmaley	Caloocan	1,555
		Fabia	1,728
3	Lingayen	Libsong	2,434
4	Pagsanjan	Sabang	1,097
5	Panitan	Phase2	1,296
6	Pontevedra	Sublangon	2,708
7	Dingle-Pototan	Abangai	2,592
8	Abuyog	Barayong	2,539
9	Midsayap	Villiarica	2,030
10	Kabacan	No.2 P.S.	2,592
total			21,867

The water volume that can be transmitted to the water supply line is equal to the balance of subtraction of the water volume for operation of the water treatment facilities from the above water volumes, as shown in the next Table.

Table 2-3 Water Supply Capacity of Target Well

No	Target WD	Target Well	Supply Capacity m^3/d
1	Solana	Basi	1,231
2	Binmaley	Caloocan	1,477
		Fabia	1,642
3	Lingayen	Libsong	2,312
4	Pagsanjan	Sabang	1,042
5	Panitan	Phase2	1,231
6	Pontevedra	Sublangon	2,573
7	Dingle-Pototan	Abangai	2,462
8	Abuyog	Barayong	2,412
9	Midsayap	Villiarica	1,929
10	Kabacan	No.2 P.S.	2,462
total			20,773

2-2-3 Planned Population &Water Supply Capacity

Each WD execute the feasibility study and various studies with 2010 year as the target year. The planned served population and water supply capacity are shown in the table below.

Table 2-4 Planned Population &Water Supply Capacity in Target WDs in 2010

Target WD	WD's Population	Population of Supply Area	Served Population	Planned Water Supply (m3/day)
Solana	80,085	14,675	11,738	2,364
Binmaley	73,604	64,556	37,758	5,295
Lingayen	89,504	51,651	41,360	5,773
Pagsanjan	38,901	31,546	26,505	5,994
Panitan	43,260	21,564	6,991	2,283
Pontevedra	51,949	43,866	15,093	2,445
Dingle-Pototan	109,301	33,796	19,690	3,955
Abuyog	64,500	18,060	16,801	2,777
Midsayap	127,897	46,508	27,705	5,074
Kabacan	82,590	43,762	22,319	3,455
Total	761,591	369,984	225,960	39,415

The transmission volume from the water treatment facilities to be set up under the Project to the water distribution lines and the production volumes of spring water and other existing boreholes from which water can be pumped up without any problem of quality are shown in the following Table.

Table 2-5 Water Supply Capacity of each WD

Target WDs	Sustainable Yield（m^3/day）			
	Production Volume of Target Well	Supply Capacity*	Supply Capacity of Other Well	Total Capacity of Water Supply
Solana	1,296	1,231	812	2,043
Binmaley Caloocam	1,555	1,477	138	3,257
Binmaley Fabia	1,728	1,642		
Lingayen	2,434	2,312	0	2,312
Pagsanjan	1,097	1,042	4,389	5,431
Panitan	1,296	1,231	0	1,231
Pontevedra	2,708	2,573	0	2,573
Dingle-Pototan	2,592	2,462	2,193	4,655
Abuyog	2,539	2,412	0	2,412
Midsayap	2,030	1,929	0	1,929
Kabacan	2,592	2,462	1,233	3,695
Total	21,867	20,773	8,765	29,538

*Supply Capacity is deducting unaccounted-for-water such as back wash draining, sludge, cleaning water inside the facilities, etc. from the yield.

The following table shows the comparison of the planned water supply rate at 2010 according to the F/S with total production volume of water of each WD after this Project is executed.

Table 2-6 Production Volume of each WD & Planned Water Supply in 2010

Target WD	Production Volume	Planned Water Supply（m3/day）
Solana	2,043	2,364
Binmaley	3,257	5,295
Lingayen	2,312	5,773
Pagsanjan	5,431	5,994
Panitan	1,231	2,283
Pontevedra	2,573	2,445
Dingle-Pototan	4,655	3,955
Abuyog	2,412	2,777
Midsayap	1,929	5,074
Kabacan	3,695	3,455
Total	29,538	39,415

2-3 Basic Design

2-3-1 Design Concept

(1) Policies on natural conditions

1) Characteristic of target wells

Examining the characteristics of the wells in each WDs, for which water treatment facilities are to be constructed as the main component of the Project, it was found that old wells were constructed in 1980 and new ones in 1998. The hydrogeological background, the results of pumping tests, and Langelier's index which indicates the tendency of scale formation and corrosion were also investigated. The yield of each wells can be evaluated from the existing data of pumping tests and the field survey done by utilizing existing intake facilities. However, as every target well has problems in terms of the quality, rehabilitation of the wells such as elimination of scale formation and pumping tests are necessary at the implementation stage of the Project for the sustainable use of the wells.

2) Policies on water quality

At the stage of the request of the Project, the objective parameters for quality improvement were iron and manganese.

During the Field Survey I, an offer was raised from the Philippines side for the exclusion of two WDs from the target WDs. The reason for the exclusion was that the water quality test for the above mentioned two WDs executed after the request was satisfactory for the Philippines National Standard for Drinking Water. However, instead of the above two WDs, other two WDs which have difficulties in the operation of water supply systems due to coloring and offensive smell were requested as the new target WDs. Thus the objective parameters for quality improvement were increased to include coloring and offensive smell.

At the stage of the analyses in Japan after the Field Survey I, the possibility of trihalomethane formation, which is the byproduct of the reaction of organic substances like humic substances and chlorine as disinfectant, was pointed out. Although this parameter is not included in the Philippines' standard, it was decided that the tests were going to be conducted. Under the constraints such as the scattered test points in 4 islands and the difficulty of quick transportation of water sampling to Tokyo via Manila, the tests of Trihalomethane Formation Potential were carried out for the sampling waters collected from all the target sites in the Field Survey II (the results of the precise analyses of Trihalomethane Formation Potential are attached in the Appendices).

The results of the test for Trihalomethane Formation Potential is within the standard of Japan and the USA. Therefore, it is not necessary to include this as a objective parameter. However, it shall be suggested that LWUA and the WDs admit the situation and carry out thorough monitoring of the water quality (e.g., frequent monitoring of Trihalomethane) after the completion of the Project.

The target parameters for water treatment for each target wells under the Project are shown in next Table.

The objective of water quality improvement is to satisfy the water quality criteria of the Philippines. In addition, the removal of iron and manganese should be aimed at meeting the requirement for prevention of coloration. Ammonia is not included, as a removed item, in the water quality criteria of the Philippines, but it should also be removed because its existence is a problem in the process of removal of manganese.

Table 2-7 Target parameter and value

Target parameter	Iron (mg/L)	Manganese (mg/L)	Ammonia (mg/L)	Color (mg/L)	Offensive Taste & Odor
Philippines standard	1.0	0.50	0	5	Normal
Target Value	0.3	0.05	0	5	Normal

3) Other

As for the ground leveling, though the conditions are different in each WDs, embankment is necessary to have the difference of water level necessary for the water treatment process. As the result of Geological Soil Survey, there are several sites whose ground is weak. In these sites, the soil improvement shall be done by the Japanese Contractor to construct heavy structures.

The temperature is high in general, and fairly high in the direct rays of sun. Some measures against the problem caused by the occurrence of convection in the water treatment facilities shall be taken.

(2) Policies on social conditions

As the environmental consideration around the sites, the discharge of sludge from sedimentation device and the washing water from the filtration device are collected into a simple discharged water treatment facility at first, and only the supernatant fluid is discharged. The design of water treatment facilities shall fit to the protection of the surrounding environment, especially the saucer of the discharge like creeks, rivers, and irrigation ditches, though there is no regulations regarding discharged water from water treatment facilities in Philippines. Judging from the results of the surveys, it is evaluated that the discharged water from each of the water treatment facilities in this project will not cause pollution to the creeks and rivers in terms of quantity and quality.

With respect to the process of the construction, since all of the 10 WDs are running water supply services, it shall be taken into consideration not to cause inconvenience for the residents such like long stop of water supply by the construction works.

(3) Policies on maintenance

Each WDs has long experience in water supply services. Their general activities such as water production, distribution, meter readings, billing and collection of water charge is in order. WD's staff are well-skilled for daily activities such as pump operation, plumbing and maintenance of the pipelines. However, they have no experience in the operation of water treatment facility to be constructed under the Project.

As for the electrical equipment and machinery to be used under this Project, there will be no increase of huge manpower since they are designed under the concept of manual operation system. However, as for the water treatment technique to improve water quality, since the basic scientific knowledge is required for operation, a training program shall be planned and executed by soft-component. A fairly long period group training and operation training for each treatment parameter for all 10 WDs are necessary(The Project Design Matrix are shown in the following pages.)

Most of the personnel in Implementing Agency do not have experience either in the operation of treatment facility for the improvement of groundwater quality or in the groundwater development method considering its quality. Counterpart training will be effective in respect of acquisition of such skills.

(4) Policies on execution by phase

There is a necessity of division by two terms on the scale of the works and the system when this Project is executed. Therefore, an original examination of the condition like the following was done.

① Efficiency to execute two or more vicinity sites to the same period in the same region by thinking from construction side.
② Evenness of amount of works in division by two terms.
③ Idea like the following presented by the Philippines side concerning the priority level of site selection for the execution.

i) Priority to the sites where the impact and the effect are high (50%)
ii) Priority to the sites with a difficult water quality problem (30%)
iii) Priority to the sites where the land securing ends (20%)

Table 2-8 Project・Design・Matrix (PDM) of Project including Soft-Component

Narrative Summary	Verifiable Indicators	Means of Verification	Important Assumptions
Overall Goal			(Necessary assumptions to sustain the effects of the development)
1. To Improve water supply services and management of WDs	1. The WDs' management is profitable. 2. Complaints from the residents decrease.	1. WDs' financial statements 2. Records of complaints	• The conditions of water supplies are not changed by the natural and social factors.
Project Purpose			(Necessary assumptions to achieve the overall goal)
1. To expand the water supply services 2. To increase the usage of water supply services	1. Served population increases. 2. The volume of served water increases.	1. Number of customers 2. Records of the quantity of supplied water	• The water policies are not changed. • The WDs' policies of management are not changed.
Outputs			(Necessary assumptions to achieve the project purposes)
1. Water quality is improved. 2.Treated water is supplied. 3.Operators' skills are improved	1. The concentration levels of iron, manganese etc. are up to the standard. 2. ( ) m3/day of treated water is supplied. 3. Technical problems are reduced.	1. Records of water analyses 2. Records of the quantity of treated water 3. Records of WDs' operation and maintenance	• The water sources are not dried out or are not salinised. • Water qualities are not deteriorated by industries and so forth. • Water is not stolen. • The cost of living does not increase extremely.
Activities	Inputs		(Necessary assumptions to achieve the outputs)
Japan 1-1. Construction of water treatment facility 1-2. Procurement of equipment for monitoring 2-1. Construction of pipelines 2-2. Rehabilitation of well pumps 2-3. Rehabilitation of existing wells 3-1. To make the plans for the training of operators 3-2. To train operators ***Philippines*** 1. Management of the facilities of water supplies 2-1. To install water supply systems 2-2. To run the services according to the budget plan 2-3. To collect water fees 3. To make the system to let operators participate the training	***Japan*** Construction of facilities and procurement of equipment Facilities for Water Treatment 11 sites Construction of pipeline 1 unit Rehabilitation of wells 11 sites Personnel Project Manager Hydro-geologist Water treatment planer Water facility planer Water quality analyst Operation and maintenance planer Contractor Environmental assessment planer ***Philippines*** Personnel Counterpart WD's operators Facilities Water Treatment facilities Existing wells		• The trained operators fulfill their duties. **Preconditions for the activities** • The residents use treated water. • WDs secures adequate personnel. • LWUA supports WDs.

Table 2-9 Project･Design･Matrix（PDM）relation to Soft-Component

Narrative Summary	Verifiable Indicators	Means of Verification	Important Assumptions
Overall Goal			(Necessary assumptions to sustain the effects of the development)
1. To improve the WD's water supply services and management	1. The WDs' management is profitable. 2. Complaints from the residents decrease. 3.	1. WDs' financial statements 2. Records of complaints	• The water policies are not changed. • The WDs' policies of management are not changed.
Project Purpose			(Necessary assumptions to achieve the overall goal)
1. To improve the operators' skills	1. Technical problems are reduced.	1. Records of operation and maintenance	• The trained operators fulfill their duties. •
Outputs			(Necessary assumptions to achieve the outputs)
1. To make the manual of operation plans 2. To control the water quantity with monitoring equipment 3. To control the water quality with monitoring equipment 4. To let the counterparts acquire the skills for water treatment 5. To let the counterparts acquire the skills for wastewater and sludge treatment	1. Operators work more efficiently. 2. Water is supplied to the consumers constantly. 3. The water quality is up to the standard. 4. The equipment for the water treatment is handled properly. 5. Wastewater and sludge are treated properly. 6.	1. WD's working record 2. Records of supplied water 3. Records of water quality 4. Records of the equipment operation 5. Records of the wastewater/sludge treatment	• The participants for the training are willing to learn.
Activities	Inputs		(Necessary assumptions to achieve the outputs)
Japan 1. To instruct general common items. 2. To carry out On the Job Training(OJT). 3. To instruct how to use the monitoring equipment and its necessity 4. O&M for Emergency 5. To instruct water quality anaysis ***Philippines*** Technical staff attend the training	***Japan*** Construction/Procurement of equipment Water Treatment facility 11 sites Construction of pipelines 1 unit Rehabilitation of wells 11 sites Personnel Project Manager Water facility planer Water quality analyst Operation and maintenance planer ***Philippines*** Personnel LWUA Counterpart WD Operators WD Engineer		• WDs' operators participate the training Preconditions for the activities • WDs secures adequate personnel • LWUA supports WDs

(5) Policies on the procurement except for facilities

In this Project, the procurement of equipment for measuring and analysis of water quality is included in the Request. It is composed of basic water quality testing equipment such as jar testers and so on. They are used for the analysis of the quality of raw water and treated water for the autonomous operation and maintenance done by WDs themselves after the completion of water treatment facilities. These equipment are adequate for the target treatment parameters of 10WDs（11water treatment facilities）.

(5) Policies on the procurement except for facilities

In this Project, the procurement of equipment for measuring and analysis of water quality is included in the Request. It is composed of basic water quality testing equipment such as jar testers and so on. They are used for the analysis of the quality of raw water and treated water for the autonomous operation and maintenance done by WDs themselves after the completion of water treatment facilities. These equipment are adequate for the target treatment parameters of 10WDs（11water treatment facilities）.

(6) Policies on ICC relation

The scale of undertaking under the project will be subject to the assessment by the ICC of the NEDA. The LWUA will apply for the ICC's assessment in the stage of pre-implementation of the project. (Refer to the flowchart of the ICC system in the next page.) It is necessary to submit the materials of the project to the NEDA, but the implementation agency has to apply for assessment on the environmental impacts and development to the Environmental Bureau and submit the "Screening for Environmental Impact Statement".

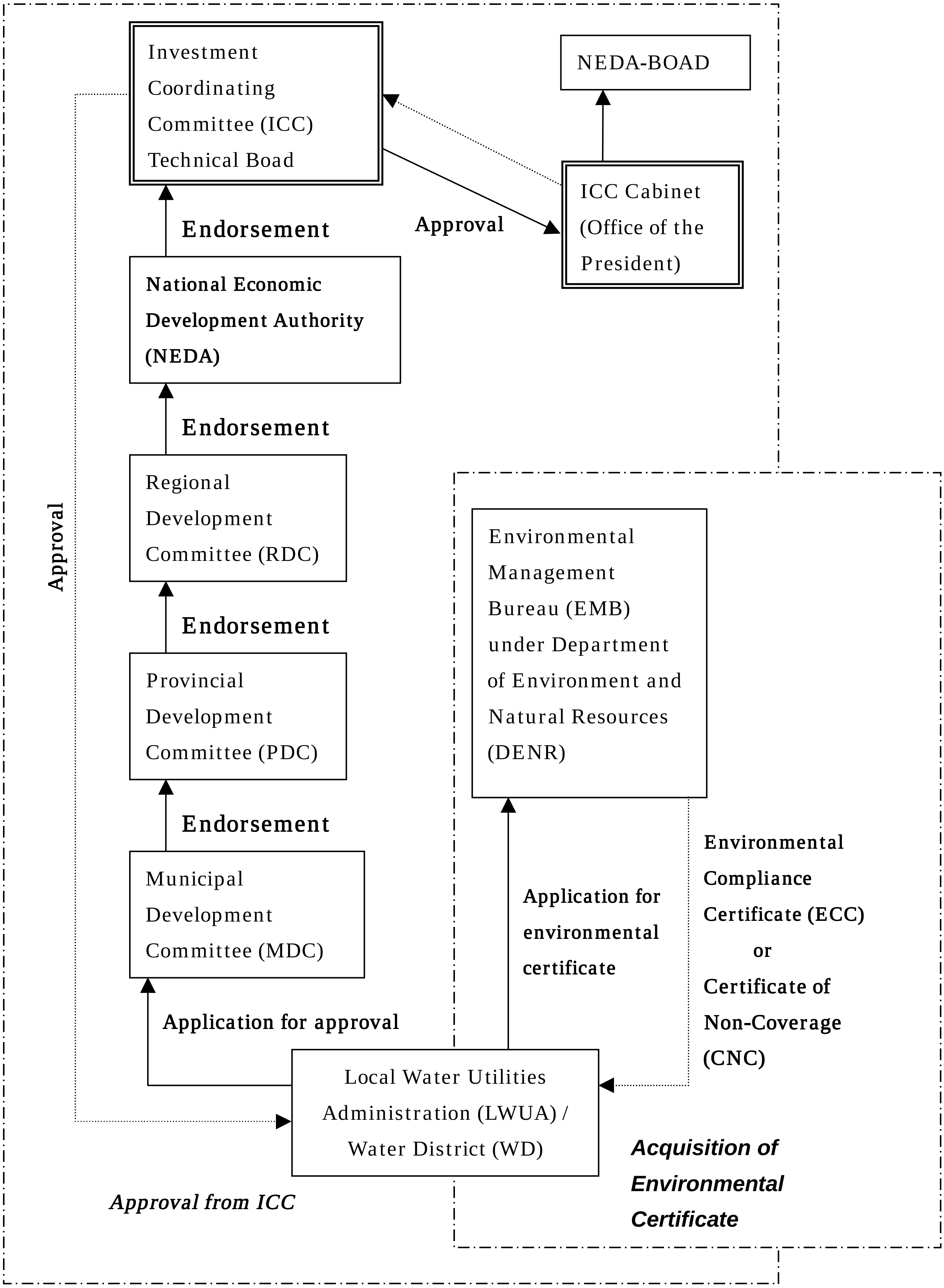

Figure 2-1 Flow Chart of ICC System

2-3-2 Basic Design

(1) Target parameter of water treatment facilities

As the result of the water quality test of the object well (Refer to the next page), the object parameter of each water treatment facilities was set based on processing target value and the water quality of the object well.

The following Table shows the 6 groups (A, B, C, C', D, E) of target parameter of water treatment facilities.

Table 2-10 Target parameter of water treatment facilities

Target WD	Well	Iron	Manganese	Ammonia	Color	Taste & Odor	Type
Solana	Basi	●	●				B
Binmaley	Caloocan				●	●	D
	Fabia				●	●	D
Lingayen	Libsong				●	●	D
Pagsanjan	Sabang	●					A
Panitan	Phase2	●	●	●			C'
Pontevedra	Sublangon	●	●	●			C
Dingle-Pototan	Abangai	●	●	●			C
Abuyog	Barayong	●	●	●	●	●	E
Midsayap	Villiarica	●	●				B
Kabacan	No.2	●	●				B

Table 2-11 Traget Wells/Result of Water Quality Analysis

No	WD	Item	Temperature	pH	DO	EC	Turbidity	Color	T-Fe	T-Mn	F	As	SiO_2	TDS	TH	CH	MRA	NO_3-N	NO_2-N	NH_3-N	PO_4	SO_4	COD	Coliforms	Standard plate count bacteria	Cl	Na	Ca	Mg	Al	Cu	Zn	Pb	Cd	Hg	CN	Cr^{6+}	Ba	Sb	Se	L.I.	Odor/Taste
		Unit	℃		mg/L	mS/m	Degree	Degree	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	/100 mL	/mL	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L		
Phillipines Standard*				6.5-8.5			5	5	1.00	0.50	1.00	0.01		500	300	300		50	3			250		0	10	250	200			0.2	1.00	5.00	0.01	0.003	0.001	0.07	0.05	0.70	0.005	0.01		Not abnormal
1	Solana	Basi	28.2	6.92	0.44	40	2	0	2.10	1.20	0.20	ND	88	310	159	128	221	ND	0.26	ND	1.7	ND	3.4	0	42	8	15	51	7.7	ND	ND	ND	ND	ND	ND	0.0	0.0	ND	ND	ND	-0.46	Metallic odor
2	Binmaley	Caloocan	30.0	8.30	0.71	50	0	80	0.06	0.05	0.20	ND	80	338	32	27	240	ND	ND	ND	ND	ND	7.6	0	300<	30	101	11	1.3	ND	0.05	ND	ND	ND	ND	0.0	0.0	ND	ND	ND	0.30	Hidrogen sulfade odor
		Fabia	32.0	8.20	0.78	53	0	50	0.14	0.06	0.20	ND	78	300	24	19	242	ND	ND	ND	ND	1.0	8.3	0	74	11	103	8	1.2	ND	ND	0.02	ND	ND	ND	0.0	0.0	ND	ND	ND	0.09	Hidrogen sulfade odor
3	Lingayen	Libsong	28.0	8.38	0.83	128	0	40	0.10	ND	ND	ND	26	698	68	59	162	ND	ND	ND	ND	ND	11.1	0	300<	318	243	24	2.2	ND	0.05	ND	ND	ND	ND	0.0	0.0	ND	ND	ND	0.46	Hidrogen sulfade odor
4	Pagsanjan	Sabang	28.5	7.28	1.01	88	1	0	2.20	0.28	0.20	ND	86	343	230	98	313	0.50	0.60	ND	2.4	8.2	3.2	0	5	65	43	39	31.7	ND	ND	0.09	ND	ND	ND	0.0	0.0	ND	ND	ND	-0.06	Metallic odor
5	Panitan	Phase 2	28.0	6.67	0.35	69	8	5	9.00	1.20	ND	ND	87	433	257	150	267	ND	ND	5.9	ND	33.7	3.2	0	500<	61	35	60	26.0	ND	ND	0.10	ND	ND	ND	0.0	0.0	ND	ND	ND	-0.58	Metallic odor
6	Pontevedra	Sublangon	27.6	6.60	0.38	114	0	0	1.40	0.96	ND	ND	88	1040	549	450	136	ND	ND	0.5	ND	33.7	1.6	0	500<	280	25	180	24.0	ND	ND	0.05	ND	ND	ND	0.0	0.0	ND	ND	ND	-0.56	Metallic odor
7	Dingle-Pototan	Abangai	27.8	7.35	0.23	149	8	10	1.00	0.68	ND	ND	63	941	433	298	570	0.20	ND	4.0	ND	0.7	1.8	0	500<	202	217	119	33.0	ND	ND	0.02	ND	ND	ND	0.0	0.0	ND	ND	ND	0.64	Metallic odor
8	Abuyog	Barayong	30.6	6.73	0.42	239	1	15	4.00	1.90	0.20	ND	76	1613	1192	425	1610	ND	0.05	7.2	1.8	ND	4.7	0	4	41	166	170	184	ND	ND	ND	ND	ND	ND	0.0	0.0	ND	ND	ND	0.60	Metallic Odor/Hydrogen sulfide odor
9	Midsayap	Villiarica	27.0	7.09	0.47	107	0	0	1.70	0.97	ND	ND	68	690	377	240	454	ND	ND	ND	1.2	ND	2	69	400<	140	90	96	32.9	ND	0.06	ND	ND	ND	ND	0.0	0.0	ND	ND	ND	0.21	Metallic odor
10	Kabacan	No.2	28.9	7.08	0.66	55	0	0	1.70	1.90	ND	ND	88	401	187	75	282	0.50	0.56	ND	2.3	8.3	1.2	3	119	22	40	30	26.9	ND	ND	ND	ND	ND	ND	0.0	0.0	ND	ND	ND	-0.43	Metallic odor

■ : Target items TH:Total Hardness CH:Calcium hardness TDS:Total Solids MRA:M alcalinity LI:Langelier's index

(2) Structure of whole system

The whole system from the intake at the target well to the service lines through the water treatment facility is as follows.

1) The raw water pumped from the existing target well by the submersible motor pump is transmitted to the water treatment facility through the existing or new raw water transmission pipes. (Each water treatment facility is located near a pump station or at a distance of about 1 km from it.)

2) Raw water is treated in the facility in accordance with each target parameter, and after the chlorine disinfection, the water is transmitted by pump to a water service area through the existing or new distribution pipelines. After that the water is distributed to each household through branches of service pipes.

3) To treat the wastewater from the backwashing the supernatant water is discharged from a treatment facility, and the sludge is landfilled after sun drying.

(3) Planned facilities in each WD

The system from intake at a well to distribution through transmission and treatment of raw water is different to some extend depending on each WD due to issues of land securing. The followings are the systems to be constructed in this Project.

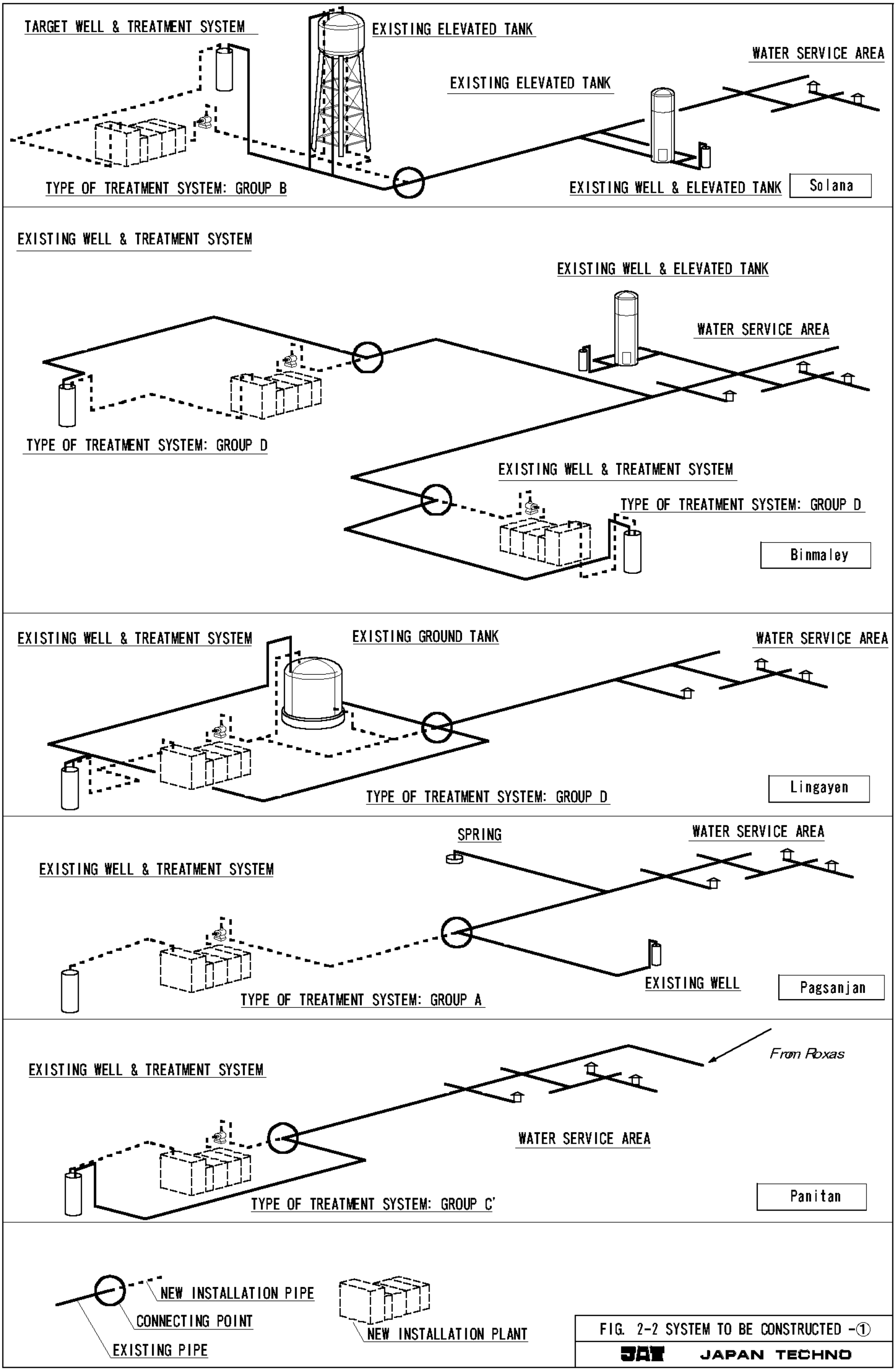

FIG. 2-2 SYSTEM TO BE CONSTRUCTED -①

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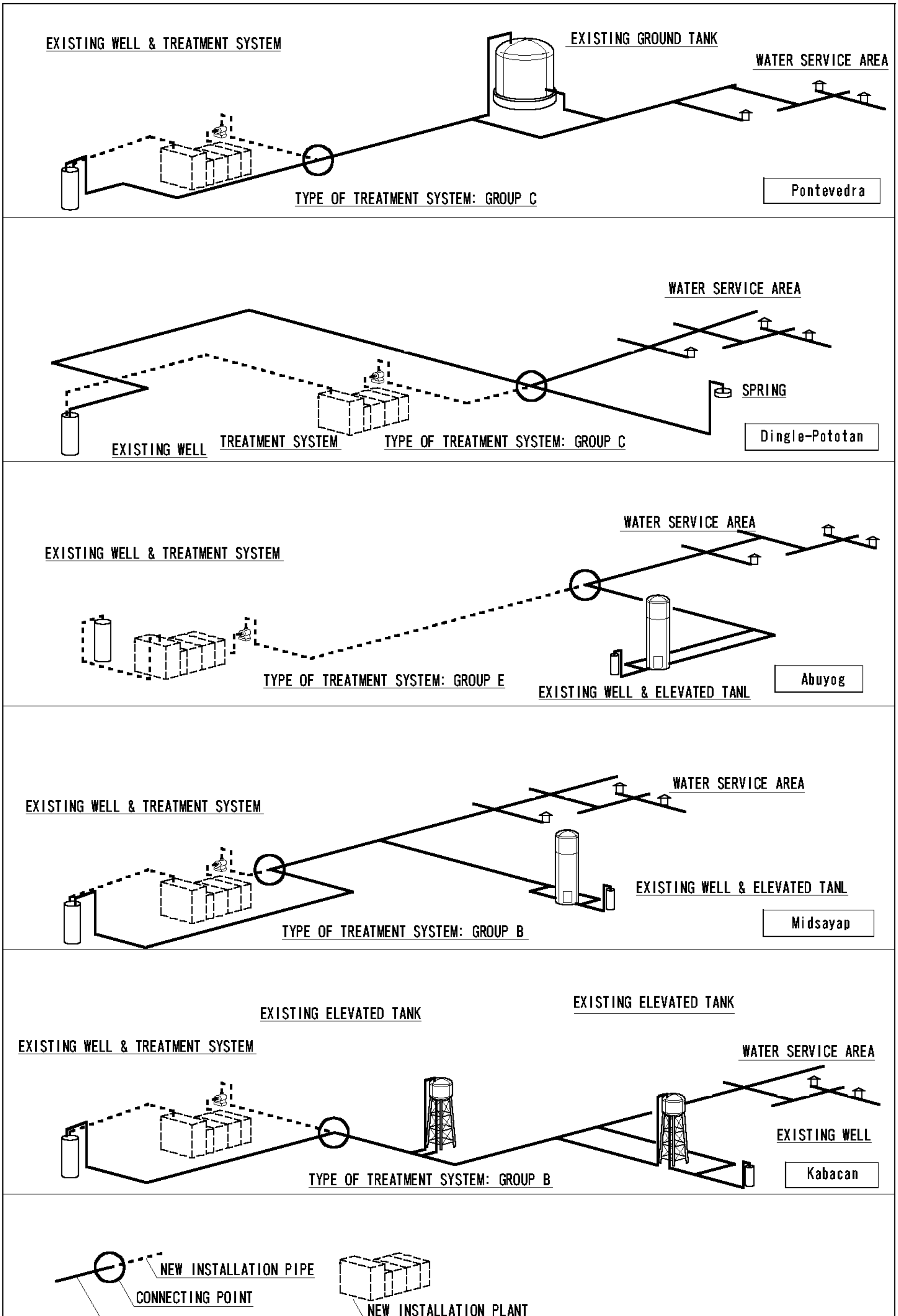

FIG. 2-3 SYSTEM TO BE CONSTRUCTED-②

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(4) Designed capacity

The designed capacity of water treatment facilities is based on the table below.

Table 2-12 Designed Capacity and Concept

	Intake Facility	Raw Water Transmission Facility	Water Treatment Facility		Water Transmission Facility	
	Borehole pump (m^3/d)	Pipe (m^3/d)	Facility (m^3/d)	Reservoir (m^3)	Pump (m^3/hr)	Pipe (m^3/hr)
Solana	1,296	1,296	1,296	540	95	95
Binmaley Caloocan	1,555	1,555	1,555	650	115	115
Binmaley Fabia	1,728	1,728	1,728	720	130	130
Lingayen	2,434	2,434	2,434	1020	180	180
Pagsanjan	1,097	1,097	1,097	460	80	80
Panitan	1,296	1,296	1,296	540	95	95
Pontevedra	2,708	2,708	2,708	1130	200	200
Dingle-Pototan	2,592	2,592	2,592	1080	190	190
Abuyog	2,539	2,539	2,539	1060	190	190
Midsayap	2,030	2,030	2,030	850	150	150
Kabacan	2,592	2,592	2,592	1080	190	190
Concept	Production of target well =Maximum daily water supply＋ Water for the operation of water treatment facility			8 hours-storage of Maximum daily water supply (also used as the distribution tank)	Maximum water supply rate per hour	

2-3-3 System Design

(1) Target well as water sources

All the target wells in 10WDs (11sites) to be treated under the Project are the existing ones constructed by each WD. The number of target wells is 11. Among these 11 wells, 9 wells are being in use in spite of water quality problem and the remaining 2 wells are abandoned due to bad water quality.

The characteristics of target wells under this Project have been evaluated based upon the results of existing pumping test, hydrogeological and engineering examination, and so forth. The characteristics of these wells are shown in the next page.

Many wells have high yield but have water quality problems. As shown in the results of water quality analysis, scale caused by the water quality is produced inside of the wells and pumps, which is an impediment of water intake. Therefore, well rehabilitation as brushing with chemical treatment needs to be carried out. At the detailed design of the Project, step pumping tests and constant discharge tests and so on, are carried out to obtain more detailed characteristics.

(2) Borehole pump

As is mentioned before, 2 wells out of 11 which had been abandoned without being equipped with pumps due to bad water quality need installation of new pumps. The other 9 wells continue the operation in spite of the inadequate water quality. Because these pumps have been transmitting raw water from the wells to the distribution pipelines directory, their discharge heads are very high and thus exhausted. The raw water transmission under the Project is from the wells to the water receiving points in the treatment facilities. The existing pumps are excessive in terms of discharge heads which cause ineffective consumption of electricity. Pumps must be replaced by the adequate ones considering the design of the treatment facilities.
Regarding pumps, many of WDs under the control of LWUA are using borehole

vertical pumps. However, for the ease of maintenance and the policy of LWUA, they are being replaced by the submersible pumps. This Project adopts submersible pumps. The specification was designed considering well structure and characteristics and conditions of delivery side.

Table 2-13 Characteristics of Target Well

No	Target WD	Pumping Station	Diam. (mm)	Depth (m)	Dynamic Water Level(m)	Static Water Level(m)	Pumping Rate (m3/d)	Note
1	Solana	Centeo	200	78	14.0	11.1	812	
		Basi	250	100	9.1	7.3	1296	
2	Binmaley	Caloocan	250	250	17.1	9.0	1555	
		Poblacion	150	120	14.2	6.8	342	×
		Nagpalangan	100	135	1.6	0.0	138	
		Naguilayan	125	117	15.2	8.5	173	×
		Camaley	100	129			173	×
		Gayaman	100	150	13.6	8.1	130	×
		Fabia	350	210	6.6	4.5	1728	
3	Lingayen	Tongton	200	183			891	×
		Libsong	250	250	15.4	3.3	2434	
		Baay	250	250			432	×
4	Pagsanjan	Binan	250	114	41.0	38.0	674	
		Sabang	250	62	14.5	3.6	1097	
		Sanjuan	250	77	18.0	11.2	1728	
		Lodge Spring**					1987	
5	Panitan	Phase2 Well	250	36	7.0	3.0	1296	
6	Pontevedra	Sublangon	250	47	10.0	7.0	2708	
		Hipona	125	9	10.0	8.0	864	
7	Dingle-Pototan	Morobo Spring**					640	
		Moroboro Spring**					1553	
		Abangai	250	40	14.0	7.0	2592	
8	Abuyog	Bito	200	84	21.0	0.0	864	×
		Barayong	250	83	25.8	0.3	2539	
		Canugive	200	60			130	×
9	Midsayap	Villiarica	250	56	12.0	7.0	2030	
		Kiwanan	100	35			124	×
		Kimagango	100	40			86	×
		Dilangalen	150	25			312	×
10	Kabacan	No.1 well	200	101	9.9	5.5	1233	
		No.2 well	300	100	10.6	3.0	2592	

×:Abandon by beginning the project. ** Water source is the spring. : Target well

(3) Raw water transmission facility

The raw water transmission facilities are pipeline facilities which conduct raw water pumped from the well by the submersible pump to water treatment facility. In the following 8 WDs (9 sites), this facility is located in the same ground of pump station house or near by.

- Solana WD Basi
- Binmaley WD Caloocan
- Lingayen WD Libsong
- Pagsanjan WD Sabang
- Panitan WD Phase 2
- Pontevedra WD Sublangon
- Abuyog WD Barayong
- Midsayap WD Villiarica
- Kabacan WD No.2 P.S.

Dingle-Pototan WD Abangai have about 1 km of raw water transmission pipelines and Binmaley WD Fabia have 200 m of raw water transmission pipelines because the land securing was impossible near the well.

(4) Water treatment facility

1) Study of treatment process by Jar Test and Filtration Test

The jar test and the filtration test were executed in 2nd Field Survey based on 1st Field Survey by which the water quality examination of target well was executed to decide the water treatment process. The jar test and the filtration test were designed corresponding to the object item of each site which is shown in the table “Target parameter of water treatment facilities.” The executed filtration test is shown in the next table “Outline of the processing examination according to the group.” The jar test and the filtration test were evaluated based on "Processing parameter and processing target value", and the treatment process in the planned facilities was examined.

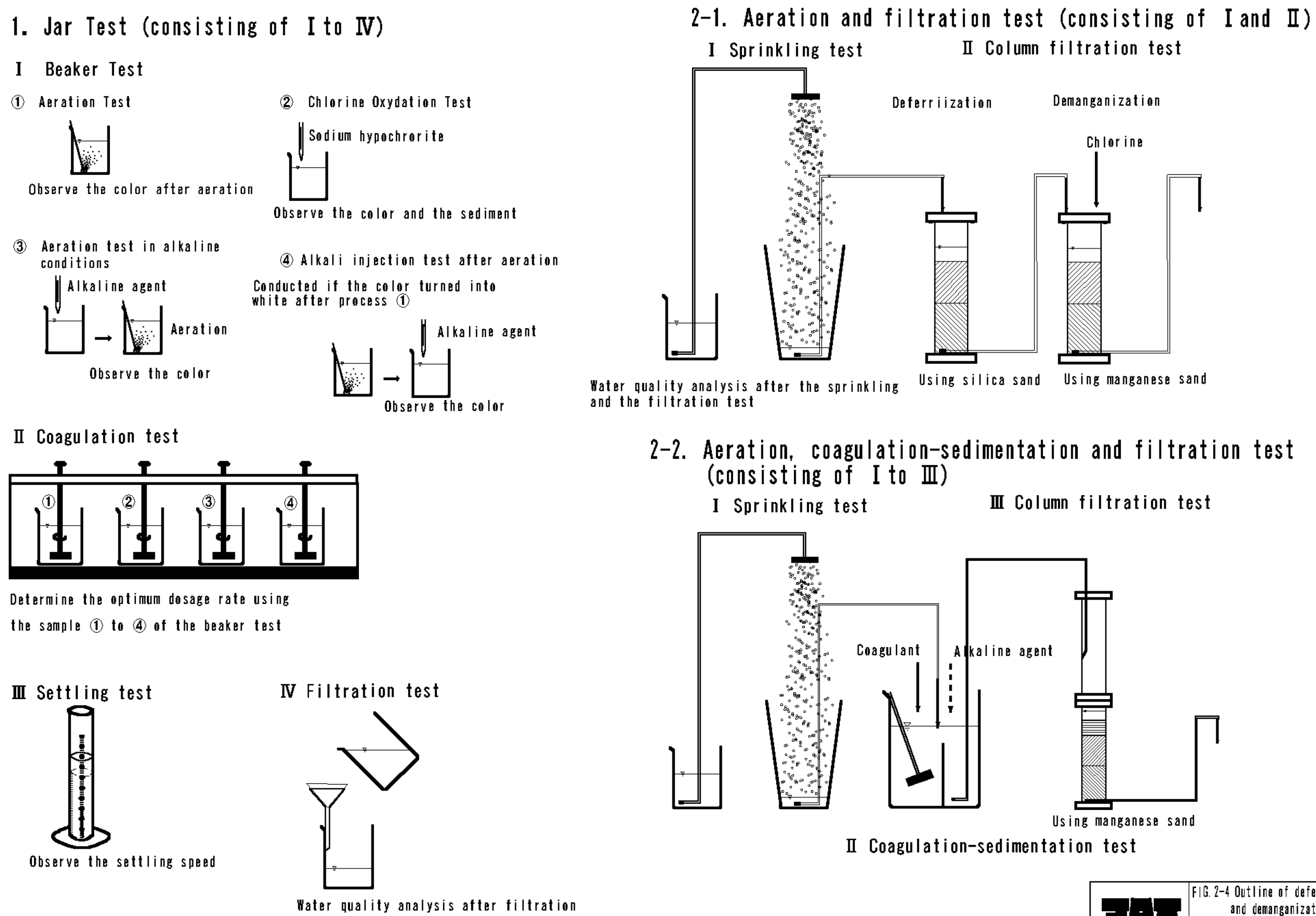

FIG. 2-4 Outline of deferrization and demanganization tests

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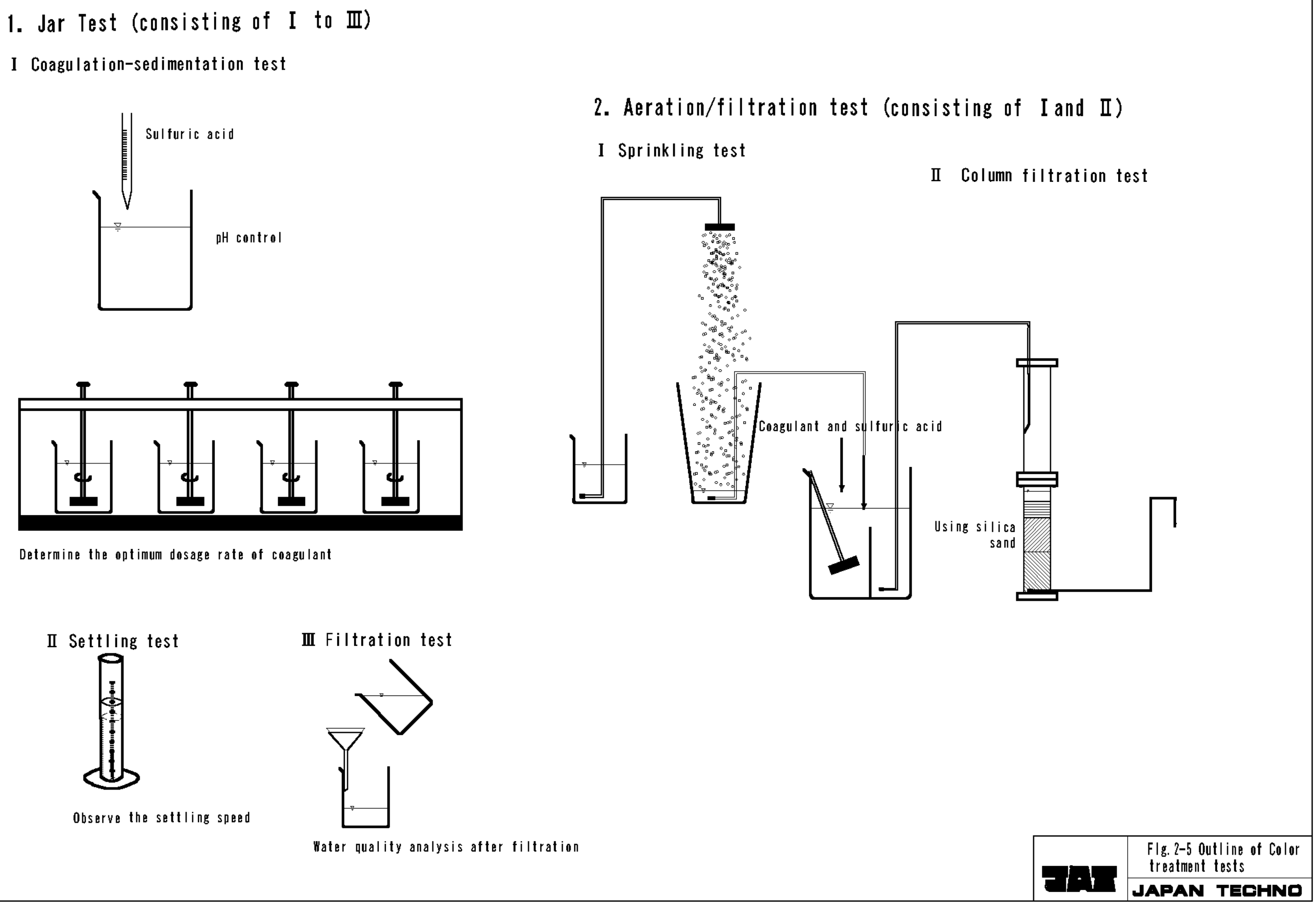

Fig. 2-5 Outline of Color treatment tests

Table 2-14 Outline of the processing examination according to the group

A	Aeration→Silica sand filtration(Iron Removal)
B	Aeration→ Silica sand filtration(Iron Removal)→Manganese sand filtration (Manganese Removal)
	Aeration→Coagulation-Sedimentation(Iron Removal)→Manganese sand filtration (Manganese Removal)
C	Aeration→Silica sand filtration(Iron Removal)→Chlorination (Ammonia Removal) →Manganese sand filtration(Manganese Removal)
	Aeration→ Coagulation-Sedimentation(Iron Removal)→Chlorination (Ammonia Removal) →Manganese sand filtration(Manganese Removal)
C'	Aeration→pH control→Coagulation-Sedimentation(Iron Removal)→ Chlorination (Ammonia Removal) →Manganese sand filtration(Manganese Removal)
D	Aeration→pH control→Coagulation-Sedimentation(Color Removal) →Silica sand filtration(Color Removal)
E	Aeration→ Coagulation-Sedimentation(Iron Removal/Color Removal) →Chlorination(Ammonia Removal) →Manganese sand filtration(Manganese Removal)

*Refer to attached material (jar test and column test result) for the filtration test result.

