NATIONAL DEVELOPMENT PLANNING AGENCY (BAPPENAS)
MINISTRY OF PUBLIC WORKS (PU)
BALI PROVINCIAL GOVERNMENT

THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

FINAL REPORT

VOLUME III

SUPPORTING REPORT (APPENDICES)

JUNE 2012

JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)

TOYOTA TSUSHO CORPORATION
NIHON SUIDO CONSULTANTS CO., LTD.
METAWATER CO., LTD

OPS
CR (5)
12-029

Currency Exchange Rate (Effective as of August 2011)
1 IDR ＝ 0.00909 JPY

THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

REPORT CONTENTS

Volume I	Summary
Volume II	Main Report
Volume III	Supporting Report (Appendix)

TABLE OF CONTENTS

APPENDIX 1

INTERVIEW SURVEY ON THE RECLAIMED WATER USE

APPENDIX 1 INTERVIEW SURVEY ON THE RECLAIMED WATER USE

1.a Introduction

Interview survey was executed to understand the usage and demand of reclaimed water in the southern Bali area by visiting the person in charge of the water supply and drainage facility management in a power plant, a harbor facility, large-scale hotels, golf courses, and shopping malls, etc., using the questionnaire prepared beforehand.

1.b Interview Survey Method

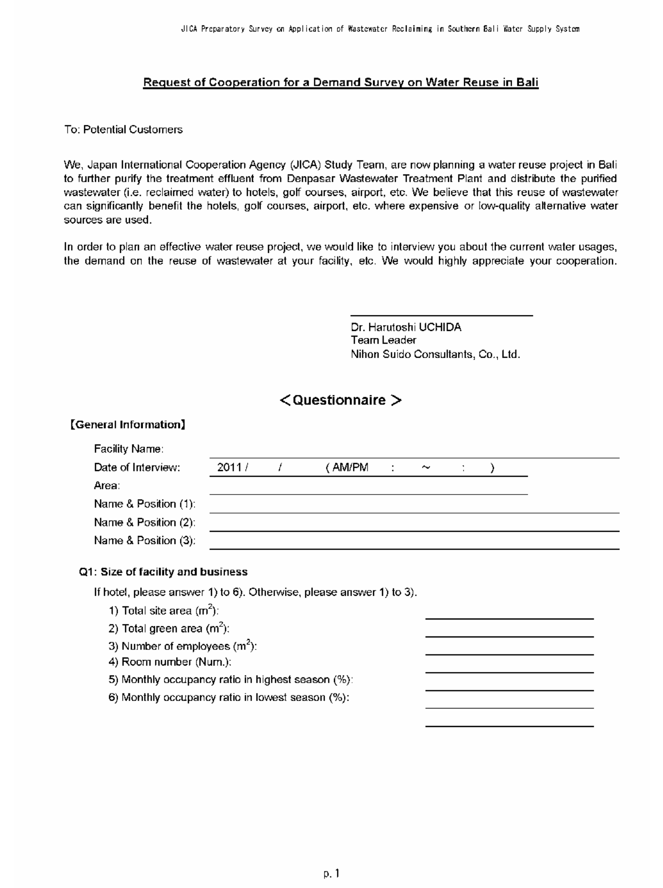
The reclaimed water demand changes depending on the water quality and the charge. Therefore, three levels of reclaimed water quality shown below are set to understand the demand of each water quality level in the interview survey. Level 1 reclaimed water was set to ask the interviewee his image on the reclaimed water.

Level 1 reclaimed water:	Reclaimed water that can be used as potable water and cooking water directly and indirectly.
Level 2 reclaimed water:	This is not water quality (level 1) that can be used as potable water and cooking water. Reclaimed water that can be used without problem on water quality for other usages (shower, pool, hand wash, toilet flush, sprinkling water for landscaping pond and garden, and others.)
Level 3 reclaimed water:	Reclaimed water that can be used for landscaping such as ponds and sprinkling water for garden. There is a problem on the water quality for other usages.

The charge of reclaimed water changes greatly depending on the kind and scale of the treatment process, the scale (diameter, length and others) of the transmission facility and the scale of the pump facility. The interview survey started at the beginning of the survey, when the construction cost and O&M cost could not be calculated yet. The reclaimed water charge was not shown at the interview. Therefore, willingness to pay (unit charge) for the reclaimed water of each level was questioned. Moreover, necessity of receiving tank that is necessary when using the reclaimed water, indoor dual water supply piping (independent pipe for clear water and reclaimed water), and others were questioned. And the maximum installation cost can be borne is also questioned.

In the interview survey, water source, demand by each usage, scale of water service facility, drain facility, waste water treatment plant, installation cost and O&M cost were confirmed to understand the background of the reclaimed water demand in each facility.

1.c Questionnaire for the Survey



JICA Preparatory Survey on Application of Wastewater Reclaiming in Southern Bali Water Supply System

Request of Cooperation for a Demand Survey on Water Reuse in Bali

To: Potential Customers

We, Japan International Cooperation Agency (JICA) Study Team, are now planning a water reuse project in Bali to further purify the treatment effluent from Denpasar Wastewater Treatment Plant and distribute the purified wastewater (i.e. reclaimed water) to hotels, golf courses, airport, etc. We believe that this reuse of wastewater can significantly benefit the hotels, golf courses, airport, etc. where expensive or low-quality alternative water sources are used.

In order to plan an effective water reuse project, we would like to interview you about the current water usages, the demand on the reuse of wastewater at your facility, etc. We would highly appreciate your cooperation.

Dr. Harutoshi UCHIDA
Team Leader
Nihon Suido Consultants, Co., Ltd.

＜Questionnaire ＞

【General Information】

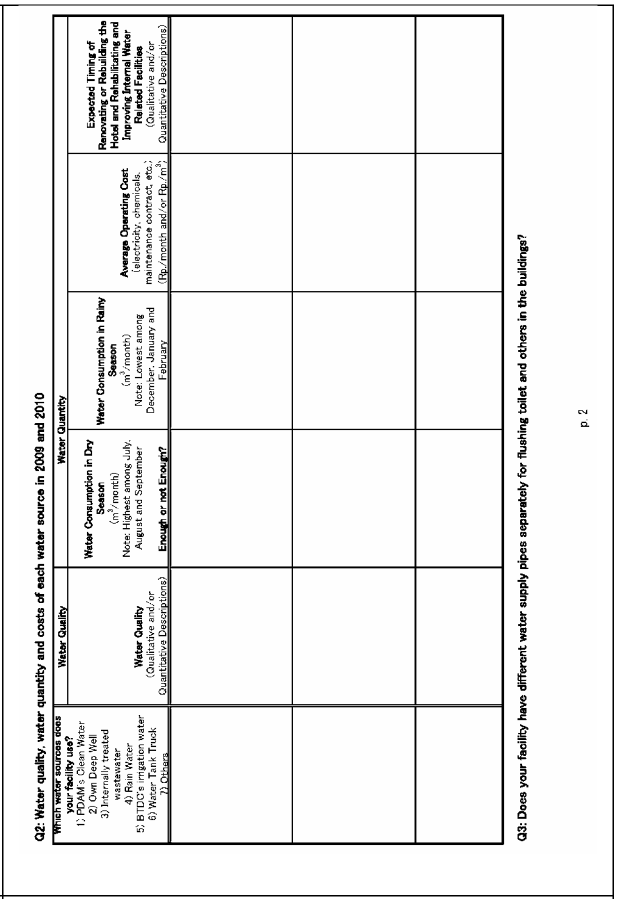
Facility Name: ______
Date of Interview: 2011 / / (AM/PM : ~ :)
Area: ______
Name & Position (1): ______
Name & Position (2): ______
Name & Position (3): ______

Q1: Size of facility and business

If hotel, please answer 1) to 6). Otherwise, please answer 1) to 3).

1) Total site area (m^2): ______
2) Total green area (m^2): ______
3) Number of employees (m^2): ______
4) Room number (Num.): ______
5) Monthly occupancy ratio in highest season (%): ______
6) Monthly occupancy ratio in lowest season (%): ______

p. 1

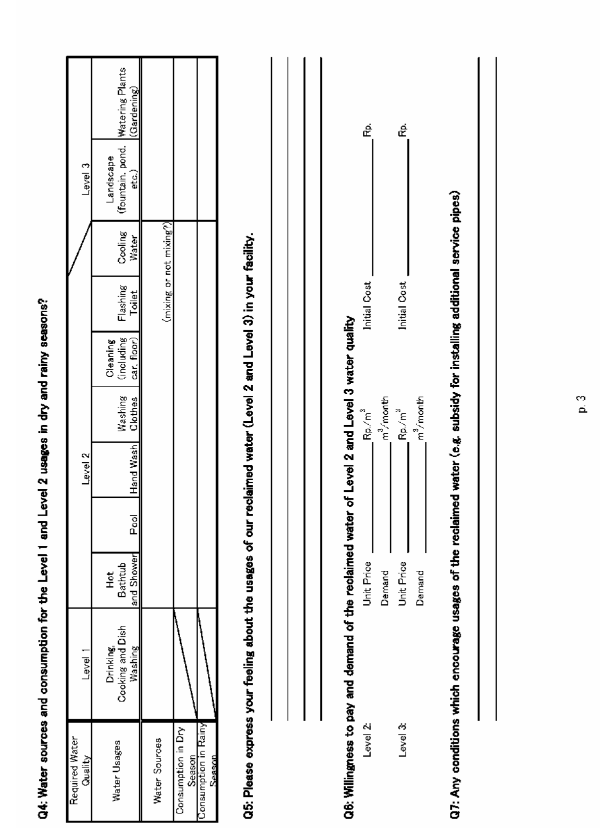


Q2: Water quality, water quantity and costs of each water source in 2009 and 2010

Which water sources does your facility use? 1) PDAM's Clean Water 2) Own Deep Well 3) Internally treated wastewater 4) Rain Water 5) BTDC's irrigation water 6) Water Tank Truck 7) Others	**Water Quality**	**Water Quantity**			
	Water Quality (Qualitative and/or Quantitative Descriptions)	**Water Consumption in Dry Season** (m^3/month) Note: Highest among July, August and September **Enough or not Enough?**	**Water Consumption in Rainy Season** (m^3/month) Note: Lowest among December, January and February	**Average Operating Cost** (electricity, chemicals, maintenance contract, etc.) (Rp./month and/or Rp./m^3)	**Expected Timing of Renovating or Rebuilding the Hotel and Rehabilitating and Improving Internal Water Related Facilities** (Qualitative and/or Quantitative Descriptions)

Q3: Does your facility have different water supply pipes separately for flushing toilet and others in the buildings?

p. 2



Q4: Water sources and consumption for the Level 1 and Level 2 usages in dry and rainy seasons?

Required Water Quality	Level 1	Level 2							Level 3	
Water Usages	Drinking, Cooking and Dish Washing	Hot Bathtub and Shower	Pool	Hand Wash	Washing Clothes	Cleaning (including car, floor)	Flashing Toilet	Cooling Water	Landscape (fountain, pond, etc.)	Watering Plants (Gardening)
Water Sources		(mixing or not mixing?)								
Consumption in Dry Season										
Consumption in Rainy Season										

Q5: Please express your feeling about the usages of our reclaimed water (Level 2 and Level 3) in your facility.

Q6: Willingness to pay and demand of the reclaimed water of Level 2 and Level 3 water quality

Level 2: Unit Price ______ Rp./m^3 Initial Cost ______ Rp.
Demand ______ m^3/month
Level 3: Unit Price ______ Rp./m^3 Initial Cost ______ Rp.
Demand ______ m^3/month

Q7: Any conditions which encourage usages of the reclaimed water (e.g. subsidy for installing additional service pipes)

p. 3

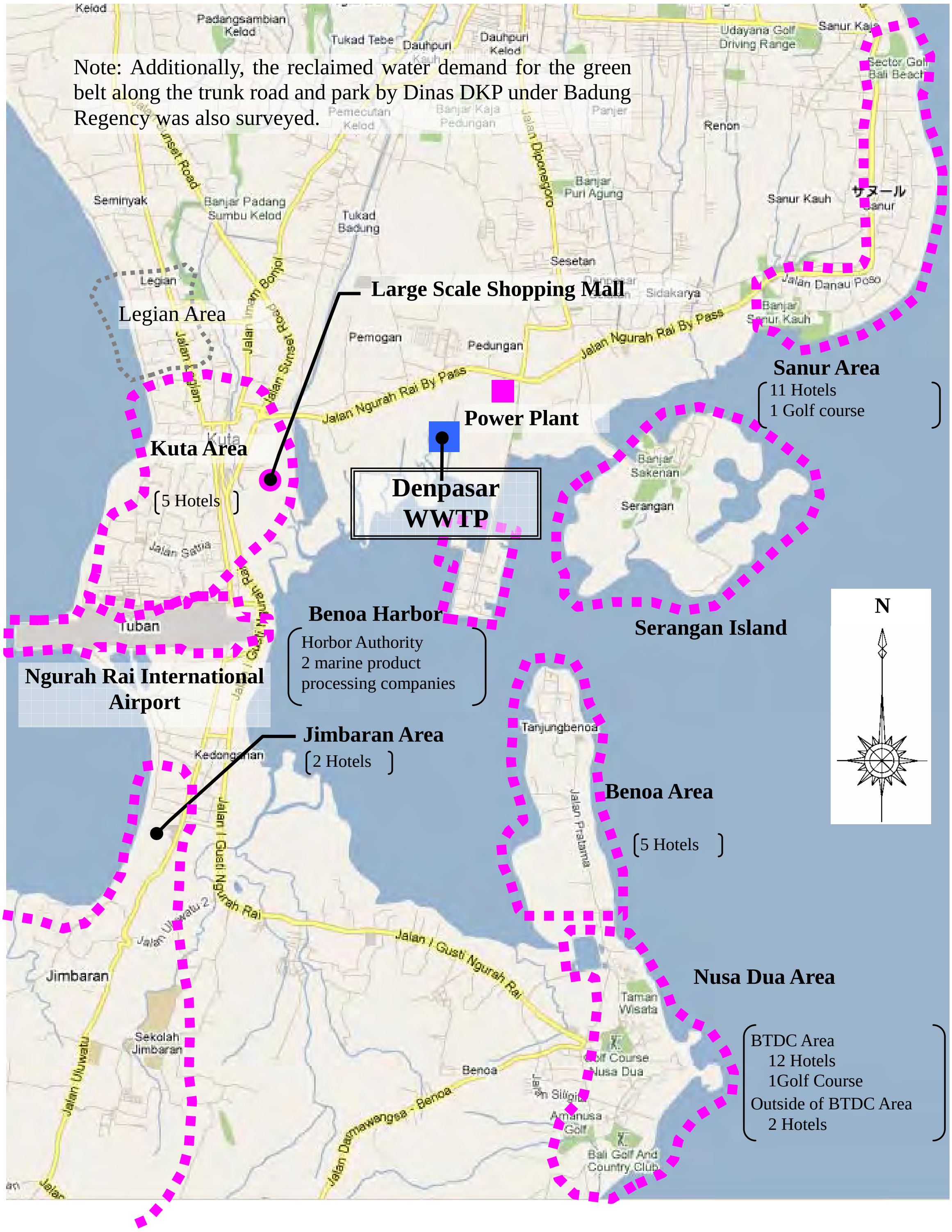
1.d Survey Target

Table 1.d.1 shows the reclaimed water demand expectations by usage for each target facility.

Table 1.d.1 Targets and Reclaimed Water Demand Expectations for Interview Survey

Target	Expectation of Usage and Demand on Reclaimed Water
Airport	- It can be used for sprinkling water of the green space in the airport and toilet flush water in the terminal facility. Especially, the volume of toilet flush water is large because there are many users.
Power Plant	- It can be used for a large amount of cooling water, sprinkling water in the site, and toilet flush water in the administration building.
Benoa Harbor	- It can be used for a large amount of washing and cleaning water for the marine product processing company. - It can also be used for washing water and the ballast water of the ship.
Large-scale luxury hotel (Four and Five star hotels)	- As there is a huge garden, it can be used for a large amount of sprinkling water. - As there are many guests, it can be used for a large amount of toilet flush water. - As high groundwater tax is imposed, it can be used for an alternative of groundwater.
Golf course	- It can be used for a large amount of sprinkling water to maintain the golf course.
New resort development (Serangan Island)	- The resort development plan for the Serangan Island was prepared in the past. It can be used for sprinkling water, toilet flush water and others if facilities such as hotels are constructed, though the situation depends on the development trend of afterwards.
Large Scale Shopping Mall	- It can be used for toilet flush water, sprinkling water and others as the counterpart proposes.

Figure 1.d.1 shows the location of the target area and facilities of the demand survey. Legian area was excluded from the demand survey, because it was thought that there were few large-scale and luxury hotels expected to use sprinkling water.



Note: Additionally, the reclaimed water demand for the green belt along the trunk road and park by Dinas DKP under Badung Regency was also surveyed.

Figure 1.d.1 Location of the Target Area and Facilities of the Demand Survey

1.e Result of Interview Survey

As a result of the interview survey, the demand for level 1 reclaimed water was little by the sensuous reason: They do not want to use the wastewater for drinking and cooking even though it is reclaimed. Therefore, the report of the survey by the facility and area will be focused on the demand for level 2 and 3.

(1) Power Plant (Indonesia Power)

This power plant was expected as a recipient of the reclaimed water because it was located near the Denpasar WWTP where the construction of reclamation facility is examined. However, it turned out that its power generating system does not need a huge amount of the cooling water. Moreover, the treated water from the internal wastewater treatment plant is used for sprinkling water, therefore it is considered that the demand of a level 3 reclaimed water is a little. On the other hand, the interviewee answered that there is a possibility to buy the level 2 treated water if the charge is under Rp.228/m^3, the groundwater tax of the power plant. However, level 2 reclaimed water demand cannot be expected under the current situation because the unit cost of current underground water is set considerably low.

(2) Ngurah Rai International Airport

This airport is using a small amount of PDAM water, relies on the groundwater from the internal deep well. It has a plan to expand the terminal. The plan which the groundwater is scheduled to be used as the main water source in the future is advanced now. It is at the tender stage at present, and scheduled the facility to be completed in 2013. On the other hand, there is a plan to improve the treatment facility to use the treated water as sprinkling water, toilet flushing water, and cooling water and others, though currently, the generated sewage has been discharged into the sea directly from the wastewater treatment plant after treatment. Moreover, the interviewee answered that the supply of the treated water is enough compared with the demand for the reclaimed water after the terminal is expanded. Therefore, the demand for level 2 and 3 reclaimed water is limited under the current situation.

However, it is thought that there is potential as a recipient for the reclaimed water if the groundwater that is the pillar of the water supply plan becomes difficult by legal regulation, groundwater quality problem, profitability, maintenance and others in the future. It seems possible to expect as future potential recipient for the reclaimed water.

(3) Benoa Harbour

In the reclaimed water business prepared by Bali province government independently, Benoa Harbour is a user of the reclaimed water. But a concrete usage of the reclaimed water is not mentioned.

It was expected that a large amount of reclaimed water could be used for ship cleaning, ballast water, washing water for marine product processing company and others. The demand for ship cleaning and ballast water was not made clear by the interview survey. The groundwater tax is set cheap as Rp.1,216/m^3 from January 2011 though currently groundwater is used in the marine product processing company. Therefore, it is thought to be difficult to expect the level 2 and 3 reclaimed water demand under the current situation.

But if the water demand for ship cleaning and ballast water is expected and/or the groundwater is difficult to use due to a regulation, the harbour would become a good recipient.

(4) Golf Course

There are two golf courses in the survey area. One is the Grand Bali Beach Golf Course in the Sanur area (9 holes). The other is Bali Golf and Country Club in the Nusa Dua area that is in the Bali Tourism Development Cooperation (BTDC) area where the national tourism project has been developed. Toilet flush water, shower water at clubhouse (level 2 reclaimed water) and sprinkling water (level 3 reclaimed water) in the course can be considered as the demand for reclaimed water but the level 2 reclaimed water demand cannot be expected in those golf courses because dual water supply piping system is required as well as a large amount of reclaimed water cannot be expected. Therefore, the result of the survey on level 3 is described below.

In the Grand Bali Beach Golf Course in Sanur area, the treated water which is collected at the adjoining Inna Grand Bali Beach Hotel and treated at the WWTP is used for the sprinkling of the golf course. Moreover, in the worst case, if the emergency that cannot use the treated water occurs, it is possible to use the nearby river water temporarily. Therefore, the demand for level 3 reclaimed water is limited. Public sewers are developed in the Sanur area under the Sewerage Project, the sewers connections are forced by a regulation and the in-house wastewater treatment facilities are to be abandoned, then the level 3 reclaimed water demand would become high.

In the Bali Golf and Country Club of Nusa Dua area, the generated sewage is treated in the WTTP of BTDC, then the treated water is purchased as reclaimed water (hereinafter referred to as BTDC irrigation water) and used for sprinkling, etc. Usually, the sprinkling water of about 500m^3/d is required during the dry season. Among them, about 100m^3/d is supplied from the rainwater reservoir in the golf course, about 400m^3/d is supplied from the BTDC irrigation water as much as possible, and the shortfall is supplied from groundwater.

According to the record of BTDC irrigation water supply amount to the golf course in the BTDC area in 2009 (Table 1.e.1), the amount of maximum reclaimed water supplied from the WWTP of BTDC to the golf course was 10,200m^3/month (October, 2009), 329m^3/d (converted into daily amount). From these records, level 3 reclaimed water demand becomes about 70, subtracted 100m^3/d (rain water) and 329m^3/d (reclaimed water of BTDC) from 500m^3/d (demand for sprinkling during the dry season). The quality of BTDC irrigation water is so bad that it is used for sprinkling after mixed the BTDC irrigation water with groundwater from the deep well in another pond of the golf course. After 2009, the demand decreased to only 70m^3/d because the groundwater tax rose though there is demand for the reclaimed water as an alternative water source of groundwater. Moreover, the interviewee answered that there was a possibility of purchasing more level 3 reclaimed water if it was possible to supply it by lower charge than Rp.6,812/m^3, BTDC irrigation water charge.

Considering the circumstances mentioned above, it was clarified that the demand of level 3 reclaimed water in the golf course is limited now, but it can be expected depending on the development of sewer connections to the public sewerage system and BTDC irrigation water supply service.

(5) Large Scale Hotel

1) Sanur Area

In the Sanur area, there seems to be approximately ten large-scale hotels (four or five star hotel) with many guest rooms, also large garden, and high reclaimed water demand. In this survey, the interview was done for the Bali Hyatt Hotel (five star hotel) and the Sanur Paradise Plaza Hotel (four star hotel), etc.

Bali Hyatt Hotel has a waste water treatment plant, and the treated water is used as sprinkling water for the garden and landscape water for the pond. There is a plan to improve the sewage treatment enough to be used as cooling water in the future. Therefore, the demand for level 3 reclaimed water is considered as a little. Moreover, the interviewee answered that use of the level 2 reclaimed water is not assumed because a large scale construction is required to have dual water supply piping system in the building to use level 2 reclaimed water for toilet flush, etc. Therefore, the demand for the level 2 reclaimed water is depending on the establishing the dual water supply piping system.

At Sanur Paradise Plaza Hotel, the level 3 demand is limited because the garden is small and the demand is only about 5m^3/d even at the dry season. The demand for the level 2 reclaimed water would be limited when it is used for the toilet flush installation of new separate pipes are required but the installation work is difficult, for pool water the total water consumption is small due to circulation use and a bad image even if the reclaimed water quality is good.

2) Nusa Dua Area

In the Nusa Dua area, there is BTDC service area developed as a national tourism project (hereinafter referred to as BTDC area), and there are approximately ten large-scale hotels (four or five stars). The generated sewage from these hotels is treated at the WWTP of BTDC. A part of treated water is purchased as BTDC irrigation water, and used as sprinkling water for the garden and others.

At present, the influent is only around 5,000m^3/d- average, and 6,000m^3/d-maximum, though the design capacity of the WWTP of BTDC is 10,000m^3/d. About 2,400m^3/d, 40% of this treated volume at present is further treated (design capacity of the facility: 3,000m^3/d) and sold as BTDC irrigation water. BTDC is now advancing the improvement program of sewage treatment facility and the reclaimed water treatment facility by BOT project, and the progress should be taken care of in the future.

There are about four large-scale hotels (four or five star hotel) outside the BTDC area. Generated sewage in the hotel is treated in the internal WWTP, and the BTDC irrigation water is not used.

Based on the above-mentioned situation, the result of the reclaimed water demand survey in large-scale hotels in Nusa Dua area is reported.

< Large-scale hotels in BTDC area >

Among large scale hotels in the BTDC area, the interview survey was done for Club Med located near the WWTP of BTDC, Ayodya Resort and Novotel Nusa Dua located far away from the WWTP, Melia Bali Villas Resort located between them, etc.

It was thought that there were hotels which have the dual pipe system because the BTDC irrigation water was supplied in the BTDC area. But it was clarified that such a hotel doesn't exist through the interview with BTDC and hotels.

First of all, Novotel Nusa Dua and Club Med answered that they would not break the wall and install the pipe only for the reclaimed water to supply the level 2 reclaimed water

Water is leaking frequently in Ayodya Resort Hotel because 20 years has already passed since the pipe was installed in the hotel. It is necessary to examine remedial measures including the dual water supply piping in the future. There was an answer that they might examine the use of the reclaimed water depending on the level 2 reclaimed water charge. Ayodya Resort Hotel uses the groundwater of the deep well about 200m^3/d at the maximum, and it is thought that it influences largely if the reclaimed water charge is cheaper than the groundwater tax when the use of the reclaimed water is examined.

It is scheduled that three hotels (250 rooms at Marriott Hotel, 50 rooms at the Royal Kamuela Hotel, and 50 rooms at Laguna Villa) will be constructed by the end of 2011, and 350 rooms will increase in total in the BTDC area. In addition, the construction of three facilities (20 rooms at Villa NW-2, 200 rooms at N-5, and 5000 seats in the convention hall) is also scheduled. As the water demand will increase further in these facilities, but the present water supply capacity is not easily increase as stated in the previous section. Therefore, a promotion of the level 2 reclaimed water use by introduction of the dual water piping system in these facilities may effective use the limited water supply.

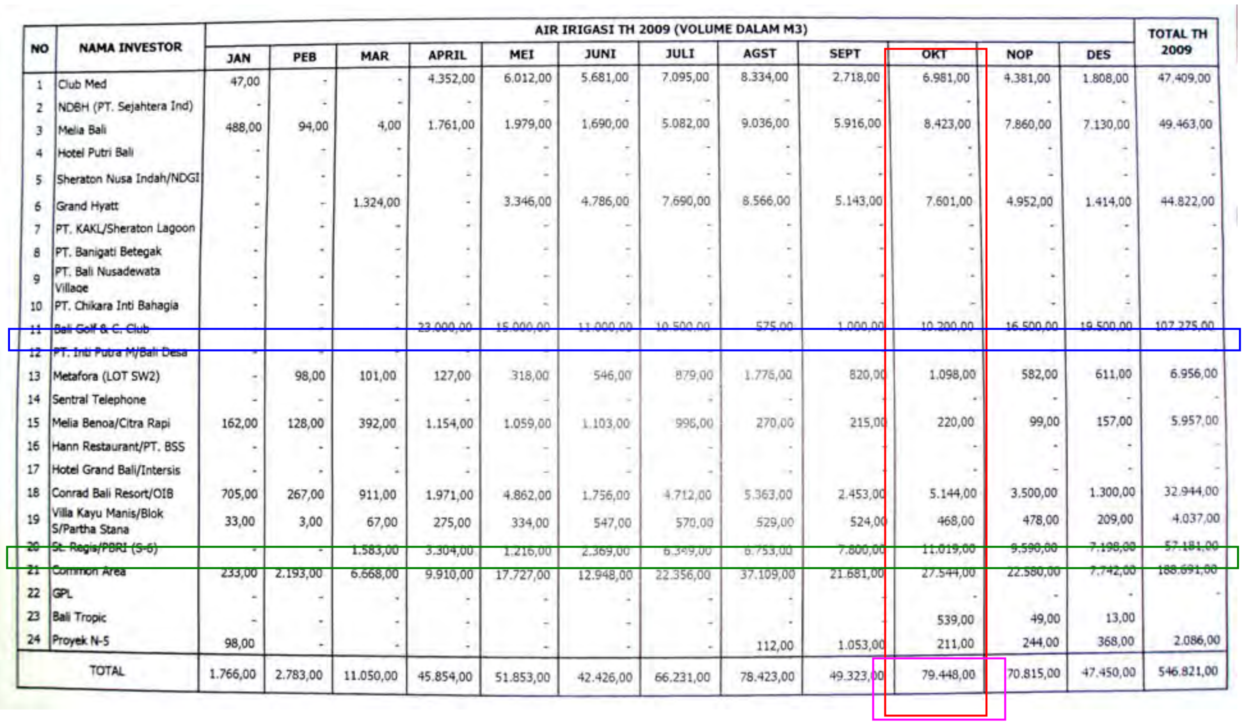
As the demand for the level 3 reclaimed water, three hotels other than Ayodya Resort Hotel answered that they have enough amount of irrigation water from BTDC. As shown in Table 4.3.2, large amount of BTDC irrigation water is supplied to St. Regis Bali Resort which is located farthest away from WWTP of BTDC. New demand for the level 3 reclaimed water can hardly be expected under the present situation that there is no complain about the BTDC irrigation water supply volume and they are satisfied with

BTDC irrigation water service.