For Groups B and C, two iron removal processes using silica sand filtering and coagulating sedimentation were conducted. For Groups B, C, C', D and E, manganese removal was conducted by adding a given amount of chlorine to the treated water and filtering the water through manganese sand after the iron removal process. (For Groups C, C' and E, the raw water contained ammonia, so that the amount of chlorine required by the ammonia content was added.)

2) Water treatment process

The water treatment systems in accordance with the target parameters of each 10WD（11 sites） based on the results of the filtration test are shown in the following pages.

① Aeration tower（Target Sites：A・B・C・C'・D・E）

The boreholes to be subject to anti-iron treatment contained 1 to 9mg/L of iron. The ferrous hydroxide that was contained in borehole water was oxidized and changed into ferric hydroxide. The primary iron has a higher solubility to be

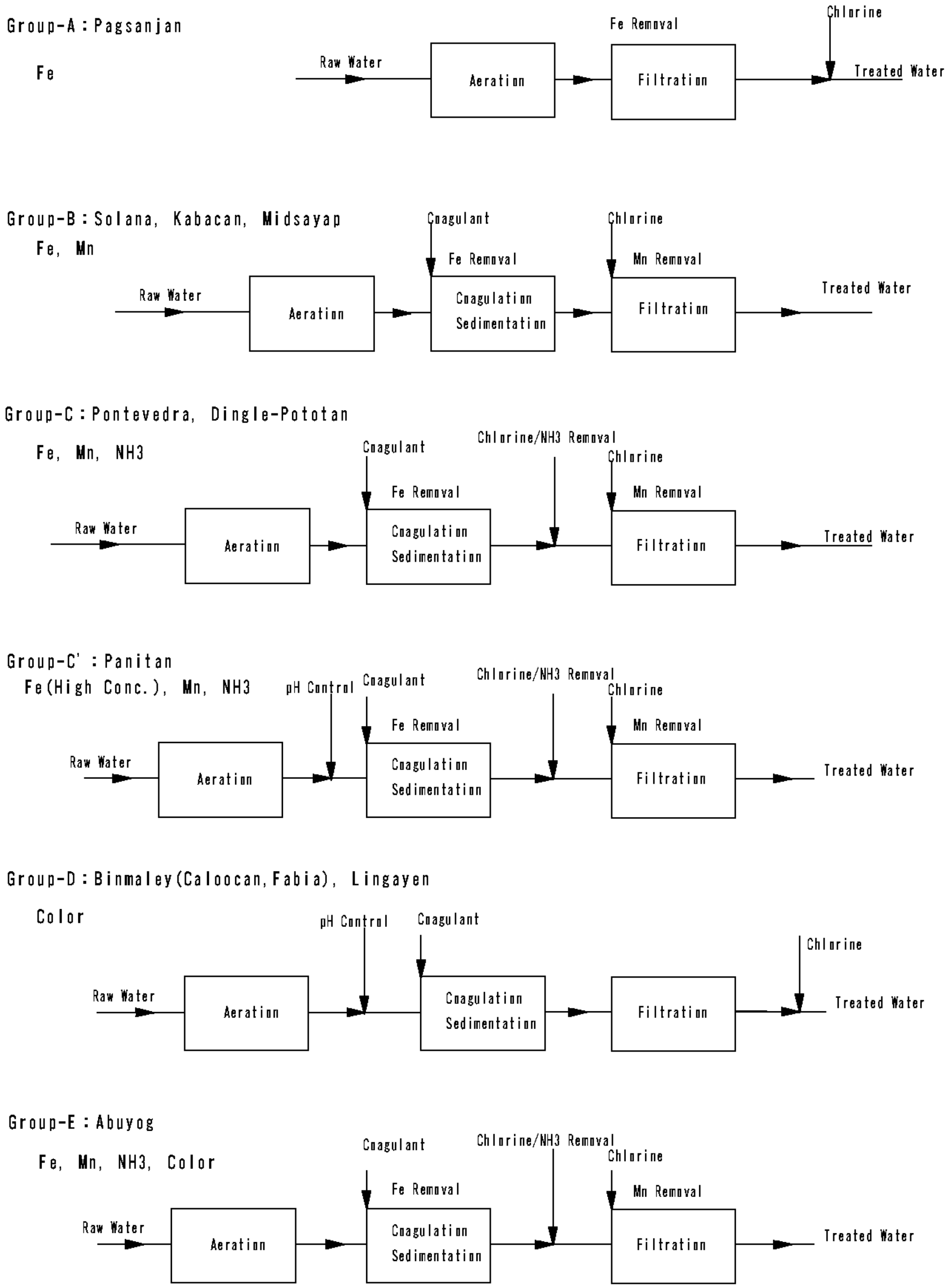

FIG. 2-6 FLOW DIAGRAM

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dissolved in water while the secondary iron has a lower solubility to be sedemented. In the boreholes not to be subject to anti-iron treatment, but to chromaticity treatment, about 0.2mg/L of sulfide was contained and the hydrogen sulfide odor exceeded the threshold value. The aeration operation gave a noticeable deodorization effect.

② Mixing Basin（Target sites：B・C・C'・D・E）

A. pH control（Target sites：C'・D）

The borehole raw water of Group D to be subject to chromaticity treatment (Caloocan of Binmaley, Fabia and Lingayen) contained a humic organic substance as a coloring components. The treatment is conducted by coagulating sedimentation, but pH control is made in order to perform the coagulating treatment using sulfuric acid in the optimum pH domain (pH: 5.8 to 6.0) for faster sedimentation of humic substance and for higher coagulation.

For the boreholes of Group C' (Panitan), the treatment combining aeration and filtering was made in the filtration test, and some residue that exceeded the iron standard value (1.0mg/L in the water quality criteria of the Philippines) was found. The pH value of the raw water was 6.6 and the pH value after aeration was 7.0. The rise of pH was suppressed more only by aeration compared with those at other sites. As described above, the project sites were deemed to be subject only to the impact of silicic acid (87mg/L was contained in raw water). In addition, the problem in the successive treatment was solved by adding hydrate lime to bring the water into the alkali domain (pH: about 8.5).

B. Coagulant（Target sites：B・C・C'・D・E）

The sedimentary iron oxide and the coloring components are coagulated. As the coagulant, aluminum sulfate is used to realize the charged neutralization of the surface of sedimentary particles suspending in colloidal state.

③ Flocculation basin（Target sites：B・C・C'・D・E）

When the charge of the sedimentary particles is neutralized, the repulsive power working between the particles is lost and flocks of particles are formed. To facilitate the formation of flocks, the upper and lower loop flow walls are provided in the basin without any driving device. The loop flow plates are installed in the basin with the wide interval to ensure that the loss of the loop flow from the upper to the lower stream is reduced.

④ Sedimentation basin（Target sites：B・C・C'・D・E）

The mixing basin and the coagulation basin are the facilities provided to perform the sedimentation treatment. These facilities will be installed at sites of Group B (Solana, Kabacan and Midsayap), Group C (Pontevedra, Dingle-Pototan), Group C', Group D and Group E (Abuyog) in the project. This sedimentation operation is aimed at precipitating and separating the flocks generated by iron removal and coloring components.

In the project, trihalomethan was not the item of survey, and the result of measurement of trihalomethan formation ability had no problem. If a filtering basin for removal of manganese is provided in the successive process, a given amount of chlorine is injected at the inlet of the filtering basin for manganese treatment. (The manganese treatment will be handled in the next section of filtration basin.) In the project sites located in the coastal zones, there is a fear of generation of promethium-trihalomethan by chlorine feeding. Therefore, it was decided that the sedimentation operation would apply to the process of iron removal followed by manganese treatment.

In the project sites for chromaticity test, it was foreseen that the sedimentation treatment would be required because the coloring components were humin organic substances. However, the significant of that treatment was confirmed based on the result of measurement of trihalomethan formation ability. On the basis of above reason, the water quality monitoring by the LWUA side in terms of trihalomethan will be described in the Chapter 4 Project Evaluation and Recommendation.

⑤ Filtration basin

In Group A, the iron oxide precipitated in the aeration basin in the previous state will be removed and the filter layer will be composed of silica sand.

In Group B, the flocks carried over in the coagulation and sedimentation processes will be removed and the filter layer will be composed of silica sand.

In Groups C, C', D and E, the content of manganese is high, so that the contact oxidation of manganese sand and manganese removal will be conducted while the iron carried over from the previous stage is removed. Namely, a required amount of free chlorine is added and the water containing manganese is flowed through the manganese sand. The manganese is oxidized promptly by chlorine by means of the manganese sand as catalyzer. The manganese is chemically combined with the manganese sand put in initially and the surface of the silica sand that is produced in Philippines added later. The required amount of free chlorine is 1.29 times higher than the concentration of the manganese solution.

The chlorine feeding is performed before the filtering process, but the required amount of chlorine for ammonia should be added because the Groups C, C' and E contain ammonia. (Refer to the table: Target Wells/Results of Water Quality Analysis)

3) Design of Water treatment facility

In addition to the above-mentioned facilities for treatment processes, the design sheets for the facilities at 11 sites of 10 WDs including treated water reservoirs, backwash water basins and sludge drying beds as water treatment facilities were prepared on the basis of the functions and design specifications as described below.

① Aeration Tower

The iron hydroxide contained in the raw water will be oxidized and treated in a state so easy to capture in the successive sedimentation basin and filtering basin. The sulfide that may cause hydrogen sulfide odor will also be removed.

The volume of treated water will be the production volume of each borehole, which will be treated by two aeration towers per borehole.
The aeration will employ the sprinkler method. It has also been decided that the area per unit volume of raw water and unit time (water area load of $0.4m^2/m^3/hr$) and 3m water head will be set in order to enhance the air-liquid contact efficiency.

② Mixing, coagulation and sedimentation basins

The mixing, coagulation and sedimentation basins will be configured as a single combined structure, in which the iron hydroxide or the chromaticity components are coagulated and separated. The treated water volume will be the sum of the production volume of each borehole and the recycled water volume because the backwash water as recycled water is reused after aeration. One mixing basin, one coagulation basin and two sedimentation basins will be installed.

The residence time in the mixing basin will be set to 1.5 minutes.

The residence time in the coagulation basin will be set to 30 minutes and non-driven slow stirring will be made by means of the upper and lower loop-flow walls. The interval between the loop-flow walls will be varied from the upper stream to the lower stream taking the stirring strength into account, so that the GT value will be about 50,000 as a whole.

The sedimentation basin is of lateral flow type. In determining its water area load (water works facilities design criteria of Japan =15 to 30mm/min), the water quality in the borehole in each site and the constant temperature of the raw water have been taken into account. The water area load of 30mm/min. and the residence time of about 2 hours have been adopted based on the sedimentation velocity of flocks as observed in jar tests.

③ Chemical Feeding Facility

i) Pretreatment of coagulation (pH control)

In Group C’, hydrate lime (wet feeding 10%) will be added as the pretreatment of the iron removal process. The feeding rate is set to 66mg/L in average as the result of the jar test and filtration test in which the pH value of about 8.5 has been the optimum in the iron removal process.

In Group D, sulfuric acid (35% dilute sulfuric acid) will be added as the pretreatment of the chromaticity component coagulation process. The feeding rate is set to 100mg/L in average as the result of the jar test and filtration test in which the pH value of about 5.8 has been the optimum in any coagulation process.

ii) Coagulant (aluminum sulfate) feeding facility

In Groups B, C, C’, D and E, aluminum sulfate (8% aluminum sulfate liquid with the specific gravity of 1.32) will be added as the coagulant. The list of feeding rates of the project sites as obtained from jar tests is shown in the next Table.

Table 2-15 Aluminum sulfate feeding rate

(mg/L)

Target Sites	Average feeding rates
Solana	20
Binmaley Caloocan	20
Binmaley Fabia	40
Lingayen	45
Panitan	20
Pontevedra	20
Dingle-Pototan	20
Abuyog	20
Midsayap	20
Kabacan	20

iii) Alkali agent (pH control) feeding facility

In the treatment process in Group D, the pH value is reduced to about 5.8.

Hydrate lime (wet feeding 10%) will be added after the filtering treatment in order that the treated water may meet the drinking water quality criteria (pH value of 6.5 to 8.5). The average feeding rates are shown in the next Table.

Table 2-16 Hydrate lime feeding rate

(mg/L)

Target Site	Average feeding rates
Binmaley Caloocan	17
Binmaley Fabia	17
Lingayen	28

iv) Chlorine feeding facility

In Group B, chlorine will be injected for removal of manganese. The injection point will be provided before the inflow into the filtering basin after the iron removal process. A theoretical value is adopted as the feeding rate, which is 1.29 times higher than the manganese content in the raw water. The list of feeding rates is shown in the next Table.

Table 2-17 Chlorine feeding rate

(mg/L)

Target Site	Manganese concentration	Average feeding rates
Solana	1.20	1.5
Midsayap	0.97	1.3
Kabacan	1.90	2.5

In Groups C, C' and E, chlorine will be injected to remove manganese and ammonia. The feeding point will be provided at the inflow point of the filtering basin after the iron removal process. A theoretical value of feeding rate is adopted, which is equal to the sum of 1.29 times higher than the manganese content and 7.6 times higher than the ammonia content in the raw water. The list of feeding rates is shown in the next Table.

Table 2-18 Chlorine feeding rate

(mg/L)

Target Site	Manganese concentration	Ammonia concentration	Average feeding rates
Panitan	1.20	5.91	46.5
Pontevedra	0.96	0.45	4.7
Dingle-Pototan	0.68	4.03	31.5
Abuyog	1.90	7.24	57.5

At all the sites in Groups A, B, C, C', D and E, chlorine will be injected for disinfection. The injection point will be provided at the outflow point of the filtering basin. The feeding rate is set to 0.2~0.5 mg/L as residual chlorine.

④ Filtration basins

At all the sites in Groups A, B, C, C', D and E, two filtration basins per site will be provided and the filtering velocity of 150m/d is adopted in accordance with the water works facilities design criteria of Japan.

Silica sand (effective diameter: 0.6mm; filter layer thickness: 600mm) in Groups A and D and manganese sand (effective diameter: 0.6mm; filter layer thickness: 600mm) in Groups B, C, C' and E will be adopted as the filter media. However, the filter layer thickness at the start of operation will be 300mm of manganese sand and 300mm of silica sand because the manganese sand is proliferated by its self-catalysis in the process of manganese removal.

The filter layers in the filtering basins will be washed once a day at all the sites of Groups A, B, C, C', D and E. Surface wash and backwash will be conducted with clear water. The velocities of surface wash are 0.2m/min at all sites and the velocities of backwash are 0.6-0.7m/min.

⑤ Treated water reservoir

As the result of review of the cumulative curve of distribution water volumes in each planned WD, it was found that the clear water would be required to be in storage for about 8 hours. The distribution basins are not included in the project. In taking into consideration that each WD has no clear water storage system with the function of a distribution basin, a clear water basin (also used as a distribution basin) capable of 8-hour storage of the maximum daily supply will be installed in each WD.

⑥ Sludge and drainage treatment

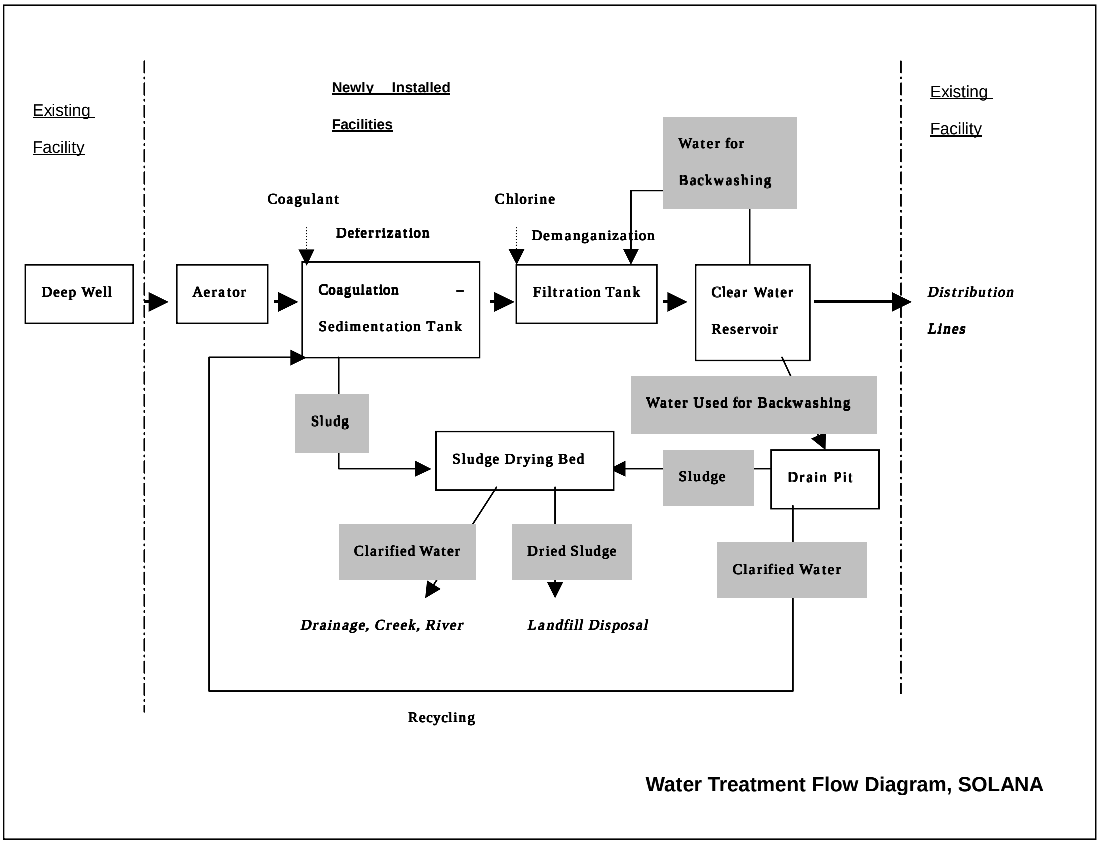
The backwash drainage used for washing the filter materials will be temporarily stored in the backwash water basin. The sludge during drainage will be precipitated at its high concentration. The supernatant will be returned to the coagulation and sedimentation basins for reuse. These basins will be equipped with a recovery pump for drainage recycling and the recycle rate will be about 10% of the inflow water volume in the system. This enables to minimize the drainage volume discharged to the external and conserve water resources.

Subsequently, the sludge precipitated at a high concentration will be sent out to the drying bed and dried under the sun with the sludge discharged from the sedimentation basin. The discharged sludge is deemed to have 0.5% ($5kg/m^3$) of concentration. The required bed area has been studied by considering the quantities of the chemicals used in the treatment processes and calculating the material balance within the treatment system. Finally, dewatering cakes and the supernatant will be discharged respectively from the sludge drying process.

The dewatering cakes contain the components removed in the water treatment processes as well as the coagulant, and their compositions are different site by site. At the sites in Group A where iron removal is performed by filtration, the iron hydroxide is contained. In the Groups B, C and E where iron removal is performed by the coagulation and sedimentation, the iron hydroxide and aluminum hydroxide are contained. In the Group C' where the iron removal is performed by the pH control using hydrate lime, the iron hydroxide, sulfate calcium and aluminum hydroxide are contained. The coloring components such as humic substances are contained in the cakes in Group D where decolorization is performed. These dewatering cakes will be filled in a solid waste disposal site in the neighborhood of each site.

On the other hand, components of the supernatant may contain the treated water in which iron, manganese and coloring components are removed from the raw water, and also small quantities of the residual of coagulant added in the treatment processes and sludge components that are not concentrated in the dewatering cakes. The supernatant will be discharged into nearby sewerage, creeks or rivers.

Figure. 2-7 Water Treatment Flow Diagram, Solana



The dewatering cakes and the components of the supernatant don't exert a bad influence on the environment.

(5) Water transmission facilities

① Distribution pumps

In the existing water supply systems at 10 target WDs (11 sites), the ground water taken up from a well by borehole pump has been distributed directly to the supply pipelines only after chlorination. This causes variable pressures according to the usage condition of the water supply systems, and the pumps are likely to be damaged by the back pressures.

By the construction of the water treatment facilities, the direct water distribution by borehole pump will be abolished. Regarding borehole pumps, as mentioned before, pumps which are relevant to transmission of water to treatment facilities exclusively are utilized. Therefore, the installation of a distributing pump is required in every site. The examine about the water hammer in each site was executed.

② Pipeline facility

The objective of these water transmission facilities is to transmit treated water to the existing distribution pipelines. The wells that have been abandoned without installing pumps and pipelines due to the water quality problems became the target of this Project, and the lands for water treatment facilities have been obtained. A distance of 2 km is allowed from water treatment facilities to a water supply area. And thus, the installation of new transmission pipelines to the existing distribution pipelines is required in Abuyog WD, Barayong well in the Leyte Island.

Description of Facility Design

Site: SOLANA

Planned water volume: 1296 m^3/d

Target parameters to be improved: (iron and manganese)

Facility	Component	Specification	No.	Factors to specify	Remarks
Water Source	Existing Borehole	250m/mφ(Diameter), 100m(Depth)			Rehabilitation
Raw Water Intake Facility	Water Intake Facility	Submersible pump 0.9m^3/min (Pumping capacity) ×33m (Pumping head), 11kw(Power)	2	Max. daily capacity of water supply + Water used within the facilities	One for stand-by
Water Treatment Facilities	Aeration Tower	RC, Nozzle sprinkling method Area: 22m^2, Capacity 65m^3 (Total of two)	2	Max. daily capacity of water supply + Water used within the facilities Overflow rate: 0.4m^2/m^3/hr, Head: 3m	
	Mixing Basin of Aluminum Sulfate	RC Area: 1.4m^2, Capacity: 2.2m^3 Vertical submersible mixer, Paddle (500m/mφ, 0.75kw)	1	Max. daily capacity of water supply + Water used within the facilities + Recycled water Retention time: 1.5min	
	Flocculation Basin	RC, Vertical baffling type Area: 15m^2, Capacity: 30m^3 Vertical slow baffling type, GT value: 50000	1	Max. daily capacity of water supply + Water used within the facilities + Recycled water Retention time: 30min	
	Sedimentation Basin	RC, Horizontal-flow sedimentation basin, Area 33m^2, Capacity 99m^3 (total of two)	2	Max. daily capacity of water supply + Water used within the facilities + Recycled water Overflow rate: 30mm/min, Effective depth: 3 m	
	Filtration Basin	RC, Gravity rapid filter Area: 9.6m^2 (total of two) Media: silica sand, manganese sand	2	Max. daily capacity of water supply + Water used within the facilities + Recycled water Filtration rate: 150m/d	
	Treated Water Reservoir	RC, Capacity: 540m^3 (total of two)	2	Max. daily water supply for 8 hrs.	
		Backwashing pump (submersible pump) 3.4m^3/min (Pumping capacity)×10m (total pumping head), 11kw (power)	1	Backwashed water: 0.64m/min×Area of one basin (m^2)	
		Surface washing pump (submersible pump) 1.1m^3/min (Pumping capacity)×30m (pumping head), 11kw(power)	1	Surface washed water: 0.20m/min×Area of one basin (m^2)	
	Drainage Basin	RC, Capacity: 27m^3	1	Surface washed water per basin	
		Recycling pump (submersible pump) 0.08m^3/min(Pumping capacity) ×10m (pumping head), 0.4kw (power)	1	Recycled water/(daily max. water supply + Water used within the facilities): 10%	
		Sludge pump (submersible pump) 0.1m^3/min (Pumping capacity)×8m (pumping head), 0.75kw (power)	1	Backwashed water + Surface washed water − Recycled water	
	Sludge Drying Bed	RC, Capacity: 2.8m^3	4	Daily vol. of sedimentation sludge Retention time: 3days	
		Drainage pump (submersible pump) 0.08m3/min (Pumping capacity)×10m (pumping head), 0.4kw (power)	1	Concentration of sedimentation sludge: 0.5%	
	Chemical Feeding Chamber	Aluminum sulfate storage basin, Capacity: 4.7m^3	1	Retention time: 7days	
		Diaphragm pump: 0.2L/min (Maximum flow), 0.2kw (power)	2	Injection rate	One for stand-by
	Chlorine Feeding Chamber	Direct connection type (68kg cylinder)	1	Residue of free chlorine: 0.2-0.5mg/L	
Water Transmission Facilities	Water Transmission Facilities	Submersible pump 1.6m3/min (Pumping capacity)×50m (pumping head), 30kw(power)	2	Max. hourly water supply	
		Pressure tank Max. pressure: 6kgf/cm^{2}, Min. pressure: 4kgf/cm^2	1		

Description of Facility Design

Site: BINMALEY_Caloocan

Planned water volume: 1555 m^3/d

Target parameters to be improved: (Color)

Facility	Component	Specification	No.	Factors to specify	Remarks
Water Source	Existing Borehole	250m/mφ(Diameter), 250m (Depth)			Rehabilitation
Raw Water Intake Facility	Water Intake Facility	Submersible pump 1.08m3/min (Pumping capacity) ×41m (Pumping head), 15kw(Power)	2	Max. daily capacity of water supply + Water used within the facilities	One for stand-by
Water Treatment Facilities	Aeration Tower	RC, Nozzle sprinkling method Area: 26㎡, Capacity: 78m^3 (Total of two)	2	Max. daily capacity of water supply + Water used within the facilities Overflow rate: 0.4㎡/m3/hr, Head: 3m	
	Mixing Basin of Sulfuric Acid	RC, Area: 1.4㎡, Capacity: 2.2m^3 Vertical submersible mixer, Paddle (500m/mφ, 0.75kw)	1	Max. daily capacity of water supply + Water used within the facilities + Recycled water Retention time: 1.5min	
	Mixing Basin of Aluminum Sulfate	RC Area: 1.4㎡, Capacity: 2.2m^3 Vertical submersible mixer Paddle (500m/mφ, 0.75kw)	1	Max. daily capacity of water supply + Water used within the facilities + Recycled water Retention time: 1.5min	
	Flocculation Basin	RC, Vertical baffling type Area: 18㎡, Capacity: 36m^3 Vertical slow baffling type, GT value: 50000	1	Max. daily capacity of water supply + Water used within the facilities + Recycled water Retention time: 30min	
	Sedimentation Basin	RC, Horizontal-flow sedimentation basin, Area 40㎡, Capacity 120m^3 (total of two)	2	Max. daily capacity of water supply + Water used within the facilities + Recycled water Overflow rate: 30mm/min, Effective depth: 3m	
	Filtration Basin	RC, Gravity rapid filter Area: 11.4㎡ (total of two) Media: silica sand	2	Max. daily capacity of water supply + Water used within the facilities + Recycled water Filtration rate: 150m/d	
	Treated Water Reservoir	RC, Capacity: 650m^3 (total of two)	2	Max. daily water supply for 8 hrs.	
		Backwashing pump (submersible pump) 4.2m^3/min (Pumping capacity)×10m (total pumping head), 15kw (power)	1	Backwashed water: 0.64m/min×Area of one basin (㎡)	
		Surface washing pump (submersible pump) 1.2m^3/min (Pumping capacity)× 30m(pumping head), 11kw(power)	1	Surface washed water: 0.20m/min×Area of one basin (㎡)	
	Drainage Basin	RC, Capacity: 43m^3	1	Surface washed water per basin	
		Recycling pump (submersible pump) 0.12m^3/min(Pumping capacity) ×10m (pumping head) 0.4kw (power)	1	Recycled water/(daily max. water supply + Water used within the facilities): 10%	
		Sludge pump (submersible pump) 0.1m^3/min (Pumping capacity)×8m (pumping head) 0.75kw (power)	1	Backwashed water + Surface washed water - Recycled water	
	Sludge Drying Bed	RC, Capacity: 1.5m^3	4	Daily vol. of sedimentation sludge Retention time: 3days	
		Drainage pump (submersible pump) 0.08m^3/min (Pumping capacity)×10m (pumping head) 0.4kw (power)	1	Concentration of sedimentation sludge: 0.5%	
	Chemical Feeding Chamber	Dilute sulfuric acid storage basin, Capacity: 2.5㎡	1	Retention time: 7days	
		Diaphragm pump: 0.5L/min (Max. flow), 0.2kW (power)	2	Injection rate	One for stand-by
		Aluminum sulfate storage basin, Capacity: 5.7m^3	1	Retention time: 7days	
		Diaphragm pump: 0.2L/min (Maximum flow), 0.2kw (power)	2	Injection rate	One for stand-by
		Hydrated lime dissolving basin, Hydrated lime storage basin	1 1	Retention time: 7days	
		Diaphragm pump: 0.02L/min (Max. flow), 0.2kW (power)	2	Injection rate	One for stand-by
	Chlorine Feeding Chamber	Direct connection type (68kg cylinder)	1	Residue of free chlorine: 0.2-0.5mg/L	
Water Transmission Facilities	Water Transmission Facilities	Submersible pump 1.9m^3/min (Pumping capacity)×50m (pumping head), 30kw(power)	2	Max. hourly water supply	
		Pressure tank Max. pressure: 6kgf/c㎡, Min. pressure: 4kgf/c㎡	1		

Description of Facility Design

Site: BINMALEY_Fabia

Planned water volume: 1728 m^3/d

Target parameters to be improved: (Color)

Facility	Component	Specification	No.	Factors to specify	Remarks
Water Source	Existing Borehole	350m/mφ(Diameter), 210m (Depth)			Rehabilitation
Raw Water Intake Facility	Water Intake Facility	Submersible pump 1.20m^3/min (Pumping capacity) ×32m (Pumping head), 11kw(Power)	2	Max. daily capacity of water supply + Water used within the facilities	One for stand-by
Water Treatment Facilities	Aeration Tower	RC, Nozzle sprinkling method Area: 29㎡, Volume: 86m3 (Total of two)	2	Max. daily capacity of water supply + Water used within the facilities Overflow rate: 0.4㎥/m3/hr, Head: 3m	
	Mixing Basin of Sulfuric Acid	RC, Area: 1.4m^2, Volume: 2.2m^3 Vertical submersible mixer, Paddle (500m/mφ, 0.75kw)	1	Max. daily capacity of water supply + Water used within the facilities + Recycled water Retention time: 1.5min	
	Mixing Basin of Alminum Sulfate	RC Area: 1.4m^2, Volume: 2.2m^3 Vertical submersible mixer Paddle (500m/mφ, 0.75kw)	1	Max. daily capacity of water supply + Water used within the facilities + Recycled water Retention time: 1.5min	
	Flocculation Basin	RC, Vertical baffling type Area: 20m^2, Volume: 40m^3 Vertical slow baffling type GT value: 50000	1	Max. daily capacity of water supply + Water used within the facilities + Recycled water Retention time: 30min	
	Sedimentation Basin	RC, Horizontal-flow sedimentation basin, Area 44m^2, Volume 132m^3 (total of two)	2	Max. daily capacity of water supply + Water used within the facilities + Recycled water Overflow rate: 30mm/min, Effective depth: 3m	
	Filtration Basin	RC, Gravity rapid filter Area: 12.6m^2 (total of two) Media: silica sand, manganese sand	2	Max. daily capacity of water supply + Water used within the facilities + Recycled water Filtration rate: 150m/d	
	Treated Water Reservoir	RC, Volume: 720m^3 (total of two)	2	Max. daily water supply for 8 hrs.	
		Backwashing pump (submersible pump) 4.9m^3/min (Pumping capacity)×10m (total pumping head) 15kw (power)	1	Backwashed water: 0.64m/min×Area of one basin (m^2)	
		Surface washing pump (submersible pump) 1.4m^3/min (Pumping capacity)× 30m(pumping head) 11kw(power)	1	Surface washed water: 0.20m/min× Area of one basin (m^2)	
	Drainage Basin	RC, Capacity: 43m3	1	Surface washed water per basin	
		Recycling pump (submersible pump) 0.12m3/min(Pumping capacity) ×10m (pumping head) 0.4kw (power)	1	Recycled water/(daily max. water supply + Water used within the facilities): 10%	
		Sludge pump (submersible pump) 0.1m3/min (Pumping capacity)×8m (pumping head) 0.75kw (power)	1	Backwashed water + Surface washed water - Recycled water	
	Sludge Drying Bed	RC, Capacity: 3.4m^3	4	Daily vol. of sedimentation sludge Retention time: 3days	
		Drainage pump (submersible pump) 0.08m3/min (Pumping capacity)×10m (pumping head) 0.4kw (power)	1	Concentration of sedimentation sludge: 0.5%	
	Chemical Feeding Chamber	Dilute sulfuric acid storage basin, Capacity: 2.8m^2	1	Retention time: 7days	
		Diaphragm pump: 0.6L/min (Max. flow), 0.2kW (power)	2	Injection rate	One for stand-by
		Aluminum sulfate storage basin, Capacity: 6.3m^3	1	Retention time: 7days	
		Diaphragm pump: 1.4L/min (Maximum flow), 0.2kw (power)	2	Injection rate	One for stand-by
		Hydrated lime dissolving basin, Hydrated lime storage basin	1 1	Retention time: 7days	
		Diaphragm pump: 0.02L/min (Max. flow), 0.2kW (power)	2	Injection rate	One for stand-by
	Chlorine Feeding Chamber	Direct connection type (68kg cylinder)	1	Residue of free chlorine: 0.2-0.5mg/L	
Water Transmission Facilities	Water Transmission Facilities	Submersible pump 2.1m^3/min (Pumping capacity)×50m (pumping head), 30kw(power)	2	Max. hourly water supply	
		Pressure tank Max. pressure: 6kgf/$cm^{2,}$ Min. pressure: 4kgf/cm^2	1		

Description of Facility Design

Site: LINGAYEN

Planned water volume: 2434 m^3/d

Target parameters to be improved: (Color)

Facility	Component	Specification	No.	Factors to specify	Remarks
Water Source	Existing Borehole	250m/mφ(Diameter), 250m (Depth)			Rehabilitation
Raw Water Intake Facility	Water Intake Facility	Submersible pump 1.69m^3/min (Pumping capacity) ×39m (Pumping head), 18.5kw(Power)	2	Max. daily capacity of water supply + Water used within the facilities	One for stand-by
Water Treatment Facilities	Aeration Tower	RC, Nozzle sprinkling method Area: 41m^2, Volume: 122m^3 (Total of two)	2	Max. daily capacity of water supply + Water used within the facilities Overflow rate: 0.4m^2/m^3/hr, Head: 3m	
	Mixing Basin of Sulfuric Acid	RC, Area: 1.4m^2, Volume: 2.2m^3 Vertical submersible mixer, Paddle (500m/mφ, 0.75kw)	1	Max. daily capacity of water supply + Water used within the facilities + Recycled water Retention time: 1.5min	
	Mixing Basin of Aluminum Sulfate	RC, Area: 1.4m^2, Volume: 2.2m^3 Vertical submersible mixer Paddle (500m/mφ, 0.75kw)	1	Max. daily capacity of water supply + Water used within the facilities + Recycled water Retention time: 1.5min	
	Flocculation Basin	RC, Vertical baffling type Area: 29m^2, Volume: 57m^3 Vertical slow baffling type GT value: 50000	1	Max. daily capacity of water supply + Water used within the facilities + Recycled water Retention time: 30min	
	Sedimentation Basin	RC, Horizontal-flow sedimentation basin, Area 62m^2, Volume 186m^3 (total of two)	2	Max. daily capacity of water supply + Water used within the facilities + Recycled water Overflow rate: 30mm/min, Effective depth: 3m	
	Filtration Basin	RC, Gravity rapid filter, Area: 17.8m^2 (total of two) Media: silica sand	2	Max. daily capacity of water supply + Water used within the facilities + Recycled water Filtration rate: 150m/d	
	Treated Water Reservoir	RC, Volume: 1020m^3 (total of two)	2	Max. daily water supply for 8 hrs.	
		Backwashing pump (submersible pump) 7.0m3/min (Pumping capacity)×10m (total pumping head) 30kw (power)	1	Backwashed water: 0.64m/min×Area of one basin (m^2)	
		Surface washing pump (submersible pump) 2.0m3/min (Pumping capacity)×30m(pumping head) 15kw(power)	1	Surface washed water: 0.20m/min× Area of one basin (m^2)	
	Drainage Basin	RC, Capacity: 61m3	1	Surface washed water per basin	
		Recycling pump (submersible pump) 0.17m3/min(Pumping capacity) ×10m (pumping head) 0.75kw (power)	1	Recycled water/(daily max. water supply + Water used within the facilities): 10%	
		Sludge pump (submersible pump) 0.1m3/min (Pumping capacity)×8m (pumping head) 0.75kw (power)	1	Backwashed water + Surface washed water - Recycled water	
	Sludge Drying Bed	RC, Capacity: 5.3m3	4	Daily vol. of sedimentation sludge Retention time: 3days	
		Drainage pump (submersible pump) 0.16m3/min (Pumping capacity)×10m (pumping head) 0.75kw (power)	1	Concentration of sedimentation sludge: 0.5%	
	Chemical Feeding Chamber	Dilute sulfuric acid storage basin, Capacity: 4.0m^2	1	Retention time: 7days	
		Diaphragm pump: 0.8L/min (Max. flow), 0.2kW (power)	2	Injection rate	One for stand-by
		Aluminum sulfate storage basin, Capacity: 8.9m^3	1	Retention time: 7days	
		Diaphragm pump: 1.4L/min (Maximum flow), 0.2kw (power)	2	Injection rate	One for stand-by
		Hydrated lime dissolving basin, Hydrated lime storage basin	1 1	Retention time: 7days	
		Diaphragm pump: 0.01L/min (Max. flow), 0.2kW (power)	2	Injection rate	One for stand-by
	Chlorine Feeding Chamber	Direct connection type (68kg cylinder)	1	Residue of free chlorine: 0.2-0.5mg/L	
Water Transmission Facilities	Water Transmission Facilities	Submersible pump 3.0m3/min (Pumping capacity)×50m (pumping head), 45kw(power)	2	Max. hourly water supply	
		Pressure tank Max. pressure: 6kgf/cm^{2,} Min. pressure: 4kgf/cm^2	1		

Description of Facility Design

Site: PAGSANJAN

Planned water volume: 1097 m^3/d

Target parameters to be improved: (Iron)

Facility	Component	Specification	No.	Factors to specify	Remarks
Water Source	Existing Borehole	250m/m φ (Diameter), 62m (Depth)			Rehabilitation
Raw Water Intake Facility	Water Intake Facility	Submersible pump 0.76m^3/min (Pumping capacity) ×39m (Pumping head), 7.5kw (Power)	2	Max. daily capacity of water supply + Water used within the facilities	One for stand-by
Water Treatment Facilities	Aeration Tower	RC, Nozzle sprinkling method Area: 18m^2, Volume 55m^3 (Total of two)	2	Max. daily capacity of water supply + Water used within the facilities Overflow rate: 0.4m^2/m^3/hr, Head: 3m	
	Filtration Basin	RC, Gravity rapid filter Area: 8.0m^2 (total of two) Media: silica sand	2	Max. daily capacity of water supply + Water used within the facilities + Recycled water Filtration rate: 150m/d	
	Treated Water Reservoir	RC, Volume: 460m^3 (total of two)	2	Max. daily water supply for 8 hrs.	
		Backwashing pump (submersible pump) 3.2m3/min (Pumping capacity) × 10m (total pumping head) 11kw (power)	1	Backwashed water: 0.64m/min × Area of one basin (m^2)	
		Surface washing pump (submersible pump) 0.9m3/min (Pumping capacity) × 30m(pumping head) 11kw (power)	1	Surface washed water: 0.20m/min × Area of one basin (m^2)	
	Drainage Basin	RC, Capacity: 25m3	1	Surface washed water per basin	
		Recycling pump (submersible pump) 0.07m3/min(Pumping capacity) × 10m (pumping head) 0.4kw (power)	1	Recycled water/(daily max. water supply + Water used within the facilities): 10%	
		Sludge pump (submersible pump) 0.1m3/min (Pumping capacity) × 8m (pumping head) 0.75kw (power)	1	Backwashed water + Surface washed water − Recycled water	
	Sludge Drying Bed	RC, Capacity: 1.2m3	4	Daily vol. of sedimentation sludge Retention time: 3days	
		Drainage pump (submersible pump) 0.02m3/min (Pumping capacity) × 10m (pumping head) 0.4kw (power)	1	Concentration of sedimentation sludge: 0.5%	
	Chlorine Feeding Chamber	Direct connection type (68kg cylinder)	1	Residue of free chlorine: 0.2−0.5mg/L	
Water Transmission Facilities	Water Transmission Facilities	Submersible pump 1.4m3/min (Pumping capacity) × 50m (pumping head) 18.5kw(power)	2	Max. hourly water supply	
		Pressure tank Max. pressure: 6kgf/cm^2, Min. pressure: 4kgf/cm^2	1		

Description of Facility Design

Site: PANITAN

Planned water volume: 1296 m^3/d

Target parameters to be improved: (Iron, Manganese, Ammonia)