Ayodya Resort Hotel answered that they were using the rain water saved in the pond of the hotel about 100m^3/the day for the garden during the dry season because the amount of the reclaimed water supplied from the WWTP of BTDC was not enough. It is difficult to say that the volume of the BTDC irrigation water only for Ayodya Resort Hotel is insufficient because the rain water saved in the pond in the hotel is free, and Novotel Nusa Dua Hotel receives the enough reclaimed water from BTDC. Therefore, there is high possibility of attempting the use of free rain water compared with the charged BTDC irrigation water.

Considering the circumstances mentioned above, it is thought that the BTDC irrigation water supply satisfies the demand for the sprinkling water in BTDC.

Table 1.e.1 Amount of BTDC Irrigation Water Supplied to Each Facility (2009)



NO	NAMA INVESTOR	AIR IRIGASI TH 2009 (VOLUME DALAM M3)												TOTAL TH 2009
		JAN	PEB	MAR	APRIL	MEI	JUNI	JULI	AGST	SEPT	OKT	NOP	DES	
1	Club Med	47,00	-	-	4.352,00	6.012,00	5.681,00	7.095,00	8.334,00	2.718,00	6.981,00	4.381,00	1.808,00	47.409,00
2	NDBH (PT. Sejahtera Ind)	-	-	-	-	-	-	-	-	-	-	-	-	-
3	Melia Bali	488,00	94,00	4,00	1.761,00	1.979,00	1.690,00	5.082,00	9.036,00	5.916,00	8.423,00	7.860,00	7.130,00	49.463,00
4	Hotel Putri Bali	-	-	-	-	-	-	-	-	-	-	-	-	-
5	Sheraton Nusa Indah/NDGI	-	-	-	-	-	-	-	-	-	-	-	-	-
6	Grand Hyatt	-	-	1.324,00	-	3.346,00	4.786,00	7.690,00	8.566,00	5.143,00	7.601,00	4.952,00	1.414,00	44.822,00
7	PT. KAKL/Sheraton Lagoon	-	-	-	-	-	-	-	-	-	-	-	-	-
8	PT. Banigati Betegak	-	-	-	-	-	-	-	-	-	-	-	-	-
9	PT. Bali Nusadewata Villaqe	-	-	-	-	-	-	-	-	-	-	-	-	-
10	PT. Chikara Inti Bahagia	-	-	-	-	-	-	-	-	-	-	-	-	-
11	Bali Golf & C. Club	-	-	-	23.000,00	15.000,00	11.000,00	10.500,00	575,00	1.000,00	10.200,00	16.500,00	19.500,00	107.275,00
12	PT. Inti Putra M/Bali Desa	-	-	-	-	-	-	-	-	-	-	-	-	-
13	Metafora (LOT SW2)	-	98,00	101,00	127,00	318,00	546,00	879,00	1.776,00	820,00	1.098,00	582,00	611,00	6.956,00
14	Sentral Telephone	-	-	-	-	-	-	-	-	-	-	-	-	-
15	Melia Benoa/Citra Rapi	162,00	128,00	392,00	1.154,00	1.059,00	1.103,00	996,00	270,00	215,00	220,00	99,00	157,00	5.957,00
16	Hann Restaurant/PT. BSS	-	-	-	-	-	-	-	-	-	-	-	-	-
17	Hotel Grand Bali/Intersis	-	-	-	-	-	-	-	-	-	-	-	-	-
18	Conrad Bali Resort/OIB	705,00	267,00	911,00	1.971,00	4.862,00	1.756,00	4.712,00	5.363,00	2.453,00	5.144,00	3.500,00	1.300,00	32.944,00
19	Villa Kayu Manis/Blok S/Partha Stana	33,00	3,00	67,00	275,00	334,00	547,00	570,00	529,00	524,00	468,00	478,00	209,00	4.037,00
20	St. Regis/PBRI (S-6)	-	-	1.583,00	3.304,00	1.216,00	2.369,00	6.349,00	6.753,00	7.800,00	11.019,00	9.590,00	7.198,00	57.181,00
21	Common Area	233,00	2.193,00	6.668,00	9.910,00	17.727,00	12.948,00	22.356,00	37.109,00	21.681,00	27.544,00	22.580,00	7.742,00	188.691,00
22	GPL	-	-	-	-	-	-	-	-	-	-	-	-	-
23	Bali Tropic	-	-	-	-	-	-	-	-	-	539,00	49,00	13,00	
24	Proyek N-5	98,00	-	-	-	-	-	-	112,00	1.053,00	211,00	244,00	368,00	2.086,00
TOTAL		1.766,00	2.783,00	11.050,00	45.854,00	51.853,00	42.426,00	66.231,00	78.423,00	49.323,00	79.448,00	70.815,00	47.450,00	546.821,00

As mentioned above, in the BTDC area, the number of accommodation facility will increase by 350 rooms by the end of 2011, then 220 rooms afterwards, and construction of the convention hall with 5000 seats is also scheduled. These facilities will be built in BTDC where the land is originally green space. Consequently the green area will decrease and the demand of the level 3 reclaimed water in BTDC can be thought to be in the direction of decrease in the future.

< Large-scale hotel outside BTDC area >

The interview was done for Nikko Bali Resort and Spa where the number of guest room is the largest outside the BTDC area. This hotel uses the groundwater of the deep well. The wastewater generated in the hotel is treated at the internal wastewater treatment facility. The treated wastewater is used as sprinkling water of the garden, cooling water, and landscaping water to ponds etc. The water for these usages will be sufficient in the future, and the demand for the level 3 reclaimed water is hardly expected. In case of the level 2 reclaimed water, if all the cost for the indoor dual water supply piping work is subsidized, interviewee answered that he may purchase the level 2 reclaimed water of 20-25m^3/d as pool water, 70-80m^3/d as clothes washing water, and toilet flush water by around Rp.10,000/m^3.

The construction of three hotels (Mulia, Ritz Calton, Kedung New Wall Hotel) and one villa is scheduled outside the BTDC in Nusa Dua area in the future. It is likely that the demand for the water supply increases, but the water supply volume cannot be increased accordingly as explained in the previous section. It is thought that the need of level 2 reclaimed water use becomes high.

From the above-mentioned viewpoint, the demand for the level 3 reclaimed water cannot be expected because the treated wastewater by their own wastewater treatment facility is already used for irrigation purposes, but the demand for the level 2 reclaimed water can be expected because the water demand itself will be increased but the supply volume is difficult to increase under the current waterworks supply capacity. It is thought that the level 2 reclaimed water should be used effectively to cover the gap between the water demand and supply.

3) Benoa Area
The interview survey was done in the Benoa area for three large-scale hotels (Melia Benoa, Bali Tropic Resort and Spa, Conrad Bali Resort and others) located near the WWTP of BTDC.

The demand for the level 2 reclaimed water may depend on the introduction of dual water supply pipe work, the same as in the case of Nusa Dua area.

On the other hand, the demand for the level 3 reclaimed water is limited because of following reasons. The WWTP of BTDC accepts and treats the sewage generated at three hotels (Melia Benoa, Bali Tropic Resort and Spa, and Conrad Bali Resort) located near the WWTP but outside of BTDC area because those hotels is close to the WWTP, and provides the BTDC irrigation water to these three hotels. In the large scale hotels in Benoa area other than these three hotels, internal wastewater treatment facilities have been constructed and the treated wastewater is used for gardening.

4) Jimbaran Area
There were three large-scale hotels in the Jimbaran area, and the interview survey was done for Bali Intercontinental and Four Seasons Resort. The demand for level 3 reclaimed water is limited because the irrigation water is already supplied from their own wastewater treatment facilities. But the demand for level 2 reclaimed water may be expected by installation of dual water supply system to the hotels.

5) Kuta Area
In Kuta area, interview survey was done for Bali Dynasty resort, Hard Rock Hotel Bali, etc. As in the case of the large-scale hotels in other area, the demand for level 3 reclaimed water is limited because the irrigation water is already supplied from their own wastewater treatment facilities. But the demand for level 2 reclaimed water may be expected by installation of dual water supply system to the hotels.

(6) Serangan Island
The development of the Serangan island started in 1994. The island is expanded from 100ha to 400ha by reclamation. But the development has been interrupted with the collapse of Suharto administration in 1998. This development was advanced without building consensus with the resident. Therefore, the problem of the interest with the resident is not solved. Moreover, Bali provincial government cannot understand the trend of the Serangan island development, because the reclamation part on this island (almost vacant lot at present) was sold to the company in Singapore. In addition, there was a bridge construction project to connect Serangan island and Benoa peninsula. But there is information that the construction plan has not approved by the opposition of Benoa harbor and airport.

From such a situation on the Serangan island, it is thought that it is not easy to think that the resort development will begin in the near future, and it is not in the situation that the demand for the reclaimed water can not be expected.

(7) Large Scale Shopping Mall

There are five large-scale shopping centers in Denpasar City and Badung Regency that was the survey area of the study. The interview survey was done for Mal Bali Galleria that was the biggest shopping mall among those shopping centers. Approximately 30m^3/d as toilet flush water and 30m^3/d as gardening water was expected as a target usage for the treated water in this facility. However, the willingness to pay for the level 2 reclaimed water as toilet flush water was quite low about Rp.1,000-2,000/m^3. Moreover, the water source of the gardening is free river water at present. Therefore, the demand for the level 2 and 3 reclaimed water can hardly be expected because of the low water demand and the low willingness to pay.

(8) Green Belt along Main Road and Park

The interview survey was done for the demand of the reclaimed water as sprinkling water for the green belt along the trunk road and the park by Dinas DKP under the Badung Regency administration. Dinas DKP uses the river water for free for watering. The water from the Mati River is used as gardening water for Nusa Dua area and Kuta area. But the water is not suitable for the watering because it contains high salinity concentration. During the dry season, the volume of the water drops, and earth and sand enters. Therefore, if the reclaimed water is purchased cheaper than the groundwater tax in the Badung Regency (After the price cut), the answer they could purchase about 60m^3/d (Each five round trips a day by two tank tracks (6m^3)) was obtained. However, it is expected that the groundwater tax for the government agency after price cut is suppressed to low about Rp.1,000/m^3. Therefore, the demand for level 3 reclaimed water may be limited due to its charge.

1

1.f Result of Water Demand Survey

Result of Water Demand Survey (Hotels)