Facility	Component	Specification	No.	Factors to specify	Remarks
Water Source	Existing Borehole	250m/mφ(Diameter), 36m (Depth)			Rehabilitation
Raw Water Intake Facility	Water Intake Facility	Submersible pump 0.9m^3/min (Pumping capacity) ×31m (Pumping head), 11kw(Power)	2	Max. daily capacity of water supply + Water used within the facilities	One for stand-by
Water Treatment Facilities	Aeration Tower	RC, Nozzle sprinkling method Area: 22m^2, Volume 65m^3 (Total of two)	2	Max. daily capacity of water supply + Water used within the facilities Overflow rate: 0.4m^2/m^3/hr, Head: 3m	
	Hydrated Lime Mixing Basin	RC, Area: 1.4m^2, Capacity: 2.2m^2 Vertical submersible mixer Paddle (500m/mφ, 0.75kw)	1	Max. daily capacity of water supply + Water used within the facilities + Recycled water Retention time: 1.5min	
	Mixing Basin of Aluminum Sulfate	RC, Area: 1.4m^2, Volume: 2.2m^3 Vertical submersible mixer Paddle (500m/mφ, 0.75kw)	1	Max. daily capacity of water supply + Water used within the facilities + Recycled water Retention time: 1.5min	
	Flocculation Basin	RC, Vertical baffling type Area: 15m^2, Volume: 30m^3 Vertical slow baffling type GT value: 50000	1	Max. daily capacity of water supply + Water used within the facilities + Recycled water Retention time: 30min	
	Sedimentation Basin	RC, Horizontal-flow sedimentation basin, Area 33m^2, Volume 99m^3 (total of two)	2	Max. daily capacity of water supply + Water used within the facilities + Recycled water Overflow rate: 30mm/min, Effective depth: 3m	
	Filtration Basin	RC, Gravity rapid filter Area: 9.6m^2 (total of two) Media: silica sand, manganese sand	2	Max. daily capacity of water supply + Water used within the facilities + Recycled water Filtration rate: 150m/d	
	Treated Water Reservoir	RC, Volume: 540m^3 (total of two)	2	Max. daily water supply for 8 hrs.	
		Backwashing pump (submersible pump) 3.4m3/min (Pumping capacity)×10m (total pumping head) 11kw (power)	1	Backwashed water: 0.64m/min×Area of one basin (m^2)	
		Surface washing pump (submersible pump) 1.1m3/min (Pumping capacity)×30m(pumping head) 11kw(power)	1	Surface washed water: 0.20m/min×Area of one basin (m^2)	
	Drainage Basin	RC, Capacity: 27m3	1	Surface washed water per basin	
		Recycling pump (submersible pump) 0.08m3/min(Pumping capacity) ×10m (pumping head) 0.4kw (power)	1	Recycled water/(daily max. water supply + Water used within the facilities): 10%	
		Sludge pump (submersible pump) 0.1m3/min (Pumping capacity)×8m (pumping head) 0.75kw (power)	1	Backwashed water + Surface washed water - Recycled water	
	Sludge Drying Bed	RC, Capacity: 40m3	4	Daily vol. of sedimentation sludge Retention time: 3days	
		Drainage pump (submersible pump) 0.65m3/min (Pumping capacity)×10m (pumping head) 2.2kw (power)	1	Concentration of sedimentation sludge: 0.5%	
	Chemical Feeding Chamber	Aluminum sulfate storage basin, Capacity: 10.4m^3	1	Retention time: 7days	
		Diaphragm pump: 1.4L/min (Maximum flow), 0.2kw (power)	2	Injection rate	One for stand-by
		Hydrated lime dissolving basin, Hydrated lime storage basin	1 1	Retention time: 7days	
		Diaphragm pump: 0.01L/min (Max. flow), 0.2kW (power)	2	Injection rate	One for stand-by
	Chlorine Feeding Chamber	Direct connection type (68kg cylinder)	1	Residue of free chlorine: 0.2-0.5mg/L	
Water Transmission Facilities	Water Transmission Facilities	Submersible pump 1.6m3/min (Pumping capacity)×50m (pumping head), 30kw(power)	2	Max. hourly water supply	
		Pressure tank Max. pressure: 6kgf/$cm^{2.}$ Min. pressure: 4kgf/cm^2	1		

Description of Facility Design

Site: Pontevedra

Planned water volume: 2708 m^3/d

Target parameters to be improved: (Iron, Manganese, Ammonia)

Facility	Component	Specification	No.	Factors to specify	Remarks
Water Source	Existing Borehole	250m/mϕ (Diameter), 47m (Depth)			Rehabilitation
Raw Water Intake Facility	Water Intake Facility	Submersible pump 1.88m^3/min (Pumping capacity) ×34m (Pumping head), 18.5kw (Power)	2	Max. daily capacity of water supply + Water used within the facilities	One for stand-by
Water Treatment Facilities	Aeration Tower	RC, Nozzle sprinkling method Area: 45m^2, Volume 135m^3 (Total of two)	2	Max. daily capacity of water supply + Water used within the facilities Overflow rate: 0.4m^2/m^3/hr, Head: 3m	
	Mixing Basin of Aluminum Sulfate	RC Area: 1.4m^2, Volume: 2.2m^3 Vertical submersible mixer Paddle (500m/mϕ, 0.75kw)	1	Max. daily capacity of water supply + Water used within the facilities + Recycled water Retention time: 1.5min	
	Flocculation Basin	RC, Vertical baffling type Area: 31m^2, Volume: 62m^3 Vertical slow baffling type GT value: 50000	1	Max. daily capacity of water supply + Water used within the facilities + Recycled water Retention time: 30min	
	Sedimentation Basin	RC, Horizontal-flow sedimentation basin, Area 69m^2, Volume 207m^3 (total of two)	2	Max. daily capacity of water supply + Water used within the facilities + Recycled water Overflow rate: 30mm/min, Effective depth: 3m	
	Filtration Basin	RC, Gravity rapid filter Area: 19.9m^2 (total of two) Media: silica sand, manganese sand	2	Max. daily capacity of water supply + Water used within the facilities + Recycled water Filtration rate: 150m/d	
	Treated Water Reservoir	RC, Volume: 1130m^3 (total of two)	2	Max. daily water supply for 8 hrs.	
		Backwashing pump (submersible pump) 7.2m3/min (Pumping capacity)×10m (total pumping head) 30kw (power)	1	Backwashed water: 0.64m/min×Area of one basin (m^2)	
		Surface washing pump (submersible pump) 2.3m3/min (Pumping capacity)× 30m(pumping head) 18.5kw(power)	1	Surface washed water: 0.20m/min× Area of one basin (m^2)	
	Drainage Basin	RC, Capacity: 55m3	1	Surface washed water per basin	
		Recycling pump (submersible pump) 0.16m3/min(Pumping capacity) ×10m (pumping head) 0.75kw (power)	1	Recycled water/(daily max. water supply + Water used within the facilities): 10%	
		Sludge pump (submersible pump) 0.1m3/min (Pumping capacity)×8m (pumping head) 0.75kw (power)	1	Backwashed water + Surface washed water - Recycled water	
	Sludge Drying Bed	RC, Capacity: 4.2m3	4	Daily vol. of sedimentation sludge Retention time: 3days	
		Drainage pump (submersible pump) 0.08m3/min (Pumping capacity)×10m (pumping head) 0.4kw (power)	1	Concentration of sedimentation sludge: 0.5%	
	Chemical Feeding Chamber	Aluminum sulfate storage basin, Capacity: 10.4m^3	1	Retention time: 7days	
		Diaphragm pump: 1.4L/min (Maximum flow), 0.2kw (power)	2	Injection rate	One for stand-by
	Chlorine Feeding Chamber	Direct connection type (68kg cylinder)	1	Residue of free chlorine: 0.2-0.5mg/L	
Water Transmission Facilities	Water Transmission Facilities	Submersible pump 3.3m3/min (Pumping capacity)×50m (pumping head), 45kw(power)	2	Max. hourly water supply	
		Pressure tank Max. pressure: 6kgf/cm^2, Min. pressure: 4kgf/cm^2	1		

Description of Facility Design

Site: DINGLE-POTOTAN

Planned water volume: 2592 m^3/d

Target parameters to be improved: (Iron, Manganese, Ammonia)

Facility	Component	Specification	No.	Factors to specify	Remarks
Water Source	Existing Borehole	250m/mϕ(Diameter), 40m (Depth)		Existing Borehole	Rehabilitation
Raw Water Intake Facility	Water Intake Facility	Submersible pump 1.8m^3/min (Pumping capacity) ×44m (Pumping head), 22kw(Power)	2	Max. daily capacity of water supply + Water used within the facilities	One for stand-by
Water Treatment Facilities	Aeration Tower	RC, Nozzle sprinkling method Area: 43m^2, Volume 130m^3 (Total of two)	2	Max. daily capacity of water supply + Water used within the facilities Overflow rate: 0.4m^2/m^3/hr, Head: 3m	
	Mixing Basin of Aluminum Sulfate	RC Area: 1.4m^2, Volume: 2.2m^3 Vertical submersible mixer Paddle (500m/mϕ, 0.75kw)	1	Max. daily capacity of water supply + Water used within the facilities + Recycled water Retention time: 1.5min	
	Flocculation Basin	RC, Vertical baffling type Area: 30m^2, Volume: 60m^3 Vertical slow baffling type GT value: 50000	1	Max. daily capacity of water supply + Water used within the facilities + Recycled water Retention time: 30min	
	Sedimentation Basin	RC, Horizontal-flow sedimentation basin, Area 66m^2, Volume 198m^3 (total of two)	2	Max. daily capacity of water supply + Water used within the facilities + Recycled water Overflow rate: 30mm/min, Effective depth: 3m	
	Filtration Basin	RC, Gravity rapid filter Area: 19.0m^2 (total of two) Media: silica sand, manganese sand	2	Max. daily capacity of water supply + Water used within the facilities + Recycled water Filtration rate: 150m/d	
	Treated Water Reservoir	RC, Volume: 1080m^3 (total of two)	2	Max. daily water supply for 8 hrs.	
		Backwashing pump (submersible pump) 6.4m3/min (Pumping capacity)×10m (total pumping head) 30kw (power)	1	Backwashed water: 0.64m/min×Area of one basin (m^2)	
		Surface washing pump (submersible pump) 2.0m3/min (Pumping capacity)×30m(pumping head) 15kw(power)	1	Surface washed water: 0.20m/min×Area of one basin (m^2)	
	Drainage Basin	RC, Capacity: 50m3	1	Surface washed water per basin	
		Recycling pump (submersible pump) 0.14m3/min(Pumping capacity) ×10m (pumping head) 0.75kw (power)	1	Recycled water/(daily max. water supply + Water used within the facilities): 10%	
		Sludge pump (submersible pump) 0.1m3/min (Pumping capacity)×8m (pumping head) 0.75kw (power)	1	Backwashed water + Surface washed water - Recycled water	
	Sludge Drying Bed	RC, Capacity: 7.6m3	4	Daily vol. of sedimentation sludge Retention time: 3days	
		Drainage pump (submersible pump) 0.08m3/min (Pumping capacity)×10m (pumping head) 0.4kw (power)	1	Concentration of sedimentation sludge: 0.5%	
	Chemical Feeding Chamber	Aluminum sulfate storage basin, Capacity: 9.5m^3	1	Retention time: 7days	
		Diaphragm pump: 1.4L/min (Maximum flow), 0.2kw (power)	2	Injection rate	One for stand-by
	Chlorine Feeding Chamber	Direct connection type (68kg cylinder)	1	Residue of free chlorine: 0.2-0.5mg/L	
Water Transmission Facilities	Water Transmission Facilities	Submersible pump 3.2m3/min (Pumping capacity)×50m (pumping head), 45kw(power)	2	Max. hourly water supply	
		Pressure tank Max. pressure: 6kgf/$cm^{2,}$ Min. pressure: 4kgf/cm^2	1		

Description of Facility Design

Site: ABUYOG

Planned water volume: 2539 m^3/d

Target parameters to be improved: (Iron, Manganese, Ammonia, Color)

Facility	Component	Specification	No.	Factors to specify	Remarks
Water Source	Existing Borehole	250m/mφ(Diameter), 83m (Depth)			Rehabilitation
Raw Water Intake Facility	Water Intake Facility	Submersible pump 1.76m^3/min (Pumping capacity) ×50m (Pumping head), 25kw(Power)	2	Max. daily capacity of water supply + Water used within the facilities	One for stand-by
Water Treatment Facilities	Aeration Tower	RC, Nozzle sprinkling method Area: 42m^2, Volume 127m^3 (Total of two)	2	Max. daily capacity of water supply + Water used within the facilities Overflow rate: 0.4m^2/m^3/hr, Head: 3m	
	Mixing Basin of Aluminum Sulfate	RC Area: 1.4m^2, Volume: 2.2m^3 Vertical submersible mixer Paddle (500m/mφ, 0.75kw)	1	Max. daily capacity of water supply + Water used within the facilities + Recycled water Retention time: 1.5min	
	Flocculation Basin	RC, Vertical baffling type Area: 29m^2, Volume: 57m^3 Vertical slow baffling type GT value: 50000	1	Max. daily capacity of water supply + Water used within the facilities + Recycled water Retention time: 30min	
	Sedimentation Basin	RC, Horizontal-flow sedimentation basin, Area 65m^2, Volume 195m^3 (total of two)	2	Max. daily capacity of water supply + Water used within the facilities + Recycled water Overflow rate: 30mm/min, Effective depth: 3m	
	Filtration Basin	RC, Gravity rapid filter Area: 18.6m^2 (total of two) Media: silica sand, manganese sand	2	Max. daily capacity of water supply + Water used within the facilities + Recycled water Filtration rate: 150m/d	
	Treated Water Reservoir	RC, Volume: 1060m^3 (total of two)	2	Max. daily water supply for 8 hrs.	
		Backwashing pump (submersible pump) 6.4m3/min (Pumping capacity)×10m (total pumping head) 30kw (power)	1	Backwashed water: 0.64m/min×Area of one basin (m^2)	
		Surface washing pump (submersible pump) 2.0m3/min (Pumping capacity)× 30m(pumping head) 15kw(power)	1	Surface washed water: 0.20m/min× Area of one basin (m^2)	
	Drainage Basin	RC, Capacity: 63m3	1	Surface washed water per basin	
		Recycling pump (submersible pump) 0.18m3/min(Pumping capacity) ×10m (pumping head) 0.75kw (power)	1	Recycled water/(daily max. water supply + Water used within the facilities): 10%	
		Sludge pump (submersible pump) 0.1m3/min (Pumping capacity)×8m (pumping head) 0.75kw (power)	1	Backwashed water + Surface washed water − Recycled water	
	Sludge Drying Bed	RC, Capacity: 8.0m3	4	Daily vol. of sedimentation sludge Retention time: 3days	
		Drainage pump (submersible pump) 0.16m3/min (Pumping capacity)×10m (pumping head) 0.75kw (power)	1	Concentration of sedimentation sludge: 0.5%	
	Chemical Feeding Chamber	Aluminum sulfate storage basin, Capacity: 9.3m^3	1	Retention time: 7days	
		Diaphragm pump: 1.4L/min (Maximum flow), 0.2kw (power)	2	Injection rate	One for stand-by
	Chlorine Feeding Chamber	Direct connection type (68kg cylinder)	1	Residue of free chlorine: 0.2-0.5mg/L	
Water Transmission Facilities	Water Transmission Facilities	Submersible pump 3.1m3/min (Pumping capacity)×50m (pumping head), 45kw(power)	2	Max. hourly water supply	
		Pressure tank Max. pressure: 6kgf/cm^2, Min. pressure: 4kgf/cm^2	1		

Description of Facility Design

Site: MIDSAYAP

Planned water volume: 2030 m^3/d

Target parameters to be improved: (Iron, Manganese)

Facility	Component	Specification	No.	Factors to specify	Remarks
Water Source	Existing Borehole	250m/mφ(Diameter), 56m (Depth)			Rehabilitation
Raw Water Intake Facility	Water Intake Facility	Submersible pump 1.41m^3/min (Pumping capacity) ×36m (Pumping head), 15kw(Power)	2	Max. daily capacity of water supply + Water used within the facilities	One for stand-by
Water Treatment Facilities	Aeration Tower	RC, Nozzle sprinkling method Area: 34m^2, Volume 101m^3 (Total of two)	2	Max. daily capacity of water supply + Water used within the facilities Overflow rate: 0.4m^2/m^3/hr, Head: 3m	
	Mixing Basin of Aluminum Sulfate	RC Area: 1.4m^2, Volume: 2.2m^3 Vertical submersible mixer Paddle (500m/mφ, 0.75kw)	1	Max. daily capacity of water supply + Water used within the facilities + Recycled water Retention time: 1.5min	
	Flocculation Basin	RC, Vertical baffling type Area: 24m^2, Volume: 48m^3 Vertical slow baffling type GT value: 50000	1	Max. daily capacity of water supply + Water used within the facilities + Recycled water Retention time: 30min	
	Sedimentation Basin	RC, Horizontal-flow sedimentation basin, Area 52m^2, Volume 155m^3 (total of two)	2	Max. daily capacity of water supply + Water used within the facilities + Recycled water Overflow rate: 30mm/min, Effective depth: 3m	
	Filtration Basin	RC, Gravity rapid filter Area: 14.8m^2 (total of two) Media: silica sand, manganese sand	2	Max. daily capacity of water supply + Water used within the facilities + Recycled water Filtration rate: 150m/d	
	Treated Water Reservoir	RC, Volume: 850m^3 (total of two)	2	Max. daily water supply for 8 hrs.	
		Backwashing pump (submersible pump) 5.1m3/min (Pumping capacity)×10m (total pumping head) 15kw (power)	1	Backwashed water: 0.64m/min×Area of one basin (m^2)	
		Surface washing pump (submersible pump) 1.6m3/min (Pumping capacity)× 30m(pumping head) 15kw(power)	1	Surface washed water: 0.20m/min× Area of one basin (m^2)	
	Drainage Basin	RC, Capacity: 40m3	1	Surface washed water per basin	
		Recycling pump (submersible pump) 0.11m3/min(Pumping capacity) ×10m (pumping head) 0.4kw (power)	1	Recycled water/(daily max. water supply + Water used within the facilities): 10%	
		Sludge pump (submersible pump) 0.1m3/min (Pumping capacity)×8m (pumping head) 0.75kw (power)	1	Backwashed water + Surface washed water - Recycled water	
	Sludge Drying Bed	RC, Capacity: 3.3m3	4	Daily vol. of sedimentation sludge Retention time: 3days	
		Drainage pump (submersible pump) 0.08m3/min (Pumping capacity)×10m (pumping head) 0.4kw (power)	1	Concentration of sedimentation sludge: 0.5%	
	Chemical Feeding Chamber	Aluminum sulfate storage basin, Capacity: 7.4m^3	1	Retention time: 7days	
		Diaphragm pump: 1.4L/min (Maximum flow), 0.2kw (power)	2	Injection rate	One for stand-by
	Chlorine Feeding Chamber	Direct connection type (68kg cylinder)	1	Residue of free chlorine: 0.2-0.5mg/L	
Water Transmission Facilities	Water Transmission Facilities	Submersible pump 2.5m3/min (Pumping capacity)×50m (pumping head), 37kw(power)	2	Max. hourly water supply	
		Pressure tank Max. pressure: 6kgf/$cm^{2,}$ Min. pressure: 4kgf/cm^2	1		

Description of Facility Design

Site: KABACAN

Planned water volume: 2592 m^3/d

Target parameters to be improved: (Iron, Manganese)

Facility	Component	Specification	No.	Factors to specify	Remarks
Water Source	Existing Borehole	300m/m φ (Diameter), 100m (Depth)			Rehabilitation
Raw Water Intake Facility	Water Intake Facility	Submersible pump 1.8m^3/min (Pumping capacity) ×35m (Pumping head), 18.5kw (Power)	2	Max. daily capacity of water supply + Water used within the facilities	One for stand-by
Water Treatment Facilities	Aeration Tower	RC, Nozzle sprinkling method Area: 43m^2, Volume 130m^3 (Total of two)	2	Max. daily capacity of water supply + Water used within the facilities Overflow rate: 0.4m^2/m^3/hr, Head: 3m	
	Mixing Basin of Aluminum Sulfate	RC Area: 1.4m^2, Volume: 2.2m^3 Vertical submersible mixer Paddle (500m/m φ, 0.75kw)	1	Max. daily capacity of water supply + Water used within the facilities + Recycled water Retention time: 1.5min	
	Flocculation Basin	RC, Vertical baffling type Area: 30m^2, Volume: 60m^3 Vertical slow baffling type GT value: 50000	1	Max. daily capacity of water supply + Water used within the facilities + Recycled water Retention time: 30min	
	Sedimentation Basin	RC, Horizontal-flow sedimentation basin, Area 66m^2, Volume 198m^3 (total of two)	2	Max. daily capacity of water supply + Water used within the facilities + Recycled water Overflow rate: 30mm/min, Effective depth: 3m	
	Filtration Basin	RC, Gravity rapid filter Area: 19m^2 (total of two) Media: silica sand, manganese sand	2	Max. daily capacity of water supply + Water used within the facilities + Recycled water Filtration rate: 150m/d	
	Treated Water Reservoir	RC, Volume: 1080m^3 (total of two)	2	Max. daily water supply for 8 hrs.	
		Backwashing pump (submersible pump) 6.4m3/min (Pumping capacity)×10m (total pumping head) 30kw (power)	1	Backwashed water: 0.64m/min×Area of one basin (m^2)	
		Surface washing pump (submersible pump) 2.0m3/min (Pumping capacity)× 30m(pumping head) 15kw (power)	1	Surface washed water: 0.20m/min× Area of one basin (m^2)	
	Drainage Basin	RC, Capacity: 50m3	1	Surface washed water per basin	
		Recycling pump (submersible pump) 0.14m3/min(Pumping capacity) ×10m (pumping head) 0.75kw (power)	1	Recycled water/(daily max. water supply + Water used within the facilities): 10%	
		Sludge pump (submersible pump) 0.1m3/min (Pumping capacity)×8m (pumping head) 0.75kw (power)	1	Backwashed water + Surface washed water - Recycled water	
	Sludge Drying Bed	RC, Capacity: 4.2m3	4	Daily vol. of sedimentation sludge Retention time: 3days	
		Drainage pump (submersible pump) 0.08m3/min (Pumping capacity)×10m (pumping head) 0.4kw (power)	1	Concentration of sedimentation sludge: 0.5%	
	Chemical Feeding Chamber	Aluminum sulfate storage basin, Capacity: 9.5m^3	1	Retention time: 7days	
		Diaphragm pump: 1.4L/min (Maximum flow), 0.2kw (power)	2	Injection rate	One for stand-by
	Chlorine Feeding Chamber	Direct connection type (68kg cylinder)	1	Residue of free chlorine: 0.2-0.5mg/L	
Water Transmission Facilities	Water Transmission Facilities	Submersible pump 3.2m3/min (Pumping capacity)×50m (pumping head), 45kw(power)	2	Max. hourly water supply	
		Pressure tank Max. pressure: 6kgf/$cm^{2,}$ Min. pressure: 4kgf/cm^2	1		

CHAPTER 3　IMPLEMENTATION PLAN

Chapter 3 Implementation Plan

3-1 Implementation Plan

The project is implemented under the Japanese Grant Aid System. The implementation plan of the project is as follows. Figure 3-1 shows the implementation system.

3-1-1 Implementation policies

The Local Water Utilities Administration (LWUA) is the executing and responsible agency for the project. LWUA is responsible for the entire procedure of the project. Upon completion of the said Project LWUA shall turn over the said facilities to the recipient WDs and shall provide technical assistance to ensure proper maintenance for sustainability. After the completion of the Exchange of Notes, LWUA will contract with a Japanese consultant firm for the detailed study and supervision of the project. And under the assistance of the consultant, LWUA will execute a tender for the procurement of equipment for the monitoring of water quality and the construction of water treatment facilities. The contract with a contractor will be made based on the result of the tender. In accordance with the guidelines of the Japanese Grant Aid Assistance, the prime contractor is a Japanese firm.

The Japanese prime contractor constructs such facilities, and procures relevant equipment and materials under the supervision of the consultant.

The constructed facilities and procured equipment are handed over to each WDs after the inspection held by concerned parties. From then on, the operation and maintenance (O&M) of the facilities are done by each WD.

The Japanese prime contractor must have enough experiences in the similar water supply projects including construction of filtration facilities, and have deep knowledge in the field. Since the project uses groundwater from existing wells as its water sources, the Japanese prime contractor is also required to have the expertise for groundwater development.

Since the 10 target WDs are scattered in 4 islands, cooperation from local side is

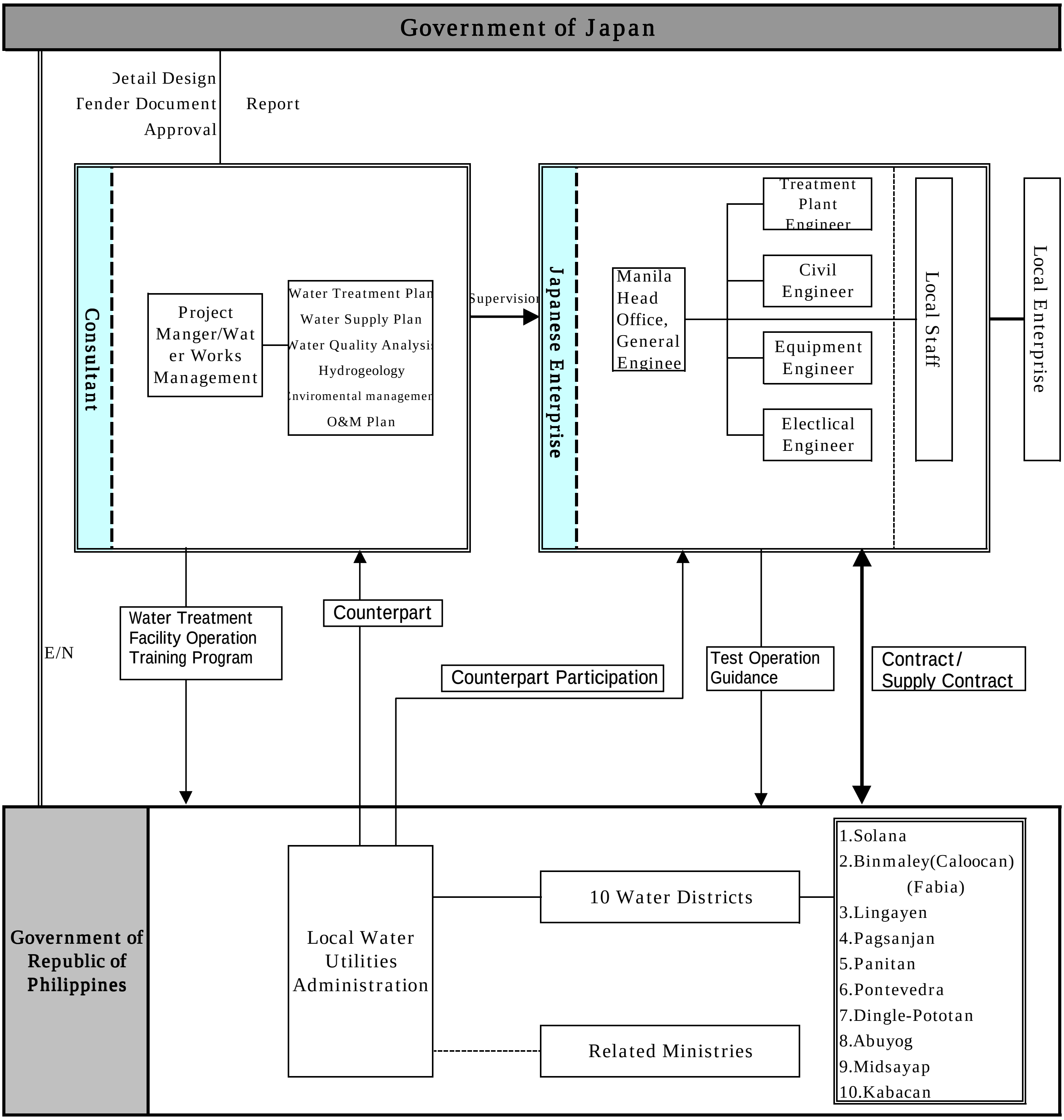


Figure 3-1 Organization for Project Implementation

indispensable. There are relatively many local firms and workers relating to the general construction works as well as water supply system construction works in the Philippines, and their capacity is appreciable.

3-1-2 Conditions for the implementation

All the necessary requirements such as right of way, permit, etc. relating to the design and construction laws, technical standards, and so forth shall be the responsibility of LWUA. However, concerning the installation of pipelines across the national roads in some target WDs, discussions with related ministries are required. All of the existing water facilities in WDs are in operation at present and the served population has reached around 123,000. The implementation schedule is planned in order to avoid inconvenience caused by the suspension of water for a long time due to the execution of construction work.

After the completion of each WD's water treatment facility, the effective backwashing of the pipelines is required before water is transmitted to the distribution pipelines. Since the pipelines are inter-connected without order in many WDs, the resident will not be able to receive water of good quality in case the back washing program is not adequate. The consultant will design the backwashing program reflecting the route of distribution pipelines. The Japanese contractor will execute the program as its responsibility in cooperation with each WDs putting effort to avoid causing inconvenience to the residents.

3-1-3 Scope of Works

Responsibilities of Japanese side are as follows:

(1) To rehabilitate existing wells and construct water treatment facilities which use the rehabilitated wells as their water sources in 10 target WDs (in 11 sites).

(2) To procure equipment necessary for the operation of the water treatment facilities.

(3) To provide consultation services during the implementation of the Project.

(4) To provide technology transfer during the Project implementation on site and/or training area as identified for LWUA and WD's staff members.

As for the Philippines' side, the executing agency is requested to conduct overall management of the project and make necessary arrangement for the matters related to other ministries. Details are as follows:

1) To provide relevant data, information and documents necessary for the execution of the project.
2) To secure lands necessary for the project.
3) To readjust the sites and access roads before the commencement of the construction works.
4) To bear banking fees of the bank in Japan in accordance with the banking arrangement.
5) To secure smooth disembarkation of the equipment and the materials at the port and bear all the costs for the custom clearance.
6) To secure smooth embarkation and disembarkation for the Japanese personnel involved in the project implementation, offer them necessary convenience and security during their stay, and exempt them from customs duties and internal taxes with respect to services under the verified contracts.
7) To give convenience to enable the Japanese personnel to enter the Philippines, and stay and conduct their duties regarding the supplies of the equipment and the services from Japan under verified contracts.
8) To assign counterparts.
9) To assign necessary staff and secure budget for proper and effective operation and maintenance of the procured equipment and constructed facilities under the project.
10) To use and maintain properly and effectively all the procured equipment and constructed facilities under the project.
11) To organize O&M system including selection and education of personnel for the effective operation of the constructed facilities.
12) To bear the expenses which are necessary for the execution of the project, but not covered by the Grant.
13) To follow a procedure (ICC, ECC, etc.) promptly concerning a grant necessary for this execution of the Project .

3-1-4 Supervision plan

The whole process including the Detailed Design Study, tendering, contracting management, supervision on facility construction, procurement of the equipment, and the operational training is conducted as follows.

Stage	Order	Contents
Pre-Construction	1.	Detailed Design Study
	2.	Preparation of tender documents
	3.	Supporting the tender
	4.	Evaluating the result of tender
	5.	Assistance for conclusion of the contract
Under-Construction	6.	Supervision of construction and procurement
	7.	Preparation of training program, on the job training
	8.	Inspection, operational instruction and training
	9.	Formulation of reports

Prior to the construction work, detailed designs including field survey necessary for implementation of the project shall be conducted for each target WDs based on the results of the Basic Design Study in order to determine the specifications for the facilities and the equipment and to prepare tender documents. Along with the preparation of the tender documents, a program for tendering procedure is prepared after discussions with the relating ministries. The consultant supports executing agency to carry out the tender and to have contract with the selected Japanese contractor after the evaluation of the results of the tender.

Regarding the construction stage, as is shown in the following project implementing flow, engineers dispatched to the project area will make necessary arrangement among concerned parties for smooth and effective implementation of the project and to perform quality control and construction supervision.

At the stage of the completion of the construction work, inspection on the constructed facilities and installed equipment is conducted and training concerning operation and maintenance through the training program is given to the personnel who will be engaged in the O&M activities. Reports on the completion of the project are also prepared.

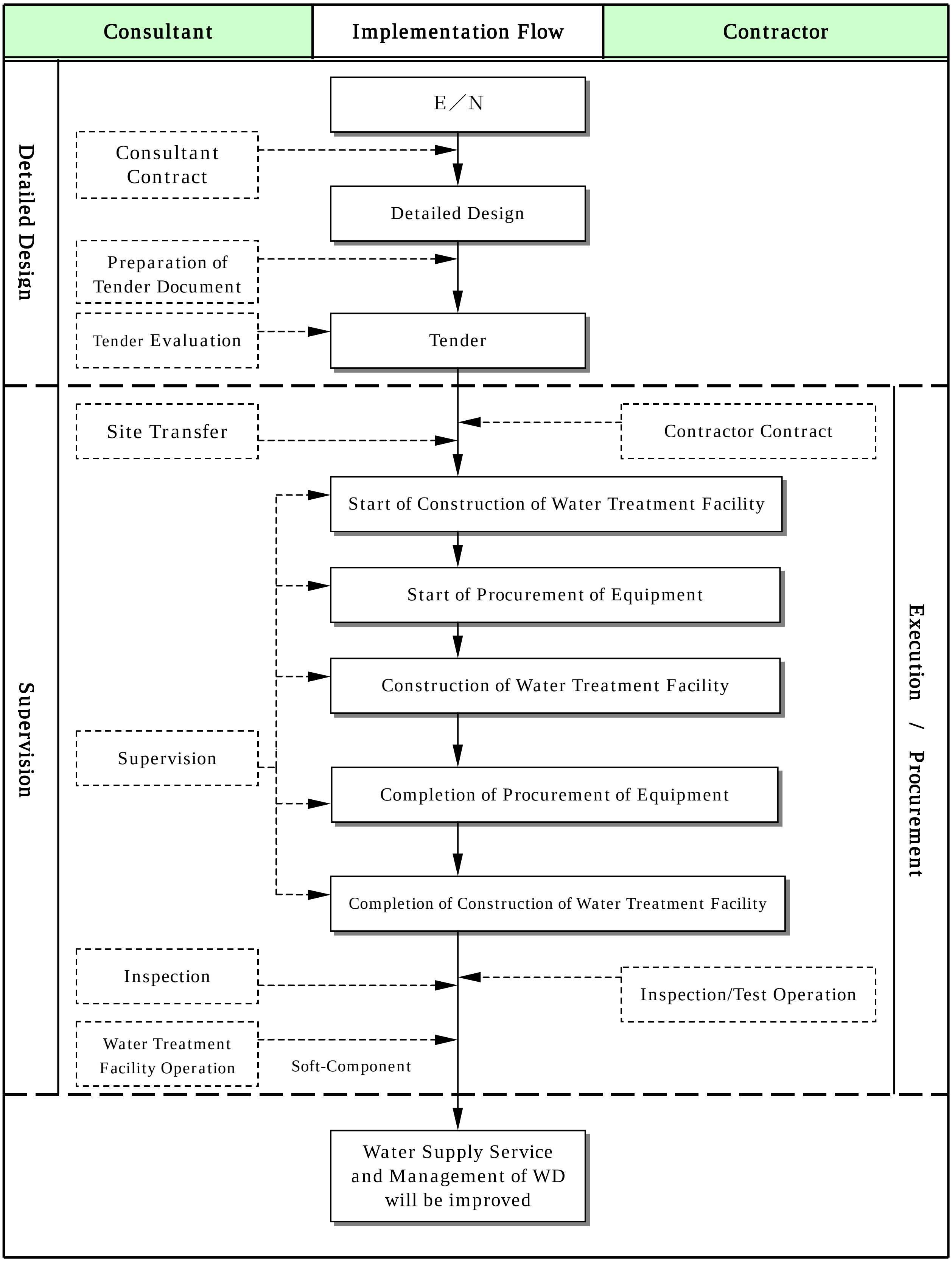


Figure 3-2 Flow of Project Implementation

3-1-5 Procurement plan

Regarding construction materials, priority is given to the locally available materials as far as the quality is guaranteed and the constant availability in the market is observed. As for the equipment, from the viewpoint of the easiness of maintenance and the provision of after-sale services, non-Japanese products are also taken into consideration. Procurement plan is as follows considering the skills and the techniques of the personnel of the Philippines' side, the existence of maintenance system and the availability in the market.

(1) Selection of the equipment to be procured

The equipment for measuring and analyses and their attached equipment are installed for the sake of the confirmation of water treatment situation and the promotion of smooth treatment process. The equipment for the measuring is portable as they are used daily and frequently. The equipment for chemical analysis adopts simple methods and can treat 5 parameters namely residual chlorine, iron, manganese, ammonia nitrogen, and COD. These equipment are installed in 11 sites, and each equipment is in correspond to the objectives of water treatment plan in each site.

(2) Objectives and items of measuring /analyses

ａ. Items necessary for observation and management of treated water quality
pH, water temperature, conductivity (EC), salinity, dissolved oxygen (DO), turbidity, color, odor, objectionable taste, residual chlorine

ｂ. Items necessary for observation and management of water treatment facility
Facilities of Group A：Iron
Facilities of Group B：Iron/Manganese/Coagulation and Sedimentation
Facilities of Group C：Iron/Manganese/Ammonia nitrogen/Coagulation and Sedimentation
Facilities of Group C'：Iron/Manganese/Ammonia nitrogen/Coagulation and Sedimentation
Facilities of Group D：Color/COD/Coagulation and Sedimentation
Facilities of Group E：Iron/Manganese/Ammonia nitrogen/Color

(3) Purpose of Equipment for measuring and analysis and attached equipment

Table 3-1 Equipment for measuring and analysis

Parameter	Equipment	Purpose	Quantity
pH	pH meter	Observation and management of raw water and treated water	11
Water temperature	Water quality checker	Observation and management of raw water and treated water	11
Conductivity	Water quality checker	Observation and management of raw water and treated water	11
Salinity	Salinometer	Observation and management of raw water and treated water	11
Dissolved oxygen	Water quality checker	Observation and management of raw water and treated water	11
Turbidity	Water quality checker	Observation and management of raw water and treated water	11
Color/Odor/Taste	Colorimeter, other	Observation and management of raw water and treated water	11
Residual chlorine	Colorimeter	Observation and management of treated water	11
Iron	Colorimeter	Observation and management of raw water and treated water	8
Manganese	Colorimeter	Observation and management of raw water and treated water	7
Ammonia nitrogen	Colorimeter	Observation and management of raw water and treated water	4
COD	COD meter	Observation and management of raw water and treated water	3
Coagulation and sedimentation	Jar tester	Observation and management of raw water and treated water	10

Table 3-2 Attached equipment

Item	Equipment	Purpose	Quantity
Glass equipment	Beaker, others	Chemical analysis	11
Storage equipment	Storage shed	Storage /management of glass equipment and measuring equipment	11
Chemicals storage equipment	Chemicals shed	Storage of chemicals, low temperature conservation	11
Data management	Computer	Management of data	11

(4) Specifications of Equipment for measuring and analysis and attached equipment

Table 3-3 Specifications of Equipment for measuring and analysis

Parameter	Equipment	Specification
pH	pH meter	Glass Electrode
Water temperature	Water quality checker	Platinum RTD
Conductivity	Water quality checker	AC 4 electrodes
Salinity	Salinometor	AC 4 electrodes
Dissolved oxygen	Water quality checker	Galvanic cell
Turbidity	Water quality checker	Scattering light
Color/Odor/Taste	Colorimeter, other	Odor/taste：Sense method
Residual chlorine	Colorimeter	Colorimetory
Iron	Colorimeter	Colorimetory
Manganese	Colorimeter	Colorimetory
Ammonia nitrogen	Colorimeter	Colorimetory
COD	COD meter	Acid Potassium Permanganate
Coagulation and sedimentation	Jar tester	4 equipped / attached chemicals injector

Table 3-4 Specifications of Attached Equipment

Item	Equipment	Specification
Glass equipment	Beaker, others	Beaker, flask, measuring cylinder, funnel, etc.
Storage equipment	Storage shed	Aluminum flame/acrylic plate (more than 500L)
Chemicals storage	Chemicals shed	Refrigerator (300L)
Data managing	Computer	CPU(more than 400MHz) HDD(more than 10GB) CDR/RW, Monitor(17 in), Printer(A4～)

As for the construction materials, judging from the results and evaluation of the past project, procuring from the local market can be appropriate in terms of quality, quantity, and price. The principal construction materials such as cement, aggregate, pipes, etc. are manufactured enough in the Philippines with the established local price. They are procured in the Philippines.

3-1-6 Implementation Schedule

There is a necessity of division by two terms because of the scale of the works and the system when this Project is executed. Therefore, an original examination under the condition like the following was done.

① Efficiency to execute two or more vicinity sites to the same period in the same region by thinking from construction side.

② Evenness of amount of works in division by two terms.

③ Idea like the following presented by the Philippines side concerning the priority level of site selection for the execution.

i）Priority to the sites where the impact and the effect are high（50%）

ii）Priority to the sites with a difficult water quality problem（30%）

iii）Priority to the sites where the land securing ends（20%）

The above-mentioned sites are shown in the table below.

Priority	Site
High impact and the effect	Panitan, Solana
Difficult water quality problem	Abuyog, Panitan
land securing ends	All others sites excluding Abuyog, Binmaley-F

The sites where the impact and the effect are high are Panitan, Solana, and the reason is the followings.

In the current state in Panitan, the water sources facilities cannot be used due to the water quality deterioration of the deep well of the own possession, they buy expensive water from the Roxas city which is adjacent now, and this has the majority of the WD management expense in Panitan. And, with the amount of production in the Roxas city it is impossible to increase the amount of the water supply because there is no room any further.

Moreover, there is marine products processing goods factory in the Panitan city, if the amount of the water supply increases in Panitan, there is large demand's of using the water at once and it will contribute to the management improvement of this WD.

As for Solana, there are a lot of WDs in the surrounding of Solana where a similar water

quality problem is caused, and a lot of improvement requests go up to the LUWA headquarters.
Therefore, the spreading effect is expected to the surrounding WDs by executing in Solana.
For the above-mentioned reasons, theses 2WDs were evaluated as the sites where the impact and the effect would be high.

From the view of the construction works, the execution of two or more vicinity sites in the same region to the same period will produce the high efficiency in the execution. Therefore, the undermentioned each group will be executed in the same period.

Group 1（Pangasinan[Luzon]）：Binmaley-C,-F, Lingayen ［3 sites］
Group 2（Panay）：Panitan, Pontevedra, Dingle-Pototan ［3 sites］
Group 3（Mindabao）：Midsayap, Kabacan ［2 sites］

Besides the above-mentioned, by the division of 2 terms, the execution sites at each period is as the following table considering the evenness of the construction amount.

In the term 1, the construction will be executed at Panitan, Solana(the impact and the effect is high) , Abuyog (the difficult problem of water quality), and Pontevedra, Dingle-Pototan which belong to the Group-2 (vicinity sites of Panitan). In the term 2 the construction will be executed in the sites of the remainder .

Term	Sites
Term 1	Panitan, Pontevedra, Dingle-Pototan, Abuyog, Solana
Term 2	Binmaley-C and F, Lingayen, Pagsanjan, Midsayap, Kabacan

Binmaley-C：Caloocan, Binmaley-F：Fabia

Moreover, as for Midsayap and Kabacan, the examination comes to be required if there is a problem in the public peace of the North Cotabato Province on the Mindanao island at the execution time of the term 2 (2002 fiscal year).

The progress schedule of the Project is shown in the following table.

Table 3-5 Progress Schedule of the Project

		1	2	3	4	5	6	7	8	9	10	11	12
Term 1	Detailed Design		(Field Survey)										
					(Domestic Work)								
						(Tender and Evaluation)							
	Procure-ment	★	(Conclusion of Contract)										
					(Procurement and Transportation)								
	Construc-tion								(5 sites)				
Term 2	Detailed Design		(Field Survey)										
					(Domestic Work)								
						(Tender and Evaluation)							
	Procure-ment	★	(Conclusion of Contract)										
					(Procurement and Transportation)								
	Construc-tion								(6 sites)				

3-2 Project cost estimation

In the case this Project is implemented under the Japanese Grant Aid System, the contribution of the Philippines is as follows.

(1) Land securing for the construction of facilities

Table 3-6 Necessary site area of each WD

No.		Necessary site area (m2)
1	Solana	900
2	Binmaley Calocan	1,100
	Binmaley Fabia	1,000
3	Lingayen	2,370
4	Pagasanjan	330
5	Panitan	1,350
6	Pontevedra	1,150
7	Dingle-Pototan	1,200
8	Abuyog	1,200
9	Midsayap	1,000
10	Kabacan	1,250
Total		12,850

(2) Electric power conduct expense（Peso）

Table 3-7 Electric power conduct expense of each WD

No.		Electric power conduct (Peso)
1	Solana	220,000
2	Binmaley Calocan	210,000
	Binmaley Fabia	280,000
3	Lingayen	260,000
4	Pagasanjan	190,000
5	Panitan	190,000
6	Pontevedra	310,000
7	Dingle-Pototan	320,000
8	Abuyog	380,000
9	Midsayap	220,000
10	Kabacan	370,000
Total		2,950,000

3-3 Maintenance Plan

3-3-1 System of Maintenance

The 10WDs under the administration of LWUA have 10 to 22 years experience of the water supply management. Basically, the existing water supply systems of these WDs use groundwaters from deep wells as main sources.

Commercial electric power is also utilized. Each of the WDs has a pump station which is provided with a borehole pump, a pressure pump, a chlorine feeding device for disinfection and a generator for the case of blackouts. House connection supplies are practiced through the pipelines whose average length is 20Km or more in each site.

The commodity charge system is adopted for the collection of water fees based on the water production cost, and the charge is based on LWUA's supervision. According to a water meter installed in each household, the invoice is issued. The water supply service has been managed with a relatively high rate of fee collection.

Because of the small business scales, these WDs lack the scale merits, and the financial situations are not so stable. However, unlike newly commencing WDs, these already existing WDs have the foundation for the development of the water supply management by introducing the water treatment facilities to improve the water quality in this Project.

The cost for the O&M in the existing facilities consists of the cost for personnel, chemicals (chlorine for disinfection), electricity and so forth. That of the newly installed facilities in this project is also composed of the same items. Although personnel expenses occupy a large ratio in the conventional management, the rate becomes relatively low in this project. On the other hand, the costs for chlorine not for disinfection use, pH adjuster and coagulant are newly added, and the electric power expenses for facilities are increased. The annual maintenance cost for treatment facilities of each WD is shown in the next table.

Table 3-8 Annual Maintenance Cost of treatment facilities of each WD (10,000 Peso)

	Electric Power	Chemicals
Solana	125	8
Binmaley	268	71
Lingayen	197	63
Pagsanjan	80	2
Panitan	126	66
Pontevedra	196	24
Dingle-Pototan	208	72
Abuyog	218	121
Midsayap	159	12
Kabacan	195	20

The costs of the electricity for intake and transmission of water account for high rate in the existing facilities. In this project, the costs for water treatment will be also added. However, the consumption of the electricity will become more efficient by the more efficient management. The costs for personnel generally account for high rates comparing with the other items. The increase of the personnel in this project will be minimized using the existing personnel. The core staffs who are working in the existing facilities continue to operate the newly installed facilities. They are supposed to have sufficient abilities through the training program provided in this project.

In case the target wells have not currently been used, new operators are required. Personnel required for the facilities' operation is shown in the next table.

Table 3-9 Personnel required for facilities' operation

	Total operators needed	Operators added
Solana	2	0
Binmaley	4	0
Lingayen	2	0
Pagsanjan	2	2
Panitan	2	2
Pontevedra	2	0
Dingle-Pototan	2	0
Abuyog	2	2
Midsayap	2	0
Kabacan	2	0

Regarding maintenance plan after the handing over of the facilities under the project, it is mainly focused on the technical aspects such as the operation and maintenance of water treatment facilities, periodical inspection and service of the equipment. They are summarized as follows.

1) Maintenance at normal operation

- The way to start up the pumps, the filtration tanks, the sedimentation tanks, and the equipment for the disinfection
- The way to check and record normal operation of the equipment
- The way to stop the equipment and manage them while they are not in use
- The way to analyze the quality of water (raw water and treated water)
- The way to inject chemicals (injection rate) according to the quality of water
- The way of daily maintenance of various machines and tools such as replacement of oil of driving gears and application of grease to rubber parts

2) Countermeasures in unusual situations

- In case of blackouts
- In case of sudden breakdowns of the equipment
- In case of abnormal quality of water

3) Others

- The way of regular cleaning and checking of the inside of the boreholes
- The way of regular cleaning and checking of the inside of the filtration tanks and the sedimentation tanks
- The way to maintain the other devices

- The way to prevent accidents which can occur in the facilities for chlorination

- The way to manage the stocks of consumptive goods, especially chemicals

The water fees which are significant for the O&M should be determined considering the total costs, the current water fees, LWUA's and other administration's policies, and the target people's incomes. LWUA now aims that the water fees should be below 5% of the target people' s incomes, and this project is supposed to achieve the aim. There are possibilities that the consumers accept the increase of water fees due to the improved quality, or that more people have contracts with LWUA. Nevertheless, it is still needed to do more stable business by cutting off the costs and developing more efficient system.

* * * * *

CHAPTER 4 PROJECT EVALUATION AND RECOMMENDATION

Chapter 4　Project Evaluation and Recommendation

4-1　Project Effect

LWUA, which is the responsible and implementing agency in this Project, is the only one water supply agency supporting WDs of more than 20,000 people in terms of finance and techniques. Moreover, the 10 target WDs in the Project are also implementing agencies like LWUA.

There are more than 600 WDs under the administration of LWUA, and most of them are dependant upon drilled wells as water sources. However, not small number of the WDs have problems of the water quality and supply the water which cannot fill the Philippines National Standard for Drinking Water. In this Project 10WD were chosen as the targets from 45 WDs. These WDs have been supplying water without any treatment against the problems of iron, manganese, the color and so on, and as a result, facing difficulties of management. The following conditions were applied for the selection of the target WDs.

<u>Conditions of the Selection of the 10WDs</u>

① WDs whose water qualities do not fulfill the Philippines National Standard for Drinking Water
② WDs which are unable to receive loans due to their limited scales
③ WDs which can secure the land necessary for the Project execution
④ WDs which are not requesting similar projects to other donors.

As many as 121,000 residents in the 10 WDs have been supplied the water which are not fulfilling the Standard, even though they pay the water charge. Among these WDs some cannot use their own water sources and buy more expensive water from the adjacent cities. The business scale of each of the WDs is too small to undertake the water quality improvement plan, and they cannot satisfy the conditions to receive the finance. It is an emergency issue to improve the water qualities in order to improve their standards of living, which currently have hygienic problems.

It is clear that the improvement of the water qualities by the Project contributes to the improvement of the water supply environment as well as the operation of these 10WDs.

In addition, the Project can have valuable effects that the concept and the knowledge of water treatment technology and operation and maintenance are transmitted to the other WDs which also need to improve their water qualities. Each of the 10 WDs shows its capacity to accept the Project by accomplishing its responsibility like securing the necessary land and dealing with its imposed tax.

Above all, the effects and the meaning of the Project are really significant. Furthermore, each WD as an implementing agency and a recipient of the grant has a long experience of water supplies and has been showing its cooperative behavior for the Project. Thus, it is considered to be appropriate that the execution of this Project under The Grant Aid System.

Table 4-1 Effects and Degree of Improvement of Project Implementation

Present Situation and Problem	Measures to be taken in the Project	Effects and Degree of Improvement
Each WD's main well(s) contain(s) high concentration of iron, manganese, color, objectionable taste and odors, and such water cannot fulfill the Philippines Standard for the Drinking Water. That causes that the users avoid water from piped water supply and leads them to use shallow wells with a high risk of contamination. Supplied water which does not fulfill the Standard for the Drinking Water is 12,500 m^3/day.	To install appropriate facilities of aeration, coagulation and sedimentation, and filtration for the target constituents of the water in each site.	Supply of improved water which achieve the National Standard for Drinking Water Capacity of water supply is 29,500 m^3/day. This volume can be enough to satisfy the demand even in peak times. Due to the improved water qualities, the residents' trust and support for the services can be obtained.
Frequent backwashes to remove slime within the pipelines generate a great amount of Unaccounted-for-water and cause a poor management of water supplies.	To improve the water quality so that the backwash is not necessary.	The reduction of un-accounted-for-water by backwash contributes to better management of WDs.
The present water qualities cannot satisfy the increasing demand, and that prevents the improvement of the water supply coverage. The population who are consuming inappropriate quality of water is 121,000 in 1999.	The training program for the operators is carried out so as to achieve smooth and effective operation of water treatment facilities.	The management improves and becomes sustainable in terms of water quality and quantity through the training program. The population who are constantly supplied good quality of water will become 226,000 persons in 2010.

4-2 Recommendations

The direct effects caused by the Project and the spin-off effects to many other WDs can be expected. However, most of the target WDs in the Project are small in their operation scales, and thus, financially weak. It can be said that the only Japan's Grant Aid can undertake the Project. The WDs' officers have strong concern to the realization of the Project and the sustainable operation after the Project's completion.

Nevertheless, there are also many issues to be handled by WD themselves like securing of lands, clarification of taxes, installation of power supply system and so on. Although each WD is acting positively, small-scale WDs need to make proper efforts. Therefore, monitoring and supports in terms of technology and finance from LWUA is necessary. At the same time budgetary and investment supports from the government of Philippines' are also required.

At the stage of the analyses in Japan after the Field Survey I, the possibility of trihalomethane formation, which is the byproduct of the reaction of organic substances like humic substances and chlorine as disinfectant, was pointed out. Although this parameter is not included in the Philippines' standard, it was decided that the tests were going to be conducted. The results of the test for Trihalomethane Formation Potential was within the standard of Japan and the USA. Therefore, it is not included in this Project as a objective parameter. However both responsible and implementing agencies need to monitor the water quality with great cares after the plants start running. Especially, it is strongly recommended that LWUA, in charge of local water supplies, has the initiative of this issue.
Backwashed water and sludge generated from the water treatment process are recycled or treated so that water resources are conserved and negative impacts on the environment are not expected. However, the regular monitoring of discharged water is also important.

For the groundwater development in future, the quality of water as well as the quantity should be emphasized. Moreover, if there are potentials of groundwater of good quality outside of the target WD, the water cannot be transmitted according to the current legislation. However, these legislative issues should be discussed for the more effective systems of water supplies.

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APPENDICES

APPENDIX-1 MEMBER LIST OF THE STUDY TEAM

1) Basic Design Study I

Name	Assignment	Affiliation
(1) Akira Nakamura	Team Leader	Deputy Director, Project Coordination and Managing Division, Grant Aid Management Department, JICA
(2) Ichiro YOKOTA	Technical Advisor	JICA Expert
(3) Takeharu Kojima	Project Coordinator	First Project Management Division Grant Aid Management Department, JICA
(4) Kanji Takamatsu	Chief Consultant /Management, Operation and Maintenance Planner	Japan Techno Co., Ltd.
(5) Yoshitaka Hamanaka	Water Supply System Planning	Japan Techno Co., Ltd.
(6) Hosaku Kato	Water Treatment Facilities Planning I	Japan Techno Co., Ltd.
(7) Shigeyoshi Kagawa	Hydrogeologist	Japan Techno Co., Ltd.
(8) Yusuke Ando	Water Treatment Facilities Planning II	Japan Techno Co., Ltd.

2) Basic Design Study II

Name	Assignment	Affiliation
(1) Kanji Takamatsu	Chief Consultant /Management, Operation and Maintenance Planner	Japan Techno Co., Ltd.
(2) Yoshitaka Hamanaka	Water Supply System Planning	Japan Techno Co., Ltd.
(3) Hosaku Kato	Water Quality Analysis I/ Water Treatment Facilities Planning I	Japan Techno Co., Ltd.
(4) Yusuke Ando	Water Treatment Facilities Planning II	Japan Techno Co., Ltd.

(5) Shoji Takamatsu	Cost Estimation /Procurement plan	Japan Techno Co., Ltd.
(6) Yasuhiro Matsui	Water Quality Analysis II	Japan Techno Co., Ltd.

3) Explanation of Draft Basic Design I

Name	Assignment	Affiliation
(1) Akira Nakamura	Team leader	Deputy Director, Project Coordination and Managing Division, Grant Aid Management Department, JICA
(2) Kanji Takamatsu	Chief Consultant /Management, Operation and Maintenance Planner	Japan Techno Co., Ltd.
(3) Yusuke Ando	Water Treatment Facilities Planning II	Japan Techno Co., Ltd.
(4) Ichiro Takamatsu	Economic and Financial Analysis/Legal System	Japan Techno Co., Ltd.

4) Explanation of Draft Basic Design II

Name	Assignment	Affiliation
(1) Akira Nakamura	Team leader	Deputy Director, Project Coordination and Managing Division, Grant Aid Management Department, JICA
(2) Kanji Takamatsu	Chief Consultant /Management, Operation and Maintenance planner	Japan Techno Co., Ltd.
(3) Ichiro Takamatsu	Economic and Financial Analysis/Legal System	Japan Techno Co., Ltd.

APPENDIX-2 STUDY SCHEDULE

1) Basic Design Study I

No.	Day	Date	Activities
1	Mon	23/8	Narita－Arrive at Manila, Courtesy call to JICA
2	Tue	24/8	Courtesy call to Embasy of Japan and LWUA Explanation of inception report
3	Wed	25/8	Site Survey（Lingayen, Binmaley）
4	Thu	26/8	Site Survey（Panitan, Mambusao, Pontevedra）
5	Fri	27/8	Team1:Site Survey（Dingle-Pototan） Team2:Site Survey（Dingle-Pototan）
6	Sat	28/8	Team1:Site Survey（Abuyog） Team2:Site Survey（Panitan）
7	Sun	29/8	Team1: Data collection/analysis（Manila） Team2: Data collection/analysis（Roxas）
8	Mon	30/8	Team1:Site Survey（Pagsanjan） Team2:Site Survey（Mambusao＝Similar Project Site）
9	Tue	31/8	Team1:Discussion of Minutes Team2:Site Survey（Pontvedra）
10	Wed	1/9	Team1:Meeting with Embasy of Japan Team2:Site Survey（Panitan）
11	Thu	2/9	Team1:Discussion and signing of Minutes Team2:Site Survey（Dingle-Pototan）
12	Fri	3/9	Site Survey（Binmaley）
13	Sat	4/9	Site Survey（Lingayen）
14	Sun	5/9	Site Survey（Binmaley）
15	Mon	6/9	Site Survey（Binmaley, Lingayen）
16	Tue	7/9	Site Survey（Binmaley, Lingayen）・Movement
17	Wed	8/9	Site Survey（Solana）
18	Thu	9/9	Site Survey（Solana）
19	Fri	10/9	Site Survey（Solana）
20	Sat	11/9	Movement / Data collection
21	Sun	12/9	Movement
22	Mon	13/9	Site Survey（Pagsanjan）
23	Tue	14/9	Site Survey（Pagsanjan）/ Movement
24	Wed	15/9	Movement
25	Thu	16/9	Site Survey（Abuyog）
26	Fri	17/9	Site Survey（Abuyog）
27	Sat	18/9	Movement / Data collection
28	Sun	19/9	Movement / Data collection
29	Mon	20/9	Site Survey（Midsayap）
30	Tue	21/9	Site Survey（Midsayap）
31	Wed	22/9	Site Survey（Kabacan）
32	Thu	23/9	Site Survey（Sultan＝Similar Project Site）, Movement
33	Fri	24/9	Site Survey（Kabacan） / Movement
34	Sat	25/9	Movement / Data collection
35	Sun	26/9	Data collection
36	Mon	27/9	Meeting with LWUA
37	Tue	28/9	Site Survey（Nasugbu＝Similar Project Site）
38	Wed	29/9	Meeting with LWUA and Embassy of Japan
39	Thu	30/9	Meeting with JICA
40	Fri	1/10	Manila－Arrive at Narita

2) Basic Design Study II

No.	Day	Date	Activities
1	Mon	15/11	Narita－Arrive at Manila, Courtesy call to JICA
2	Tue	16/11	Courtesy call to Embassy of Japan and LWUA
3	Wed	17/11	Explanation of inception report
4	Thu	18/11	Site Survey(Nasugbu)
5	Fri	19/11	Movement, Site Survey(Pagsanjan)
6	Sat	20/11	Site Survey(Pagsanjan)
7	Sun	21/11	Site Survey(Pagsanjan)
8	Mon	22/11	Site Survey(Pagsanjan), Movement
9	Tue	23/11	Movement
10	Wed	24/11	Site Survey(Lingayen)
11	Thu	25/11	Site Survey(Lingayen)
12	Fri	26/11	Site Survey(Binmaley)
13	Sat	27/11	Site Survey(Binmaley)
14	Sun	28/11	Movement
15	Mon	29/11	Site Survey(Solana)
16	Tue	30/11	Site Survey(Solana)
17	Wed	1/12	Movement
18	Thu	2/12	Meeting with LWUA
19	Fri	3/12	Movement
20	Sat	4/12	Site Survey(Abuyog)
21	Sun	5/12	Site Survey(Abuyog)
22	Mon	6/12	Site Survey(Abuyog)
23	Tue	7/12	Movement
24	Wed	8/12	Movement
25	Thu	9/12	Site Survey(Dingle-Pototan)
26	Fri	10/12	Site Survey(Dingle-Pototan)
27	Sat	11/12	Site Survey(Pontevedra), Movement
28	Sun	12/12	Site Survey(Pontevedra)
29	Mon	13/12	Site Survey(Panitan, Roxas)
30	Tue	14/12	Site Survey(Panitan, Manbusao)
31	Wed	15/12	Movement
32	Thu	16/12	Movement
33	Fri	17/12	Site Survey(Midsayap), Movement
34	Sat	18/12	Site Survey(Midsayap)
35	Sun	19/12	Site Survey(Kabacan)
36	Mon	20/12	Site Survey(Kabacan)
37	Tue	21/12	Movement
38	Wed	22/12	Movement, Meeting with Embassy of Japan and JICA
39	Thu	23/12	Meeting with LWUA
40	Fri	24/12	Manila－Arrive at Narita

3) Explanation of Draft Basic Design I

No.	Day	Date	Activities
1	Mon	6/3	Narita－Manila, Courtesy call to JICA
2	Tue	7/3	Courtesy call to LWUA, Explanation of draft final report, meeting
3	Wed	8/3	Site Survey（Panitan, Pontevedra, Dingle-Pototan）, Meeting with LWUA
4	Thu	9/3	Explanation to each WD, discussion of Minutes
5	Fri	10/3	Meeting with NEDA, Signing of Minutes
6	Sat	11/3	Data collection /analysis
7	Sun	12/3	Data collection /analysis
8	Mon	13/3	Site Survey（Abuyog）
9	Tue	14/3	Meeting with LWUA
10	Wed	15/3	Manila－Arrive at Narita

4) Explanation of Draft Basic Design II

No.	Day	Date	Activities
1	Mon	26/6	Narita－Arrive at Manila, Courtesy call to JICA
2	Tue	27/6	Courtesy call to LWUA, Explanation of draft final report, Meeting
3	Wed	28/6	Site Survey（Panitan, Pontevedra, Dingle-Pototan）, Meeting with LWUA
4	Thu	29/6	Explanation to each WD, Discussion for Minutes
5	Fri	30/6	Meeting with NEDA, Signing of Minutes
6	Sat	1/7	Data collection /analysis
7	Sun	2/7	Data collection /analysis

APPENDIX-3 LIST OF CONCERNED PARTIES IN THE PHILIPPINES

1) Basic Design Study I

1 Embassy of Japan in the Philippines

Hikaru Hukuda	First Secretary

2 JICA Philippines Office

Hideo Ono	Resident Representative
Toshiyuki Kuroyanagi	Deputy Resident Representative
Tomoya Yoshida	Project Management Section
Masatoshi Takahashi	Project Management Section
Koichi Takizawa	Project Management Section

3 Local Water Utilities Administration：LWUA

Prodencio M. Reyes, Jr	Administrator
Simolicio C. Belisario, Jr	Senior Deputy Administrator
Emmanuel B. Mlicdem	Deputy Administrator
Gil M. Infantado	Head Executive Assistant
Jessielen D. Catapang	Chemist
Manuel T. Yoingco	Management Service Office Manager
Boy Baraan	Water Resource/Supply Engineer
Antonio Magtibay	Area 1 Division Manager
Oscar M Jusi	Area 3 Division Manager
Ephraim M. Jacildo	Area 5 Division Manager
Cielito P. Establecida	Area 6 Division Manager
Clint Cuchuele	Area 8 Division Manager

4 Water District：WD

Vincent G. Soriano	Solana WD General Manager
Mariao Gonzalo	Binmaley WD General Manager
Jorge A. Salazar	Lingayen WD General Manager
Jessie C. Permalino	Pagsanjan WD General Manager
Jocelyn D. Catalan	Panitan WD General Manager
Leandro Antonio B. Capulso	Pontevedra WD General Manager
Adeo B. Luntao	Dingle-Pototan WD General Manager
Generoso B. Adolfo, Jr	Abuyog WD General Manager
Carol S. Ringor	Midsayap WD General Manager
Rouben D. Landingin	Kabacan WD General Manager
Jessica M. Mansilla	Manbusao WD General Manager
Jose D. Tabuga	Sultan-Kadrat WD General Manager
Abelardo L. Rojales	Nasugbu WD General Manager

5 National Economic and Development Authority：NEDA

Nelson Gievara	Planning staff
Vanessa Aghes Dimaano	Planning staff
Edna B. Capacillo	Planning staff
Aloha T. Samoza	Infrastructure staff

2) Basic Design Study II

1 Embassy of Japan in the Philippines

Hikaru Hukuda	First Secretary

2 JICA Philippines Office

Tomoya Yoshida	Project Management Section

3 Local Water Utilities Administration：LWUA

Prodencio M. Reyes, Jr	Administrator
Emmanuel B. Mlicdem	Deputy Administrator
Gil M. Infantado	Head Executive Assistant
Jessielen D. Catapang	Chemist
Manuel T. Yoingco	Management Service Office Manager
Boy Baraan	Water Resource/Supply Engineer
Antonio Magtibay	Area 1 Division Manager
Oscar M Jusi	Area 3 Division Manager
Ephraim M. Jacildo	Area 5 Division Manager
Cielito P. Establecida	Area 6 Division Manager
Clint Cuchuele	Area 8 Division Manager
Ichiro Yokota	JICA expert

4 Water District：WD

Vincent G. Soriano	Solana WD General Manager
Mariao Gonzalo	Binmaley WD General Manager
Jorge A. Salazar	Lingayen WD General Manager
Jessie C. Permalino	Pagsanjan WD General Manager
Jocelyn D. Catalan	Panitan WD Deputy Manager
Leandro Antonio B. Capulso	Pontevedra WD General Manager
Adeo B. Luntao	Dingle-Pototan WD General Manager
Generoso B. Adolfo, Jr	Abuyog WD General Manager
Carol S. Ringor	Midsayap WD General Manager
Mr.Amba	Kabacan WD Deputy Manager
Jessica M. Mansilla	Manbusao WD General Manager
Jose D. Tabuga	Sultan-Kadrat WD General Manager
Abelardo L. Rojales	Nasugbu WD General Manager

3) Explanation of Draft Basic Design I

1 JICA Philippines Office

Hideo Ono	Resident Representative
Toshiyuki Kuroyanagi	Deputy Resident Representative
Tomoya Yoshida	Project Management Section

2 Local Water Utilities Administration：LWUA

Prodencio M. Reyes, Jr	Administrator
Simolicio C. Belisario, Jr	Senior Deputy Administrator
Emmanuel B. Mlicdem	Deputy Administrator
Gil M. Infantado	Head Executive Assistant
Jessielen D. Catapang	Chemist
Manuel T. Yoingco	Management Service Office Manager
Boy Baraan	Water Resource/Supply Engineer
Antonio Magtibay	Area 1 Division Manager
Oscar M Jusi	Area 3 Division Manager
Mario I Quitoriano	Area 4 Division Manager
Ephraim M. Jacildo	Area 5 Division Manager
Cielito P. Establecida	Area 6 Division Manager
Clint Cuchuele	Area 8 Division Manager
Ichiro Yokota	JICA expert

3 Water District：WD

Vincent G. Soriano	Solana WD General Manager
Mariao Gonzalo	Binmaley WD General Manager
Jorge A. Salazar	Lingayen WD General Manager
Mena Lisa M. Trinidad	Pagsanjan WD
Jocelyn D. Catalan	Panitan WD Officer in charge
Leandro Antonio B. Capulso	Pontevedra WD General Manager
Adeo B. Luntao	Dingle-Pototan WD General Manager
Generoso B. Adolfo, Jr	Abuyog WD General Manager
Carol S. Ringor	Midsayap WD General Manager
Rouben D. Landingin	Kabacan WD General Manager

4 National Economic and Development Authority：NEDA

Nelson Gievara	Public Investment staff
Edna B. Capacillo	Project Monitoring staff
Nar Prudente	Infrastructure staff

4) Explanation of Draft Basic Design II

1 Embassy of Japan	
Kuniaki Miyake	Second Secretary
2 JICA Philippine Office	
Hideo Ono	Resident Representative
Maita P. Alcampado	Project Liaison Officer
Tomoya Yoshida	Project Management Section
3 Local Water Utilities Administration：LWUA	
Manuel T. Yoingco	Officer-in-Charge
Simplicio C. Belisario, Jr	Senior Deputy Administrator
Antonio B.Ramirez, Jr	Office of SDA
Gil M. Infantado	Head Executive Assistant
Jessielen D. Catapang	Chemist
Jpan A. Aban	Engineer
Nilo Dela Cruz	Area 1 Division Manager
Oscar M Jusi	Area 3 Division Manager
Danulo Basilio	Area 5 Division Manager
Franco Bula, Jr	Area 6 Division Manager
Armando Fernandez	Area 8 Division Manager
Ichiro Yokota	JICA expert
4 Water District：WD	
Vincent G. Soriano	Solana WD General Manager
5 National Economic and Development Authority：NEDA	
Nelson Gievara	Public Investment staff
Vanessa Dimaano	Public Investment staff
Edna B. Capacillo	Project Monitoring staff
6 Dept. of Environment Natural Resources	
Raynald P. Alcances	Chief Environmental Management Specialist

APPENDIX-4 MINUTES OF DISCUSSIONS

MINUTES OF DISCUSSIONS
ON THE BASIC DESIGN STUDY
ON THE PROJECT FOR IMPROVEMENT OF WATER QUALITY
IN LOCAL AREAS
IN THE REPUBLIC OF THE PHILIPPINES

In response to a request from the Government of Republic of the Philippines (herein after referred to as "the Philippines"), the Government of Japan decided to conduct a Basic Design Study on the Project for Improvement of Water Quality in Local Areas in the Republic of the Philippines (herein after referred to as "the Project") and entrusted the study to the Japan International Cooperation Agency (herein after referred to as "JICA").

JICA sent to the Philippines the Basic Design Study Team (herein after referred to "the Team"), which is headed by Mr. Akira Nakamura, Deputy Director, Project Coordination and Monitoring Division, Grant Aid Management Department, and is scheduled to stay in the country from August 23 to September 2.

The team held discussions with the officials concerned of the Government of the Philippines and conducted a field survey at the study area.

In the course of discussions and field survey, both parties have confirmed the main items described on the attached sheets. The Team will proceed to further works and prepare the Basic Design Study Report.

Quezon, September 2, 1999

Akira Nakamura
Leader,
Basic Design Study Team,
Japan International Cooperation Agency

Prudencio M. Reyes Jr.
Administrator
Local Water Utilities Administration

ATTACHMENT

1. Objective

The overall objective of the Project, which shall be achieved by undertakings of both sides, is to improve the water supply services and the operating conditions of Water Districts (hereinafter referred to as "WDs"). The objective of the Grant Aid is to improve the quality of the water being supplied to the existing water distribution system of the WDs.

2. Project Sites

By an official request from the Philippines Side, Balayan WD (Batangas Province) and Matnog WD (Sorsogon Province) were deleted from the target WDs, and Binmaley WD (Pangasinan Province) and Lingayen WD (Pangasinan Province) were newly proposed as target WDs. The reasons are as listed below;

(1) The water quality of the boreholes in Balayan WD and Matnog WD fulfill the Philippines Standards for drinking water.
(2) The water from the boreholes in Binmaley WD and Lingayen WD were found to have objectionable odor and color, and contain high concentration of COD.
(3) The water quality of the boreholes in Binmaley WD and Lingayen WD are typical of that found in many WDs. Therefore the two WDs will be a model for WDs that have the similar water quality.

The final target WDs requested by the Philippines Side are shown in Annex-1. The Philippines Side also confirmed that these WDs fulfill the following conditions:

(1) The water of the boreholes contains water quality items that do not fulfill the Philippines National Standard for drinking water.
(2) The WDs are unable to receive loans due to their limited scale.
(3) The WDs can secure the land necessary for Project execution.
(4) The WDs are not requesting other donors for the execution of the Projects.

However, the final target WDs shall be determined by further studies.

3. Responsible and Implementing Agencies

(1) Responsible Agency of the Project

Local Water Utilities Administration (hereinafter referred to as "LWUA", Annex-2)

(2) Implementing Agencies of the Project

LWUA and WDs

4. Items requested by the Government of the Philippines

After discussions on the demarcation and the objective of the Project, the Philippines Side finally requested the Japanese Side for the construction of facilities and procurement/installation of equipment that are necessary for improving the quality of water supplied to the existing distribution network, such as listed below;

(1) Construction/Installation of water treatment facilities
(2) Replacement of well pump
(3) Replacement of disinfecting facility
(4) Rehabilitation/Construction of pump station house
(5) Installation of pipes and electrical equipment for related facilities mentioned above
(6) Procurement of monitoring and laboratory equipment

Also the Philippines Side requested the Team to apply the below design criteria to the Project.

(1) Target Year: 2010
(2) Average Daily Consumption per Capita: 90 to 120 (liters/day/capita)

The Team will assess the appropriateness of the above request by further studies.

5. Japan's Grant Aid system

(1) The Philippines Side understands the Japan's Grant Aid scheme and procedures explained by the Team as shown in Annex-3 and Annex-4.

(2) The Philippines Side will take the necessary measures, described in Annex-5, for smooth implementation of the Project, as a condition for the Japanese Grant Aid to be implemented.

6. Schedule of the study

(1) The consultants will proceed to future studies in the Philippines until October 1, 1999.

(2) JICA will prepare the interim report in English and dispatch a mission in order to conduct a second field study in the Philippines around November 1999.

(3) Based on the results of the studies, JICA will prepare the draft report in English and dispatch a mission in order to explain its contents around February 2000.

7. Other Relevant Issues

The Philippines Side and the Team has confirmed the following issues.

(1) Both Sides have envisaged the water quality problems of Iron, NH_4-N, color, odor and other items from the water from boreholes of WDs.

(2) LWUA and the target WDs will take all necessary precautions to secure the full safety of the Team during their study in the Philippines.

(3) The Project does not have an approval from the Investment Coordination Committee (ICC) as of now because the contents of the former request submitted by the Philippines Side in 1997 did not require the approval from ICC. However, by further findings of LWUA and the Team, both sides envisaged that the possibilities of this Project requiring an approval from ICC is high.

(4) As soon as the outline of this Project is designed, LWUA and other relevant agencies will take all necessary measures to acquire the approval of ICC in time.

(5) LWUA and other relevant agencies will allocate necessary budget and take necessary measures in order to exempt Japanese nationals from taxes in the Philippines regarding this Project.

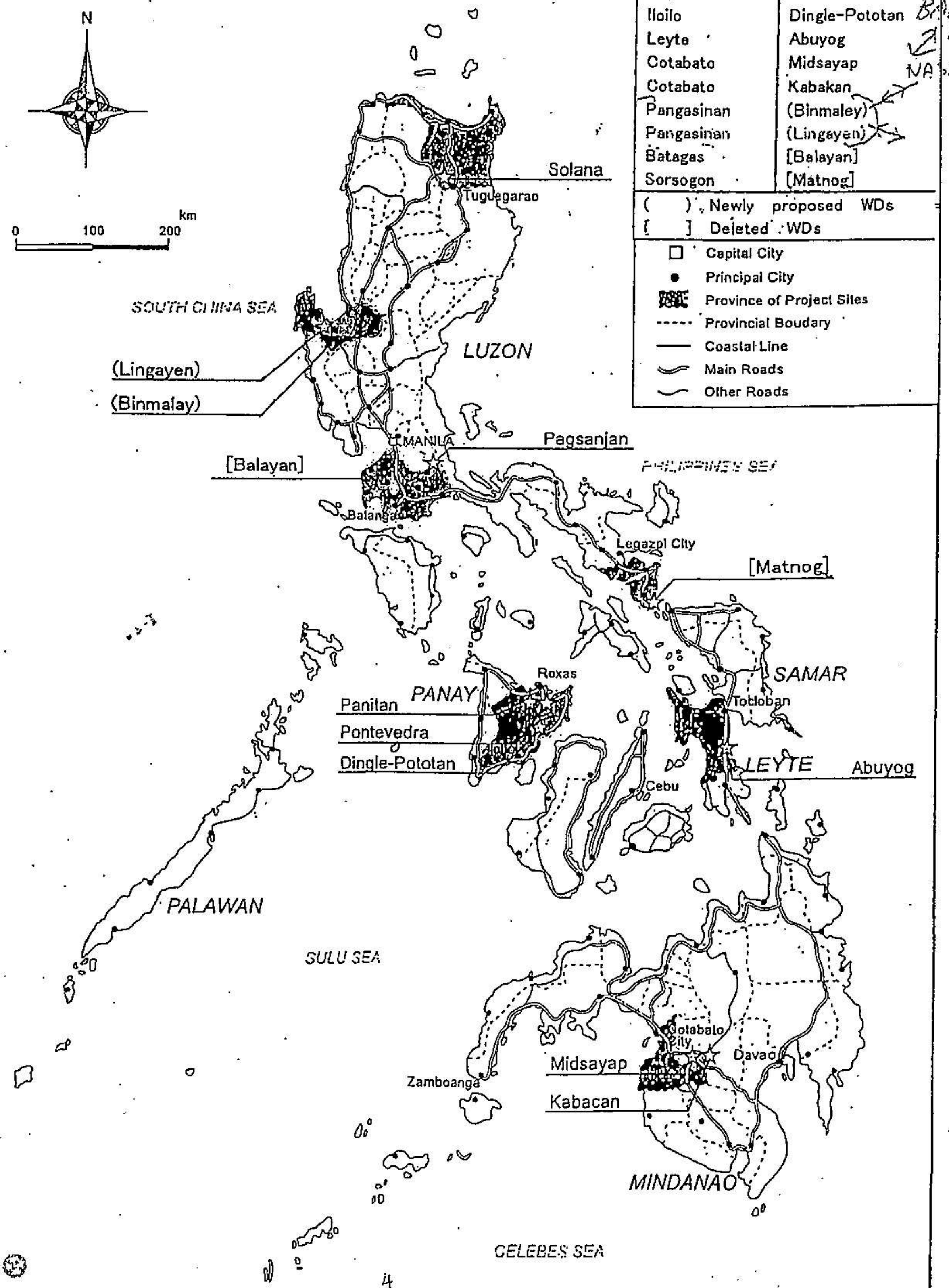
(6) If the Grant Aid is extended to the Project, LWUA will ensure the sustainability of the Project by monitoring the target WDs and providing technical assistance for operation and maintenance to the target WDs.

Basic Design Study for the Project for Improvement of Water Quality of Local Area in the Republic of Philippines

ANNEX-1
Map of Project Area

Province	Project Site
Cagayan	Solana
Laguna	Pagsanjan
Capiz	Panitan
Capiz	Pontevedra
Iloilo	Dingle-Pototan
Leyte	Abuyog
Cotabato	Midsayap
Cotabato	Kabakan
Pangasinan	(Binmaley)
Pangasinan	(Lingayen)
Batagas	[Balayan]
Sorsogon	[Matnog]

( ) Newly proposed WDs
[ ] Deleted WDs



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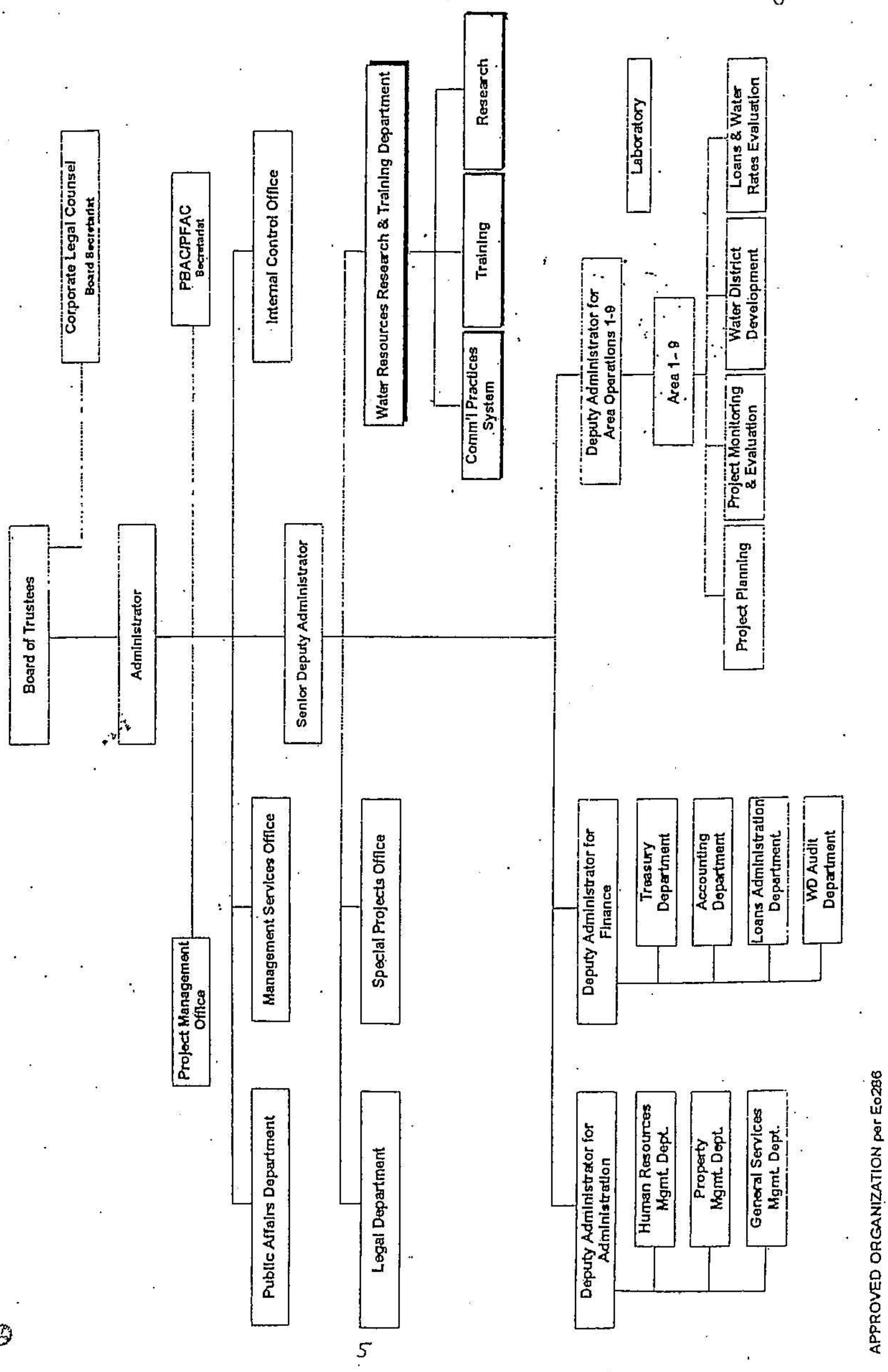
Annex-2.1 Organization Chart of LWUA



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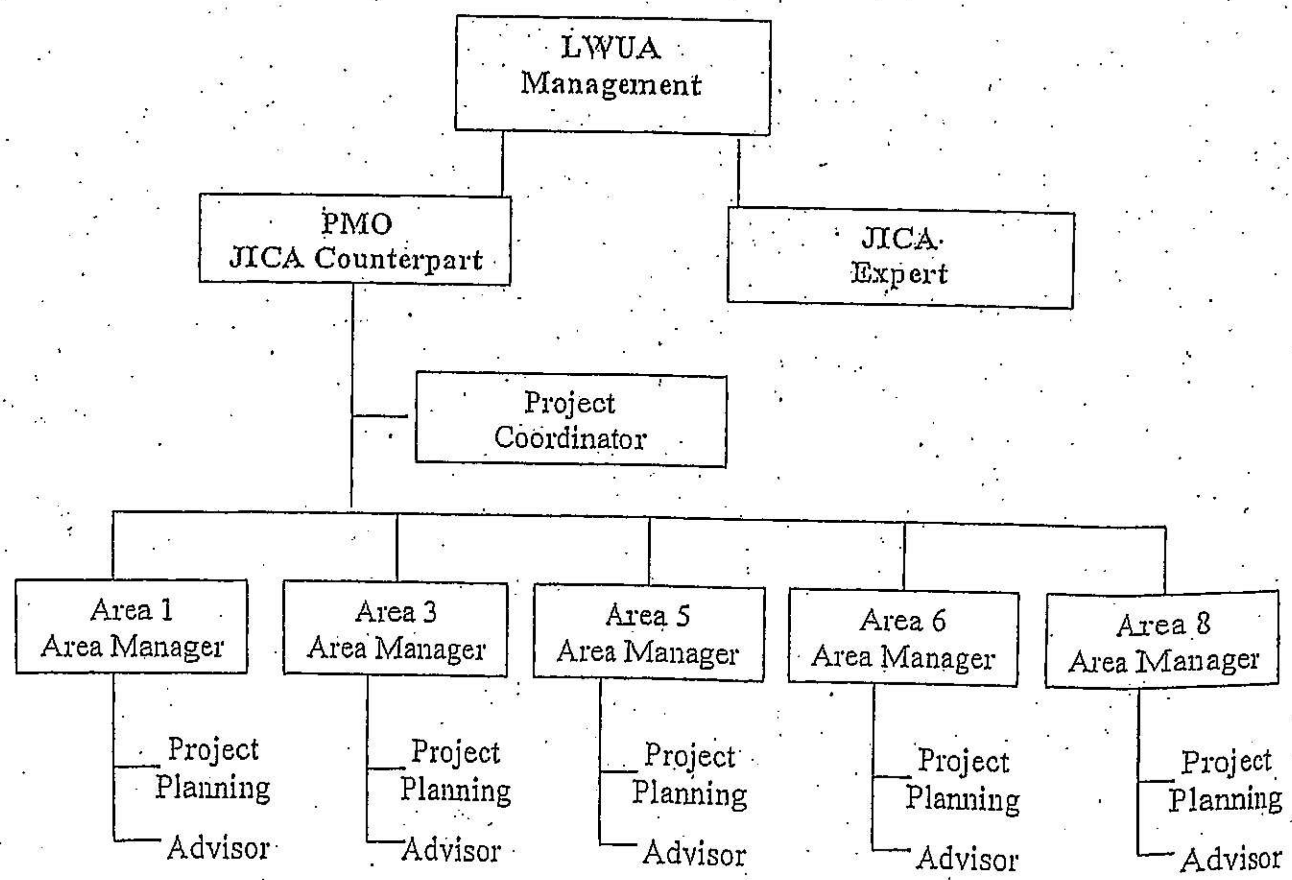
Annex-2.2 Organization Chart of JICA Project Management Unit in LWUA

Function

- To assist the Basic Design Team of JICA in the preparation study for the Ten (10) Water Districts for the grant-in aid project.
- To coordinate with Water Districts concerned and other agencies units
- To provide all necessary technical, financial and management information needed for the study.
- To assist in the preparation of reports required by the Study Team
- To prepare monthly report to LWUA Management

Structure



Annex-3 JAPAN'S GRANT AID PROGRAM

1. Japan's Grant Aid Procedures

(1) The Japan's Grant Aid Program is executed by the following procedures.

- Application (request made by a recipient country)
- Study (Preliminary Study / Basic Design Study conducted by JICA)
- Appraisal & Approval (Appraisal by the Government of Japan and Approval by the Cabinet of Japan)
- Determination of Implementation (Exchange of Notes between both Governments)
- Implementation (Implementation of the Project)

(2) Firstly, an application or a request for a Grant Aid project submitted by the recipient country is examined by the Government of Japan (the Ministry of Foreign Affairs) to determine whether or not it is eligible for Japan's Grand Aid. If the request is deemed appropriate, the Government of Japan entrusts a study on the request to JICA (Japan International Cooperation Agency).

Secondly, JICA conducts the Study (Basic Design Study), using a Japanese consulting firm

Thirdly, the Government of Japan appraises to see whether or not the project is suitable for Japan's Grant Aid Program, based on the Basic Design Study report prepared by JICA, and the results are then submitted to the Cabinet for approval.

Fourthly, the Project, once approved by the Cabinet, becomes official when pledged by the Exchange of Notes signed by the Governments of Japan and the recipient country.

Finally, for the implementation of the Project, JICA assists the recipient country in such matters as preparing tenders, contracts and so on.

2. Contents of the Study

(1) Contents of the Study

The aim of the Study (hereinafter referred to as "the Study") conducted by JICA on a requested project (hereinafter referred to as "the Project") is to provide a basic document necessary for appraisal of the Project by the Japanese Government. The contents of the Study are as follows:

a) Confirmation of the background, objectives, and benefits of the requested project and also institutional capacity of agencies concerned of the recipient country necessary for project implementation,

b) Evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme from a technical, social and economical point of view,
c) Confirmation of items agreed on by both parties concerning the basic concept of the Project,
d) Preparation of a basic design of the Project,
e) Estimation of costs of the project.

The contents of the original request are not necessarily approved in their initial form as the contents of the Grant Aid project. The Basic Design of the Project is confirmed considering the guidelines of Japan's Grant Aid Scheme.

The Government of Japan requests the Government of the recipient country to take whatever measures are necessary to ensure its self-Reliance in the implementation of the Project. Such measures must be guaranteed even though they may fall outside of the jurisdiction of the organization in the recipient country actually implementing the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country through to Minutes of Discussions.

(2) Selecting (a) Consulting Firm(s)
For smooth implementation of the study, JICA uses (a) registered consulting firm(s). JICA selects (a) firm(s) based on proposals submitted by interested firms. The firm(s) selected carry (ies) out a Basic Design Study and write(s) a report, based upon terms of reference set by JICA.

The consulting firm(s) used for the study is (are) recommended by JICA to the recipient country to also work on the Project's implementation after the Exchange of Notes, in order to maintain technical consistency.

3. Japan's Grant Aid Scheme

(1) What is Grant Aid?
The Grant Aid Program provides a recipient country with non reimbursable funds needed to procure facilities, equipment and services (engineering services and transportation of the products, etc.) for economic and social development of the country under principles in accordance with the relevant laws and regulations of Japan. The Grant Aid is not in a form of donation of materials or such.

(2) Exchange of Notes (E/N)

Japan's Grant Aid is extended in accordance with the Notes exchanged by the two Governments concerned, in which the objectives of the Project, period of execution, conditions and amount of the Grant Aid, etc., are confirmed.