Area	No.	Hotel	Rating	Rooms	Address	Contacts(0361-)		JICA Team Attendant **)	Interview Date(2011)/Time		Current Condition							Demand Survey					Other Information
						tel.	Main Person				PDAM Tariff (Rp./m3)	Deep Well Consumption (m3/d)	Deep Well Tax (Rp./m3)	Gardening Consumption (m3/d)	Internal WWTP Operating Cost (Rp./m3)	Indoor Dual Piping System	Renovation Schedule	Possibility of the reclaimed water use	Willingness to pay	Water Use Tolerance Level		Indoor Dual Piping Installtion Work	
																				Pool	Gardening		
Sanur	1	**Aston Legend Villas**	Villa	10	Jl. Cemara 33 Sanur	270567	Putu Budiarta (Chief Eng)	NT,DP	30-Mar	14.05 – 14.40	NA	500 m3/month	NA	NA	Septic tank	not installed	no schedule	can be considered	2000-3000Rp/m3	NG	OK	can not, need new investment	will connect DSDP
	2	**Bali Hyatt**	5 star	380	Jl. Danau Tamblingan No89 Sanur PoBox392	281234	Mikael Yanei (Asst. Director of Engineering)	SK,SM,YK,DP	24-Feb	14:00-15:20	8,916	Abolished in 1996	Abolished in 1996	Ave300,Max700	equipped with WWTP (600m3/d)/Cost: NA	not installed	Will be renovated in 2012	not required	less than 4,500Rp./m3	NG	OK	can not be installed because large scale work is required	has some interest but not necessary because they are already investing in WWTP
	3	**Gazebo Beach**	2 star	76	Jl. Danau Tamblingan No35 Sanur	288212	Ida Bagus Wira Adnyana(Operation Mgr)	NT,DP	30-Mar	15.50-16.10	9,800	Capacity: NA	NA	40	Septic tank	not installed	no schedule	can be considered	2000-3000Rp/m3	NG	OK	can not, need new investment	will connect DSDP
	4	**Inna Grand Bali Beach Hotel**	5 star	523	Jl. Hang Tuah Sanur PoBox3275	288511	Nyoman Sukasada(Chief Eng)	NT,DP	21-Mar	13.05-14.15	11,506	1800	9165	700	equipped with WWTP (700 m3/day) investment 300millionRp	not installed	proposal to improve cost estimated 3 billion Rp	no idea, because of new proposal for WWTP	no idea	NG	OK	can not, need new investment	waiting to connect DSDP, but the price to high
	5	**La Tavelna Bali**	2 star	39	Jl. Danau Tamblingan No29 Sanur	288497	Ida Ayu Armini(HRD) Pitono (Ass Chief Eng)	NT,DP	30-Mar	16.20-16.45	NA	NA	NA	9	Septic tank	not installed	no schedule	can be considered	2000Rp/m3	NG	OK	can not, need new investment	will connect DSDP
	6	**Mercure Resort Sanur**	4 stars	189	Jl. Mertasari Sanur	288833	I B Supresna(Chief Eng)	NT,DP	30-Mar	10.30-11.05	6,539	only back up	NA	70	equipped with WWTP (300m3)	not installed	just build new STP cost 1.3 billion	can be considered	2000-3000Rp/m3	OK	OK	can not, need new investment	will use the water 50 m3/day
	7	**Puri Santrian Hotel**	4 stars	182	Jl. Cemara 35 Sanur PoBox3055	288009	I Wayan Sukarsa(Chief Eng)	NT,DP	30-Mar	11.35-12.15	stand by condition	334	NA	NA	Septic tank	not installed	no schedule	can be considered	3000-4000Rp/m3	NG	OK	can not, need new investment	will use reclaimed water 50 m3/day
	8	**Sanur Beach Hotel**	5 stars	428	Jl. Danau Tamblingan Sanur PoBox3279	288011	Erwin Lewy Rensus(Chief Eng)	NT,DP	21-Mar	14.25-15.35	use only for kitchen	1100	NA	600	equippd with WWTP (600 m3/day)	not installed	new WWTP proposal already discussed	can be considered	3000-3500Rp/m3	OK	OK	can not be installed because large scale work is required	
	9	**Sanur Paradise Plaza Hotel**	4 stars	329	Jl. Hang Tuah 46 Sanur 80228	281781	I Made Sudarsana (Chief Engineering)	HU,SK,SM,DP	18-Feb	14:00-15:50	7,950	Capacity: NA	4,104	5 (Dry season)	not equipped	not installed	under renovation	can be considered	3,000Rp./m3	NG	OK	will not be installed	customer awareness is more important than hotel intention
	10	**Segara Village**	4 stars	120	Jl. Segara Ayu Sanur PoBox3091	288407	Kadek Ariana(Chief Eng)	NT,DP	30-Mar	13.05-13.40	for back up	334	NA	NA	Septic tank	not installed	no schedule	can be considered	4000-5000Rp/m3	NG	OK	can not, need new investment	will use reclaimed water 100 m3/day
	11	**Waka Maya Resort**	Butique Resort	25	Jl. Tanjung Pinggir Pantai No41 Sanur	289912	Komang Agus Sujarwadi (Finance-Adm Mgr)	NT,DP	30-Mar	15.10-15.40	NA	no deep well	no deep well	NA	Septic tank	not installed	no schedule	can be considered	4000Rp/m3	NG	OK	can nott,need new investment	will use reclaimed water 100 m3/day
Nusa Dua	1	**Amanusa Resort *)**	5 stars	35	Nusa Dua PoBox 33 Nusa Dua 80363	772333	I G N Udayana (Chief Eng)	NT,DP	1-Apr	11.55-12.45	use water from Bali Golf	no deep well	no deep well	NA	use BTDC	not installed	no schedule	can be considered 5000-6000Rp/m3		OK	OK	can not, need new investment	will use reclaimed water 50-80m3/day
	2	**Ayodya Resort *)**	5Bstars	451	Jalan Pantai Megiat PoBox 46 Nusa Dua 80363	771102	Ketut Wijaya (Director of Engineering)	SK,SM,YK,DP	1-Mar	10:15-11:00	12,700	Max200	NA	Max100	use BTDC	not installed	no plan	needs cost comparison with the planned internal WWTP		NG	OK	depends on the cost	Installation of self WWTP and desalination facility will be planned soon.
	3	**Bali Tropic Resort**	4 stars	150	Jl. Pratama 34A Nusa Dua	772130	Gusti Lanang Swastika(Chief Eng)	NT,DP	18-Mar	15.10-15.55	11,365	no deep well	no deep well	75	eqquiped with WWTP	not installed	no schedule	can be cosidered	no idea	OK	OK	can not, need new investment	they plan to improve the WWTP facility to get a drink water quality
	4	**Club Med *)**	4 stars	400	PoBox7 Lot No6 Nusa Dua	771521	Michel Naulot (Technical Services Manager)	SK,SM,TY,YK,DP	28-Feb	10:00-11:00	12,491	no deep well	-	Ave60	use BTDC	not installed	no hotel expansion plan	may be used	less than BTDC IW tariff (6,156Rp./m3)	NG	OK	will not be installed unless new building is constructed	BTDC irrigation water is not used in rainy season
	5	**Grand Hyatt Bali *)**	5Bstars	750	PoBox53 Nuda Dua	771234	Edward Teh (Director of Engineering)	SK,NT,SM,DP	8-Mar	14:00-15:30	NA	no deep well	-	NA	use BTDC	not installed	no plan	less than 40cent		NG	NG	will be installed if the cost is subsidized	Reclaimed water cannot be used for gardening because people may touch it.
	6	**Inna Putri Bali *)**	5 stars	392	Lot 3-3 Nusa Dua PoBox1 Nusa Dua	771020	Made Sudiarta(Chief Eng)	NT,DP	18-Mar	16.10-17.05	12,520	no deep well	no deep well	NA	use BTDC	not installed	no plan	can be considered	7000Rp/m3	OK	OK	can not, need new investment	will use reclaimed water 30% of PDAM water uses
	7	**Melia Bali Villas Resort *)**	5Bstars	500	Lot N-1 Nusa Dua PoBox88	771510	Binbin Gin Wibowo (Chief Engineering)	HU,SK,SM,YK,DP	25-Feb	16:45-17:00	NA	Max240	NA	NA	use BTDC	not installed	NA	NA	NA	NA	NA	will not be installed	interview time was not enough
	8	**Nikko Bali Resort**	5Bstars	395	Jl. Raya Nusa Dua Selatan PoBox18	773377	I WAYAN SUDIARSA (Chief Engineer)	SK,SM,DP	23-Feb	16:00-17:00	12,500(2010.Aug)	252(2010.Jul)	6,856(2010.Jul)	NA	equipped with WWTP (550m3/d)/Cost: NA	not installed	no plan	may be used for flashing toilet, washing clothes, pool	less than 10,000Rp./m3	OK	OK	will be installed if the cost is subsidized	PDAM water and deep well water are mixed in the 2,000m3 receiving tank
	9	**Novotel Nusa Dua Bali *)**	5 stars	268	BTDC Complex PoBox116 Nusa Dua 80363	8480555	Tri Adhi Wirya Astama (Chief Engineer)	SK,SM,YK,DP,SS	1-Mar	14:00-15:00	6,514-15,122	no deep well	-	Max25	use BTDC	not installed	NA	NA		NG	OK	will not be installed if the wall is damaged	better to sell the reclaimed water via BTDC
	10	**Nusa Dua Beach Hotel *)**	5 stars	381	Lot N-4 Nusa Dua PoBox217	771210	Dwi Sutoyo(Ass.Chief Eng)	NT,DP	23-Mar	09.55-10.50	current price	120	current price	NA	use BTDC	not installed	no plan	can be considered	5000Rp/m3	OK	OK	need investment	will use 100m3/day
	11	**Nusa Dua Golf Resort *)**	5 stars	225	Lot SW 2 BTDC	8480555			1-Mar	11.45-12.45	10,300	19	20,000	1,000	use BTDC		NA	can be considered	less than BTDC	NA	OK	can be considered	
	13	**Swiss Grand Bali *)**	4 stars	63	Jl. Nusa Dua Selatan No8 Nusa Dua	776688	I Wayan S Saputra(Chief Eng)	NT,DP	1-Apr	14.05-14.55	13,797	125	11,380	NA	use BTDC	not installed	no plan	can be considerd	4000Rp/m3	NG	OK	need investment	will use 1000m3/month
	15	**The St. Regis Bali Resort *)**	5 stars	123	Kawasan Nusa Dua Lot S6	8478111	Wy Wirantaja (Chief Eng)	NT,DP	23-Mar	11.55-12.50	12,499	137	13,768	NA	use BTDC	not installed	no plan	can be consired	2500-3000Rp/m3	OK	OK	need investment	if TDS less than 2500 ppm
	16	**The Westin Resort Nusa Dua *)**	5 stars	334	Kawasan BTDC Lot2 Nusa Dua	771906	I Gde Somonita	NT,DP	23-Mar	11.05-11.45	12,501	no deep well	no deep well	NA	use BTDC	not installed	no plan	can be considered	2500Rp/m3	OK	OK	need investment	will use 300 m3/day
Benoa Area	1	**Bali Reef Resort**	Villa	28	Jalan Pratama Tanjung Benoa PoBox5000	776291	Mr. Dedi Suweca (Engineer)	SK,SM,DP	28-Feb	12:00-12:30	14,908	no deep well	-	NA/PDAM water is not used	Septic Tank	not installed	NA	needs confirmation to hotel owner		NA	NA		will not connect to BTDC WWTP (Expensive and far)
	2	**Conrad Bali Resort**	4 stars	313	Jl. Pratama No.168Tj Benoa Nusa Dua	778788	Mr.Rai Puslaka (Chief Engineer)	SK,NT,SM,DP	7-Mar	10:00-11:30	13,740	no deep well	-	NA	equipped with WWTP, use BTDC	not installed	no plan	may be used if the water wuality is better than BTDC-IW.	same as BTDC-IW	NG	OK	may be installed at renewal period after 10 years	rainwater is collected to use (consumption is NA)
	3	**Melia Benoa Bali**	5 stars	128	Jl. Pratama Tanjung Benoa Nusa Dua	771714	Wayan Mardiasa(Chief Eng)	NT,DP	23-Mar	14.10-15.45	actual price	no deep well	no deep well	NA	use BTDC	not installed	no plan	can be considered	3500Rp/m3	NG	OK	need investment	will use 100 m3/day
	4	**Novotel Rsesort Bali Benoa**	5 stars	186	Jl. Pratama Tanjung Benoa PoBox39	772239	Agus Subagio (Chief Engineer)	SK,SM,TY,YK,DP	28-Feb	11:20-11:45	13,000	no deep well	-	NA	equipped with WWTP / Capacity, Cost: NA	not installed	NA	NA	NA	NG	OK	NA	will not connect to BTDC WWTP (self WWTP has no problem)
	5	**The Royal Santrian**	Villa	22	Jl. Pratama Tanjung Benoa 80362	778181	Mr. Wayan Subawa (Chief Engineering)	SK,SM,DP	28-Feb	14:15-14:45	NA	Max10	NA	NA	SepticTank + Underground Penetration	not installed	NA	needs confirmation to hotel owner					will not connect to BTDC WWTP (self WWTP is cheaper)
Jimbaran	1	**Bali Intercontinental**	5Bstars	425	Jl. Uluwatu 45 Jimbaran	701888	I Made Suwinten (Assistant Chief Engineer)	SK,NT,DP	11-Mar	10:00-11:00	10,113	no deep well	-	NA	equipped with WWTP (600m3/d)/Cost: NA	not installed	no plan	may be used for pool	8,000Rp./m3	OK	OK	will not be installed	low price, continous supply and water quality test is required for use
	2	**Four Seasons Resort Jimbaran**	5 stars	147	JL Bukit Permai Jimbaran Badung	701010	Ida Bagus Supardana(Dir of Eng)	DP	24-Mar	14.05-14.50	10,343	no deep well	no deep well	7000-8000m3/month	equiped with STP	not installed	no plan	can be considered	3000-4000Rp/m3	OK	OK	need investment	
Kuta	1	**Bali Bintang**	5 stars	401	Jl Kartika Plaza PO Box 1068 Kuta	753288	Anang E{P (Chief Eng)	NT,DP	29-Mar	16.05-16.30	for back up only	917	7,323	NA	equped with STP	not installed	no plan	can be considered	2000-3000Rp/m3	NA	OK	need investment	will use 100 m3/day
	2	**Bali Dynasty Resort**	4 stars	312	Jl Kartika Plaza Po Box 2047 Kuta	752403	Dewa Yudiarta(Chief Eng)	NT,DP	29-Mar	11.30-12.35	no PDAM water	656	actual price	NA	equped with STP	not installed	no plan	can be considered	3000-4000Rp/m3	OK	OK	need investment	will use 250 m3/day
	3	**Discovery Kartika Plaza Hotel**	5 stars	318	Jl Kartika Plaza PO Box 1012	751067	Nur Chamid(Chief Eng)	NT,DP	29-Mar	15.20-16.00	only use for kitchen	470	7,155	NA	equiped with STP	not installed	no plan	can be considerd	5000-6000/m3	OK	OK	need investment	will use 100-150 m3/day
	4	**Hard Rock Hotel Bali**	4 stars	418	Jl Pantai Kuta,Br pande Mas Kuta	761869	Abdullah(Ass Chief Eng)	NT,DP	1-Apr	10.35-11.05	actual price	300	actual price	NA	equiped with STP	not installed	no plan	can be considered	5000Rp/m3	NA	OK	need investment	will use 300 m3/day
	5	**Kuta Paradiso Hotel**	5 stars	243	Jl Kartika Plaza PO Box 1133 Kuta	761414	Anang Suryana(Chief Eng)	NT,DP	29-Mar	14.00-15.10	actual price	50	actual price	NA	equiped with STP	not installed	no plan	can be considerd	3000Rp/m3	OK	OK	need investment	will use 250 m3/day

*) BTDC : Bali Tourism Development Corporation IW : Irrigation water NA : Not Available

**) HU : Harutoshi UCHIDA SK : Shinichiro KAWAMURA NT : Naoto TAKATOI SM : Shozo MORI KF : Kiyoshi FUKUI TY : Tokuya YAZAWA YK : Yoshiro KANTO DP : K.G.Dharma Putra SS : Sunjoyo SADIARTO

Result of Water Demand Survey (Except for Hotels)

No.	Facilities	Name	Area	Address	Contacts(0361-)		JICA Team Attendant **)	Interview Date(2011)/Time	Current Condition							Demand Survey					Other Information
					tel.	Main Person			PDAM Tariff (Rp./m3)	Deep Well Consumption (m3/d)	Deep Well Tax (Rp./m3)	Gardening Consumption (m3/d)	Internal WWTP Operating Cost (Rp./Month)	Indoor Dual Piping System	Renovation Schedule	Possibility of the reclaimed water use	Willingness to pay	Water Use Tolerance Level		Indoor Dual Piping Installtion Work	
																		Pool	Gardening		
101	Generating Station	**Indonesia Power**	Pesanggaran	Jl. By Pass I Gusti Ngurah Rai No535	720421	IR.IGAN SUBAWA PURTA (MANAGER TEKNIK)	SK,SM,KF,DP	2/21 15:30-16:30	PDAM water is not used	Ave132	228	NA	NA	not equipped	under FS (water will not used)	possible	less than 228Rp./m3	NA	OK	can invest upto 250,000KRp.	Treated water will be supplied from WWTP in the future. Therefore gardening water will be enough.
102	Golf Course	**The Grand Bali Beach Golf Course**	Sanur	Jl. Hang Tuah 58 Sanur	287733	I Ketut Raka Adnyana (HR. GA. & Leagal Manager)	HU,SK,SM,DP	2/18 16:00-18:20	8,000	NA	NA	NA	equipped with WWTP Capacity, Cost: NA	not equipped	not equipped	may be used only in emergency	1,000Rp./m3	NA	OK	will not be installed even if the cost is subsidized	Our group, Inna Grand Bali Beach Hotel owns WWTP.
103		**Bali Golf & Country Culb**	Nusa Dua	Kawasan Wisata Nusa Dua 80363	771791	Wayan Nawa (Executive Asst. Manager General Affairs)	SK,SM,YK,DP	3/1 16:00-18:20	10,300	(2010)Ave233	20,000	Max1,100	use BTDC	not equipped	not equipped	possible	less than BTDC-IW (5,200Rp./m3)	NG	OK	will not be installed	The pond which stores the rain water, well water, BTDC-IW and PDAM-IW is used for gardening.
104	Airport	**Ngurah Rai Internationarl Airport**	Tuban	Bandar Udara Ngurah Rai Gedung Wisti Sabha Lt.3 Tuban Kuta	751011	Gunung Banendro (Manager of General Engineering and Equipment)	HU,SK,SM,YK,DP	2/25 14:20-15:00	NA	(2010)Ave2,247	7,434	NA	equipped with WWTP Capacity, Cost: NA	not equipped	has expansion plan	will not be used (deep well has enough capacity and expansion of WWTP will be planned)		NA	OK	will be installed at expansion part	Current well capacity is 4,200m3/d, while actual consumption is 2,247m3/d.
105	Shopping Mall	**Mal Bali Galleria**	Kuta	Jl. By Pass I Gst. Ngurah Rai Simpang Dewa Ruci Kuta	755277	Jeffry M. Lomban (Building Manger)	SK,SM,DP	3/9 15:50-16:15	5,000	not in operation	NA	NA	equipped with WWTP Capacity, Cost: NA	not equipped	not equipped	Depends on the cost for dual piping installtion work and tariff	1,000-2,000Rp./m3	NA	OK	may be installed if the cost is subsidized	Current consumption for toilet is around 30m3/day, for gardening is around 30m3/day.
109	Harbour	**Benoa Harbour Authority**	Benoa Harbour	Jl. Raya Pelabuhan Benoa Denpasar	720560	Judiharto (Technical Manager)	SK,NT,SM,DP	3/7 14:00-16:20	See attachment: Current volume of gardening water in dry season is around 20m^3/d, future volume is around 75m^3.							possible	3,000Rp./m3	NA	OK	needs confirmation to Surabaya headquarter due to high installation cost	There is a harbour expansion plan, but reclaim water use potential is low.
110		**PT. Inti Mas Surya (Fish Processing Company)**	Benoa Harbour	Jl. Ikan Tuna Barat Pelabuhan Benoa	724246	Mr. Amin(Manager)	SK,SM,DP	3/10 10:00-10:30	See attachment: Current volume of PDAM water is around 66m3/d. 90% of that is used for fish processing.							See attachment: Difficult to use for fish processing considering becteria					Water quality for fish processing follows ISO and Japanese Minister of Health, Labour and Welfare standards
111		**PT.SARI SEGER LAUT INDONESIA (Fish Processing Company)**	Benoa Harbour	Jl. Ikan Tuna Raya Timur1 Pelabuhan Benoa	770233	Mr. Maruko (Director Factory Manager)	SK,SM,DP	3/10 10:45-11:15	See attachment: Current volume of PDAM water is around 39m3/d. 90% of that is used for fish processing.							See attachment: Difficult to use for fish processing considering becteria					Reclaimed water may be used for fish washing before processing
112	Public Office	**DINAS DKP Badung**	Badung	Pusen Badung Jl. Raya Sempidi Mangupura Badung	9004263	Eka Mertawan (Head of Dinas DKP Badung)	SK,SM,DP	3/8 10:0-11:00	See attachment: 135m3/d is used for roadside plant by tank trucks.							See attachment: 54-60m3/d may be used if price is cheaper than PDAM water and deep well tax					
113		**PDAM Badung**	Badung	Jln. Bedahulu No3 Denpasar	421845	KOMARUDIN,ST(DIRTEK)	HU,SK,SM,KF,TY,DP	2/22 14:00-15:30	See attachment							See attachment					
114		**BTDC*) part1**	Nusa Dua	PoBox3 Nusa Dua80363	771010	A. A. I. Ratna Dewi, St (Head of WWTP Unit)	HU,SK,SM,KF,TY,DP	2/22 09:15-11:20	See attachment							See attachment					
		BTDC*) part2	↑	↑	↑	I Putu Trisna Wijaya (Business Dev. Division)	SK,SM,YK,DP,SS	3/2 09:00-11:00	See attachment							See attachment					
		BTDC*) part3	↑	↑	↑	Mr. Nyoman Wedastra (Supervising Operator of BTDC's WWTP)	SK,NT,SM,DP	3/8 15:30-14:30	See attachment							See attachment					

*) BTDC : Bali Tourism Development Corporation IW : Irrigation water NA : Not Available

**) HU : Harutoshi UCHIDA SK : Shinichiro KAWAMURA NT : Naoto TAKATOI SM : Shozo MORI KF : Kiyoshi FUKUI TY : Tokuya YAZAWA YK : Yoshiro KANTO DP : K.G.Dharma Putra SS : Sunjoyo SADIARTO

APPENDIX 2

WATER QUALITY SURVEY

APPENDIX 2 WATER QUALITY SURVEY

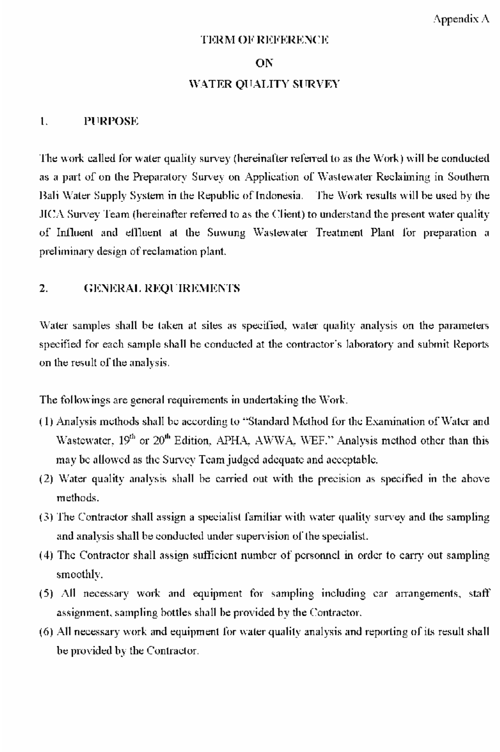
2.a Terms of Reference

Water quality survey was carried out to prepare the material to understand the characteristics of the effluent of Denpasar WWTP which is the raw water, and to determine the treatment process which is required for the reclaimed water treatment facility. The contents of the survey are shown below.

Outline of the Water Quality Survey

Item	Contents
1. Sampling Location	Influent and Effluent of Denpasar WWTP
2. Sample Number	1 sample x 4 events x 2 locations = 8
3. Parameters	Influent: 7 parameters (pH, Water Temp, COD, BOD_5, SS, Total Nitrogen (T-N), Total Phosphorus (T-P)) Effluent: 16 parameters (pH, Water Temp, COD, BOD_5, SS, UV_{254}, Turbidity, Color, Cl^-, CO_3^{2-}, KMO_4, Total Nitrogen (T-N), NH_4^+-N, NO_2-N, NO_3-N, Total Phosphorus (T-P))

Terms of Reference



Appendix A

TERM OF REFERENCE
ON
WATER QUALITY SURVEY

1. PURPOSE

The work called for water quality survey (hereinafter referred to as the Work) will be conducted as a part of on the Preparatory Survey on Application of Wastewater Reclaiming in Southern Bali Water Supply System in the Republic of Indonesia. The Work results will be used by the JICA Survey Team (hereinafter referred to as the Client) to understand the present water quality of Influent and effluent at the Suwung Wastewater Treatment Plant for preparation a preliminary design of reclamation plant.

2. GENERAL REQUIREMENTS

Water samples shall be taken at sites as specified, water quality analysis on the parameters specified for each sample shall be conducted at the contractor's laboratory and submit Reports on the result of the analysis.

The followings are general requirements in undertaking the Work.

(1) Analysis methods shall be according to "Standard Method for the Examination of Water and Wastewater, 19th or 20th Edition, APHA, AWWA, WEF." Analysis method other than this may be allowed as the Survey Team judged adequate and acceptable.

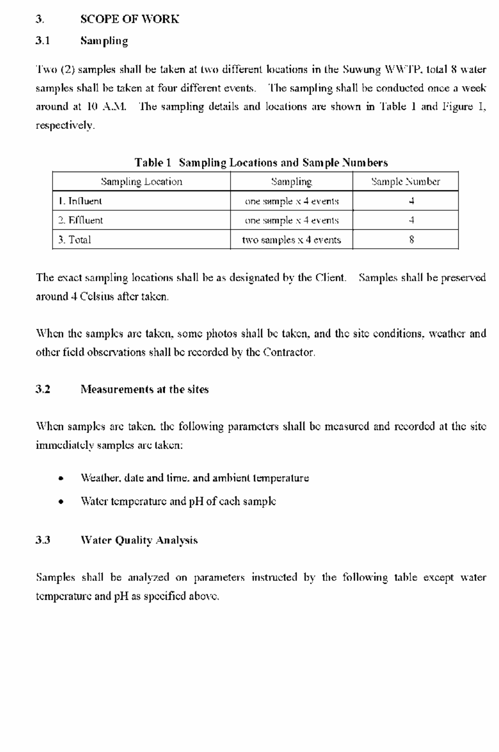
(2) Water quality analysis shall be carried out with the precision as specified in the above methods.

(3) The Contractor shall assign a specialist familiar with water quality survey and the sampling and analysis shall be conducted under supervision of the specialist.

(4) The Contractor shall assign sufficient number of personnel in order to carry out sampling smoothly.

(5) All necessary work and equipment for sampling including car arrangements, staff assignment, sampling bottles shall be provided by the Contractor.

(6) All necessary work and equipment for water quality analysis and reporting of its result shall be provided by the Contractor.



3. SCOPE OF WORK

3.1 Sampling

Two (2) samples shall be taken at two different locations in the Suwung WWTP, total 8 water samples shall be taken at four different events. The sampling shall be conducted once a week around at 10 A.M. The sampling details and locations are shown in Table 1 and Figure 1, respectively.

Table 1 Sampling Locations and Sample Numbers

Sampling Location	Sampling	Sample Number
1. Influent	one sample x 4 events	4
2. Effluent	one sample x 4 events	4
3. Total	two samples x 4 events	8

The exact sampling locations shall be as designated by the Client. Samples shall be preserved around 4 Celsius after taken.

When the samples are taken, some photos shall be taken, and the site conditions, weather and other field observations shall be recorded by the Contractor.

3.2 Measurements at the sites

When samples are taken, the following parameters shall be measured and recorded at the site immediately samples are taken:

- Weather, date and time, and ambient temperature
- Water temperature and pH of each sample

3.3 Water Quality Analysis

Samples shall be analyzed on parameters instructed by the following table except water temperature and pH as specified above.

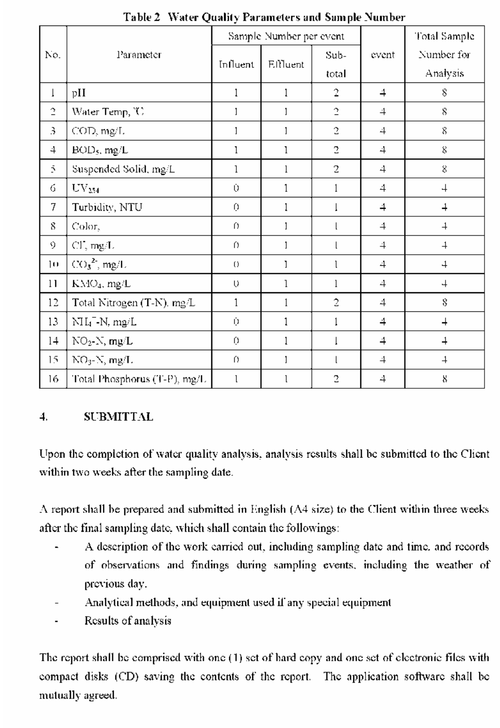


Table 2 Water Quality Parameters and Sample Number

No.	Parameter	Sample Number per event			event	Total Sample Number for Analysis
		Influent	Effluent	Sub-total		
1	pH	1	1	2	4	8
2	Water Temp, ℃	1	1	2	4	8
3	COD, mg/L	1	1	2	4	8
4	BOD_5, mg/L	1	1	2	4	8
5	Suspended Solid, mg/L	1	1	2	4	8
6	UV_{254}	0	1	1	4	4
7	Turbidity, NTU	0	1	1	4	4
8	Color,	0	1	1	4	4
9	Cl^-, mg/L	0	1	1	4	4
10	CO_3^{2-}, mg/L	0	1	1	4	4
11	KMO_4, mg/L	0	1	1	4	4
12	Total Nitrogen (T-N), mg/L	1	1	2	4	8
13	NH_4^+-N, mg/L	0	1	1	4	4
14	NO_2-N, mg/L	0	1	1	4	4
15	NO_3-N, mg/L	0	1	1	4	4
16	Total Phosphorus (T-P), mg/L	1	1	2	4	8

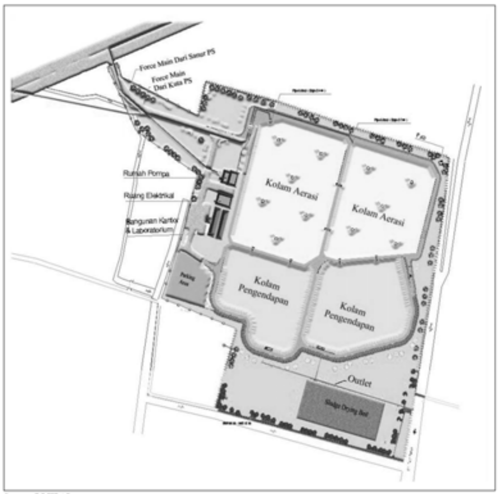
4. SUBMITTAL

Upon the completion of water quality analysis, analysis results shall be submitted to the Client within two weeks after the sampling date.