(3) "The period of the Grant Aid" means one Japanese fiscal year which the Cabinet approves the Project for. Within the fiscal year, all procedures such as exchanging of the Notes, concluding contracts with (a) consulting firm(s) and (a) contractor(s) and final payment to them must be completed.

However in case of delays in delivery, installation of construction due to unforeseen factors such as weather, the period of the Grant Aid can be further extended for a maximum of one fiscal year at most by mutual agreement between the two Governments..

(4) Under the Grant, in principle, Japanese products and services including transport or those of the recipient country are to be purchased.

When the two Governments deem it necessary, the Grant may be used for the purchase of products or services of a third country.

However the prime contractors, namely, consulting, contractor and procurement firms, are limited to "Japanese nationals". (The term "Japanese nationals" means persons of Japanese nationality or Japanese corporations controlled by persons of Japanese nationality

(5) Necessity of the "Verification"

The Government of the recipient country or its designated authority will conclude contracts denominated in Japanese Yen with Japanese nationals. Those contracts shall be verified by the Government of Japan. This "Verification" is deemed necessary to secure accountability to Japanese tax payers.

(6) Undertakings required to the Government of the recipient country

In the Implementation of the Grant Aid Project, the recipient country is required to undertake necessary measures such as the follows:.

a) To secure land necessary for the sites of the project and to clear, level and reclaim the land prior to commencement of the construction work,

b) To provide facilities for distribution of electricity, water supply and drainage and other incidental facilities in and around the sites,

c) To secure buildings prior to the installation work in case the Project is providing equipment,

d) To ensure all the expenses and prompt execution for unloading, customs clearance at the port of disembarkation and internal transportation of the products purchased under the Grant Aid,

e) To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which will be imposed in the recipient country with respect to the supply of the products and services under the Verified Contracts,

f) To accord Japanese nationals whose services may be required in connection with the supply of the products and services under the Verified Contracts, such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their works.

(7) "Proper Use"

The recipient country is required to maintain and use facilities constructed and equipment purchased under the Grant Aid properly and effectively and to assign the necessary staff for operation and maintenance of them as well as to bear all expenses other than those to be covered by the Grant Aid.

(8) Re-export

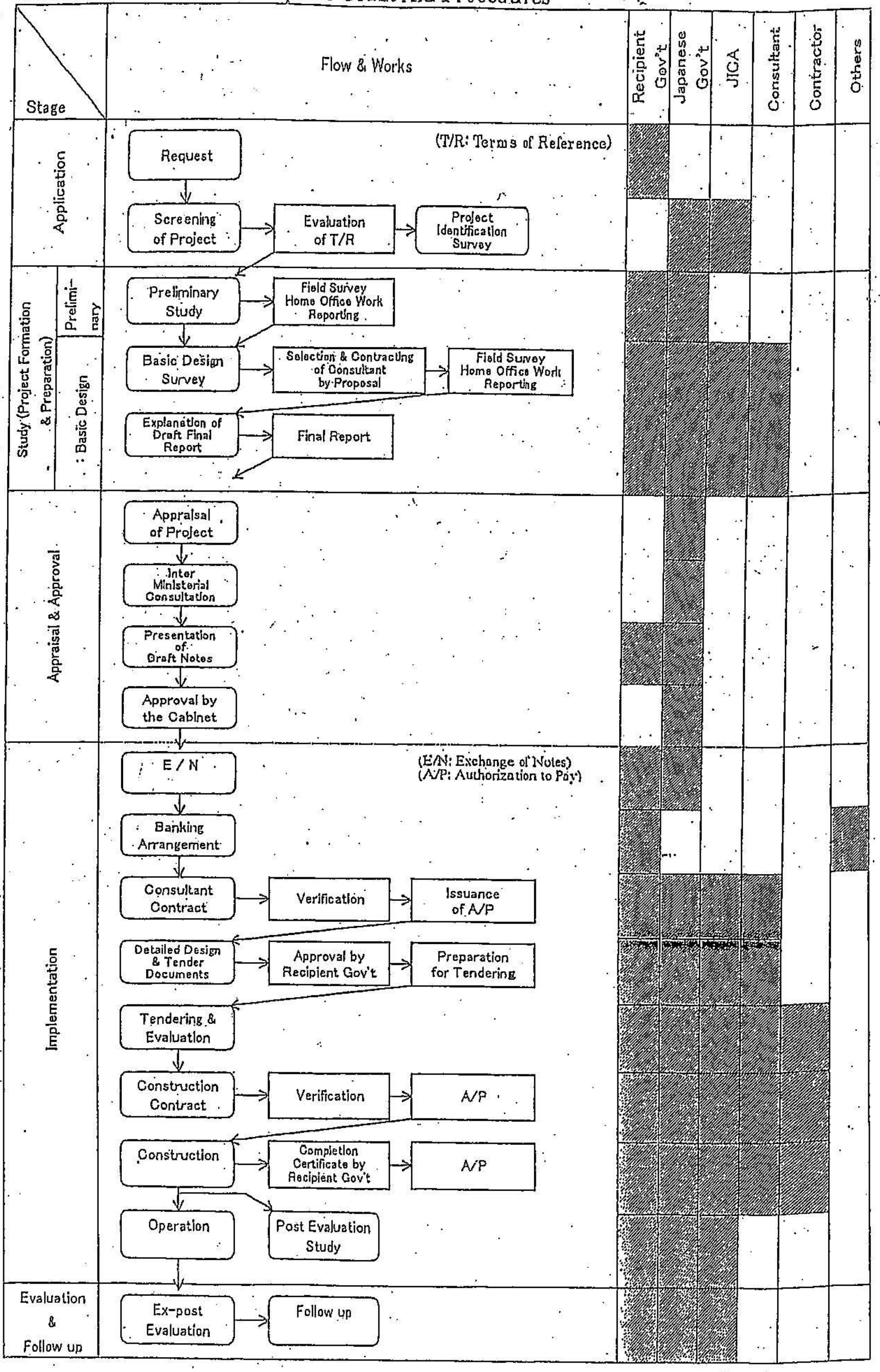
The products purchased under the Grant Aid shall not be re-exported from the recipient country.

(9) Banking Arrangement (B/A)

a) The Government of the recipient country or its designated authority should open an account in the name of the Government of the recipient country in a bank in Japan (hereinafter referred to as "the Bank"). The Government of Japan will execute the Grant Aid by making payments in Japanese yen to cover the obligations incurred by Government of the recipient country or its designated authority under the Verified Contracts.

b) The payments will be made when payment requests are presented by the Bank to the Government of Japan under an Authorization to pay issued by the Government of the recipient country or its designated authority.

Annex-4 Flow Chart of Japan's Grant Aid Procedures



Annex-5 Necessary measures to be taken by the Government of the Philippines on condition that Japan's Grant Aid is extended.

1. To secure land necessary for the sites of the Project and to clear, level and reclaim the land prior to commencement of the construction work.

2. To bear commissions to the Japanese foreign exchange bank to execute the banking services based upon the banking arrangement.

3. To ensure prompt unloading and customs clearance at port of disembarkation in the Philippines and facilitate internal transportation therein of the products purchased under the Grant.

4. To ensure the customs clearance at the port, inland transportation from the port to each site, and to bear the cost for bonded storage at the port.

5. To exempt Japanese nationals from custom duties, internal taxes and other fiscal levies which may be imposed in the Philippines with respect to the supply of the products and services under the verified contracts. And to take necessary measures for such tax exemption.

6. To accord Japanese nationals, whose services may be required in connection with the supply of products and services under the verified contracts, such facilities as may be necessary for their entry into the Philippines and stay therein for the performance of their work.

7. To use and maintain properly and effectively all the equipment purchased and facilities constructed under the Grant.

8. To bear all the expenses other than those covered by the Grant, necessary for the execution of the Project.

9. To provide necessary data and information for the project.

10. To assign exclusive counterpart engineers and technicians for the Project.

Minutes of Discussions
on the Basic Design Study on the Project
for Improvement of Water Quality
in Local Areas
in the Republic of the Philippines
(EXPLANATION ON DRAFT REPORT)

In September and December 1999, the Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched a Basic Design Study Team on the Project for Improvement of Water Quality in Local Areas in the Republic of the Philippines (hereinafter referred to as "the Project") to the Government of the Republic of the Philippines (hereinafter referred to as "the GOP"), and through discussion, field survey, and technical examination of the results in Japan, JICA prepared a draft report of the study.

In order to explain to and consult the GOP side on the components of the draft report, JICA sent to the Philippines the Draft Report Explanation Team (hereinafter referred to as "the Team"), which is headed by Mr. Akira NAKAMURA, Deputy Director, Project Coordination and Monitoring Div., Grant Aid Management Dept., from March 6 to March 15.

As a result of discussions, both parties confirmed the main items described in the attached sheets.

Quezon, March 10, 2000

Akira Nakamura
Leader
Draft Report Consultation Team
Japan International Cooperation Agency

Prudencio M. Reyes Jr.
Administrator
Local Water Utilities Administration

ATTACHMENT

1 . Concepts of the Draft Report

The Philippines side agreed and accepted in principle the concepts of the draft report as explained by the Team.

2. Contents of Items of the Project

Both sides have confirmed the Eleven (11) sites shown in Annex-1 and each item which will be constructed or procured under the Japanese Grant Aid attached as Annex-2.

3 . Japan's Grant Aid scheme

The Philippines side has understood the Japan's Grant Aid Scheme as explained by the Team and described in Annex-3 of the Minutes of Discussions signed by both parties on September 2, 1999.

4. Necessary Measures to be taken by the GOP

(1) The GOP will take necessary measures described in Annex-3 for the smooth implementation of the Project, on the condition that Japan's Grant Aid is extended to the Project.

(2) Each Water District (hereinafter referred to as "the WD") is responsible to secure the land for the Project. Among ten (10) WDs, four (4) WDs, Solana, Lingayen, Dingle-Pototan and Midsayap have already secured the land and will submit a copy of the certificate of ownership to JICA Philippines office by the end of April, 2000. The rest six (6) WDs are presently negotiating with landowners and will submit a copy of the commitment of landowner to sell to JICA Philippines office by the end of June, 2000.

5 . Schedule of the Study

JICA will complete the final report in accordance with the confirmed items and send it to the Philippines by June, 2000.

6. Other relevant issues

(1) LWUA and the target WDs will take all necessary precautionary measures for the security for the Project during implementation.
(2) LWUA and other relevant agencies will allocate necessary budget and take all necessary action so as to exempt Japanese nationals from custom duties, internal taxes and other fiscal levies which may be imposed in the Philippines with respect to the supply of products and materials, and services under the verified contracts during implementation stage.
(3) LWUA and other relevant agencies will allocate necessary budget for implementation of the Project such as land acquisition, site clearance and others.
(4) LWUA ensure that the WDs will allocate necessary budget and assign proper personnel for the operation, maintenance and management of the facilities.
(5) LWUA and the WDs will make a request to the Team for technical guidance services (hereinafter referred to as the "Soft Component") under Japan's Grant Aid in terms of training in the operation, maintenance and management of the facilities.
(6). LWUA and other relevant agencies will take all necessary measures to acquire the timely approval of Investment Coordinating Committee (ICC).
(7) LWUA and other relevant agencies will take all necessary measures to acquire Environmental Compliance Certificate (ECC) or Certificate of Non-Coverage (CNC) from Department of Environment and Natural Resources (DENR) at the soonest possible time.
(8) LWUA and the WDs will enter into a Memorandum of Agreement (MOA) for the execution of the Project by the end of March, 2000.
(9) LWUA will ensure the sustainability of the Project by monitoring the target WDs and providing the WDs with technical and financial assistance for the appropriate operation, maintenance and management of the WDs.
(10) Philippines side requested the Team to provide the following information required for ICC, ECC and other necessary permit clearances.
a) Information necessary for Project description for each WD and other data relevant for application for ECC or CNC as well as for Regional Development Committee (RDC) / National Economic Development Authority (NEDA) Regional Office Endorsement to ICC.
b) Information necessary for cost estimation of land acquisition, right of way, power take-off, taxes and other expenditure to be borne by the Philippines side for the Project implementation by each WD.
(11) Philippines side made the following comments on the draft report of the Project.
a) The following set of criteria shall also be considered in the prioritization of the WDs in the implementation of the Project.

Criteria	Weight
i) Project with the highest and most significant impact and benefit	... 50%
ii) Project with the most difficult water quality problem	... 30%
iii) WDs who have secured the Project sites	... 20%

b) Shorten the execution of the Project to two years considering that the present poor water quality condition highly affects the health, social and economic situation; it being a basic human needs. The sustainability of the WDs can immediately be attained if the Project duration can be condensed further.

(12) LWUA and the Team have conferred with NEDA and have been informed that a "commitment of landowner to sell" is a requirement for ICC approval.

Annex-1 List of Sites to be constructed under the Japanese Grant Aid Project

Island	Water Supply Area LWUA	Province	Target Water Districts	Project Sites (Pumping Station)	Region
Luzon	Area 1	Cagayan	1.Solana	Basi	Region-2
	Area 1	Pangasinan	2.Binmaley	Caloocan	Region-1
				Fabia	
			3.Lingayen	Libsong	
	Area 3	Laguna	4.Pagsanjan	Sabang	Region-4
Panay	Area 5	Capiz	5.Panitan	Phase 2	Region-6
			6.Pontevedra	Sublangon	Region-6
		Iloilo	7.Dingle-Pototan	Abangai	Region-6
Leyte	Area 6	Leyte	8.Abuyog	Barayong	Region-8
Mindanao	Area 8	North Cotabato	9.Midsayap	Villiarica	Region-12
			10.Kabacan	No.2	

Annex-2 The Contents of Items for the Project

(1) Proposed Facilities for each Water District (WD)

Water District	Name of Pumping Station	Intake Facilities			Treatment Facilities		Self-Generating Electricity	Pipe Line		Drainage Facility	Distance to Outlet-Point	Electric Supply from Power Company
		Well Rehabilitation	Well Pump	Pump House	Treatment Facility	Disinfection Facility		Plumbing (Well to Treatment Plant)	Plumbing (outside Plant Site)			
Solana	Basi	Necessary	Replacement	Reconstruction	New Construction	Replacement	New Construction	Possible only inside Plant Site	-	New Construction	long	available
Binmaley	Caloocan	Necessary	Replacement	Reconstruction	New Construction	Replacement	New Construction	Possible only inside Plant Site	-	New Construction	short	available
Binmaley	Fabia	Necessary	Replacement	Reconstruction	New Construction	Replacement	New Construction	Possible inside and outside Plant Site	Conduit	New Construction	middle	available
Lingayen	Libsong	Necessary	Replacement	Reconstruction	New Construction	Replacement	New Construction	Possible inside and outside Plant Site	-	New Construction	short	available
Pagsanjan	Sabang	Necessary	New Construction	New Construction	New Construction	New Construcrion	New Construction	Possible inside and outside Plant Site	Pumping Main	New Construction	middle	available
Panitan	Phase2	Necessary	Replacement	Reconstruction	New Construction	New Construcrion	New Construction	Possible only inside Plant Site	-	New Construction	long	available
Pontevedra	Sublagon	Necessary	Replacement	Reconstruction	New Construction	Replacement	New Construction	Possible only inside Plant Site	-	New Construction	short	available
Dingle-Pototan	Abangay	Necessary	Replacement	Reconstruction	New Construction	Replacement	New Construction	Possible inside and outside Plant Site	Conduit	New Construction	middle	available
Abuyog	Barayong	Necessary	New Construction	New Construction	New Construction	New Construcrion	New Construction	Possible only inside Plant Site	Pumping Main	New Construction	middle	available
Midsayap	Villarica	Necessary	Replacement	Reconstruction	New Construction	Replacement	New Construction	Possible only inside Plant Site	-	New Construction	short	available
Kabacan	No.2	Necessary	Replacement	Reconstruction	New Construction	Replacement	New Construction	Possible only inside Plant Site	-	New Construction	short	available

(2) Proposed Equipment for the Project

Purpose of Equipment for measuring and analysis and attached equipment

a. Equipment for measuring and analysis

Parameter	Equipment	Purpose	No.
pH	pH meter	Observation and management of raw water and treated water	11
Water temperature	Water quality checker	Observation and management of raw water and treated water	11
Conductivity	Water quality checker	Observation and management of raw water and treated water	11
Salinity	Salinometer	Observation and management of raw water and treated water	11
Dissolved oxygen	Water quality checker	Observation and management of raw water and treated water	11
Turbidity	Water quality checker	Observation and management of raw water and treated water	11
Color/Odor/Taste	Colorimeter, other	Observation and management of raw water and treated water	11
Residual chlorine	Colorimeter	Observation and management of Treated water	11
Iron	Colorimeter	Observation and management of raw water and treated water	8
Manganese	Colorimeter	Observation and management of raw water and treated water	7
Ammonia nitrogen	Colorimeter	Observation and management of raw water and treated water	3
COD	COD meter	Observation and management of raw water and treated water	3
Coagulation and sedimentation	Jar tester	Observation and management of raw water and treated water	7

b. Attached equipment

Item	Equipment	Purpose	No.
Glass equipment	Beaker, others	Chemical analysis	11
Storage equipment	Storage shed	Storage /management of glass equipment and measuring equipment	11
Chemicals storage equipment	Chemicals shed	Storage of chemicals, low temperature conservation	11
Data management	Computer	Management of data	11

Annex-3 Necessary Measures to be taken by the Government of the Philippines on condition that Japan's Grant Aid is extended.

1. To secure land necessary for the sites of the Project and to clear, level and reclaim the land prior to commencement of the construction work.

2. To bear commissions to the Japanese foreign exchange bank to execute the banking services based upon the banking arrangement.

3. To ensure prompt unloading, customs clearance at the port of disembarkation in the Philippines and facilitate internal transportation therein of the products purchased under the Grant Aid.

4. To ensure the customs clearance at the port, inland transportation from the port to each site, and to bear the cost for bonded storage at the port.

5. To exempt Japanese nationals from custom duties, internal taxes and other fiscal levies which may be imposed in the Philippines with respect to the supply of the products and services under the verified contracts. And to take necessary measures for such tax exemption.

6. To accord Japanese nationals, whose services may be required in connection with the supply of products and services under the verified contracts, such facilities as may be necessary for their entry into the Philippines and stay therein for the performance of their work.

7. To use and maintain properly and effectively all the equipment purchased and facilities constructed under the Grant.

8. To bear all the expenses other than those covered by the Grant, necessary for the execution of the Project.

9. To provide necessary data and information for the Project.

10. To assign exclusive counterpart engineers and technicians for the Project

Minutes of Discussions
on the Basic Design Study on the Project
for Improvement of Water Quality
in Local Areas
in the Republic of the Philippines
(EXPLANATION ON DRAFT FINAL REPORT)

In September and December 1999, the Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched a Basic Design Study Team on the Project for Improvement of Water Quality in Local Areas in the Republic of the Philippines (hereinafter referred to as "the Project") to the Republic of the Philippines (hereinafter referred to as "the GOP"), and through discussion, field survey, and technical examination of the results in Japan, JICA prepared a draft report of the study.

In order to explain to and to consult the GOP on the components of the draft final report, JICA sent to the Philippines the Draft Final Report Explanation Team (hereinafter referred to as "the Team"), which is headed by Mr. Akira NAKAMURA, Deputy Director, Project Coordination and Monitoring Div., Grant Aid Management Dept., from June 26 to July 2.

As a result of discussions, both parties confirmed the main items described on the attached sheets.

Quezon, June 30, 2000

Akira Nakamura
Leader
Draft Final Report Consultation Team
Japan International Cooperation Agency

Manuel T. Yoingco
Officer-in-Charge
Local Water Utilities Administration

ATTACHMENT

1. Components of the Draft Final Report

The Philippines side agreed and accepted in principle the components of the draft final report explained by the Team.

2. Contents of Items of the Project

Both sides have confirmed the Ten (10) Water Districts (hereinafter referred to as "the WDs") (Eleven (11) sites) shown in Annex-1 and each item which will be constructed or procured under the Japanese Grant Aid attached as Annex-2.

3. Japan's Grant Aid scheme

The Philippines side understands the Japan's Grant Aid Scheme as explained by the Team and described in Annex-3 of the Minutes of Discussions signed by both parties on September 2, 1999.

4. Necessary Measures to be Taken by GOP

The GOP will take necessary measures describes in Annex-3 for the smooth implementation of the Project, on the condition that Japan's grant aid is extended to the Project.

5. Schedule of the Study

JICA will complete the final report in accordance with the confirmed items and send it to the Philippines by the middle of August 2000.

6. Other relevant issues

(1) Both sides confirmed that the approval of Investment Coordination Committee (ICC) for the Project should be acquired by the end of March 2001. The Philippines side understands that LWUA is responsible for preparation of the Project proposal based on the Draft Final Report. LWUA and other relevant agencies will take all necessary measures to ensure the said schedule as per Annex-4.

(2) LWUA and other relevant agencies will take all necessary measures to acquire Environmental Compliance Certificate (ECC) or Certificate of Non – Coverage (CNC) from Department of Environment and Natural Resources (DENR) at the soonest possible time.

(3) LWUA shall take all over responsibility for the expense of the import duty and taxes.

(4) LWUA will ensure the sustainability of the Project by monitoring the target WDs and providing technical assistance for operation and maintenance. In the event that the WDs need capital for expansion LWUA will extend financial assistance as needed.

(5) Each WD shall acquire the required land for the Project by the end of November, 2000.

(6) LWUA and each WD will assign appropriate personnel for the implementation of the Project.

(7) The Philippines side has presented its suggestion on the Draft Final Report as reflected in the highlight of discussion described in Annex-5.

Annex-1 List of Sites to be constructed under the Japanese Grant Aid Project

Island	Water Supply Area LWUA / 1999	Province	Target Water Districts	Project Sites (Pumping Station)	Region
Luzon	Area 1	Cagayan	1.Solana	Basi	Region-2
	Area 2	Pangasinan	2.Binmaley	Caloocan	Region-1
				Fabia	
			3.Lingayen	Libsong	
	Area 3	Laguna	4.Pagsanjan	Sabang	Region-4
Panay	Area 5	Capiz	5.Panitan	Phase 2	Region-6
			6.Pontevedra	Sublangon	
		Iloilo	7.Dingle-Pototan	Abangai	
Leyte	Area 6	Leyte	8.Abuyog	Barayong	Region-8
Mindanao	Area 8	North Cotabato	9.Midsayap	Villiarica	Region-12
			10.Kabacan	No.2	

Annex-2 (1) The Contents of Facilities of Each Project site and Equipment

WD	Target Well	Intake Facilities (Well Pump)	Raw Water Transmission Facility	Treatment Facilities	Drainage Facility	Electric Generator	Transmission Facility
Solana	Basi	Renewal	Well→Treatment Plant (Inside Plant)	New Installation	New Installation	New Installation	New Installation Pump
Binmaley	Caloocan	Renewal	Well→Treatment Plant (Inside Plant)	New Installation	New Installation	New Installation	New Installation Pump
	Fabia	Renewal	Well→(Along the Road)→Plant	New Installation	New Installation	New Installation	New Installation Pump
Lingayen	Libsong	Renewal	Well→Treatment Plant (Inside Plant)	New Installation	New Installation	New Installation	New Installation Pump
Pagsanjan	Sabang	New Installation	Well→Treatment Plant (Inside Plant)	New Installation	New Installation	New Installation	New Installation Pump + Trunk Main
Panitan	Phase2	Renewal	Well→Treatment Plant (Inside Plant)	New Installation	New Installation	New Installation	New Installation Pump
Pontevedra	Sublagon	Renewal	Well→Treatment Plant (Inside Plant)	New Installation	New Installation	New Installation	New Installation Pump
Dingle-Pototan	Abanagay	Renewal	Well→(Along the Road)→Plant	New Installation	New Installation	New Installation	New Installation Pump
Abuyog	Barayong	New Installation	Well→Treatment Plant (Inside Plant)	New Installation	New Installation	New Installation	New Installation Pump + Trunk Main
Midsayap	Villarica	Renewal	Well→Treatment Plant (Inside Plant)	New Installation	New Installation	New Installation	New Installation Pump
Kabacan	No.2	Renewal	Well→Treatment Plant (Inside Plant)	New Installation	New Installation	New Installation	New Installation Pump

Annex-2 (2)

Equipment for measuring and analysis and attached equipment

a. Equipment for measuring and analysis

Parameter	Equipment	Purpose	Quantity
PH	pH meter	Observation and management of raw water and treated water	11
Water temperature	Water quality checker	Observation and management of raw water and treated water	11
Conductivity	Water quality checker	Observation and management of raw water and treated water	11
Salinity	Salinometer	Observation and management of raw water and treated water	11
Dissolved oxygen	Water quality checker	Observation and management of raw water and treated water	11
Turbidity	Water quality checker	Observation and management of raw water and treated water	11
Color/Odor/Taste	Colorimeter, other	Observation and management of raw water and treated water	11
Residual chlorine	Colorimeter	Observation and management of treated water	11
Iron	Colorimeter	Observation and management of raw water and treated water	8
Manganese	Colorimeter	Observation and management of raw water and treated water	7
Ammonia nitrogen	Colorimeter	Observation and management of raw water and treated water	4
COD	COD meter	Observation and management of raw water and treated water	3
Coagulation and sedimentation	Jar tester	Observation and management of raw water and treated water	10

b. Attached equipment

Item	Equipment	Purpose	Quantity
Glass equipment	Beaker, others	Chemical analysis	11
Storage equipment	Storage shed	Storage /management of glass equipment and measuring equipment	11
Chemicals storage equipment	Chemicals shed	Storage of chemicals, low temperature conservation	11
Data management	Computer	Management of data	11

Annex-3 Necessary Measures to be taken by the Government of the Philippines on condition that Japan's Grant Aid is extended

1. To secure land necessary for the sites of the Project and to clear, level and reclaim the land. prior to commencement of the construction work.

2. To bear commissions to the Japanese bank to execute the banking services based upon the banking arrangement.

3. To ensure prompt unloading, customs clearance at the port of disembarkation in the Philippines and facilitate internal transportation therein of the products purchased under the Grant Aid.

4. To ensure the customs clearance at the port, inland transportation from the port to each site, and to bear the cost for bonded storage at the port.

5. To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in the Philippines with respect to the supply of the products and services under the verified contracts. And to take necessary measures for such tax exemption.

6. To accord Japanese nationals, whose services may be required in connection with the supply of products and services under the verified contracts, such facilities as may be necessary for their entry into the Philippines and stay therein for the performance of their work.

7. To use and maintain properly and effectively all the equipment purchased and facilities constructed under the Grant.

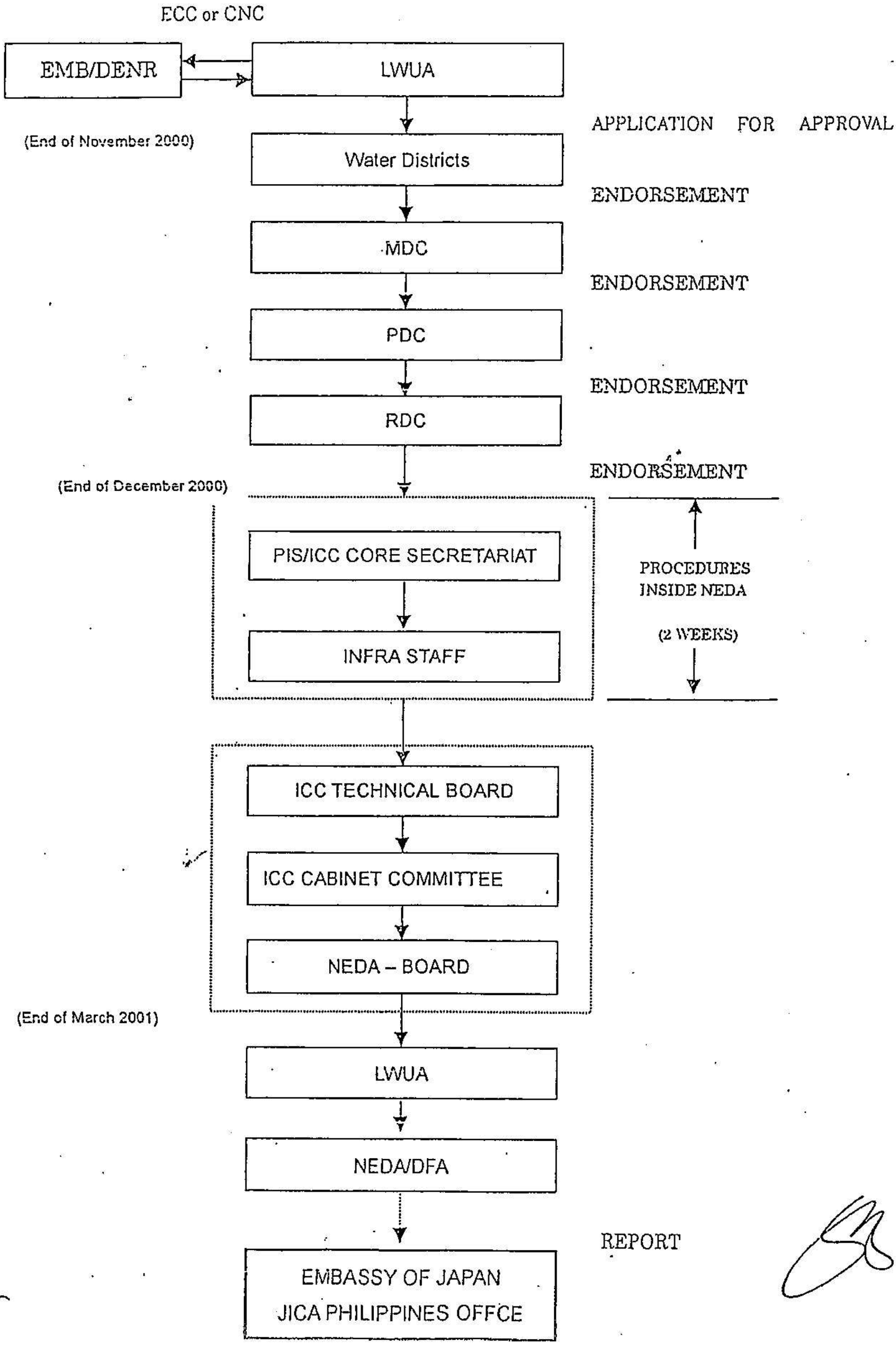
8. To bear all the expenses other than those covered by the Grant, necessary for the execution of the Project.

9. To provide necessary data and information for the Project.

10. To assign exclusive counterpart engineers and technicians for the Project.

ANNEX-4 (1)

WORK PROCESS FLOW FOR APPROVAL OF ICC



NEDA: National Economic and Development Authority
LWUA: Local Water Utilities Administration
PIS : Project Investment Staff
ICC : Investment Coordination Committee
RDC : Regional Development Committee
PDC : Provincial Development Committee
MDC :Municipal Development Committee

Annex-5 The Highlight of the Discussion

The Team explained the Draft Final Report of the Basic Design Study to the Philippines side. The following suggestions were presented by the Philippines side on the Draft Final Report during the discussion. The Team confirmed that the suggestions would be reflected to the Final report.

No.	Page/Paragraph/Line	Suggestion
1	Page 1-15,Table "Target Parameter and value"	Suggestion: "Odor" shall be described additionally as one of the parameters.
2	Page2-1,"2-1-1 Implementation Plan" 1st paragraph, Line 2 to Line 4	Deletion: "And with WDs," and "such as the detailed design study, supervision of the construction work, and handing over of the facilities and their maintenance." Addition: "LWUA is responsible for the entire procedure of the Project. Upon completion of the said Project LWUA shall turn over the said facilities to the recipient WDs and shall provide technical assistance to ensure proper maintenance for sustainability."
3	Page 2-2,"Figure 2-1, Organization for Project Implementation"	Deletion: "Area Manager" (in the "Government of Republic of Philippines") Because Area Manager is included in LWUA.
4	Page 2-3, "2-1-2 Conditions for the Implementation" 1st paragraph Line 1 to Line 2	Draft: "All the obstacles relating to the design and construction laws, technical standards, and so forth are solved by the administration of LWUA." Suggestion: "All the necessary requirements such as right of way, permit, etc. relating to the design and construction laws, technical standards, and so forth shall be the responsibility of LWUA."
5	Page 2-4, 2nd paragraph	Draft: "(3) To provide consultation regarding the implementation of the project which include the offer of the training program for the candidates for maintenance works." Suggestion:"(3)To provide consulting services during the implementation of the project." and "(4) To provide technology transfer during the project implementation on site and/or training area as identified for LWUA and WDs' staff members."

APPENDIX-5 COST TO BE BORNE BY THE RECIPIENT COUNTRY

In the case this Project is implemented under the Japanese Grant Aid System, the contribution of the Philippines is as follows.

Responsibility of the Philippines

① Land securing for the construction of facilities

No.		Necessary site area (m2)
1	Solana	900
2	Binmaley Calocan	1,100
	Binmaley Fabia	1,000
3	Lingayen	2,370
4	Pagasanjan	330
5	Panitan	1,350
6	Pontevedra	1,150
7	Dingle-Pototan	1,200
8	Abuyog	1,200
9	Midsayap	1,000
10	Kabacan	1,250
Total		12,850

① Electric power conduct expense（Peso）

No.		Electric power conduct (Peso)
1	Solana	220,000
2	Binmaley Calocan	210,000
	Binmaley Fabia	280,000
3	Lingayen	260,000
4	Pagasanjan	190,000
5	Panitan	190,000
6	Pontevedra	310,000
7	Dingle-Pototan	320,000
8	Abuyog	380,000
9	Midsayap	220,000
10	Kabacan	370,000
Total		2,950,000

APPENDIX-6 REFERENCES

Title	Date of Issue	Publisher
Medium-Term Philippine Development Plan 1999-2004	1999	NEDA
Feasibility Study Report: Solana WD	1985	LWUA
Feasibility Study Report: Lingayen WD	1997	LWUA
Feasibility Study Report: Binmaley WD	1993	LWUA
Feasibility Study Report: Pagsanjan WD	1998	LWUA
Feasibility Study Report: Dingle-Pototan WD	1982	LWUA
Feasibility Study Report: Abuyog WD	1982	LWUA
Feasibility Study Report: Midsayap WD	1999	LWUA
Feasibility Study Report: Kabacan WD	1988	LWUA
Served population and water demand projection by Solana WD		Solana WD
Engineering study by Project planning Div:Binmaley	1998	LWUA
Program of Work :Panitan	1999	LWUA
Pontevedra Water Supply System Improvement Program		LWUA
Engineering Study :Dingle-Pototan		LWUA
Program of Work :Abuyog	1998	LWUA
Water Rate Review by Kabacan WD	1999	Kabacan WD
The study on the provincial water supply, sewerage and sanitation sector plan in the Republic of the Philippines	1999	JICA
The study on the provincial water supply, sewerage and sanitation sector plan in the Republic of the Philippines	1999	JICA
The study on the provincial water supply, sewerage and sanitation sector plan in the Republic of the Philippines	1999	JICA
Study on the provincial water supply, sewerage and sanitation sector plan in the Republic of the Philippines	1996	JICA
Master plan study on water resources management in the Republic of the Philippines final report	1998	JICA
Master plan study on water resources management in the Republic of the Philippines final report	1998	JICA
Study on the provincial water supply, sewerage and sanitation sector plan in the Republic of the Philippines	1996	JICA

APPENDIX-7

TECHNICAL DATA

1.Result of the precise analysis Trihalomethane Formation Potencial

2.Existing Wells/Result of Water Quality Analysis

3.Jar Test Result

4.Column Test Result

BASIC DESIGN DRAWINGS

1. Flow Diagram

2. Layout Plan

3. Hydraulic Profile

1. Result of the precise analysis Trihalomethane Formation Potential

WDs	Target well		Trihalomethane (mg/L)				
			Chloroform	Bromodichloro methane	Dibromochloro methane	Bromoform	Total Trihalomethane
Solana	Basi(No.2 P.S.)	raw	0.0072	0.0047	0.0031	N.D.	0.0150
		treated	0.0075	0.0022	0.0004	N.D.	0.0101
Lingayen	Libsong(No.4 P.S.)	raw	0.0415	0.0046	N.D.	N.D.	0.0461
		treated	0.0051	0.0115	0.0102	0.0114	0.0382
Binmaley	Caloocan(No.1 P.S.)	raw	0.0513	0.0009	N.D.	N.D.	0.0522
		treated	0.0085	0.0025	0.0007	N.D.	0.0117
	Fabia(No.5 P.S.)	raw	0.0279	N.D.	N.D.	N.D.	0.0279
		treated	0.0079	0.0040	0.0013	N.D.	0.0132
Pagsanjan	Sabang(No.4 P.S.)	raw	N.D.	0.0038	0.0138	0.0193	0.0369
		treated	N.D.	0.0008	0.0031	0.0063	0.0102
Panitan	Phase2	raw	0.0235	0.0080	0.0039	N.D.	0.0354
		treated	0.0025	N.D.	N.D.	N.D.	0.0025
Pontevedra	Sablangon	raw	N.D.	0.0016	0.0088	0.0508	0.0612
		treated	N.D.	0.0009	0.0034	0.0059	0.0102
Dingle-Pototan	Abangai	raw	0.0019	0.0006	N.D.	N.D.	0.0025
		treated	0.0013	N.D.	N.D.	N.D.	0.0013
Abuyog	Barayong(No.4 well)	raw	0.0023	N.D.	N.D.	N.D.	0.0023
		treated	0.0015	N.D.	N.D.	N.D.	0.0015
Midsayap	Villiarica(No.1 P.S.)	raw	N.D.	0.0080	0.0219	0.0323	0.0622
		treated	N.D.	0.0048	0.0158	0.0291	0.0497
Kabacan	No.2 P.S.	raw	0.0058	0.0065	0.0091	0.0061	0.0275
		treated	0.0036	0.0035	0.0036	N.D.	0.0107
Standard value			0.06	0.03	0.1	0.09	0.1

Limit of determination		
	Chloroform	0.0013 (mg/L)
	Bromodichloromethane	0.0004 (mg/L)
	Dibromochloromethane	0.0005 (mg/L)
	Bromoform	0.0025 (mg/L)

2. Existing Wells / Result of Water Quality Analysis

No	WD	Item	Temperature	pH	EC	Turbidity	Color	T-Fe	T-Mn	F	NO_3-N	NO_2-N	NH_4-N	PO_4	COD	Coliforms	Standard plate count bacteria	Cl	CN	Cr^{6+}
		Unit	℃		mS/m	degree	degree	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	/100mL	/mL	mg/L	mg/L	mg/L
1	Solana	Centro	28.9	7.62	65	1	0	0.07	0.22	ND	ND	1.20	ND	1.1	3	0	132	3.1	0.0	0.0
2	Binmaley	Poblacion	29.3	7.70	58	0	40	0.00	0.00	0.0	0.00	0.00	0.0	0.5	25	0	88	190.0	0.0	0.0
		Nagpalangan	30.0	7.60	62	0	40	0.20	0.20	0.2	0.00	0.00	0.5	0.0	20	1	120	110.0	0.0	0.0
		Naguilayan	31.0	7.30	40	1	50	0.00	0.00	0.0	0.00	0.00	0.0	0.2	8	0	88	150.0	0.0	0.0
		Camaley	32.0	7.40	52	0	40	0.20	0.00	0.0	0.20	0.00	0.0	0.0	20	0	100	82.0	0.0	0.0
		Gayaman	29.8	7.60	49	0	20	0.20	0.00	0.2	0.00	0.00	0.0	0.5	10	0	10	60.0	0.0	0.0
3	Lingayen	Tongton	31.0	8.24	61	0	30	0.50	0.00	0.5	0.00	0.00	0.5	2.0	50	2	49	25.0	0.0	0.0
		Baay	32.6	8.08	284	1	30	0.50	0.00	1.0	0.00	0.00	1.0	0.5	50	2	149	375.0	0.0	0.0
4	Pagsanjan	Binan	31.3	7.95	84	0	0	0.21	0.11	0.3	2.00	2.00	ND	2.9	10	0	200<	88.6	0.0	0.0
		Sanjan	33.0	8.02	40	1	0	ND	0.00	0.5	0.5	0.0	0.0	0.5	5	0	123	50.0	0.0	0.0
		Lodge Spring	30.4	7.38	40	0	2	ND	ND	0.5	0.0	0.0	0.0	0.5	5	0	300<	25.0	0.0	0.0
5	Pontevedra	Hipona	27.5	7.36	35	1	0	0.20	0.00	0.0	0.00	0.00	0.0	0.2	0	0	50	20.0	0.0	0.0
6	Dingle-Pototan	Morobo Spring	25.7	7.04	52	0	0	0.14	ND	ND	1.60	ND	ND	ND	4	0	21	4.5	0.0	0.0
		Moroboro Spring	25.5	7.10	49	0	0	0.08	ND	ND	0.20	ND	ND	ND	3	0	18	19.0	0.0	0.0
7	Abuyog	Bito	31.5	7.60	96	1	7	0.44	0.35	ND	0.50	0.34	ND	2.8	6	0	500<	65.4	0.0	0.0
		Can-ugib	32.2	7.12	230	5	40	2.00	1.20	0.2	-	-	ND	6.3	13	0	42	-	0.0	0.0
8	Midsayap	Kiwanan	29.0	6.87	110	0	0	0.10	0.49	0.2	0.10	0.00	0.0	0.0	4	0	12	75.0	0.0	0.0
		Kimagango	28.8	6.83	102	0	2	0.20	0.20	0.3	0.00	0.00	0.0	0.2	8	0	54	125.0	0.0	0.0
		Dilangalen	29.0	7.18	124	0	0	0.50	0.00	1.0	0.20	0.10	0.1	2.0	3	0	36	132.0	0.0	0.0
9	Kabacan	No.1	28.8	7.01	61	0	0	0.46	0.26	ND	ND	0.02	ND	1.8	11	0	0	24.1	0.0	0.0

Jar Test Results

Solana WD	Basi
Binmaley WD	Caloocan
Binmaley WD	Fabia
Lingayen WD	Libsong
Panitan WD	Phase 2
Pontevedra WD	Sublangon
Dingle-Pototan WD	Abangai
Abuyog WD	Barayong
Midsayap WD	Villarica
Kabacan WD	No.2

Jar Test (Solana WD)

Target Site	Solana
Target Well	Basi

Raw water Quality	
Temperature	28.2 ℃
pH	6.92
Electric Conductivity	40 mS/m
Fe*1	3.0 mg/L

Before dosing aluminum sulfate, 2-minutes aeration is conducted. All of the jar set under same condition.

Results of Jar Test Experiments

No. of Jar	1		2		3		4	
Rapid Mixing (min^{-1})	300		300		300		300	
Duration (min)	1		1		1		1	
Slow Mixing (min^{-1})	30		30		30		30	
Duration (min)	10		10		10		10	
pH value after Coagulant Dosage	8.3		8.18		8		7.96	
Coagulant Dosage Rate *2	10		20		30		40	
Test Results								
Formed Flocs*3 Conditions	E	No Floc	C	Formed in Slow Mixing	C	Formed in Slow Mixing	C	Formed in Slow Mixing
Flocs Settling rate	-		about 5mm/min		about 5mm/min		about 5mm/min	
Flocs Settling	-		About 60% of Flocs are settled in 30 minutes.		About 60% of Flocs are settled in 30 minutes.		-	
	-		About 80% of Flocs are settled in 30 minutes.		About 80% of Flocs are settled in 30 minutes.		-	
pH (Filtrated Water*4)	-		7.5		-		-	
EC(Filtrated Water)	-		40		-		-	
Fe*1(Filtrated Water)	-		0.5		-		-	

*1 Fe — Analysed on site using simplified analysis

*2 Coagulant Dosing Rate — Considering the conversion rate of Aluminum Sulfate(MW:342).

*3 Formed Flocs Conditions — A- more than 3mm φ B- 2～3mm φ C- 1～2mm φ D- less than 1mm φ E- No Floc

*4 Filtrated Water — Using filter paper of No.5A

Optimum Dosage: 20mg/L as the conversion rate of Aluminum Sulfate (mole weight: 342)

Jar Test (Binmaley WD Caloocan) First Process

Target Site	Binmaley WD
Target Well	Caloocan

In accordance with the established theory for removal of humic acid, coagulation experiment in weak acid area is performed.

Jar test is repeated in order to determine optimum pH value (first process), and optimum dosing rate of coagulation chemical(second process).
Optimum dosing rate is obtained considering formed flocs conditions and color in treated water.
Color in raw water has 80 degrees.

Sulfuric acid is used in pH control.