A report shall be prepared and submitted in English (A4 size) to the Client within three weeks after the final sampling date, which shall contain the followings:

- A description of the work carried out, including sampling date and time, and records of observations and findings during sampling events, including the weather of previous day.
- Analytical methods, and equipment used if any special equipment
- Results of analysis

The report shall be comprised with one (1) set of hard copy and one set of electronic files with compact disks (CD) saving the contents of the report. The application software shall be mutually agreed.



Source: BLUPAL

Figure 1 Sampling Locations at the Suwung WWTP

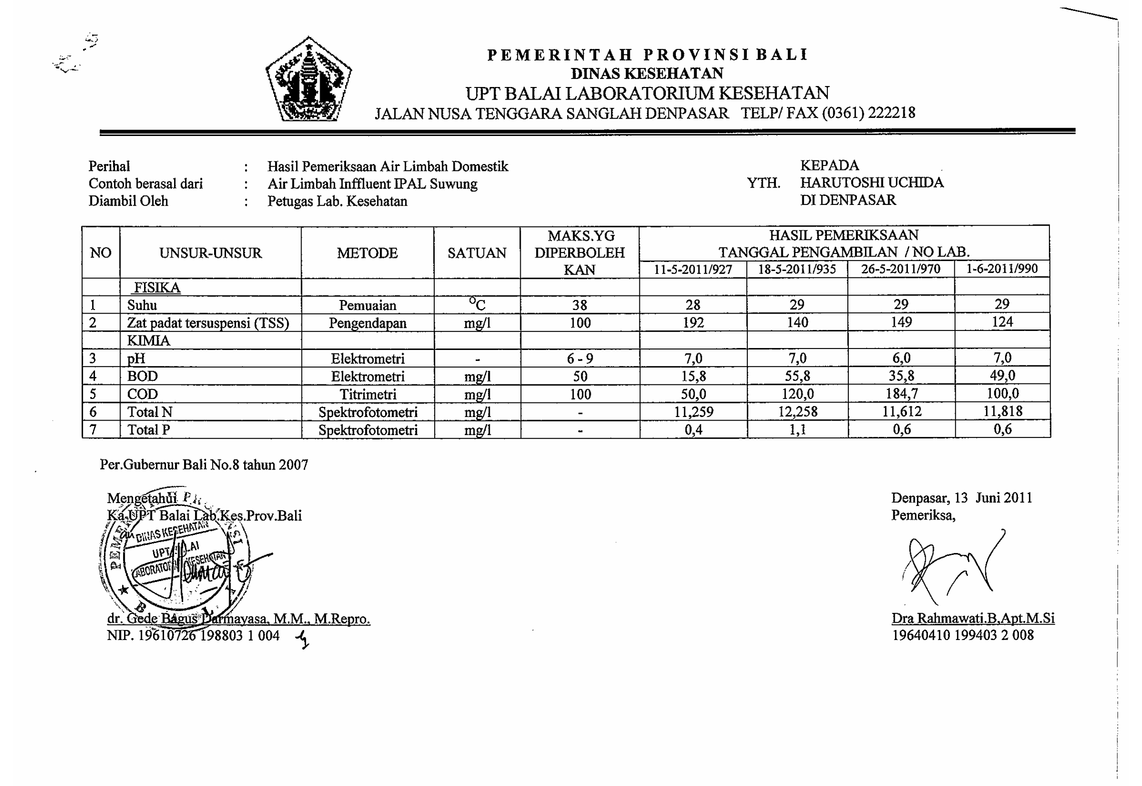
2.b Survey Photo

2nd sampling on 18th May

3rd sampling on 26th May

4th sampling on 1st June

2.c Survey Result



PEMERINTAH PROVINSI BALI
DINAS KESEHATAN
UPT BALAI LABORATORIUM KESEHATAN
JALAN NUSA TENGGARA SANGLAH DENPASAR TELP/ FAX (0361) 222218

Perihal : Hasil Pemeriksaan Air Limbah Domestik
Contoh berasal dari : Air Limbah Inffluent IPAL Suwung
Diambil Oleh : Petugas Lab. Kesehatan

KEPADA
YTH. HARUTOSHI UCHIDA
DI DENPASAR

NO	UNSUR-UNSUR	METODE	SATUAN	MAKS.YG DIPERBOLEH KAN	HASIL PEMERIKSAAN TANGGAL PENGAMBILAN / NO LAB.			
					11-5-2011/927	18-5-2011/935	26-5-2011/970	1-6-2011/990
	FISIKA							
1	Suhu	Pemuaian	°C	38	28	29	29	29
2	Zat padat tersuspensi (TSS)	Pengendapan	mg/l	100	192	140	149	124
	KIMIA							
3	pH	Elektrometri	-	6 - 9	7,0	7,0	6,0	7,0
4	BOD	Elektrometri	mg/l	50	15,8	55,8	35,8	49,0
5	COD	Titrimetri	mg/l	100	50,0	120,0	184,7	100,0
6	Total N	Spektrofotometri	mg/l	-	11,259	12,258	11,612	11,818
7	Total P	Spektrofotometri	mg/l	-	0,4	1,1	0,6	0,6

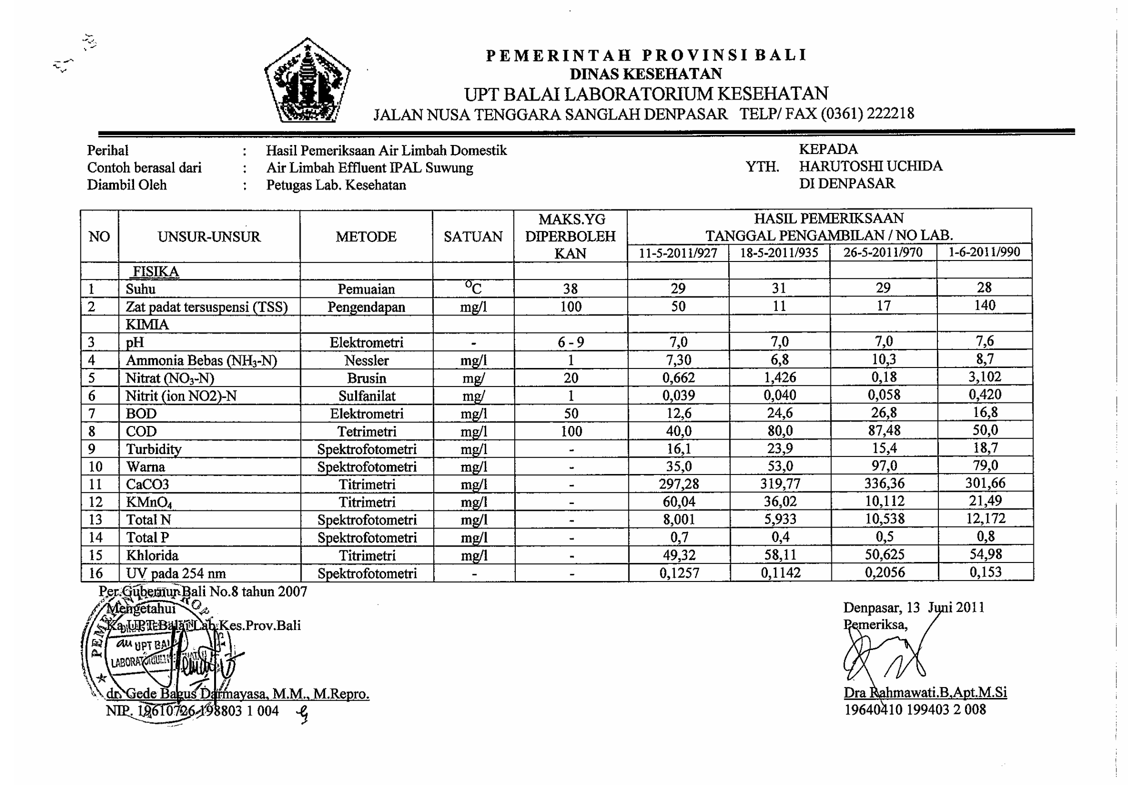
Per.Gubernur Bali No.8 tahun 2007

Mengetahui
Ka.UPT Balai Lab.Kes.Prov.Bali

dr. Gede Bagus Darmayasa, M.M., M.Repro.
NIP. 19610726 198803 1 004

Denpasar, 13 Juni 2011
Pemeriksa,

Dra Rahmawati.B.Apt.M.Si
19640410 199403 2 008



PEMERINTAH PROVINSI BALI
DINAS KESEHATAN
UPT BALAI LABORATORIUM KESEHATAN
JALAN NUSA TENGGARA SANGLAH DENPASAR TELP/ FAX (0361) 222218

Perihal : Hasil Pemeriksaan Air Limbah Domestik
Contoh berasal dari : Air Limbah Effluent IPAL Suwung
Diambil Oleh : Petugas Lab. Kesehatan

KEPADA
YTH. HARUTOSHI UCHIDA
DI DENPASAR

NO	UNSUR-UNSUR	METODE	SATUAN	MAKS.YG DIPERBOLEH KAN	HASIL PEMERIKSAAN TANGGAL PENGAMBILAN / NO LAB.			
					11-5-2011/927	18-5-2011/935	26-5-2011/970	1-6-2011/990
	FISIKA							
1	Suhu	Pemuaian	°C	38	29	31	29	28
2	Zat padat tersuspensi (TSS)	Pengendapan	mg/l	100	50	11	17	140
	KIMIA							
3	pH	Elektrometri	-	6 - 9	7,0	7,0	7,0	7,6
4	Ammonia Bebas (NH_3-N)	Nessler	mg/l	1	7,30	6,8	10,3	8,7
5	Nitrat (NO_3-N)	Brusin	mg/	20	0,662	1,426	0,18	3,102
6	Nitrit (ion NO2)-N	Sulfanilat	mg/	1	0,039	0,040	0,058	0,420
7	BOD	Elektrometri	mg/l	50	12,6	24,6	26,8	16,8
8	COD	Tetrimetri	mg/l	100	40,0	80,0	87,48	50,0
9	Turbidity	Spektrofotometri	mg/l	-	16,1	23,9	15,4	18,7
10	Warna	Spektrofotometri	mg/l	-	35,0	53,0	97,0	79,0
11	CaCO3	Titrimetri	mg/l	-	297,28	319,77	336,36	301,66
12	$KMnO_4$	Titrimetri	mg/l	-	60,04	36,02	10,112	21,49
13	Total N	Spektrofotometri	mg/l	-	8,001	5,933	10,538	12,172
14	Total P	Spektrofotometri	mg/l	-	0,7	0,4	0,5	0,8
15	Khlorida	Titrimetri	mg/l	-	49,32	58,11	50,625	54,98
16	UV pada 254 nm	Spektrofotometri	-	-	0,1257	0,1142	0,2056	0,153

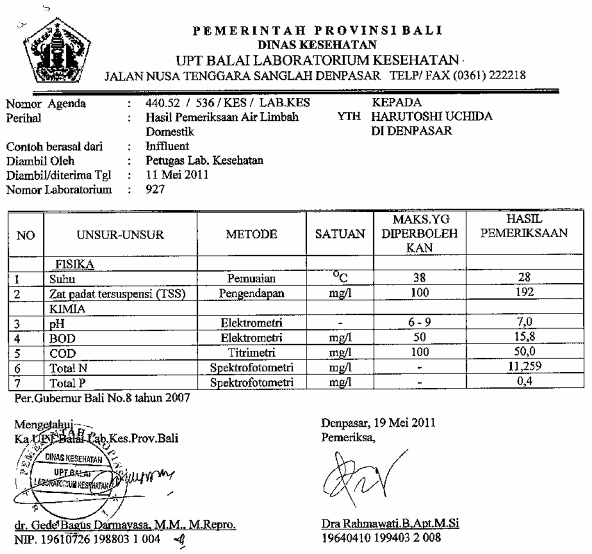
Per.Gubernur Bali No.8 tahun 2007

Mengetahui
Ka.UPT Balai Lab.Kes.Prov.Bali

dr. Gede Bagus Darmayasa, M.M., M.Repro.
NIP. 19610726 198803 1 004

Denpasar, 13 Juni 2011
Pemeriksa,

Dra Rahmawati.B.Apt.M.Si
19640410 199403 2 008



PEMERINTAH PROVINSI BALI
DINAS KESEHATAN
UPT BALAI LABORATORIUM KESEHATAN
JALAN NUSA TENGGARA SANGLAH DENPASAR TELP/ FAX (0361) 222218

Nomor Agenda : 440.52 / 536 / KES / LAB.KES
Perihal : Hasil Pemeriksaan Air Limbah Domestik
Contoh berasal dari : Inffluent
Diambil Oleh : Petugas Lab. Kesehatan
Diambil/diterima Tgl : 11 Mei 2011
Nomor Laboratorium : 927

KEPADA
YTH HARUTOSHI UCHIDA
DI DENPASAR

NO	UNSUR-UNSUR	METODE	SATUAN	MAKS.YG DIPERBOLEH KAN	HASIL PEMERIKSAAN
	FISIKA				
1	Suhu	Pemuaian	°C	38	28
2	Zat padat tersuspensi (TSS)	Pengendapan	mg/l	100	192
	KIMIA				
3	pH	Elektrometri	-	6 - 9	7,0
4	BOD	Elektrometri	mg/l	50	15,8
5	COD	Titrimetri	mg/l	100	50,0
6	Total N	Spektrofotometri	mg/l	-	11,259
7	Total P	Spektrofotometri	mg/l	-	0,4

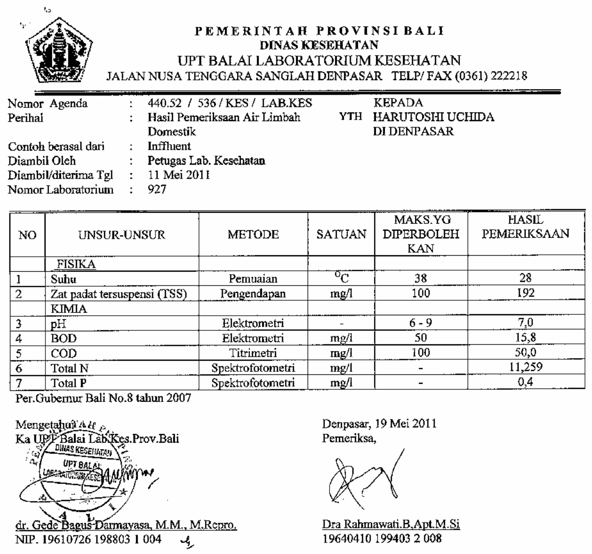
Per.Gubernur Bali No.8 tahun 2007

Mengetahui
Ka UPT Balai Lab.Kes.Prov.Bali

dr. Gede Bagus Darmayasa, M.M., M.Repro.
NIP. 19610726 198803 1 004

Denpasar, 19 Mei 2011
Pemeriksa,

Dra Rahmawati.B.Apt.M.Si
19640410 199403 2 008



PEMERINTAH PROVINSI BALI
DINAS KESEHATAN
UPT BALAI LABORATORIUM KESEHATAN
JALAN NUSA TENGGARA SANGLAH DENPASAR TELP/ FAX (0361) 222218

Nomor Agenda : 440.52 / 536 / KES / LAB.KES
Perihal : Hasil Pemeriksaan Air Limbah Domestik
Contoh berasal dari : Inffluent
Diambil Oleh : Petugas Lab. Kesehatan
Diambil/diterima Tgl : 11 Mei 2011
Nomor Laboratorium : 927

KEPADA
YTH HARUTOSHI UCHIDA
DI DENPASAR

NO	UNSUR-UNSUR	METODE	SATUAN	MAKS.YG DIPERBOLEH KAN	HASIL PEMERIKSAAN
	FISIKA				
1	Suhu	Pemuaian	°C	38	28
2	Zat padat tersuspensi (TSS)	Pengendapan	mg/l	100	192
	KIMIA				
3	pH	Elektrometri	-	6 - 9	7,0
4	BOD	Elektrometri	mg/l	50	15,8
5	COD	Titrimetri	mg/l	100	50,0
6	Total N	Spektrofotometri	mg/l	-	11,259
7	Total P	Spektrofotometri	mg/l	-	0,4

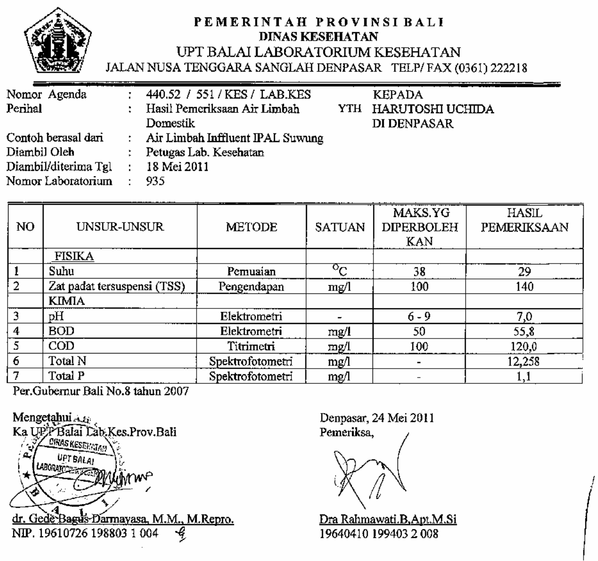
Per.Gubernur Bali No.8 tahun 2007

Mengetahui
Ka UPT Balai Lab.Kes.Prov.Bali

dr. Gede Bagus Darmayasa, M.M., M.Repro.
NIP. 19610726 198803 1 004

Denpasar, 19 Mei 2011
Pemeriksa,

Dra Rahmawati.B.Apt.M.Si
19640410 199403 2 008



PEMERINTAH PROVINSI BALI
DINAS KESEHATAN
UPT BALAI LABORATORIUM KESEHATAN
JALAN NUSA TENGGARA SANGLAH DENPASAR TELP/ FAX (0361) 222218

Nomor Agenda : 440.52 / 551 / KES / LAB.KES
Perihal : Hasil Pemeriksaan Air Limbah Domestik
Contoh berasal dari : Air Limbah Inffluent IPAL Suwung
Diambil Oleh : Petugas Lab. Kesehatan
Diambil/diterima Tgl : 18 Mei 2011
Nomor Laboratorium : 935

KEPADA
YTH HARUTOSHI UCHIDA
DI DENPASAR

NO	UNSUR-UNSUR	METODE	SATUAN	MAKS.YG DIPERBOLEH KAN	HASIL PEMERIKSAAN
	FISIKA				
1	Suhu	Pemuaian	°C	38	29
2	Zat padat tersuspensi (TSS)	Pengendapan	mg/l	100	140
	KIMIA				
3	pH	Elektrometri	-	6 - 9	7,0
4	BOD	Elektrometri	mg/l	50	55,8
5	COD	Titrimetri	mg/l	100	120,0
6	Total N	Spektrofotometri	mg/l	-	12,258
7	Total P	Spektrofotometri	mg/l	-	1,1

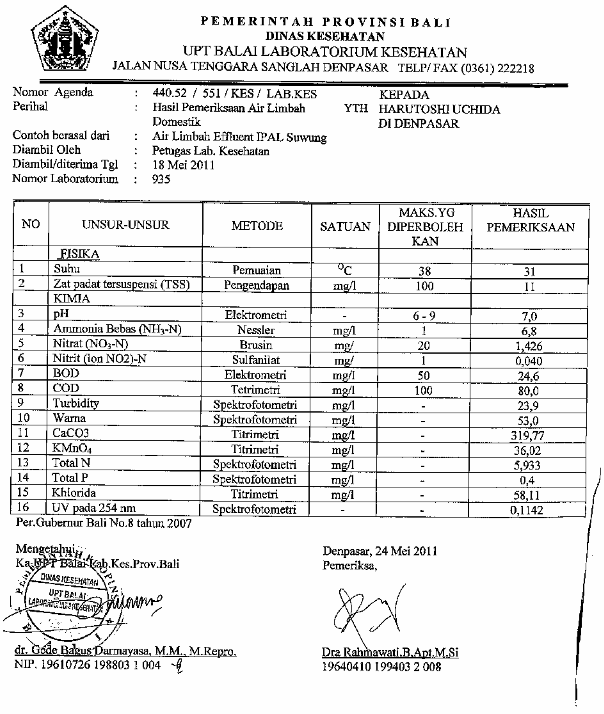
Per.Gubernur Bali No.8 tahun 2007

Mengetahui
Ka UPT Balai Lab.Kes.Prov.Bali

dr. Gede Bagus Darmayasa, M.M., M.Repro.
NIP. 19610726 198803 1 004

Denpasar, 24 Mei 2011
Pemeriksa,

Dra Rahmawati.B.Apt.M.Si
19640410 199403 2 008



PEMERINTAH PROVINSI BALI
DINAS KESEHATAN
UPT BALAI LABORATORIUM KESEHATAN
JALAN NUSA TENGGARA SANGLAH DENPASAR TELP/ FAX (0361) 222218

Nomor Agenda : 440.52 / 551 / KES / LAB.KES
Perihal : Hasil Pemeriksaan Air Limbah Domestik
Contoh berasal dari : Air Limbah Effluent IPAL Suwung
Diambil Oleh : Petugas Lab. Kesehatan
Diambil/diterima Tgl : 18 Mei 2011
Nomor Laboratorium : 935

KEPADA
YTH HARUTOSHI UCHIDA
DI DENPASAR

NO	UNSUR-UNSUR	METODE	SATUAN	MAKS.YG DIPERBOLEH KAN	HASIL PEMERIKSAAN
	FISIKA				
1	Suhu	Pemuaian	°C	38	31
2	Zat padat tersuspensi (TSS)	Pengendapan	mg/l	100	11
	KIMIA				
3	pH	Elektrometri	-	6 - 9	7,0
4	Ammonia Bebas (NH_3-N)	Nessler	mg/l	1	6,8
5	Nitrat (NO_3-N)	Brusin	mg/	20	1,426
6	Nitrit (ion NO2)-N	Sulfanilat	mg/	1	0,040
7	BOD	Elektrometri	mg/l	50	24,6
8	COD	Tetrimetri	mg/l	100	80,0
9	Turbidity	Spektrofotometri	mg/l	-	23,9
10	Warna	Spektrofotometri	mg/l	-	53,0
11	CaCO3	Titrimetri	mg/l	-	319,77
12	$KMnO_4$	Titrimetri	mg/l	-	36,02
13	Total N	Spektrofotometri	mg/l	-	5,933
14	Total P	Spektrofotometri	mg/l	-	0,4
15	Khlorida	Titrimetri	mg/l	-	58,11
16	UV pada 254 nm	Spektrofotometri	-	-	0,1142

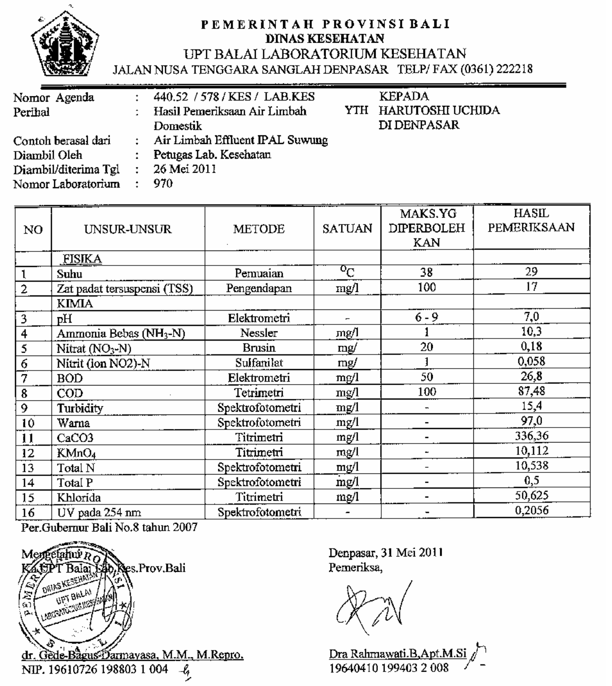
Per.Gubernur Bali No.8 tahun 2007

Mengetahui
Ka UPT Balai Lab.Kes.Prov.Bali

dr. Gede Bagus Darmayasa, M.M., M.Repro.
NIP. 19610726 198803 1 004

Denpasar, 24 Mei 2011
Pemeriksa,

Dra Rahmawati.B.Apt.M.Si
19640410 199403 2 008



PEMERINTAH PROVINSI BALI
DINAS KESEHATAN
UPT BALAI LABORATORIUM KESEHATAN
JALAN NUSA TENGGARA SANGLAH DENPASAR TELP/ FAX (0361) 222218

Nomor Agenda : 440.52 / 578 / KES / LAB.KES
Perihal : Hasil Pemeriksaan Air Limbah Domestik
Contoh berasal dari : Air Limbah Effluent IPAL Suwung
Diambil Oleh : Petugas Lab. Kesehatan
Diambil/diterima Tgl : 26 Mei 2011
Nomor Laboratorium : 970

KEPADA
YTH HARUTOSHI UCHIDA
DI DENPASAR

NO	UNSUR-UNSUR	METODE	SATUAN	MAKS.YG DIPERBOLEH KAN	HASIL PEMERIKSAAN
	FISIKA				
1	Suhu	Pemuaian	^{o}C	38	29
2	Zat padat tersuspensi (TSS)	Pengendapan	mg/l	100	17
	KIMIA				
3	pH	Elektrometri	-	6 - 9	7,0
4	Ammonia Bebas (NH_3-N)	Nessler	mg/l	1	10,3
5	Nitrat (NO_3-N)	Brusin	mg/	20	0,18
6	Nitrit (ion NO2)-N	Sulfanilat	mg/	1	0,058
7	BOD	Elektrometri	mg/l	50	26,8
8	COD	Tetrimetri	mg/l	100	87,48
9	Turbidity	Spektrofotometri	mg/l	-	15,4
10	Warna	Spektrofotometri	mg/l	-	97,0
11	CaCO3	Titrimetri	mg/l	-	336,36
12	$KMnO_4$	Titrimetri	mg/l	-	10,112
13	Total N	Spektrofotometri	mg/l	-	10,538
14	Total P	Spektrofotometri	mg/l	-	0,5
15	Khlorida	Titrimetri	mg/l	-	50,625
16	UV pada 254 nm	Spektrofotometri	-	-	0,2056

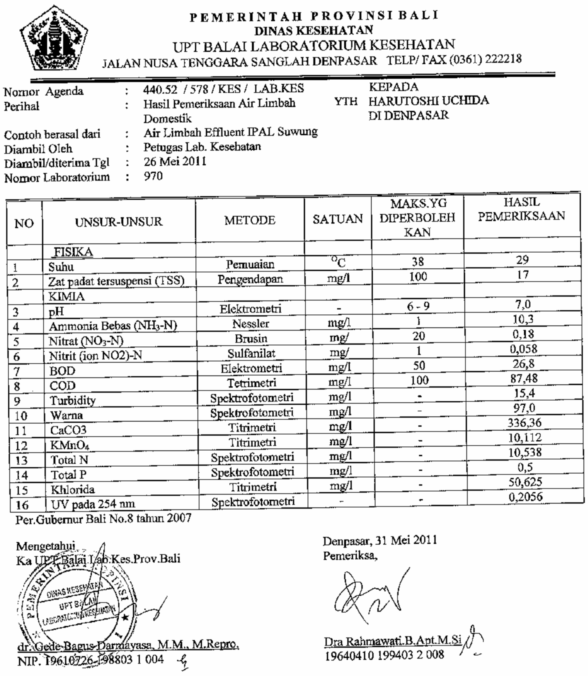
Per.Gubernur Bali No.8 tahun 2007

Mengetahui
Ka UPT Balai Lab.Kes.Prov.Bali

dr. Gede Bagus Darmayasa, M.M., M.Repro.
NIP. 19610726 198803 1 004

Denpasar, 31 Mei 2011
Pemeriksa,

Dra Rahmawati.B,Apt.M.Si
19640410 199403 2 008



PEMERINTAH PROVINSI BALI
DINAS KESEHATAN
UPT BALAI LABORATORIUM KESEHATAN
JALAN NUSA TENGGARA SANGLAH DENPASAR TELP/ FAX (0361) 222218