Results of Jar Test Experiment

No. of Jar	1		2		3		4	
Rapid Mixing (min^{-1})	300		300		300		300	
Duration (min)	1		1		1		1	
Slow Mixing (min^{-1})	30		30		30		30	
Duration (min)	10		10		10		10	
Adjusted pH	5.8		6.2		6.6		7.0	
Coagulant Dosage Rate[*1]	20		20		20		20	
Test Results								
Formed Flocs[*2] Condition	C	Formed in Slow mixing	D	Formed micro-flocs in slow mixing	E	No Floc	E	No Floc
Flocs Settling Rate	less than 5mm/min		Surface Settling in a few mm		-		-	
Filtrated Water[*3]Color	1		5		40		-	
Observation of filtrated water	Very Clear		Colored with slightly white		-		-	

[*1]Coagulant Dosing Ratio	Considering the conversion rate of Aluminum Sulfate(MW:342).									
[*2]Formed Flocs Conditions	A-	more than 3mm φ	B-	2〜3mm φ	C-	1〜2mm φ	D-	less than 1mm φ	E-	No Floc
[*3]Filtrated Water	Using filter paper of No.5A									

<u>Optimum pH value: 5.8</u>

Jar Test (Binmaley WD Caloocan) Second Process

Target Site	Binmaley WD
Target Well	Caloocan

Raw water Qualty	
Temperature	30℃
Color	80
pH	8.3
EC	50mS/m
COD[*1]	35

In Second process of Jar Test, all the jars are controlled in the pH value 5.8, and find optimum dosing rate of coagulation chemical.

Results of Jar Test Experiment

No. of Jar	1		2		3		4		5	
Rapid Mixing (min^{-1})	300		300		300		300		300	
Duration (min)	1		1		1		1		1	
Slow Mixing (min^{-1})	30		30		30		30		30	
Duration (min)	10		10		10		10		10	
pH value after Coagulant Dosage	5.8		5.8		5.8		5.8		5.8	
Coagulant Dosage Rate [*2]	10		20		30		45		80	
Test Results										
Formed Flocs[*3] Conditions	E	No Floc	C	Formed in Slow mixing	C	Formed in Slow mixing	D	Formed micro-flocs in slow mixing	D	Formed micro-flocs in slow mixing
Flocs Settling rate	-		less than 5mm/min		less than 5mm/min		less than 5mm/min		less than 5mm/min	
Flocs Settling	-		About 60% of Flocs are settled in 30 minutes.		About 60% of Flocs are settled in 30 minutes.		About 50% of Flocs are settled in 30 minutes.		-	
	-		About 80% of Flocs are settled in 60 minutes.		About 80% of Flocs are settled in 60 minutes.		About 60% of Flocs are settled in 60 minutes.		-	
Filtrated Water[*4]Color	20		1		5		5		5	
Filtrated Water pH	5.7		5.7		5.2		5		4.8	
Filtrated Water EC	50		52		52		56		59	
Filtrated Water COD[*1]	-		4		6		6			
Obsarvation of filtrated water	-		Sedimentated flocs: light looking in density		Sedimentated flocs: light looking in density		-		-	

[*1]COD	Analysed on site using simplified analysis									
[*2]Coagulant Dosing Rate	Considering the conversion rate of Aluminum Sulfate(MW:342).									
[*3]Formed Flocs Conditions	A-	more than 3mm φ	B-	2〜3mm φ	C-	1〜2mm φ	D-	less than 1mm φ	E-	No Floc
[*4]Filtrated Water	Using filter paper of No.5A									

<u>Optimum Dosage: 20mg/L</u> as the conversion rate of Aluminum Sulfate (mole weight: 342)

Jar Test (Binmaley WD Fabia) First Process

Target Site	Binmaley WD
Target Well	Fabia

In accordance with the established theory for removal of humic acid, coagulation experiment in weak acid area is performed.

Jar test is repeated in order to determine optimum pH value (first process), and optimum dosing rate of coagulation chemical(second process).
Optimum dosing rate is obtained considering formed flocs conditions and color in treated water.
Color in raw water has 50 degrees.

Sulfuric acid is used in pH control.

Results of Jar Test Experiment

No. of Jar	1		2		3		4	
Rapid Mixing (min^{-1})	300		300		300		300	
Duration (min)	1		1		1		1	
Slow Mixing (min^{-1})	30		30		30		30	
Duration (min)	10		10		10		10	
Adjusted pH	5.2		5.8		6.2		6.8	
Coagulant Dosage Rate[*1]	20		20		20		20	
Test Results								
Formed Flocs[*2] Condition	E	No Floc	D	Formed micro-flocs in slow mixing	E	Formed micro-flocs in slow mixing	E	No floc
Flocs Settling Rate	-		Surface Settling in a few mm		No Settling		-	
Filtrated Water[*3]Color	50		15		20		-	
Observation of filtrated water	-		-		-		-	

[*1]Coagulant Dosing Ratio — Considering the conversion rate of Aluminum Sulfate(MW:342).

[*2]Formed Flocs Conditions — A- more than 3mm φ; B- 2〜3mm φ; C- 1〜2mm φ; D- less than 1mm φ; E- No Floc

[*3]Filtrated Water — Using filter paper of No.5A

Optimum pH value: 5.8

Jar Test (Binmaley WD Fabia) Second Process

Target Site	Binmaley WD
Target Well	Fabia

Raw water Qualty	
Temperature	32℃
Color	50
pH	8.2
EC	53mS/m
COD[*1]	35

In Second process of Jar Test, all the jars are controlled in the pH value 5.8, and find out optimum dosing rate of coagulation chemical.

Results of Jar Test Experiment

No. of Jar	1		2		3		4	
Rapid Mixing (min^{-1})	300		300		300		300	
Duration (min)	1		1		1		1	
Slow Mixing (min^{-1})	30		30		30		30	
Duration (min)	10		10		10		10	
pH value after Coagulant Dosage	5.8		5.8		5.8		5.8	
Coagulant Dosage Rate [*2]	10		20		30		40	
Test Results								
Formed Flocs[*3] Conditions	E	No Floc	D	Formed micro-flocs in slow mixing	C	Formed in Slow mixing	C	Formed in Slow mixing
Flocs Settling rate	-		-		less than 5mm/min		about 5mm/min	
Flocs Settling	-		-		About 50% of Flocs are settled in 30 minutes.		About 60% of Flocs are settled in 30 minutes.	
	-		-		About 60% of Flocs are settled in 60 minutes.		About 80% of Flocs are settled in 60 minutes.	
Filtrated Water[*4]Color	50		15		15		8	
Filtrated Water pH	5.8		5.8		5.4		5.2	
Filtrated Water EC	54		54		58		58	
Filtrated Water COD[*1]			20		12		4	
Obsarvation of filtrated water	-		-		Sedimentated flocs: light looking in density		Sedimentated flocs: light looking in density	

[*1]COD — Analysed on site using simplified analysis

[*2]Coagulant Dosing Rate — Considering the conversion rate of Aluminum Sulfate(MW:342).

[*3]Formed Flocs Conditions — A- more than 3mm φ B- 2～3mm φ C- 1～2mm φ D- less than 1mm φ E- No Floc

[*4]Filtrated Water — Using filter paper of No.5A

<u>Optimum Dosage: 40mg/L</u> as the conversion rate of Aluminum Sulfate (mole weight: 342)

Jar Test (Lingayen WD) First Process

Target Site	Lingayen WD
Target Well	Libsong

In accordance with the established theory for removal of humic acid, coagulation experiment in weak acid area is performed.

Jar test is repeated in order to determine optimum pH value (first process), and optimum dosing rate of coagulation chemical(second process).
Optimum dosing rate is obtained considering formed flocs conditions and color in treated water.
Color in raw water has 40 degrees.

Sulfuric acid is used in pH control.

Results of Jar Test Experiment

No. of Jar	1	2	3	4	5	6
Rapid Mixing (min^{-1})	300	300	300	300	300	300
Duration (min)	1	1	1	1	1	1
Slow Mixing (min^{-1})	30	30	30	30	30	30
Duration (min)	10	10	10	10	10	10
Adjusted pH	3.6	4.9	5.8	6.1	6.6	7.1
Coagulant Dosage Rate[*1]	15	15	15	15	15	15
Test Results						
Formed Flocs[*2] Condition	E No Floc	E No Floc	D Formed micro-flocs in slow mixing	E Formed micro-flocs in slow mixing	E No Floc	E No Floc
Flocs Settling Rate	-	-	Surface Settling in a few mm	-	-	-
Filtrated Water[*3] Color	40	40	20	40	40	40
Observation of filtrated water	-	-	Clear	Colored with slightly white	-	-

[*1]Coagulant Dosing Ratio	Considering the conversion rate of Aluminum Sulfate(MW:342).									
[*2]Formed Flocs Conditions	A-	more than 3mm φ	B-	2～3mm φ	C-	1～2mm φ	D-	less than 1mm φ	E-	No Floc
[*3]Filtrated Water	Using filter paper of No.5A									

<u>Optimum pH value: 5.8</u>

Jar Test (Lingayen WD) Second Process

Target Site	Lingayen WD
Target Well	Libsong

Raw water Qualty	
Temperature	28℃
Color	40
pH	8.38
EC	128mS/m
COD*1	40

In Second process of Jar Test, all the jars are controlled in the pH value 5.8, and find out optimum dosing rate of coagulation chemical.

Results of Jar Test Experiment

No. of Jar	1		2		3		4		5	
Rapid Mixing (min^{-1})	300		300		300		300		300	
Duration (min)	1		1		1		1		1	
Slow Mixing (min^{-1})	30		30		30		30		30	
Duration (min)	10		10		10		10		10	
pH value after Coagulant Dosage	5.8		5.8		5.8		5.8		5.8	
Coagulant Dosage Rate *2	5		15		30		45		60	
Test Results										
Formed Flocs*3 Conditions	E	No Floc	D	Formed micro-flocs in slow mixing	C	Formed in Slow mixing	C	Formed in Slow mixing	C	Formed in Slow mixing
Flocs Settling rate	-		-		less than 5mm/min		about 5mm/min		about 5mm/min	
Flocs Settling	-		-		About 60% of Flocs are settled in 30 minutes.		About 70% of Flocs are settled in 30 minutes.		About 70% of Flocs are settled in 30 minutes.	
	-		-		-		About 80% of Flocs are settled in 30 minutes.		About 80% of Flocs are settled in 30 minutes.	
Filtrated Water*4 Color	40		20		8		6		6	
Filtrated Water pH	5.7		5.5		5.4		5.1		4.8	
Filtrated Water EC	130		130		132		132		133	
Filtrated Water COD*1			20		10		8		8	
Obsarvation of filtrated water	-		-		Sedimentated flocs: light looking in density		Sedimentated flocs: light looking in density		Sedimentated flocs: light looking in density	

*1 COD — Analysed on site using simplified analysis

*2 Coagulant Dosing Rate — Considering the conversion rate of Aluminum Sulfate(MW:342).

*3 Formed Flocs Conditions — A- more than 3mm φ　B- 2～3mm φ　C- 1～2mm φ　D- less than 1mm φ　E- No Floc

*4 Filtrated Water — Using filter paper of No.5A

Optimum Dosage: 45mg/L as the conversion rate of Aluminum Sulfate (mole weight: 342)

Jar Test (Panitan WD)

Target Site	Panitan
Target Well	Phase 2

Raw water Quality	
Temperature	28.8 ℃
pH	6.67
Electric Conductivity	69 mS/m
Fe[*1]	10 mg/L

Before dosing aluminum sulfate, 2-minutes aeration is conducted. All of the jar set under same condition.

Results of Jar Test Experiment

No. of Jar	1		2		3		4	
Rapid Mixing (min^{-1})	300		300		300		300	
Duration (min)	1		1		1		1	
Slow Mixing (min^{-1})	30		30		30		30	
Duration (min)	10		10		10		10	
pH value after Coagulant Dosage	8.3		8.18		8		7.96	
Coagulant Dosage Rate [*2]	10		20		30		40	
Test Results								
Formed Flocs[*3] Conditions	E	No Floc	C	Formed in Slow Mixing	C	Formed in Slow Mixing	C	Formed in Slow Mixing
Flocs Settling rate	-		about 5mm/min		about 5mm/min		about 5mm/min	
Flocs Settling	-		About 60% of Flocs are settled in 30 minutes.		About 60% of Flocs are settled in 30 minutes.		-	
	-		About 80% of Flocs are settled in 60 minutes.		About 80% of Flocs are settled in 60 minutes.		-	
pH (Filtrated Water[*4]	-		8.11		-		-	
EC(Filtrated Water)	-		67		-		-	
Fe[*1](Filtrated Water)	-		0.2		-		-	

[*1]Fe Analysed on site using simplified analysis

[*2]Coagulant Dosing Rate Considering the conversion rate of Aluminum Sulfate(MW:342).

[*3]Formed Flocs Conditions A- more than 3mm φ B- 2～3mm φ C- 1～2mm φ D- less than 1mm φ E- No Floc

[*4]Filtrated Water Using filter paper of No.5A

<u>Optimum Dosage: 20mg/L</u> as the conversion rate of Aluminum Sulfate (mole weight: 342)

Jar Test (Pontevedra WD)

Target Site	Pontevedra
Target Well	Sublangon

Raw water Quality	
Temperature	27.6 ℃
pH	6.68
Electric Conductivity	114 mS/m
Fe*1	1.0 mg/L

Before dosing aluminum sulfate, 2-minutes aeration is conducted. All of the jar set under same condition.

Results of Jar Test Experiment

No. of Jar	1		2		3		4	
Rapid Mixing (min^{-1})	300		300		300		300	
Duration (min)	1		1		1		1	
Slow Mixing (min^{-1})	30		30		30		30	
Duration (min)	10		10		10		10	
pH value after Coagulant Dosage	7.63		7.59		7.51		7.24	
Coagulant Dosage Rate *2	5		10		15		20	
Test Results								
Formed Flocs*3 Conditions	E	No Floc	C	Formed in Slow Mixing	C	Formed in Slow Mixing	C	Formed in Slow Mixing
Flocs Settling rate	-		about 5mm/min		about 5mm/min		about 5mm/min	
Flocs Settling	-		About 60% of Flocs are settled in 30 minutes.		About 60% of Flocs are settled in 30 minutes.		About 60% of Flocs are settled in 30 minutes.	
	-		About 80% of Flocs are settled in 60 minutes.		About 80% of Flocs are settled in 60 minutes.		About 80% of Flocs are settled in 60 minutes.	
pH (Filtrated Water*4	-		7.6		-		-	
EC(Filtrated Water)	-		154		-		-	
Fe*1(Filtrated Water)	-		0.2		-		-	

*1Fe — Analysed on site using simplified analysis

*2Coagulant Dosing Rate — Considering the conversion rate of Aluminum Sulfate(MW:342).

*3Formed Flocs Conditions — A- more than 3mm φ　B- 2～3mm φ　C- 1～2mm φ　D- less than 1mm φ　E- No Floc

*4Filtrated Water — Using filter paper of No.5A

<u>Optimum Dosage: 10～20mg/L</u> as the conversion rate of Aluminum Sulfate (mole weight: 342)

Jar Test (Dingle-Pototan WD)

Target Site	Dingle-Pototan
Target Well	Abangai

Raw water Quality	
Temperature	27.8 ℃
pH	7.35
Electric Conductivity	149 mS/m
Fe[*1]	1.0 mg/L

Before dosing aluminum sulfate, 2-minutes aeration is conducted. All of the jar set under same condition.

Results of Jar Test Experiment

No. of Jar	1		2		3		4	
Rapid Mixing (min^{-1})	300		300		300		300	
Duration (min)	1		1		1		1	
Slow Mixing (min^{-1})	30		30		30		30	
Duration (min)	10		10		10		10	
pH value after Coagulant Dosage	7.63		7.59		7.51		7.24	
Coagulant Dosage Rate [*2]	10		15		20		30	
Test Results								
Formed Flocs[*3] Conditions	E	No Floc	D	Formed micro-flocs in slow mixing	C	Formed in Slow Mixing	C	Formed in Slow Mixing
Flocs Settling rate	-		-		about 5mm/min		about 5mm/min	
Flocs Settling	-		-		About 60% of Flocs are settled in 30 minutes.		About 60% of Flocs are settled in 30 minutes.	
	-		About 50% of Flocs are settled in 60 minutes.		About 80% of Flocs are settled in 60 minutes.		About 80% of Flocs are settled in 60 minutes.	
pH (Filtrated Water[*4]	-		-		7.6		-	
EC(Filtrated Water)	-		-		154		-	
Fe[*1](Filtrated Water)	-		-		0.5		-	

[*1]Fe — Analysed on site using simplified analysis

[*2]Coagulant Dosing Rate — Considering the conversion rate of Aluminum Sulfate(MW:342).

[*3]Formed Flocs Conditions — A- more than 3mm φ B- 2～3mm φ C- 1～2mm φ D- less than 1mm φ E- No Floc

[*4]Filtrated Water — Using filter paper of No.5A

<u>Optimum Dosage: 20mg/L</u> as the conversion rate of Aluminum Sulfate (mole weight: 342)

Jar Test (Abuyog WD)

Target Site	Abuyog
Target Well	Barayong

Raw water Quality	
Temperature	30.6℃
Color	15
pH	6.73
EC	239mS/m
Fe[*1]	5
COD[*1]	10

Before dosing aluminum sulfate, 2-minutes aeration is conducted. All of the jar set under same condition.

Results of Jar Test Experiment

No. of Jar	1	2	3	4
Rapid Mixing (min^{-1})	300	300	300	300
Duration (min)	1	1	1	1
Slow Mixing (min^{-1})	30	30	30	30
Duration (min)	10	10	10	10
pH value after Coagulant Dosage	7.6	7.6	7.6	7.6
Coagulant Dosage Rate [*2]	10	15	20	30
Test Results				
Formed Flocs[*3] Conditions	D Formed micro-flocs in slow mixing	D Formed micro-flocs in slow mixing	D Formed micro-flocs in slow mixing	C Formed in Slow Mixing
Flocs Settling rate	-	-	-	about 5mm/min
Flocs Settling	-	-	-	About 60% of Flocs are settled in 30 minutes.
	-	-	-	About 80% of Flocs are settled in 60 minutes.
Color(Filtrated Water[*4])	-	-	40	10
pH(Filtrated Water)	-	-	7.4	7.4
EC(Filtrated Water)	-	-	240	240
Fe[*1](Filtrated Water)	-	-	0.5	0.5
COD[*1](Filtrated Water)	-	-	10	8
Obsarvation	-	-	No Sedimentation	Colored with slightly white

[*1]Fe・COD — Analysed on site using simplified analysis

[*2]Coagulant Dosage Rate — Considering the conversion rate of Aluminum Sulfate(MW:342).

[*3]Formed Flocs Condition — A- more than 3mm φ　B- 2～3mm φ　C- 1～2mm φ　D- less than 1mm φ　E- No Floc

[*4]Filtrated Water — Using filter paper of No.5A

<u>Optimum Dosage: 30mg/L</u> as the conversion rate of Aluminum Sulfate (mole weight: 342)

Jar Test (Midsayap WD)

Target Site	Midsayap
Target Well	Villarica

Raw water Quality	
Temperature	27 ℃
pH	7.09
Electric Conductivity	107 mS/m
Fe[*1]	1.0 mg/L

Before dosing aluminum sulfate, 2-minutes aeration is conducted. All of the jar set under same condition.

Results of Jar Test Experiment

No. of Jar	1		2		3		4	
Rapid Mixing (min^{-1})	300		300		300		300	
Duration (min)	1		1		1		1	
Slow Mixing (min^{-1})	30		30		30		30	
Duration (min)	10		10		10		10	
pH value after Coagulant Dosage	7.63		7.59		7.51		7.24	
Coagulant Dosage Rate [*2]	10		15		20		30	
Test Results								
Formed Flocs[*3] Conditions	E	No Floc	D	Formed micro-flocs in slow mixing	C	Formed in Slow Mixing	C	Formed in Slow Mixing
Flocs Settling rate	-		-		about 5mm/min		about 5mm/min	
Flocs Settling	-		-		About 60% of Flocs are settled in 30 minutes.		About 60% of Flocs are settled in 30 minutes.	
	-		About 50% of Flocs are settled in 60 minutes.		About 80% of Flocs are settled in 60 minutes.		About 80% of Flocs are settled in 60 minutes.	
pH (Filtrated Water[*4])	-		-		7.6		-	
EC(Filtrated Water)	-		-		120		-	
Fe[*1](Filtrated Water)	-		-		0.2		-	

[*1]Fe — Analysed on site using simplified analysis

[*2]Coagulant Dosing Rate — Considering the conversion rate of Aluminum Sulfate(MW:342).

[*3]Formed Flocs Conditions — A- more than 3mm φ B- 2～3mm φ C- 1～2mm φ D- less than 1mm φ E- No Floc

[*4]Filtrated Water — Using filter paper of No.5A

<u>Optimum Dosage: 20mg/L</u> as the conversion rate of Aluminum Sulfate (mole weight: 342)

Jar Test (Kabacan WD)

Target Site	Kabacan
Target Well	No.2 P.S.

Raw water Quality	
Temperature	28.9 ℃
pH	7.08
Electric Conductivity	55 mS/m
Fe*1	1.5 mg/L

Before dosing aluminum sulfate, 2-minutes aeration is conducted. All of the jar set under same condition.

Results of Jar Test Experiment

No. of Jar	1		2		3		4	
Rapid Mixing (min^{-1})	300		300		300		300	
Duration (min)	1		1		1		1	
Slow Mixing (min^{-1})	30		30		30		30	
Duration (min)	10		10		10		10	
pH value after Coagulant Dosage	7.63		7.59		7.51		7.24	
Coagulant Dosage Rate *2	10		15		20		30	
Test Results								
Formed Flocs*3 Conditions	E	NO Floc	D	Formed micro-flocs in slow mixing	C	Formed in Slow Mixing	C	Formed in Slow Mixing
Flocs Settling rate	-		-		about 5mm/min		about 5mm/min	
Flocs Settling	-		-		About 60% of Flocs are settled in 30 minutes.		About 60% of Flocs are settled in 30 minutes.	
	-		-		About 80% of Flocs are settled in 60 minutes.		About 80% of Flocs are settled in 60 minutes.	
pH (Filtrated Water*4)	-		-		7.5		-	
EC(Filtrated Water)	-		-		62		-	
Fe*1(Filtrated Water)	-		-		0.5		-	

*1Fe — Analysed on site using simplified analysis

*2Coagulant Dosing Rate — Considering the conversion rate of Aluminum Sulfate(MW:342).

*3Formed Flocs Conditions — A- more than 3mm φ B- 2～3mm φ C- 1～2mm φ D- less than 1mm φ E- No Floc

*4Filtrated Water — Using filter paper of No.5A

Optimum Dosage: 20mg/L as the conversion rate of Aluminum Sulfate (mole weight: 342)

Filtration(Column) Test Results

Solana WD	Basi
Binmaley WD	Caloocan
Binmaley WD	Fabia
Lingayen WD	Libsong
Pagsanjan WD	Sabang
Panitan WD	Phase 2
Pontevedra WD	Sublangon
Dingle-Pototan WD	Abangai
Abuyog WD	Barayong
Midsayap WD	Villarica
Kabacan WD	No.2

Filtration (Column) Test
Solana

	Target WD		Solana
	Target Well		Basi
Raw Water	Fe	mg/L	2.1
	Mn	mg/L	1.2
	pH	-	6.92
	EC	mS/m	40
	DO	mg/L	0.44
	Turbidity	mg/L	2
	Color	degree	0
	Odor	-	Metallic odor
	Temperature	℃	28.2

	Test No		Test 1
Experiment Condition	Silica Sand	cm	60
	Filtration rate	m/d	130
	Aeration		Conducted
Water Quality After Aeration	pH	-	7.62
	DO	mg/L	6.5
	EC	mS/m	42
	Turbidity	mg/L	15
	Color	degree	White
	Temperature	℃	26.9
Water Quality After Filtration	Fe	mg/L	0.19
	Mn	mg/L	1.15
	pH	-	7.72
	DO	mg/L	7.25
	EC	mS/m	40
	Turbidity	mg/L	0
	Color	degree	0
	Odor	-	Unobjectionable
	Temperature	℃	25.7
	Reference		Aeration Silica Sand Filtration

Filtration (Column) Test
Binmaley_Caloocan

	WD		Binmaley
	Target Well		Caloocan
Raw Water	pH	-	8.3
	EC	mS/m	50
	DO	mg/L	0.71
	Turbidity	mg/L	0
	Color	degree	80
	Odor	-	Hydrogen Sulfide Odor
	COD	mg/L	35
	Temperature	℃	30

	Test No		Test 1	Test 2
Experiment Condition	Silica Sand	cm	40	60
	Anthracite	cm	20	0
	Filtration Rate	m/d	120	117
	Aluminum Sulfate Dosage Rate	mg/L	20	20
	Sulfuric Acid Dosage Rate	mg/L	100	100
	Aeration		Conducted	-
Water Quality After Aeration	pH	-	5.86	5.89
	DO	mg/L	6.15	2.72
	EC	mS/m	60	60
	Turbidity	mg/L	0	0
	Color	degree	20	20
	Odor	-	Slightly Hydrogen Sulfide Odor	Hydrogen Sulfide Odor
	Temperature	℃	29.5	30.2
Water Quality After Filtration	pH	-	6	6.31
	DO	mg/L	6.5	4.3
	EC	mS/m	60	61
	Turbidity	mg/L	1	0
	Color	degree	1	3
	Odor	-	Unobjectionable	Unobjectionable
	COD	mg/L	4	5
	Temperature	℃	32	29.8
	Reference		Aeration Dosing Sulfuric Acid Dosing Aluminum Sulfate Anthracite+ Silica Sand Filtration	Dosing Sulfuric Acid Dosing Aluminum Sulfate Silica Sand Filtration

Filtration (Column) Test
Binmaley_Fabia

	WD		Binmaley
	Target Well		Fabia
Raw Water	pH	-	8.2
	EC	mS/m	53
	DO	mg/L	0.78
	Turbidity	mg/L	0
	Color	degree	50
	Odor	-	Hydrogen Sulfide Odor
	COD	mg/L	35
	Temperature	℃	32

	Test No		Test 1	Test 2	Test 3	Test 4
Experiment Condition	Silica Sand	cm	40	60	60	60
	Anthracite	cm	20	0	0	0
	Filtration Rate	m/d	120	125	120	140
	Aluminum Salfate Dosage Rate	mg/L	40	40	40	0
	Sulfuric Acid Dosage Rate	mg/L	95	95	95	0
	Aeration		Conducted	Conducted	-	-
Water Quality After Aeration	pH	-	5.84	5.85	5.84	
	DO	mg/L	5.88	6.02	2.32	
	EC	mS/m	66	65	64	
	Turbidity	mg/L	2	2	2	
	Color	degree	50	50	40	
	Odor	-	Hydrogen Sulfide Odor	Hydrogen Sulfide Odor	Hydrogen Sulfide Odor	
	Temperature	℃	29.9	29.6	29.5	
Water Quality After Filtration	pH	-	6.02	5.97	5.93	7.41
	DO	mg/L	6.84	6.05	3.96	3.22
	EC	mS/m	66	66	66	54
	Turbidity	mg/L	0	1	1	0
	Color	degree	0	1	3	40
	Odor	-	Unobjectionable	Unobjectionable	Hydrogen Sulfide Odor	Hydrogen Sulfide Odor
	COD	mg/L	5	7	7	35
	Temperature	℃	29.2	29.1	29.3	29.3
	Reference		Aeration Dosing Sulfuric Acid Dosing Aluminum Salfate Anthracite+ Silica Sand Filtration	Aeration Dosing Sulfuric Acid Dosing Aluminum Salfate Silica Sand Filtration	Dosing Sulfuric Acid Dosing Aluminum Salfate Silica Sand Filtration	Silica Sand Filtration

Filtration (Column) Test
Lingayen

	WD		Lingayen
	Target Well		Libsong
Raw Water	pH	-	8.38
	EC	mS/m	128
	DO	mg/L	0.83
	Turbidity	mg/L	0
	Color	-	40
	Odor	-	Hydrogen Sulfide Odor
	COD	mg/L	30
	Temperature	℃	28

	Test No		Test 1	Test 2
Experiment Condition	Silica Sand	cm	40	60
	Anthracite	cm	20	0
	Filtration Rate	m/d	125	132
	Aluminum Salfate Dosage Rate	mg/L	45	45
	Caustic Soda Dosage Rate	mg/L	100	0
	Sulfuric Acid Dosage Rate	mg/L	67	67
	Aeration		-	Conducted
Water Quality After Aeration	pH	-	7.33	5.4
	DO	mg/L	2.78	6.08
	EC	mS/m	139	140
	Turbidity	mg/L	3	4
	Color	degree	80	80
	Odor	-	Hydrogen Sulfide Odor	Hydrogen Sulfide Odor
	Temperature	℃	29	29.5
Water Quality After Filtration	pH	-	7.6	5.7
	DO	mg/L	4.01	6.55
	EC	mS/m	138	136
	Turbidity	mg/L	2	0
	Color	degree	30	2
	Odor	-	Hydrogen Sulfide Odor	Unobjectionable
	COD	mg/L	20	7
	Temperature	℃	28.8	29.1
	Reference		Dosing Sulfuric Acid Dosing Aluminum Salfate Dosing Caustic Soda Anthracite+ Silica Sand Filtration	Aeration Dosing Sulfuric Acid Dosing Aluminum Salfate Silica Sand Filtration

Filtration (Column) Test
Pagsanjan

	WD		Pagsanjan
	Target Well		Sabang
Raw Water	Fe	mg/L	2.2
	Mn	mg/L	0.28
	pH	-	7.28
	EC	mS/m	88
	DO	mg/L	1.01
	Turbidity	mg/L	1
	Color	-	0
	Odor	-	Metallic
	Temperature	℃	28.5

	Test No		Test 1
Experiment Condition	Silica Sand	cm	42
	Filtration Rate	m/d	114
	Aeration	-	Conducted
Water Quality After Aeration	pH	-	7.66
	DO	mg/L	5.83
	EC	mS/m	86
	Turbidity	mg/L	17
	Color	-	50
	Temperature	℃	28.5
Water Quality After Filtration	Fe	mg/L	0.08
	pH	-	7.74
	DO	mg/L	6.38
	EC	mS/m	86
	Turbidity	mg/L	0
	Color	-	0
	Odor	-	Unobjectionable
	Temperature	℃	28.5
	Reference		Aeration Silica Sand Filtration

Filtration (Column) Test
Panitan

	WD		Panitan
	Target Well		Phase2
Raw Water	Fe	mg/L	9
	Mn	mg/L	1.2
	pH	-	6.67
	EC	mS/m	69
	DO	mg/L	0.35
	Turbidity	mg/L	8
	Color	-	5
	Odor	-	Metallic
	Temperature	℃	28

	Test No		Test 1	Test 2
Experiment Condition	Silica Sand	cm	50	50
	Filtration Rate	m/d	138	103
	Caustic Soda Dosage Rate	mg/L	0	96
	Aeration		Conducted	Conducted
Water Quality After Aeration	pH	-	7.05	8.47
	DO		5.65	6.63
	EC	mS/m	67	79
	Turbidity	mg/L	67	5
	Color	-	Slightly white	
	Temperature	℃	28.4	27.4
Water Quality After Filtration	Fe	mg/L	1.63	0
	Mn	mg/L	0.75	0.54
	pH	-	8.22	8.52
	DO		5.99	6.67
	EC	mS/m	65	79
	Turbidity	mg/L	22	2
	Color	-	50	0
	Odor	-	Metallic	Unobjectionable
	Temperature	℃	30.1	27.8
	Reference		Aeration Silica Sand Filtration	Aeration and Alkaline dosage Silica Sand Filtration

Filtration (Column) Test
Dingle-Pototan

	WD	Dingle-Pototan	
	Target Well	Abangai	
Raw Water	Fe	mg/L	1
	Mn	mg/L	0.68
	pH	-	7.35
	EC	mS/m	149
	DO	mg/L	0.23
	Turbidity	mg/L	8
	Color	degree	10
	Odor	-	Metallic
	Temperature	℃	27.8

	Test No		Test 1	Test 2
Experiment Condition	Silica Sand	cm	53	53
	Anthracite	cm	0	0
	Filtration Rate	m/d	143	113
	Chlorine dosage rate	mg/L	0	30
	Aeration		Conducted	Conducted
Water Quality After Aeration	pH	-	7.95	7.44
	DO		6.57	0.23
	EC	mS/m	148	148
	Turbidity	mg/L	8	0
	Color	degree	20	
	Temperature	℃	27.5	27.7
Water Quality After Filtration	Fe	mg/L	0.06	0
	Mn	mg/L	0.27	0.34
	pH	-	8.35	7.6
	DO		7.26	4.46
	EC	mS/m	147	154
	Turbidity	mg/L	0	1
	Color	degree	5	20
	Odor	-	Unobjectionable	Unobjectionable
	Residual Chlorine	mg/L	0	6
	Temperature	℃	30.2	29.2
	Reference		Aeration Silica Sand Filtration	Chlorine injection Silica Sand Filtration

Filtration (Column) Test
Pontevedra

	WD		Pontevedra
	Target Well		Sublangon
Raw Water	Fe	mg/L	1.4
	Mn	mg/L	0.96
	pH	-	6.6
	EC	mS/m	114
	DO	mg/L	0.38
	Turbidity	mg/L	0
	Color	degree	0
	Odor	-	Metallic
	Temperature	℃	27.6

	Test No		Test 1	Test 2
Experiment Condition	Silica Sand	cm	55	0
	Manganese Sand	cm	0	60
	Filtration Rate	m/d	145	127
	Chlorine dosage rate	mg/L	0	2
	Aeration		Conducted	-
Water Quality After Aeration	pH	-	7.17	7.34
	DO		6.06	7.41
	EC	mS/m	105	102
	Turbidity	mg/L	6	0
	Color	degree	5	8
	Temperature	℃	27.4	27.5
Water Quality After Filtration	Fe	mg/L	0.08	0
	Mn	mg/L	0.78	0.07
	pH	-	7.48	7.23
	DO		5.5	7.24
	EC	mS/m	105	103
	Turbidity	mg/L	0	2
	Color	degree	0	0
	Odor	-	0	Unobjectionable
	Chlorine dosage rate	mg/L	0	0
	Temperature	℃	27.7	28.6
	Reference		Aeration Silica Sand Filtration	Using the treated water of Test 1 Manganese Sand Filtration

Filtratio (Column) Test
Abuyog

	WD		Abuyog
	Target Well		Barayong
Raw Water	Fe	mg/L	4
	Mn	mg/L	1.9
	pH	-	6.73
	EC	mS/m	239
	DO	mg/L	0.42
	Turbidity	mg/L	1
	Color	-	15
	Odor	-	Metallic and hydrogen sulfide odor
	COD	mg/L	4.69
	TOC	mg/L	4.2
	NH4	mg/L	3.3
	Temperature	℃	30.6

	Test No		Test 1	Test 2
Experiment Condition	Silica Sand	cm	53	54
	Filtration Rate	m/d	131	134
	Chlorine dosage rate	mg/L	0	30
	Aluminum Sulfate Dosage Rate	mg/L	30	0
	Aeration		Conducted	-
Water Quality After Aeration	pH	-	7.33	7.09
	DO	mg/L	5.75	2.07
	EC	mS/m	243	238
	Turbidity	mg/L	28	2
	Color	-	White	Brown
	Odor	-	-	-
	Temperature	℃	29.2	30
Water Quality After Filtration	Fe	mg/L	0.06	0.12
	Mn	mg/L	1.9	1.84
	pH	-	7.74	7.65
	DO	mg/L	5.89	6.53
	EC	mS/m	238	246
	Turbidity	mg/L	3	2
	Color	-	8	10
	Odor	-	Unobjectionable	Unobjectionable
	COD	mg/L	2.2	2.88
	TOC	mg/L	2.2	0
	NH4	mg/L	2	0
	Temperature	℃	28.1	29.2
	Reference		Aeration Aluminum sulfate dosage Silica sand filtration	Chlorine dosage Silica sand filtration

Filtration (Column) Test
Midsayap

	WD		Midsayap
	Target Well		Villarica
Raw Water	Fe	mg/L	1.7
	Mn	mg/L	0.97
	pH	-	7.09
	EC	mS/m	107
	DO	mg/L	0.47
	Turbidity	mg/L	0
	Color	-	0
	Odor	-	Metallic
	Temperature	℃	27

	Test No		Test 1	Test 2
Experiment Condition	Silica Sand	cm	47	0
	Manganese Sand	cm	0	60
	Filtration Rate	m/d	136	151
	Chlorine dosage rate	mg/L	0	8
	Aeration		Conducted	-
Water Quality After Aeration	pH	-	7.66	8.03
	DO		5.03	6.1
	EC	mS/m	109	110
	Turbidity	mg/L	7	4
	Color	-	White	Backish Brown
	Temperature	℃	32.5	31.8
Water Quality After Filtration	Fe	mg/L	0.14	0.08
	Mn	mg/L	0.87	0.05
	pH	-	8.08	7.92
	DO		4.88	6.18
	EC	mS/m	109	109
	Turbidity	mg/L	0	0
	Color	-	0	0
	Odor	-	Unobjectionable	Unobjectionable
	Residual chlorine	mg/L	0	0
	Temperature	℃	33.5	32.9
	Reference		Aeration Silica filtration	Using the treated water of Test 1 Manganese sand filtration

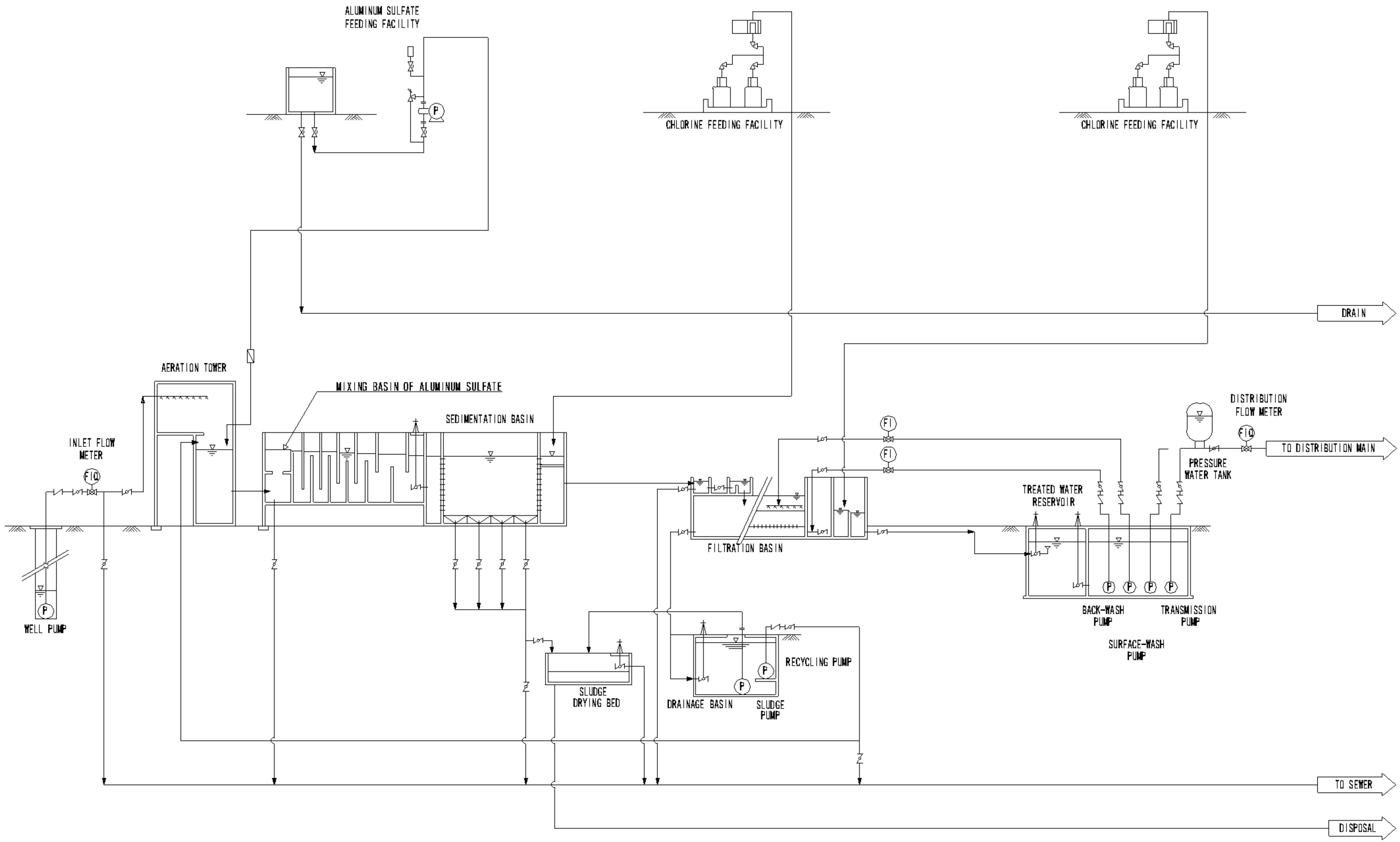
Filtration (Column) Test
Kabacan

	WD		Kabacan
	Target Well		No.2 P.S.
Raw Water	Fe	mg/L	1.7
	Mn	mg/L	1.9
	pH	-	7.08
	EC	mS/m	55
	DO	mg/L	0.66
	Turbidity	mg/L	0
	Color	-	0
	Odor	-	Metallic
	Temperature	℃	28.9

	Test No		Test 1	Test 2
Experiment Condition	Silica Sand	cm	42	0
	Manganese Sand	cm	0	55
	Filtration Rate	m/d	152	142
	Chlorine dosage rate	mg/L	0	8
	Aeration		Aeration	-
Water Quality After Aeration	pH	-	7.62	7.95
	DO	mg/L	6	5.3
	EC	mS/m	55	57
	Turbidity	mg/L	9	7
	Color	-	White	Blackish brown
	Temperature	℃	29.8	34.1
Water Quality After Filtration	Fe	mg/L	0.3	0.11
	Mn	mg/L	0.76	0.07
	pH	-	7.85	7.96
	DO	mg/L	4.44	5.8
	EC	mS/m	55	57
	Turbidity	mg/L	0	0
	Color	-	0	0
	Odor	-	N.D.	N.D.
	Residual chlorine	mg/L	0	0
	Temperature	℃	32	32.4
	Reference		Aeration Silica filtration	Using treated water of Test 1 Manganese sand filtration

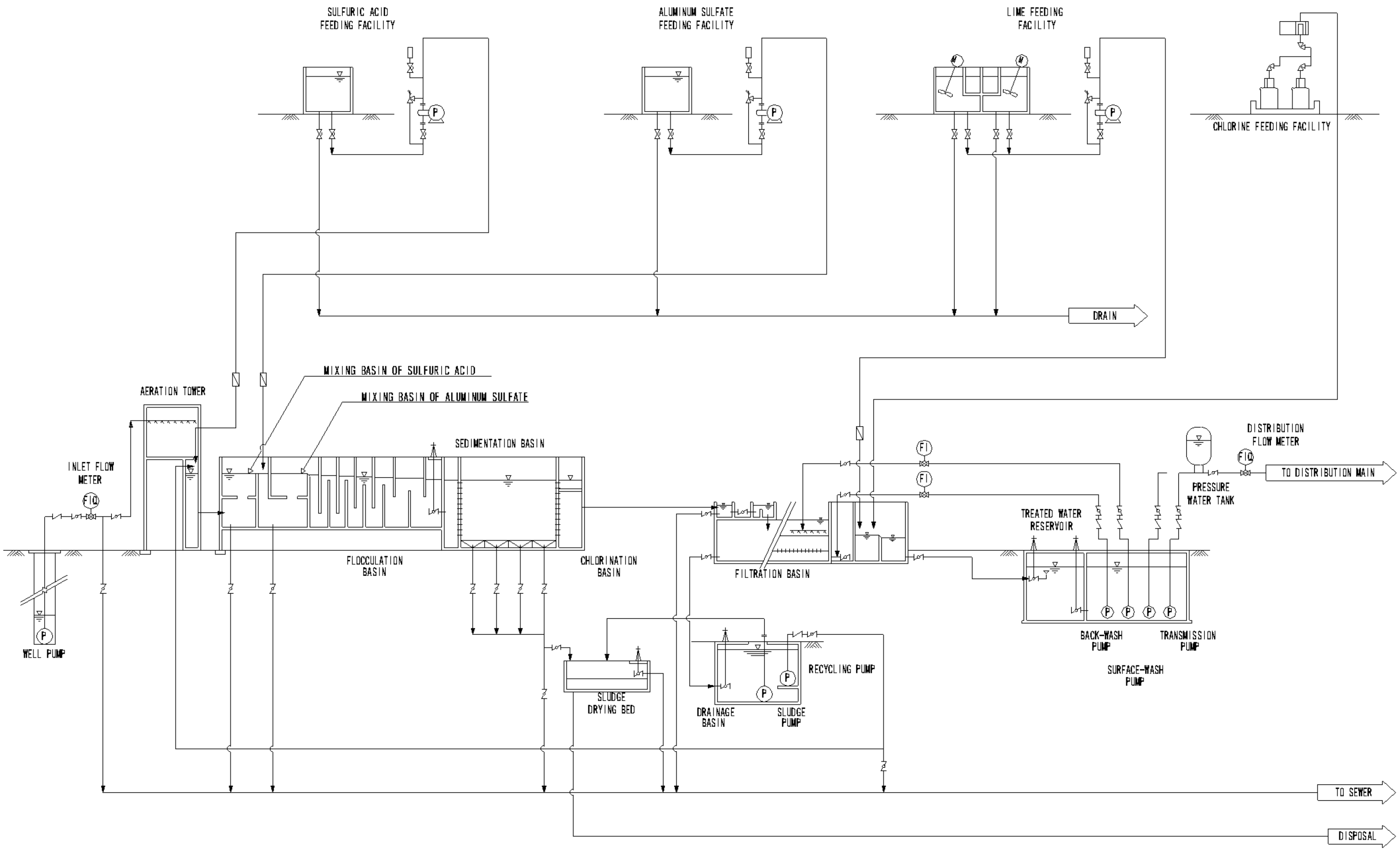
1. Flow Diagram

Solana, Pontevedra
Binmaley(Caloocan, Fabia)
Lingayen
Pagsanjan
Panitan
Dingle-Pototan
Abuyog, Midsayap, Kabacan



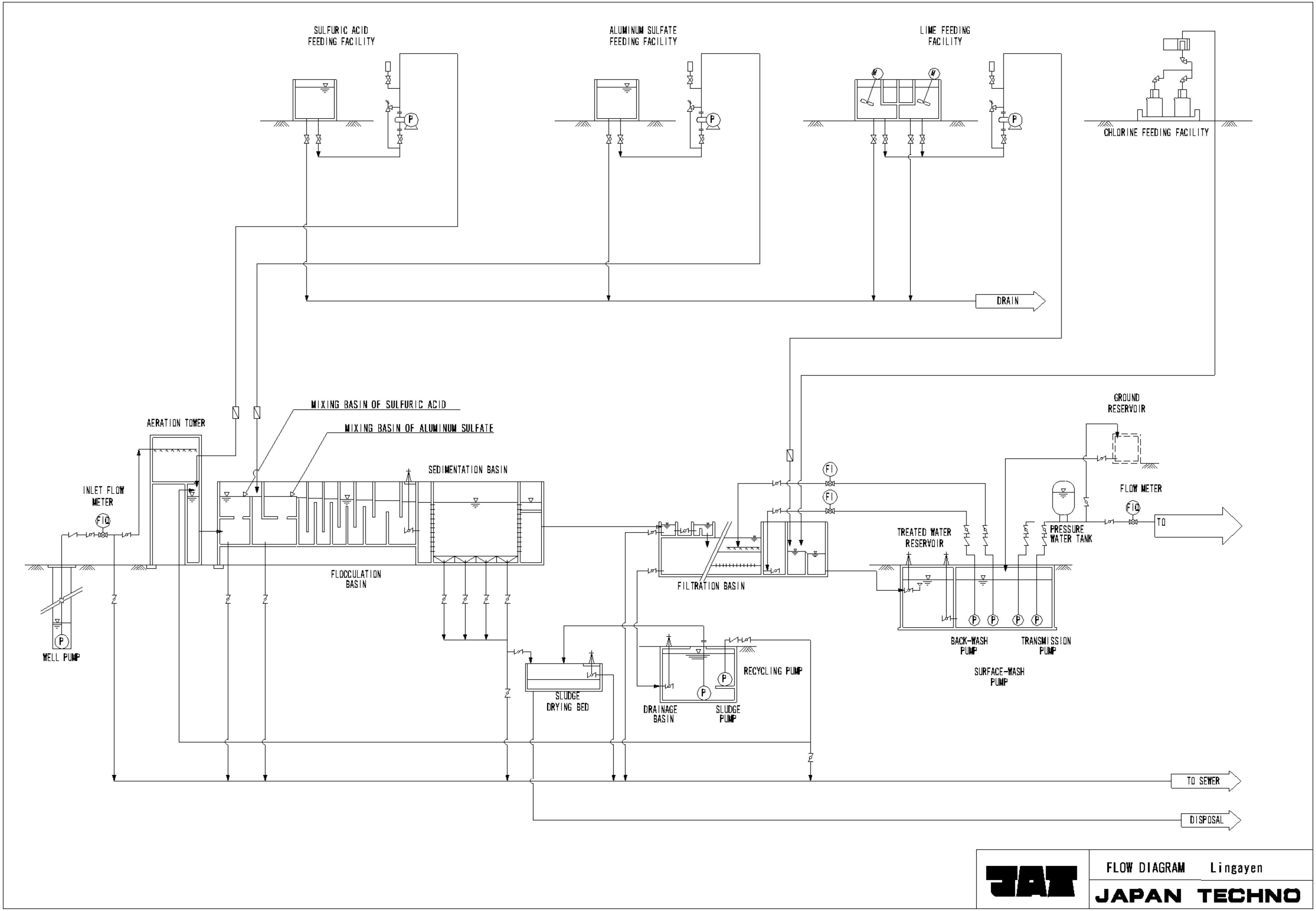
FLOW DIAGRAM Solana, Pontevedra

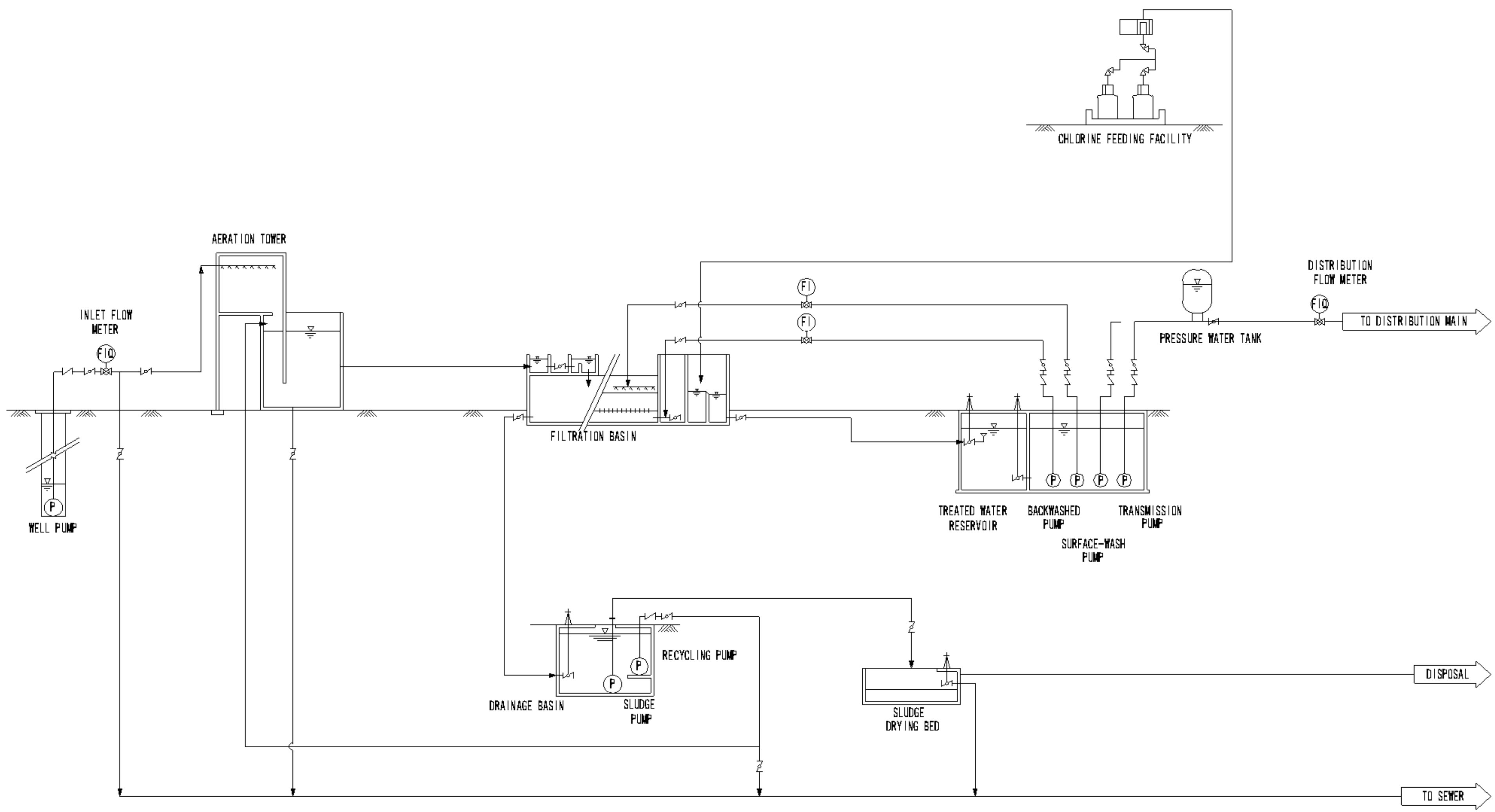
JAPAN TECHNO



FLOW DIAGRAM Binmaley(Caloocan, Fabia)

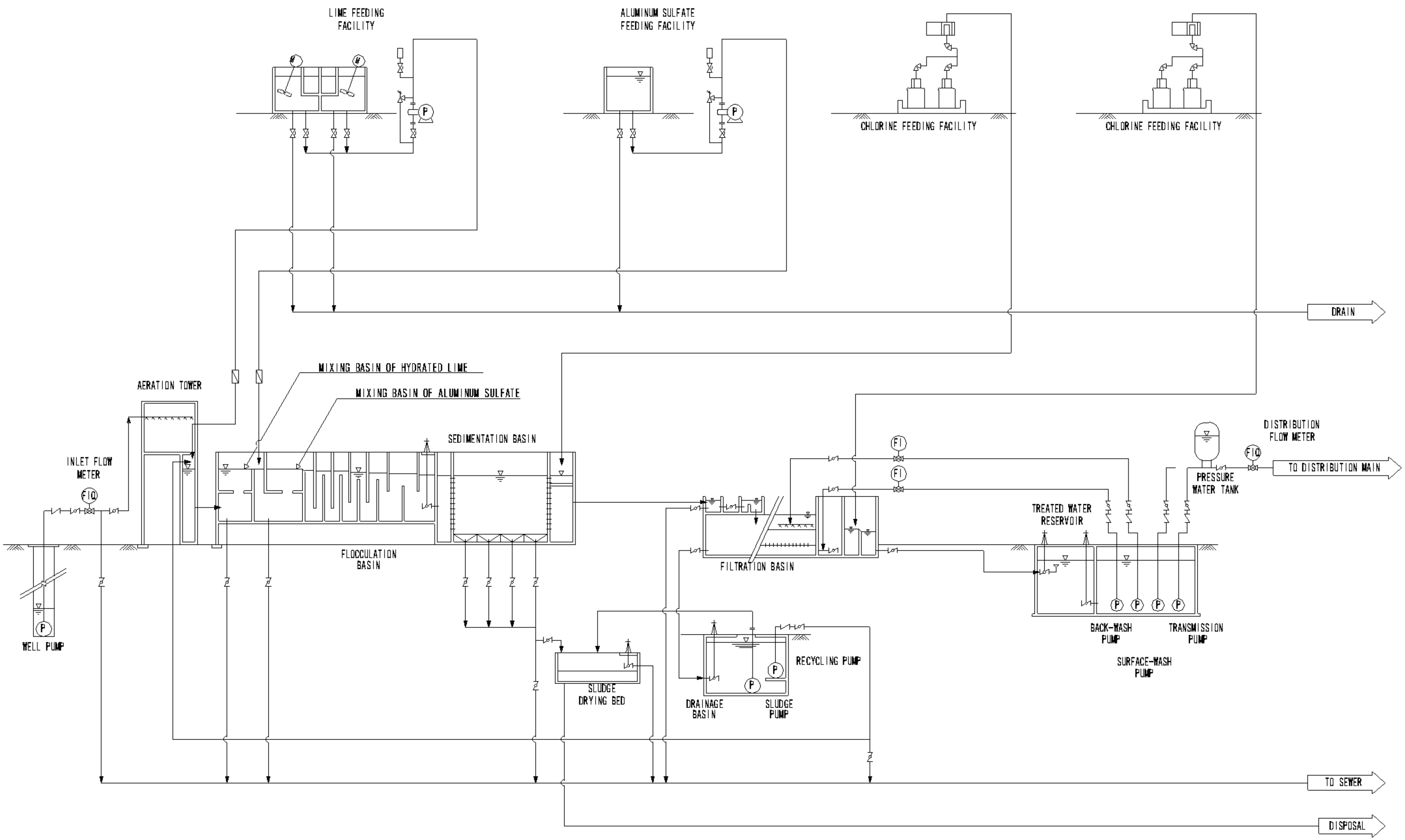
JAPAN TECHNO


SULFURIC ACID FEEDING FACILITY
ALUMINUM SULFATE FEEDING FACILITY
LIME FEEDING FACILITY
CHLORINE FEEDING FACILITY
DRAIN
MIXING BASIN OF SULFURIC ACID
MIXING BASIN OF ALUMINUM SULFATE
AERATION TOWER
SEDIMENTATION BASIN
INLET FLOW METER
FIQ
FLOCCULATION BASIN
WELL PUMP
FI
FILTRATION BASIN
GROUND RESERVOIR
FLOW METER
TO
TREATED WATER RESERVOIR
PRESSURE WATER TANK
BACK-WASH PUMP
TRANSMISSION PUMP
SURFACE-WASH PUMP
RECYCLING PUMP
SLUDGE DRYING BED
DRAINAGE BASIN
SLUDGE PUMP
TO SEWER
DISPOSAL
FLOW DIAGRAM Lingayen
JAPAN TECHNO



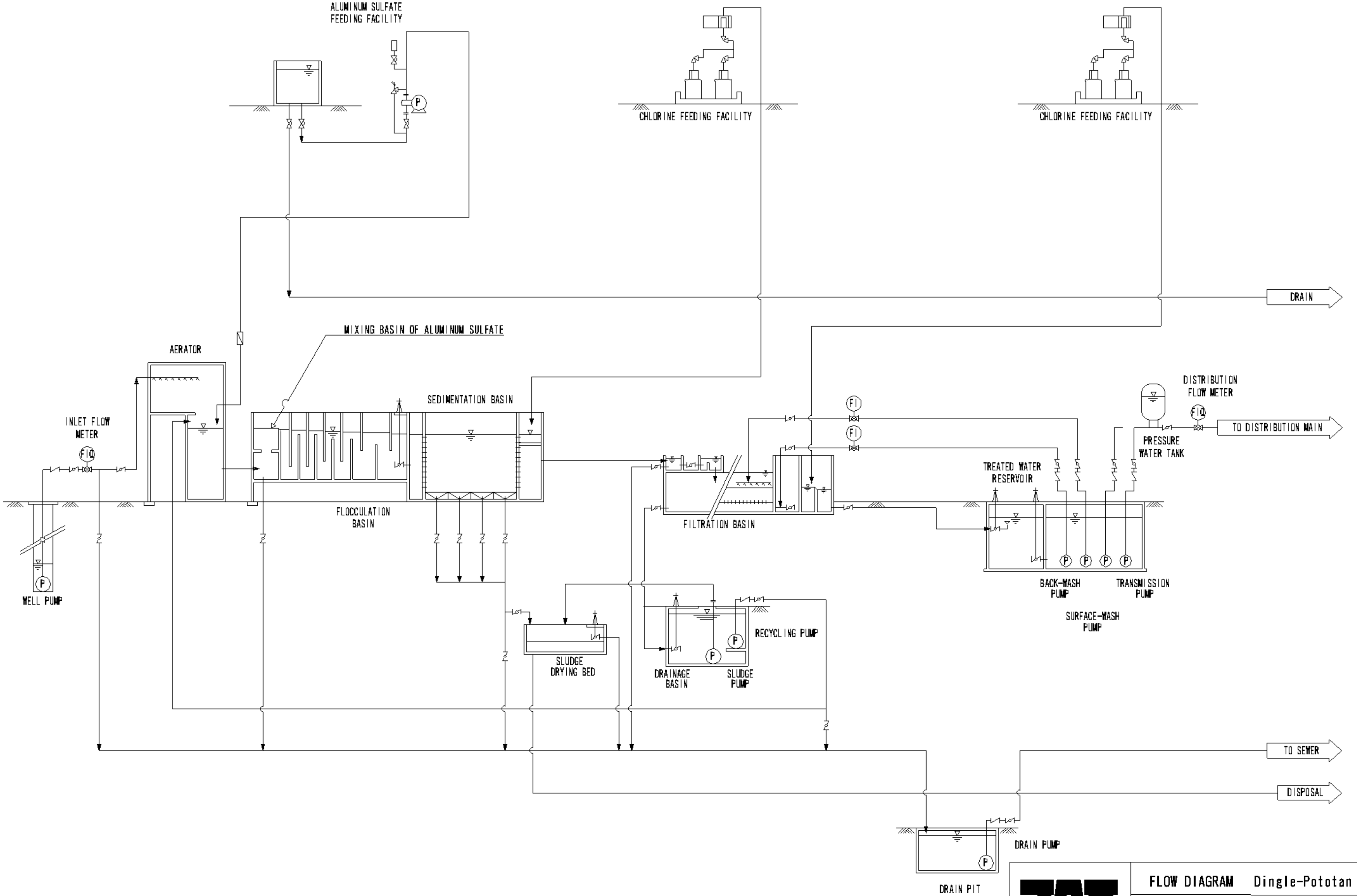
FLOW DIAGRAM Pagsanjan

JAPAN TECHNO



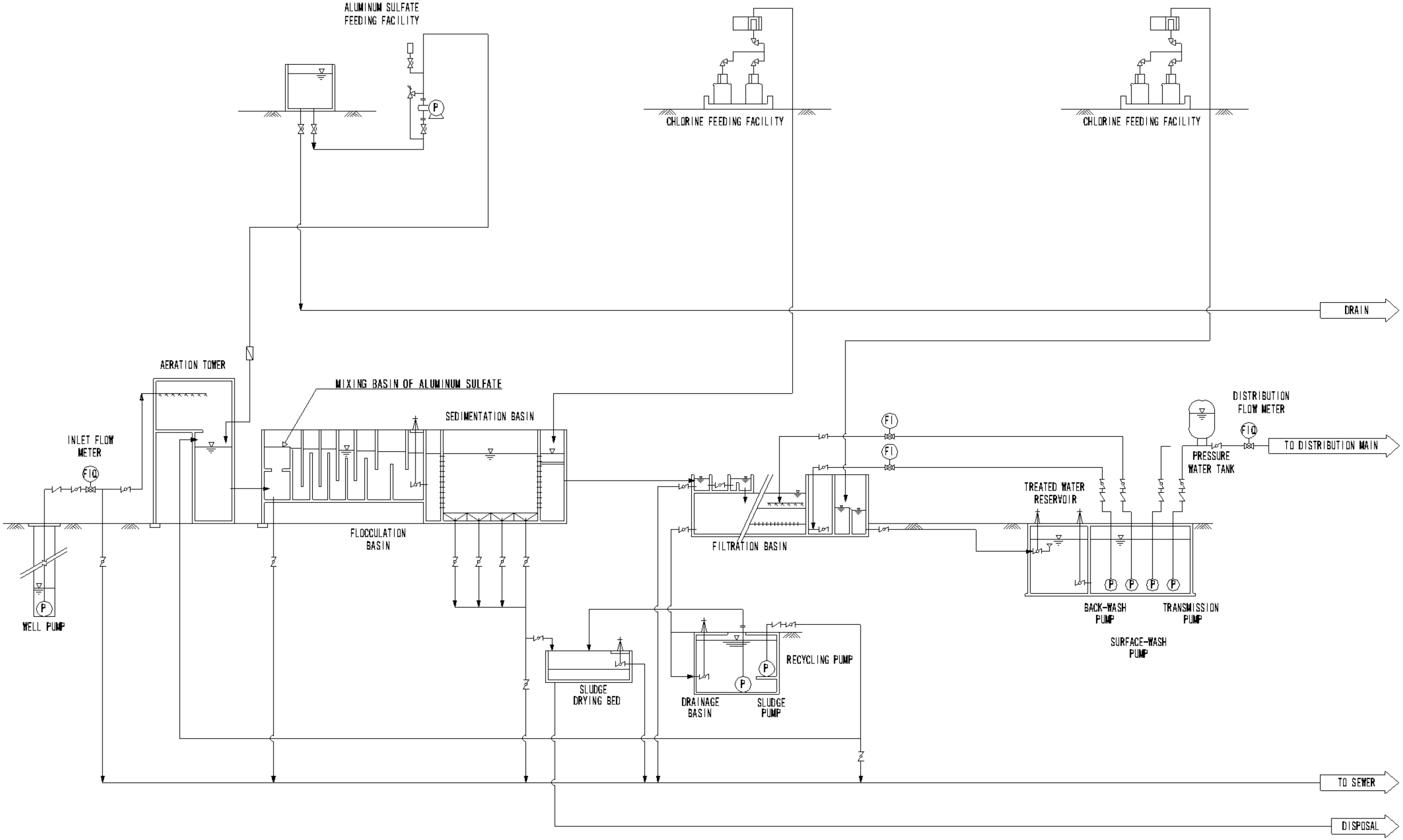
FLOW DIAGRAM Panitan

JAPAN TECHNO



FLOW DIAGRAM Dingle-Pototan

JAPAN TECHNO

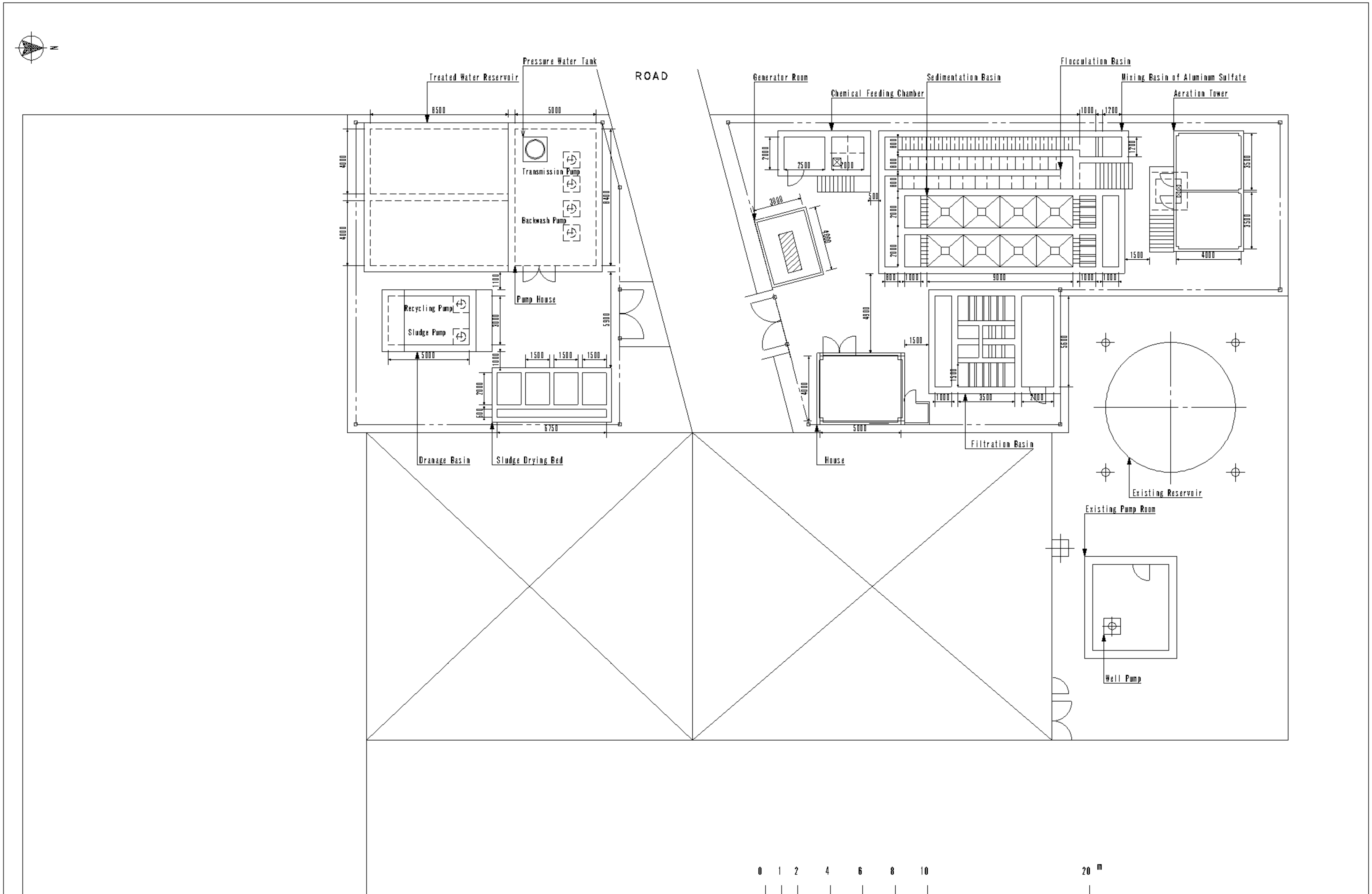


FLOW DIAGRAM Abuyog, Midsayap, Kabacan

JAPAN TECHNO

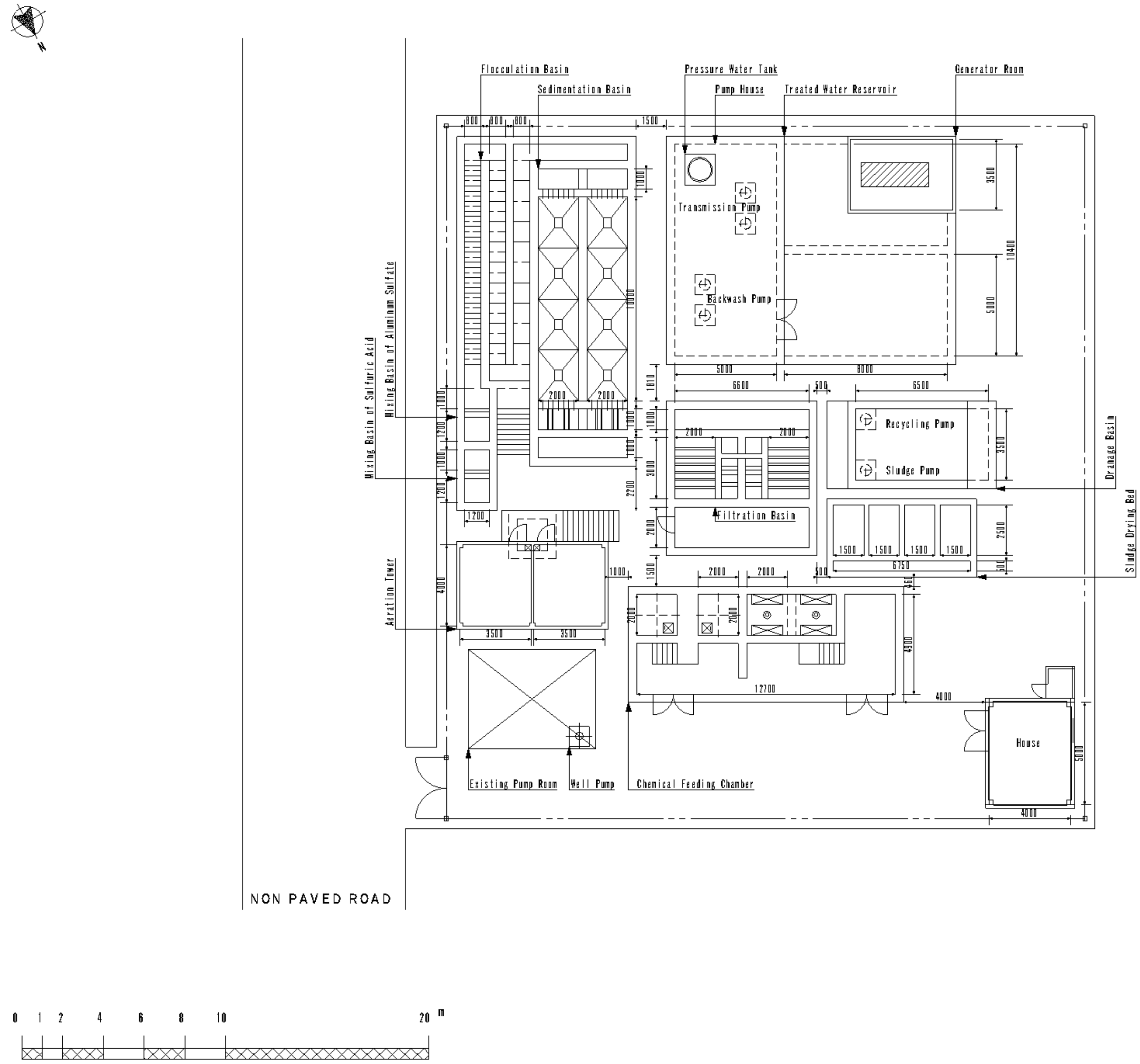
2. Layout Plan

Solana
Binmaley Caloocan
Binmaley Fabia
Lingayen
Pagsanjan
Panitan
Pontevedra
Dingle-Pototan
Abuyog
Midsayap
Kabacan



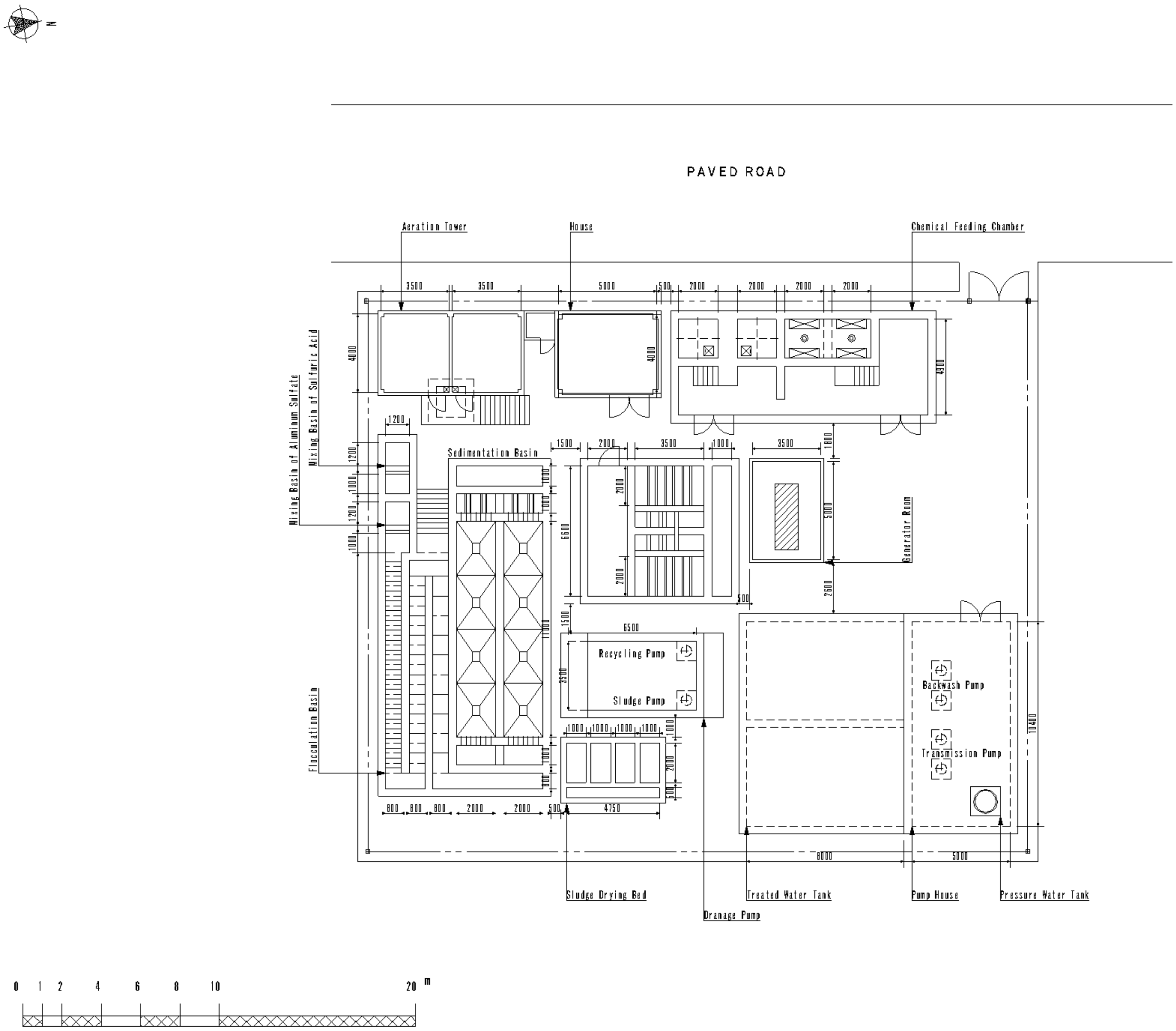
LAYOUT PLAN (Solana)

JAPAN TECHNO



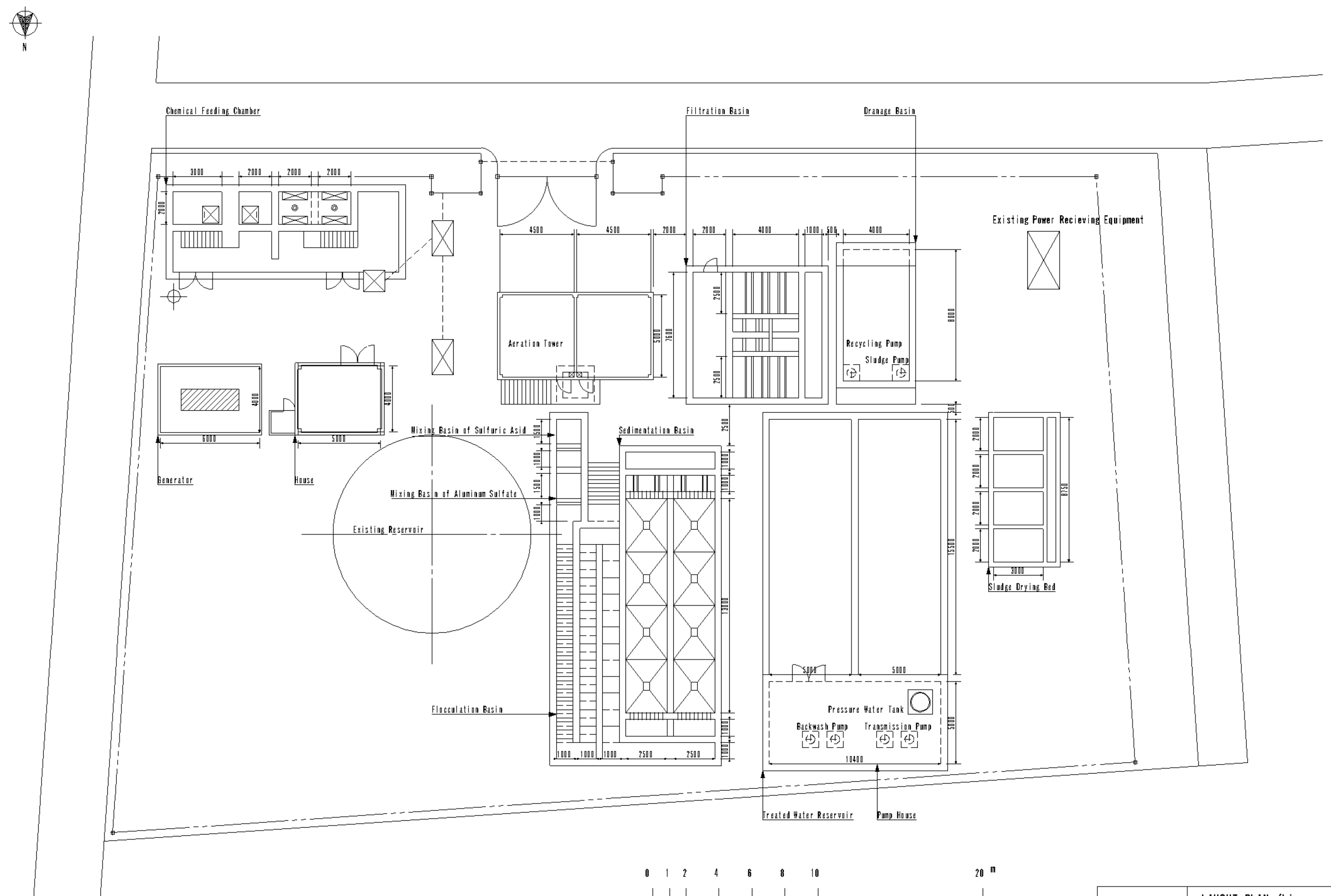
LAYOUT PLAN (Binmaley Calnocan)

JAPAN TECHNO



LAYOUT PLAN (Binmaley Fabia)

JAPAN TECHNO

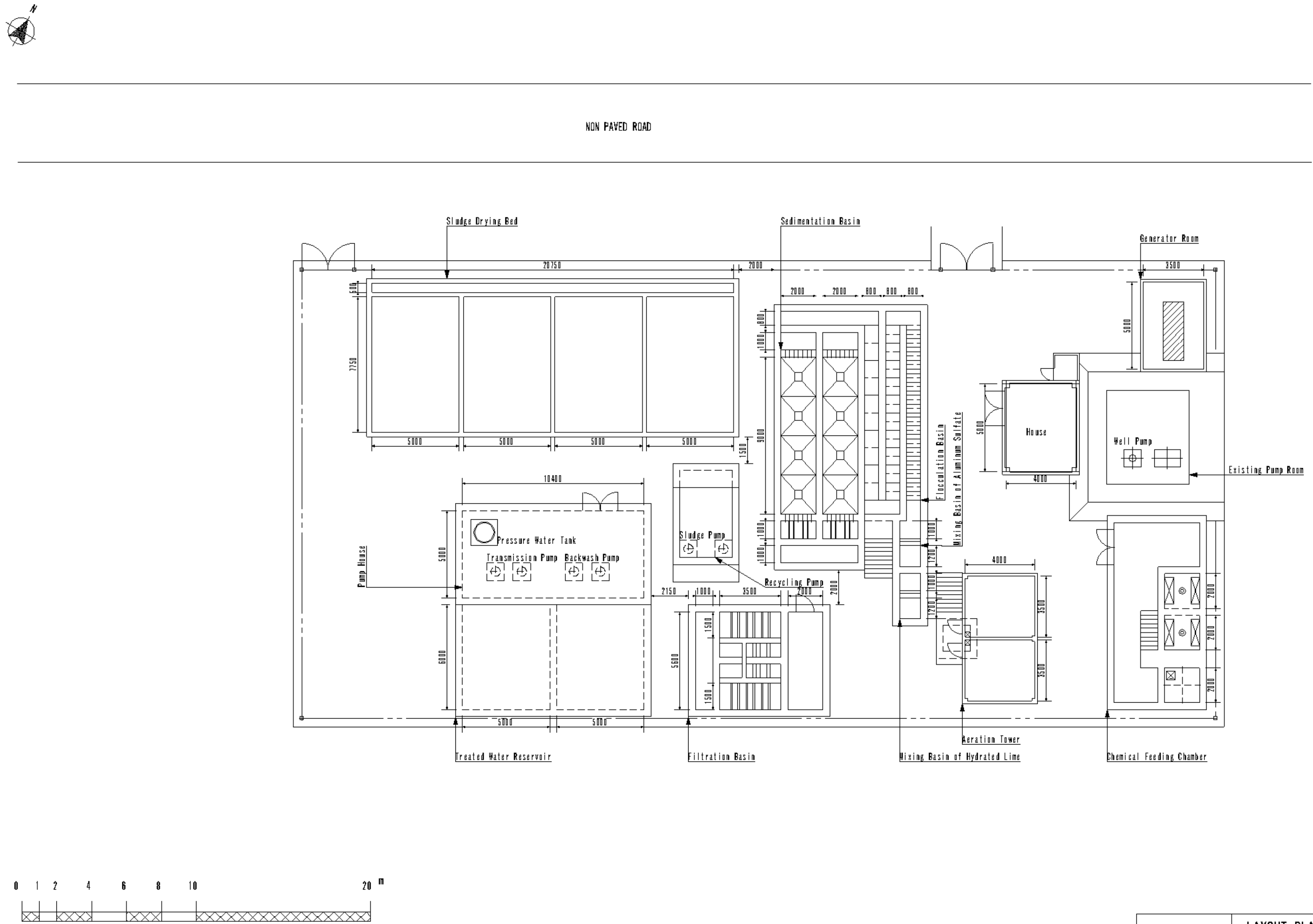


LAYOUT PLAN (Lingayen)

JAPAN TECHNO

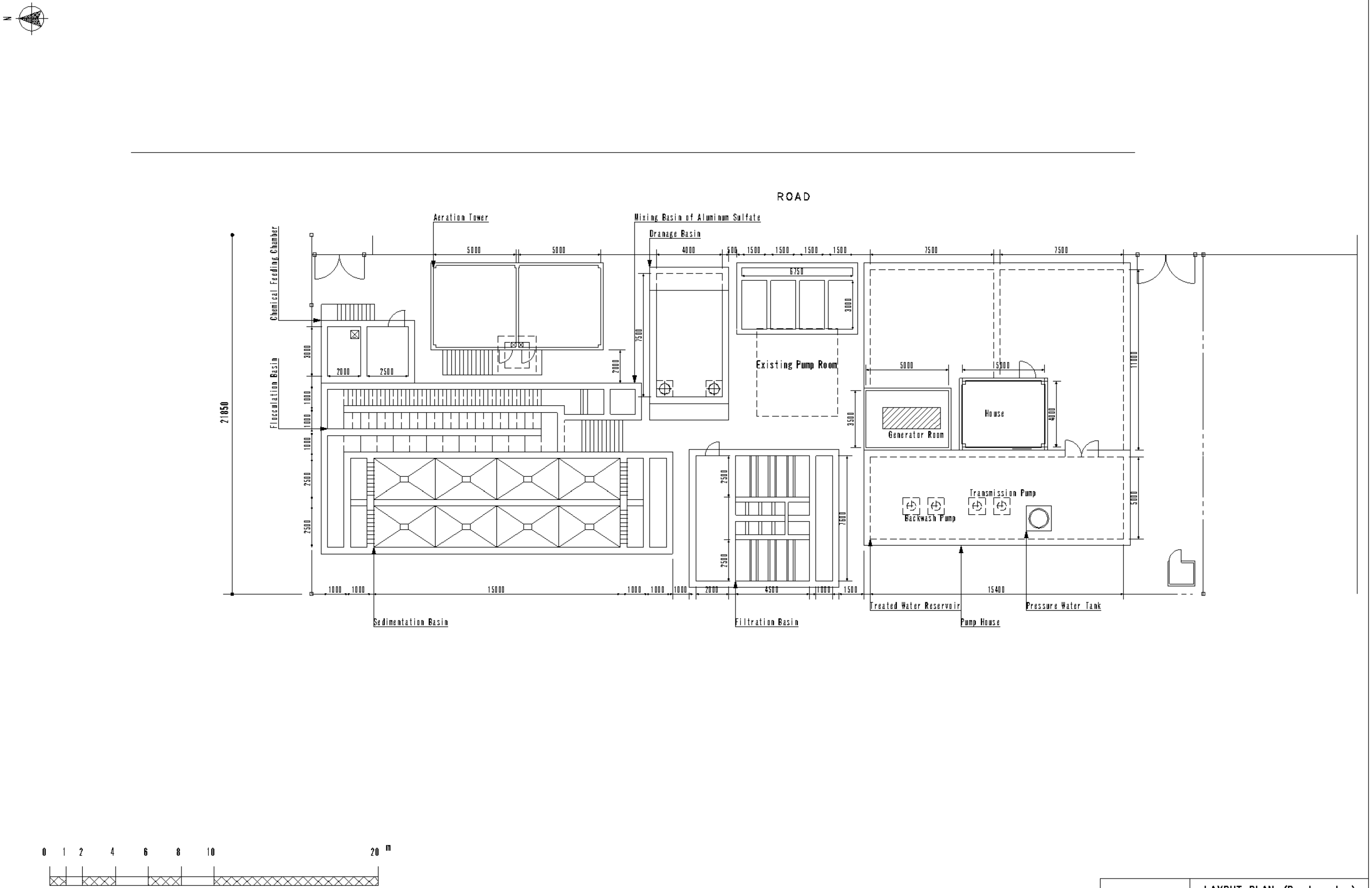
LAYOUT PLAN (Pagsanjan)

JAPAN TECHNO



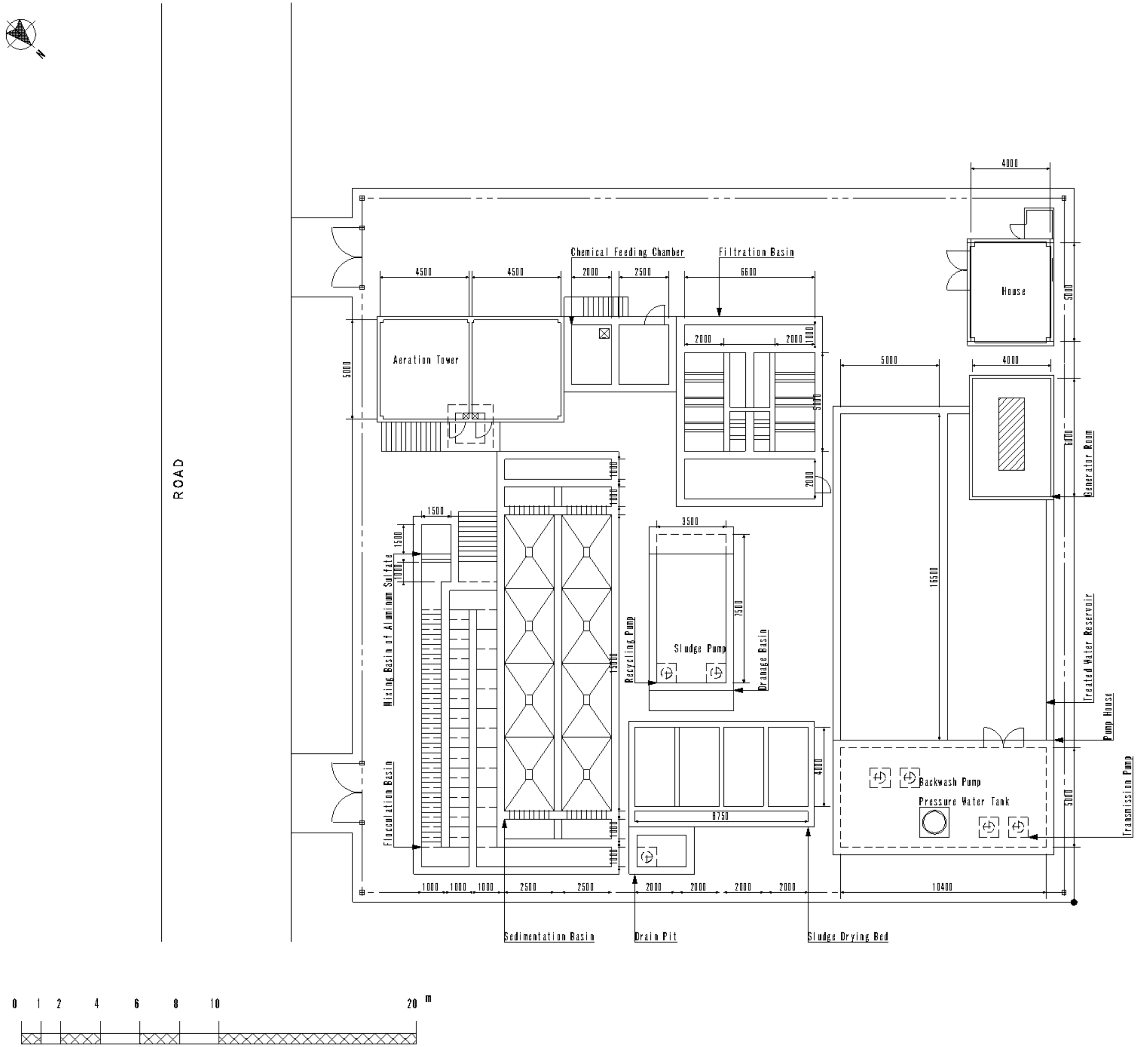
LAYOUT PLAN (Panitan)

JAPAN TECHNO



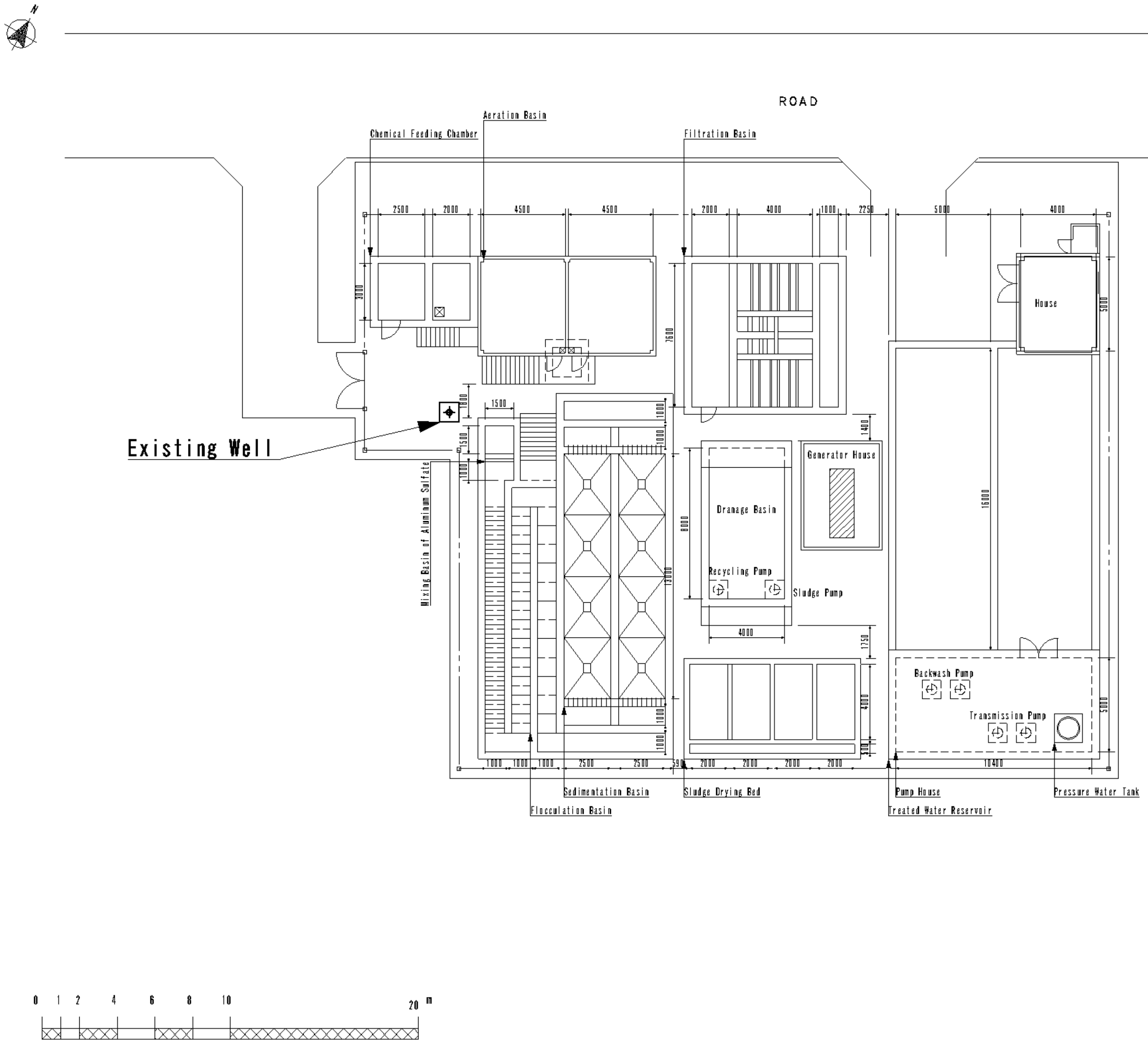
LAYPUT PLAN (Pontevedra)

JAPAN TECHNO



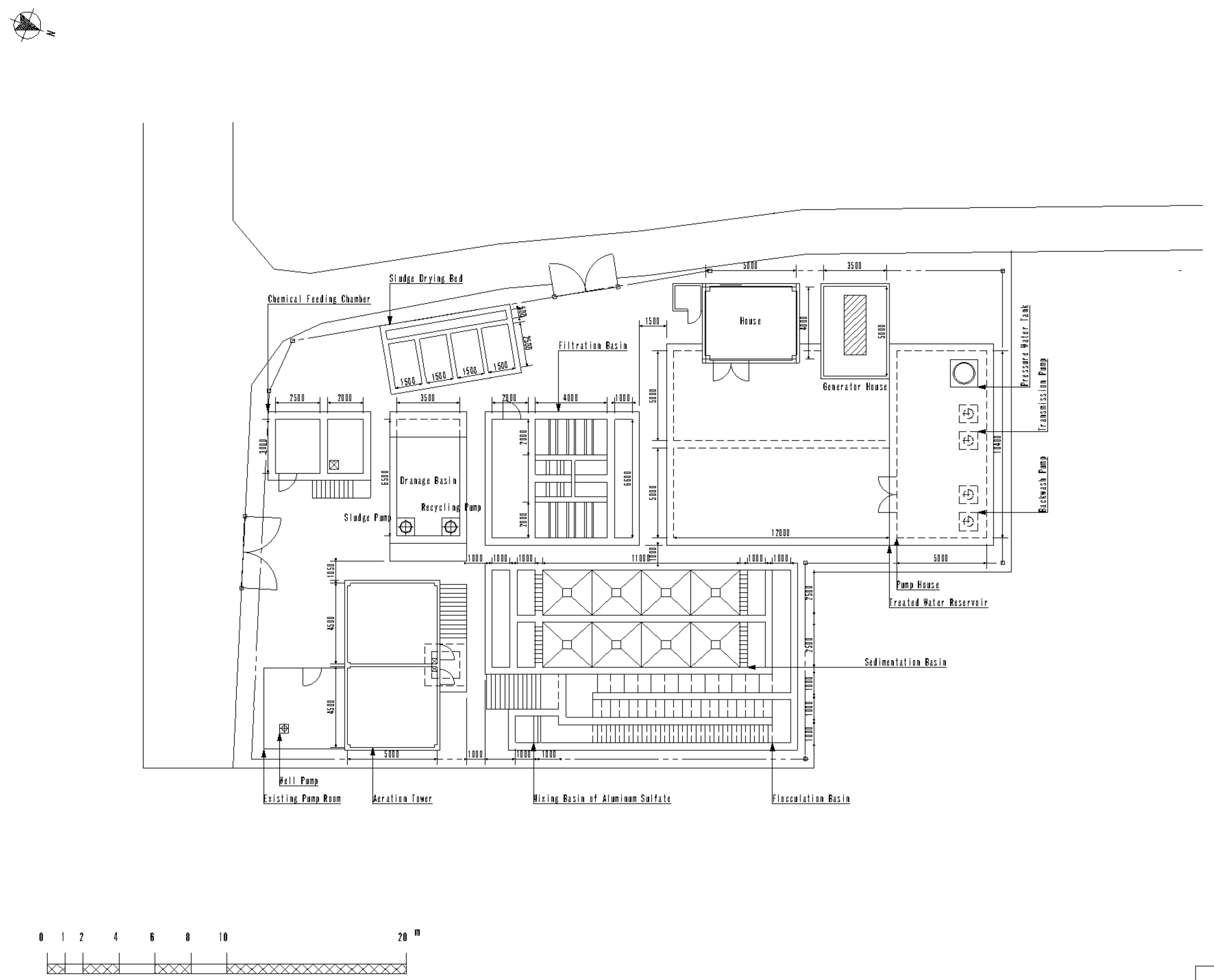
LAYOUT PLAN (Dingle-Pototan)

JAPAN TECHNO



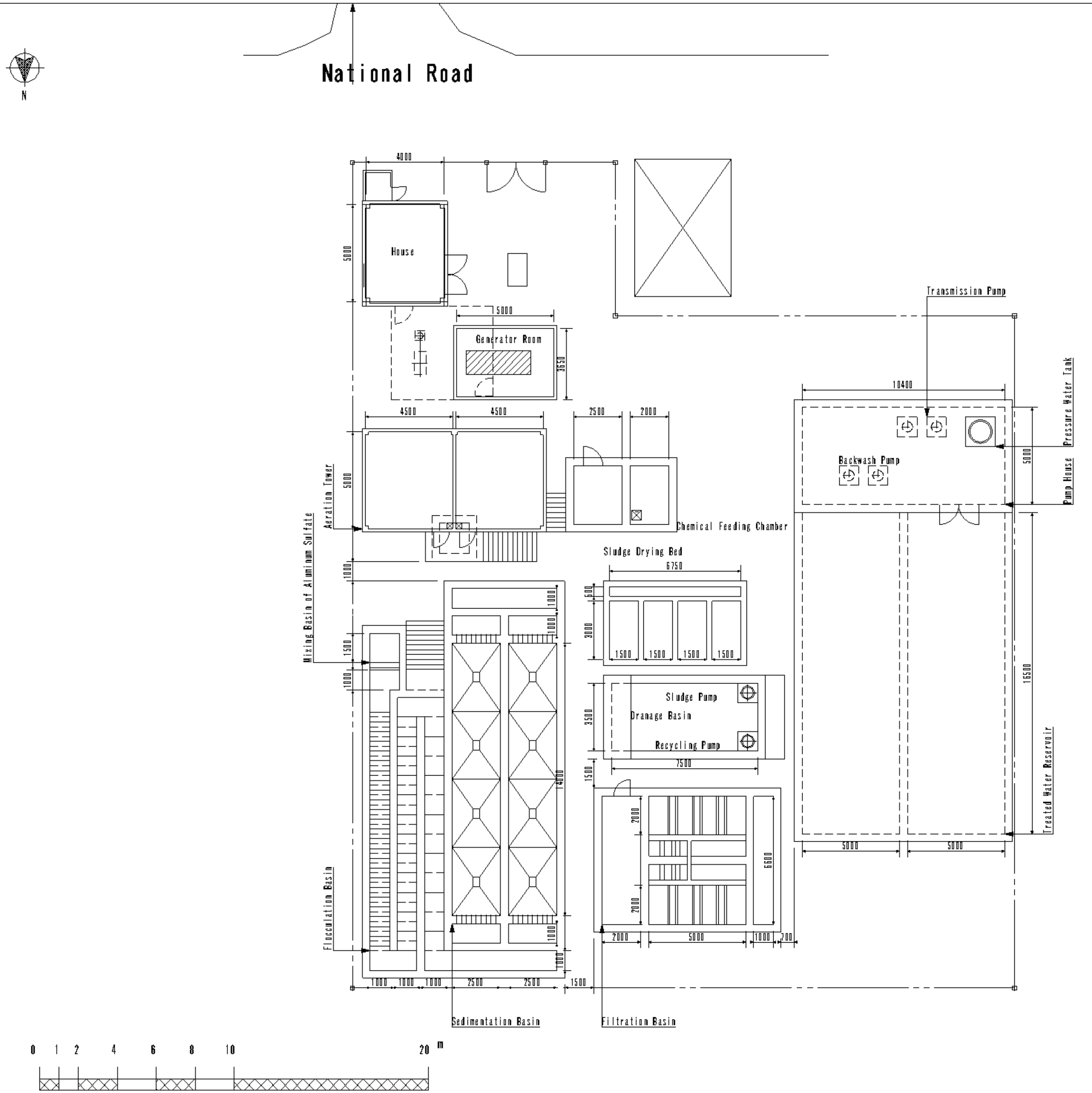
LAYOUT PLAN (Abuyog)

JAPAN TECHNO



LAYOUT PLAN (Midsayap)

JAPAN TECHNO

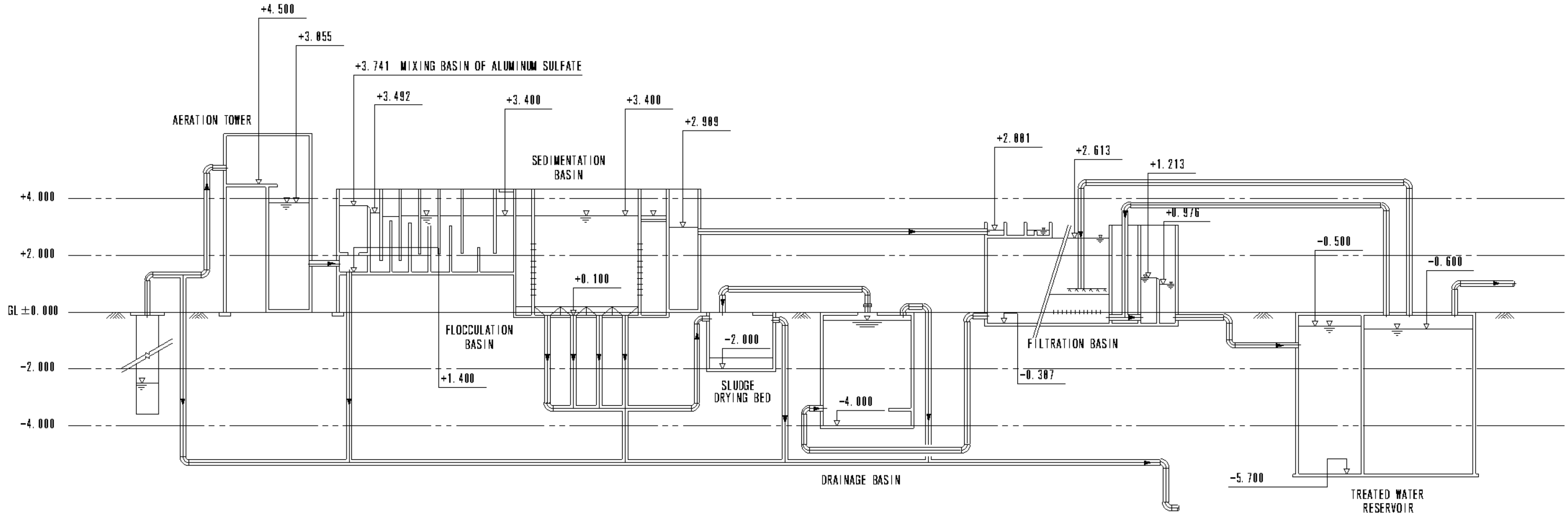


LAYOUT PLAN (Kabacan)

JAPAN TECHNO

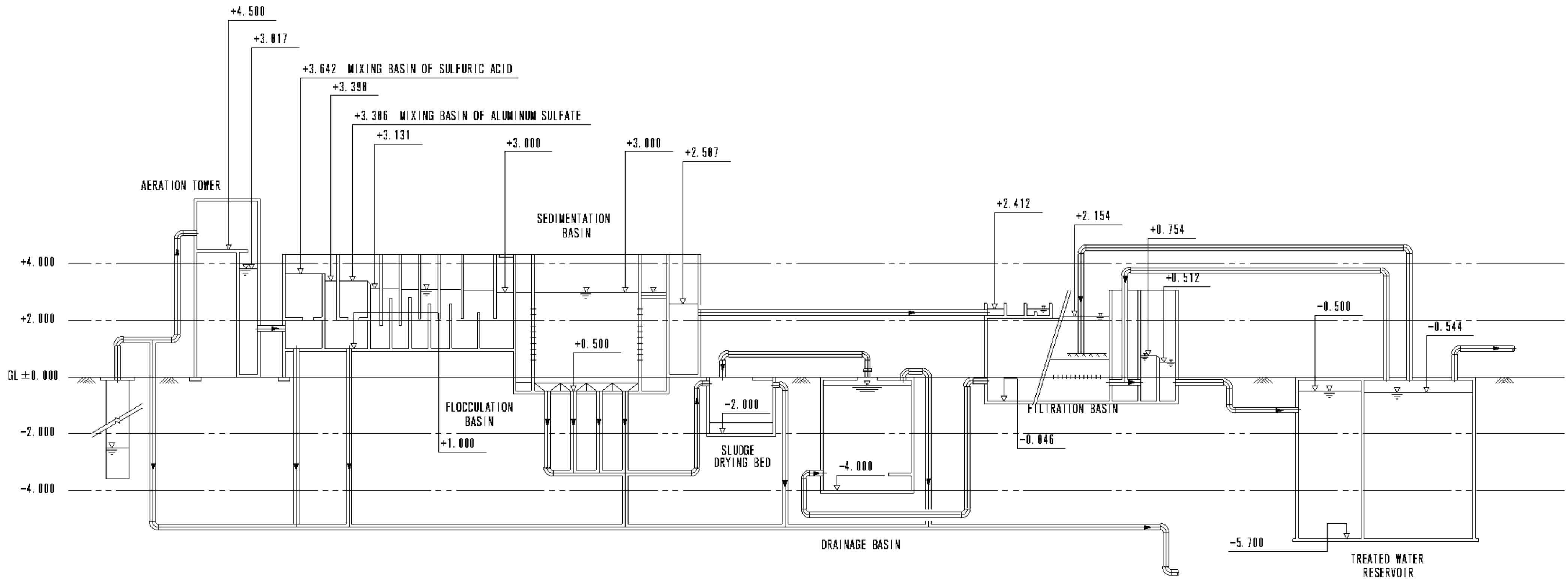
3. Hydraulic Profile

Solana
Binmaley Caloocan
Binmaley Fabia
Lingayen
Pagsanjan
Panitan
Pontevedra
Dingle-Pototan
Abuyog
Midsayap
Kabacan



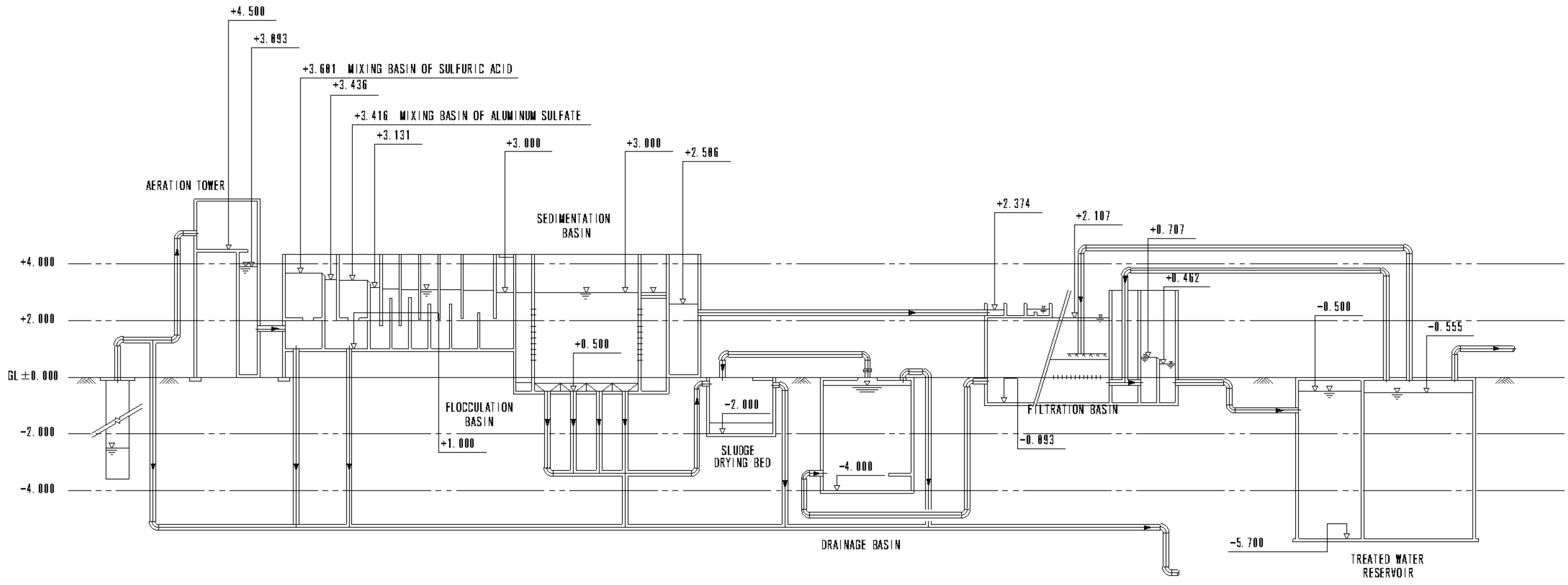
Hydraulic Profile
Solana

JAPAN TECHNO



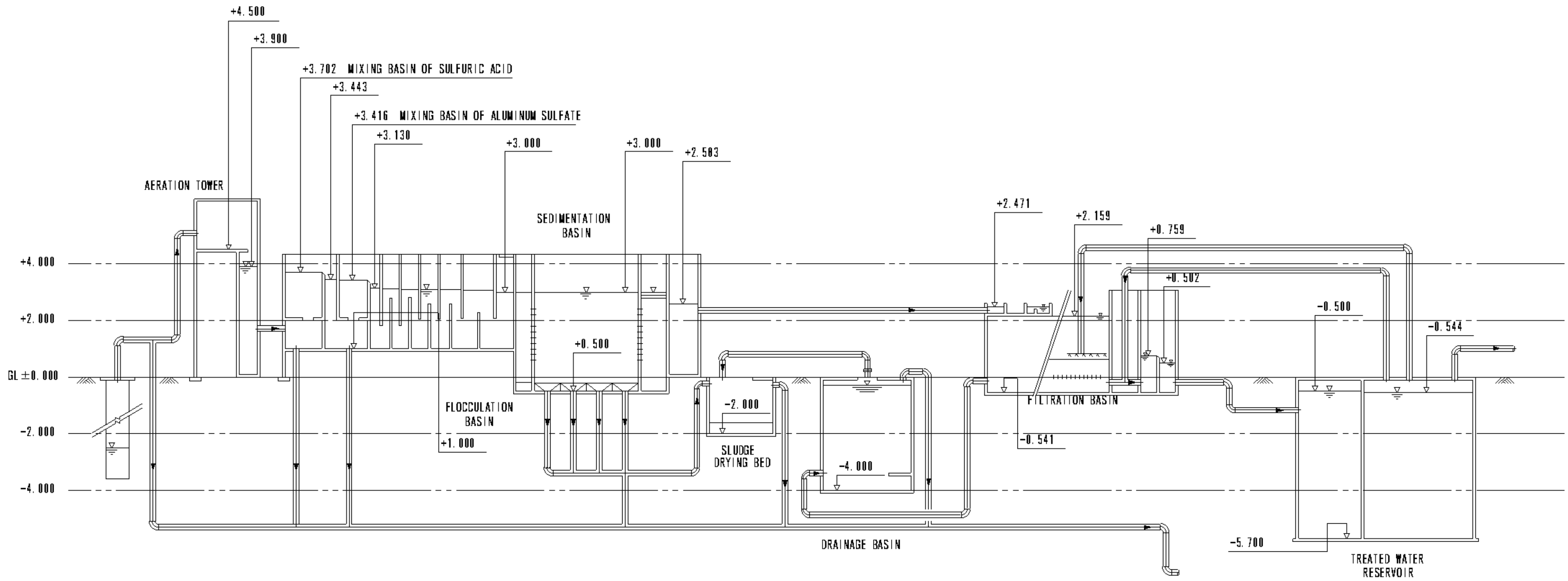
Hydraulic Profile
Binmaley Caloocan

JAPAN TECHNO



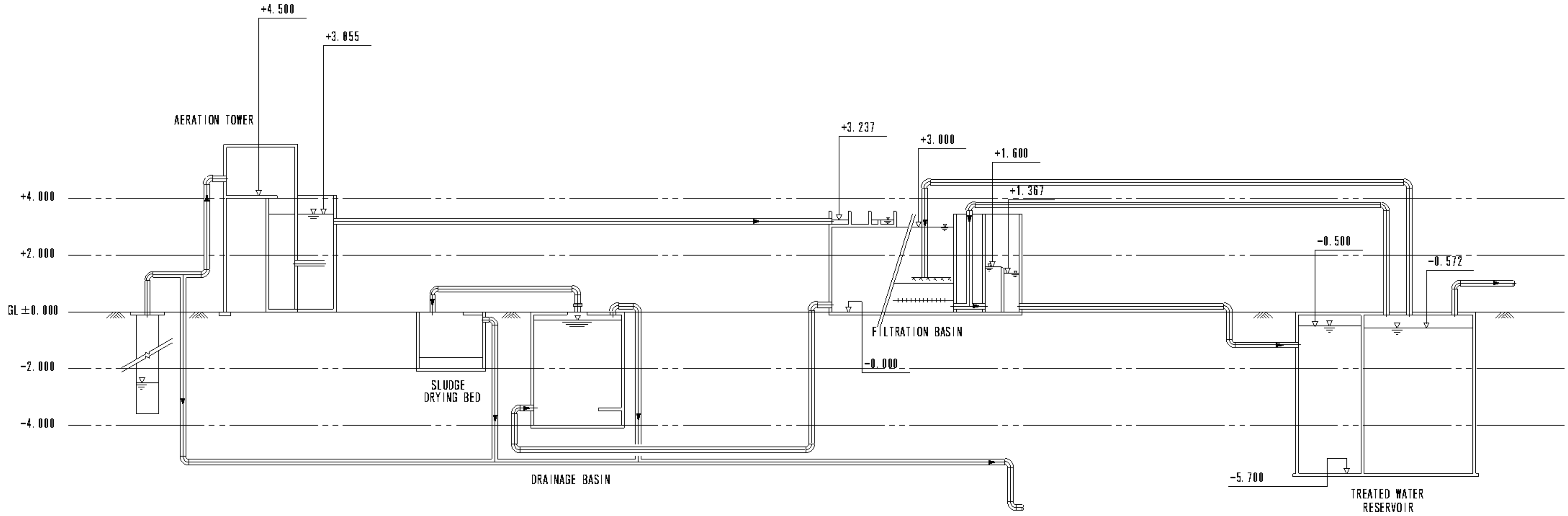
Hydraulic Profile
Binmaley Fabia

JAPAN TECHNO



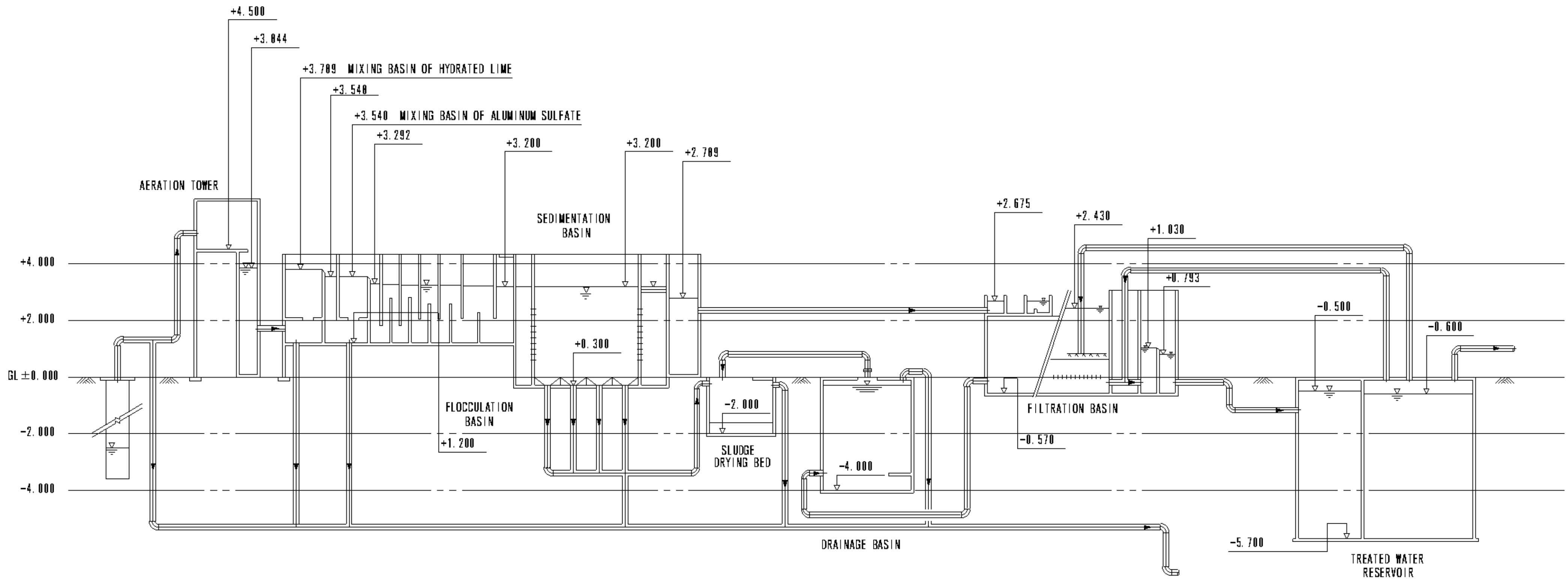
Hydraulic Profile
Lingayen

JAPAN TECHNO



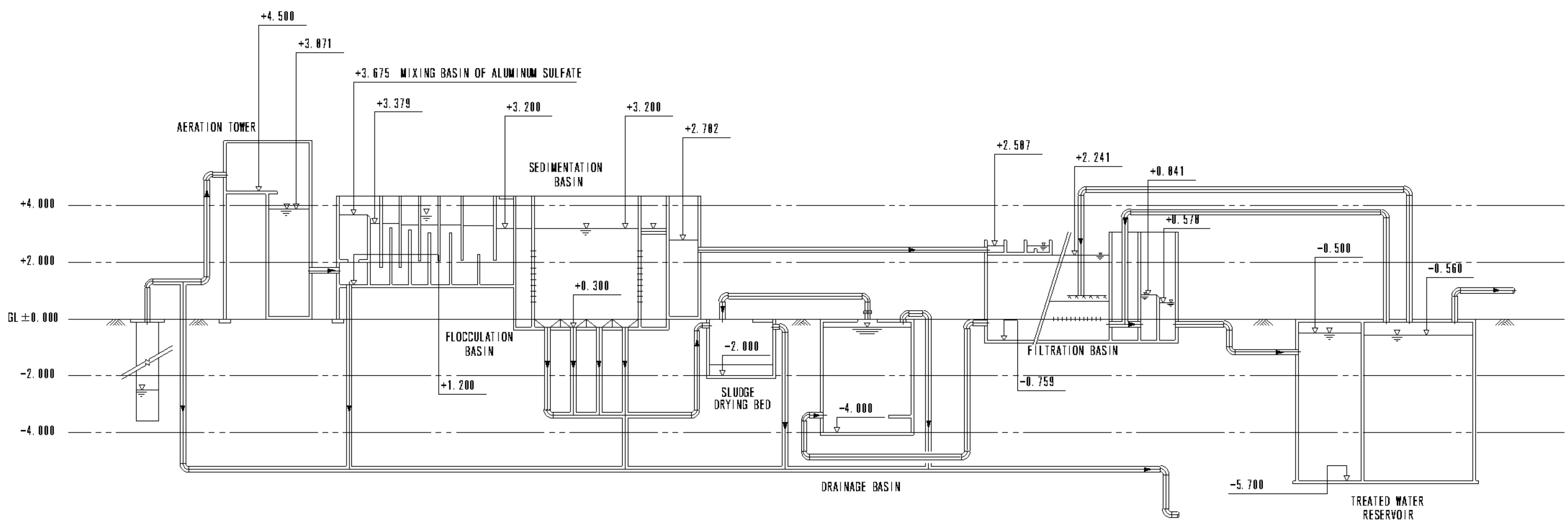
Hydraulic Profile
Pagsanjan

JAPAN TECHNO



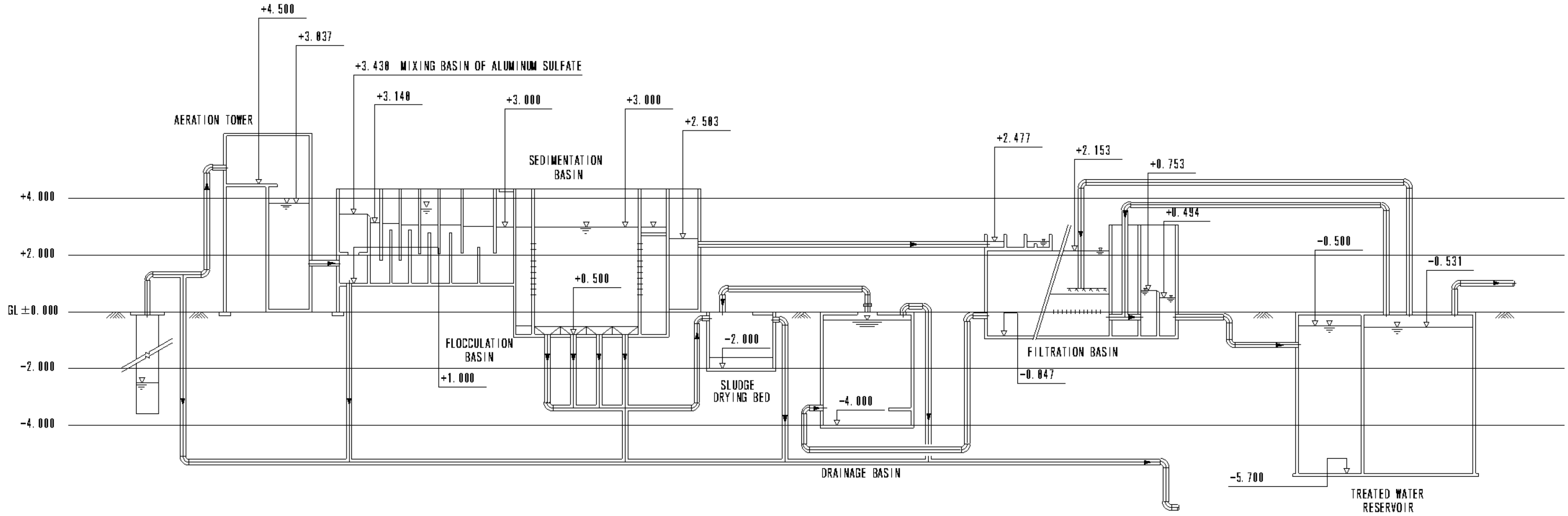
Hydraulic Profile
Panitan

JAPAN TECHNO



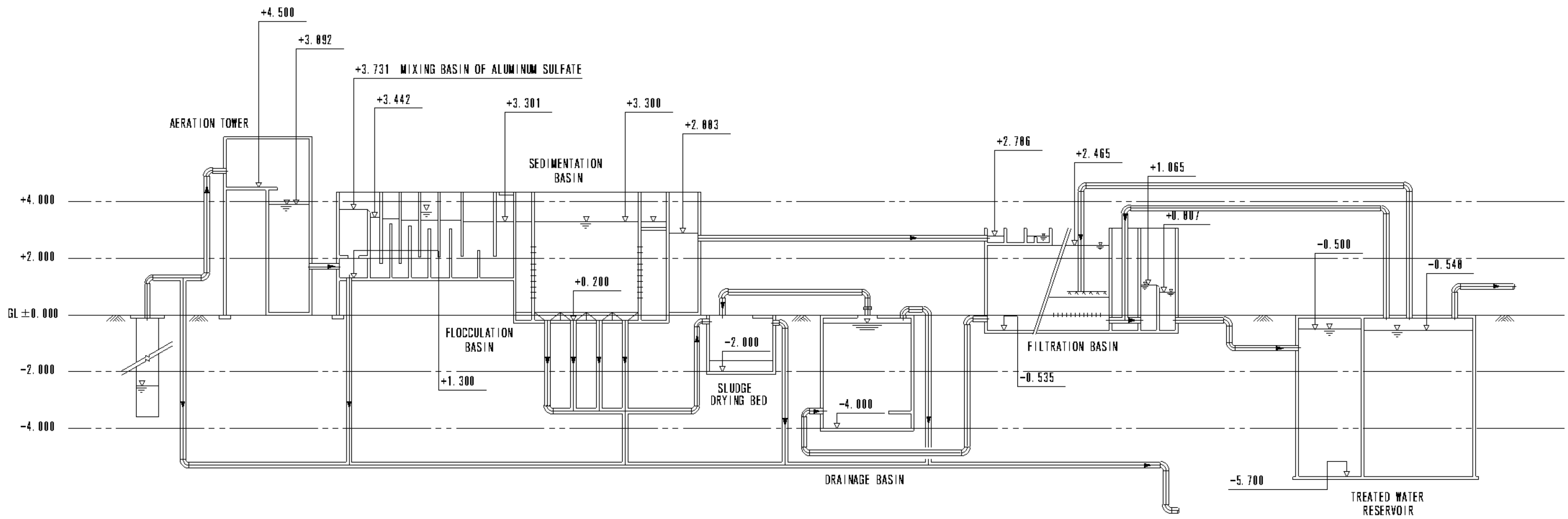
Hydraulic Profile
Pontevedra

JAPAN TECHNO



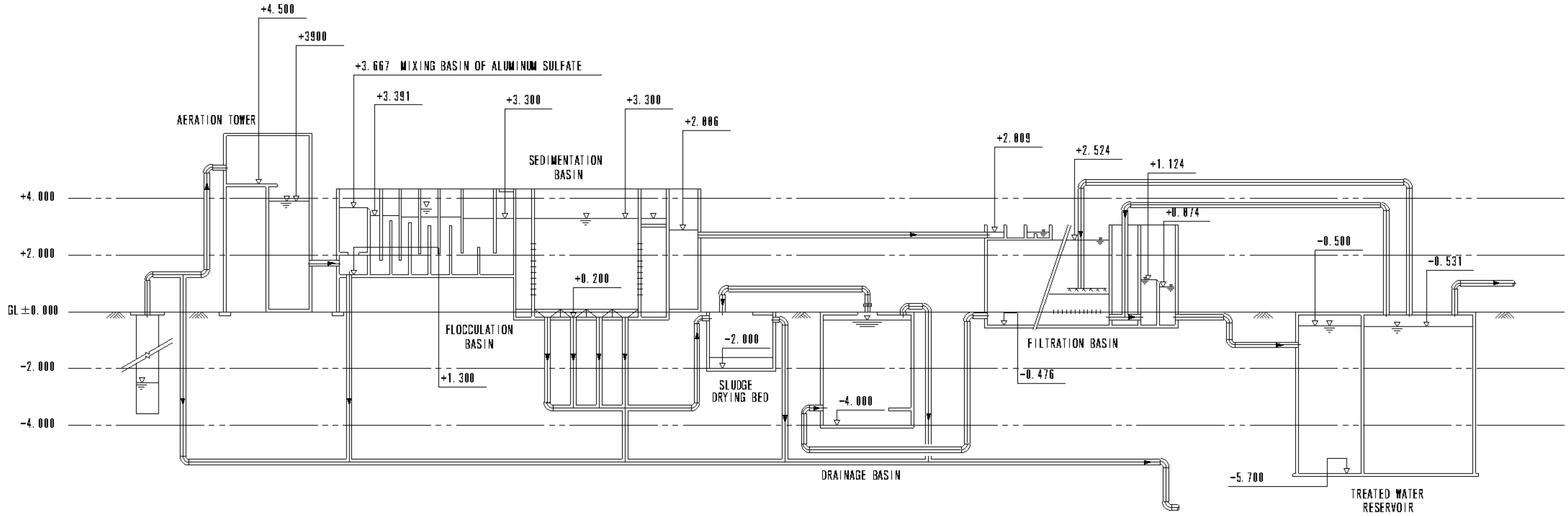
Hydraulic Profile
Dingle-Pototan

JAPAN TECHNO



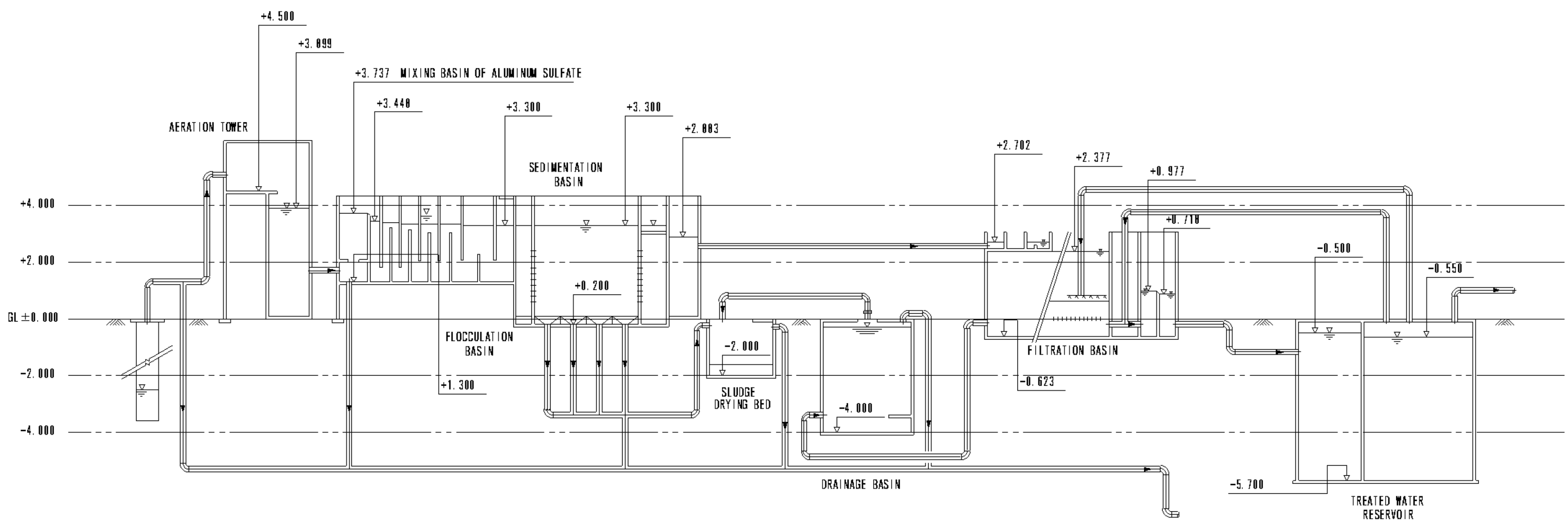
Hydraulic Profile
Abuyog

JAPAN TECHNO



Hydraulic Profile
Midsayap

JAPAN TECHNO



Hydraulic Profile
Kabacan

JAPAN TECHNO