Nomor Agenda : 440.52 / 578 / KES / LAB.KES
Perihal : Hasil Pemeriksaan Air Limbah Domestik
Contoh berasal dari : Air Limbah Effluent IPAL Suwung
Diambil Oleh : Petugas Lab. Kesehatan
Diambil/diterima Tgl : 26 Mei 2011
Nomor Laboratorium : 970

KEPADA
YTH HARUTOSHI UCHIDA
DI DENPASAR

NO	UNSUR-UNSUR	METODE	SATUAN	MAKS.YG DIPERBOLEH KAN	HASIL PEMERIKSAAN
	FISIKA				
1	Suhu	Pemuaian	^{o}C	38	29
2	Zat padat tersuspensi (TSS)	Pengendapan	mg/l	100	17
	KIMIA				
3	pH	Elektrometri	-	6 - 9	7,0
4	Ammonia Bebas (NH_3-N)	Nessler	mg/l	1	10,3
5	Nitrat (NO_3-N)	Brusin	mg/	20	0,18
6	Nitrit (ion NO2)-N	Sulfanilat	mg/	1	0,058
7	BOD	Elektrometri	mg/l	50	26,8
8	COD	Tetrimetri	mg/l	100	87,48
9	Turbidity	Spektrofotometri	mg/l	-	15,4
10	Warna	Spektrofotometri	mg/l	-	97,0
11	CaCO3	Titrimetri	mg/l	-	336,36
12	$KMnO_4$	Titrimetri	mg/l	-	10,112
13	Total N	Spektrofotometri	mg/l	-	10,538
14	Total P	Spektrofotometri	mg/l	-	0,5
15	Khlorida	Titrimetri	mg/l	-	50,625
16	UV pada 254 nm	Spektrofotometri	-	-	0,2056

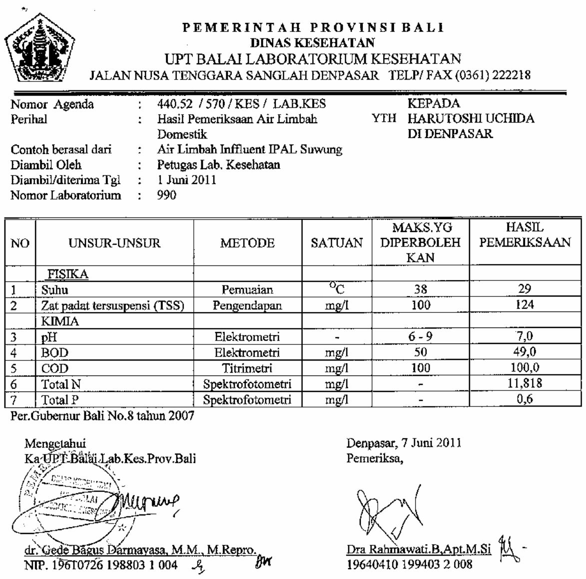
Per.Gubernur Bali No.8 tahun 2007

Mengetahui
Ka UPT Balai Lab.Kes.Prov.Bali

dr. Gede Bagus Darmayasa, M.M., M.Repro.
NIP. 19610726 198803 1 004

Denpasar, 31 Mei 2011
Pemeriksa,

Dra Rahmawati.B,Apt.M.Si
19640410 199403 2 008



PEMERINTAH PROVINSI BALI
DINAS KESEHATAN
UPT BALAI LABORATORIUM KESEHATAN
JALAN NUSA TENGGARA SANGLAH DENPASAR TELP/ FAX (0361) 222218

Nomor Agenda : 440.52 / 570 / KES / LAB.KES
Perihal : Hasil Pemeriksaan Air Limbah Domestik
Contoh berasal dari : Air Limbah Inffluent IPAL Suwung
Diambil Oleh : Petugas Lab. Kesehatan
Diambil/diterima Tgl : 1 Juni 2011
Nomor Laboratorium : 990

KEPADA
YTH HARUTOSHI UCHIDA
DI DENPASAR

NO	UNSUR-UNSUR	METODE	SATUAN	MAKS.YG DIPERBOLEH KAN	HASIL PEMERIKSAAN
	FISIKA				
1	Suhu	Pemuaian	^{o}C	38	29
2	Zat padat tersuspensi (TSS)	Pengendapan	mg/l	100	124
	KIMIA				
3	pH	Elektrometri	-	6 - 9	7,0
4	BOD	Elektrometri	mg/l	50	49,0
5	COD	Titrimetri	mg/l	100	100,0
6	Total N	Spektrofotometri	mg/l	-	11,818
7	Total P	Spektrofotometri	mg/l	-	0,6

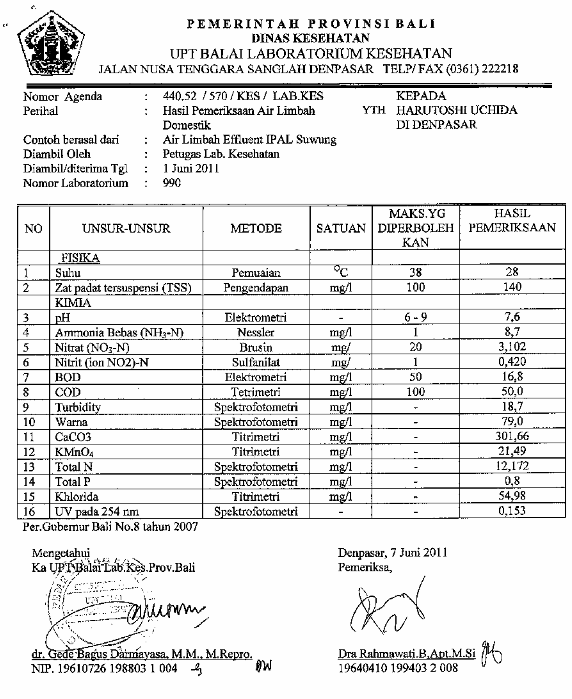
Per.Gubernur Bali No.8 tahun 2007

Mengetahui
Ka UPT Balai Lab.Kes.Prov.Bali

dr. Gede Bagus Darmayasa, M.M., M.Repro.
NIP. 19610726 198803 1 004

Denpasar, 7 Juni 2011
Pemeriksa,

Dra Rahmawati.B,Apt.M.Si
19640410 199403 2 008



PEMERINTAH PROVINSI BALI
DINAS KESEHATAN
UPT BALAI LABORATORIUM KESEHATAN
JALAN NUSA TENGGARA SANGLAH DENPASAR TELP/ FAX (0361) 222218

Nomor Agenda : 440.52 / 570 / KES / LAB.KES
Perihal : Hasil Pemeriksaan Air Limbah Domestik
Contoh berasal dari : Air Limbah Effluent IPAL Suwung
Diambil Oleh : Petugas Lab. Kesehatan
Diambil/diterima Tgl : 1 Juni 2011
Nomor Laboratorium : 990

KEPADA
YTH HARUTOSHI UCHIDA
DI DENPASAR

NO	UNSUR-UNSUR	METODE	SATUAN	MAKS.YG DIPERBOLEH KAN	HASIL PEMERIKSAAN
	FISIKA				
1	Suhu	Pemuaian	^{o}C	38	28
2	Zat padat tersuspensi (TSS)	Pengendapan	mg/l	100	140
	KIMIA				
3	pH	Elektrometri	-	6 - 9	7,6
4	Ammonia Bebas (NH_3-N)	Nessler	mg/l	1	8,7
5	Nitrat (NO_3-N)	Brusin	mg/	20	3,102
6	Nitrit (ion NO2)-N	Sulfanilat	mg/	1	0,420
7	BOD	Elektrometri	mg/l	50	16,8
8	COD	Tetrimetri	mg/l	100	50,0
9	Turbidity	Spektrofotometri	mg/l	-	18,7
10	Warna	Spektrofotometri	mg/l	-	79,0
11	CaCO3	Titrimetri	mg/l	-	301,66
12	$KMnO_4$	Titrimetri	mg/l	-	21,49
13	Total N	Spektrofotometri	mg/l	-	12,172
14	Total P	Spektrofotometri	mg/l	-	0,8
15	Khlorida	Titrimetri	mg/l	-	54,98
16	UV pada 254 nm	Spektrofotometri	-	-	0,153

Per.Gubernur Bali No.8 tahun 2007

Mengetahui
Ka UPT Balai Lab.Kes.Prov.Bali

dr. Gede Bagus Darmayasa, M.M., M.Repro.
NIP. 19610726 198803 1 004

Denpasar, 7 Juni 2011
Pemeriksa,

Dra Rahmawati.B,Apt.M.Si
19640410 199403 2 008

APPENDIX 3

TOPOGRAPHIC SURVEY

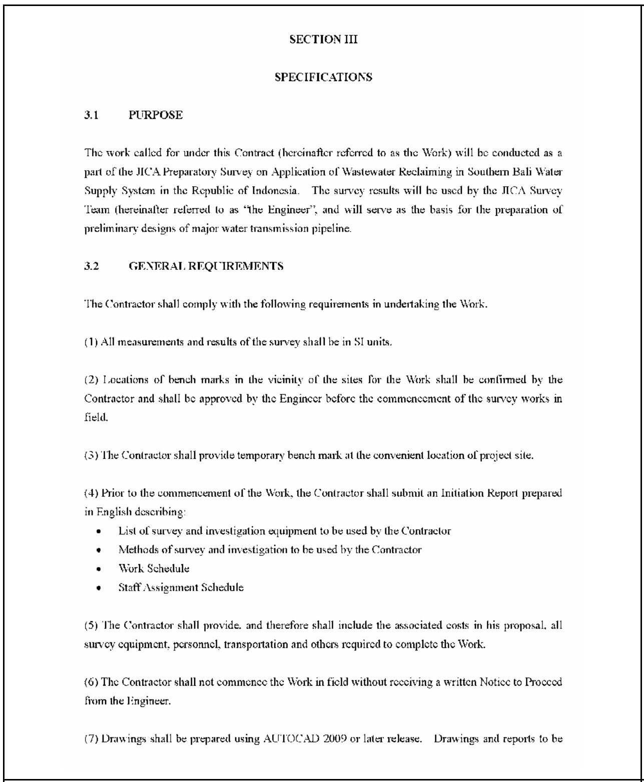
APPENDIX 3 TOPOGRAPHIC SURVEY

3.a Terms of Reference

Transmission pipe route was selected and the line survey with the following specifications was carried out.

Total Length: about 16km with the width of about 25m
Scale of Plan: 1/500
Scale of Longitudinal Section: H=1/500, V=1/100
Scale of Cross Section: 1/100

Terms of Reference



SECTION III

SPECIFICATIONS

3.1 PURPOSE

The work called for under this Contract (hereinafter referred to as the Work) will be conducted as a part of the JICA Preparatory Survey on Application of Wastewater Reclaiming in Southern Bali Water Supply System in the Republic of Indonesia. The survey results will be used by the JICA Survey Team (hereinafter referred to as "the Engineer", and will serve as the basis for the preparation of preliminary designs of major water transmission pipeline.

3.2 GENERAL REQUIREMENTS

The Contractor shall comply with the following requirements in undertaking the Work.

(1) All measurements and results of the survey shall be in SI units.

(2) Locations of bench marks in the vicinity of the sites for the Work shall be confirmed by the Contractor and shall be approved by the Engineer before the commencement of the survey works in field.

(3) The Contractor shall provide temporary bench mark at the convenient location of project site.

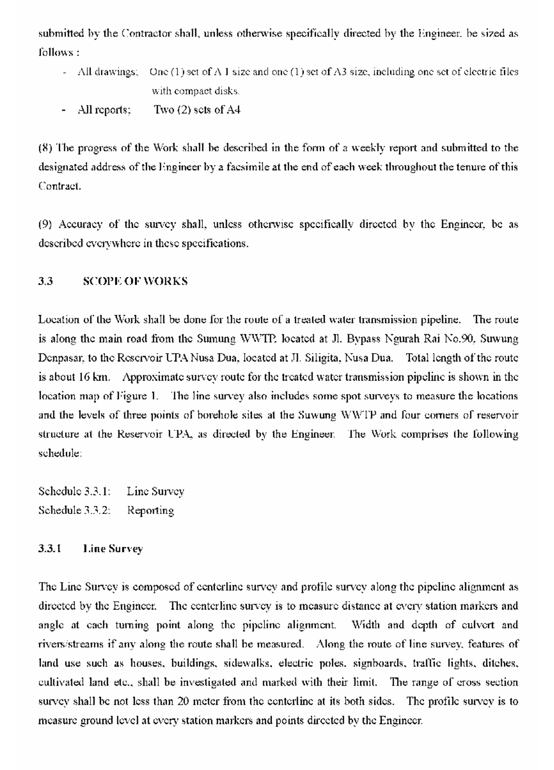
(4) Prior to the commencement of the Work, the Contractor shall submit an Initiation Report prepared in English describing:

- List of survey and investigation equipment to be used by the Contractor
- Methods of survey and investigation to be used by the Contractor
- Work Schedule
- Staff Assignment Schedule

(5) The Contractor shall provide. and therefore shall include the associated costs in his proposal, all survey equipment, personnel, transportation and others required to complete the Work.

(6) The Contractor shall not commence the Work in field without receiving a written Notice to Proceed from the Engineer.

(7) Drawings shall be prepared using AUTOCAD 2009 or later release. Drawings and reports to be



submitted by the Contractor shall, unless otherwise specifically directed by the Engineer. be sized as follows :

- All drawings; One (1) set of A 1 size and one (1) set of A3 size, including one set of electric files with compact disks.
- All reports; Two (2) sets of A4

(8) The progress of the Work shall be described in the form of a weekly report and submitted to the designated address of the Engineer by a facsimile at the end of each week throughout the tenure of this Contract.

(9) Accuracy of the survey shall, unless otherwise specifically directed by the Engineer, be as described everywhere in these specifications.

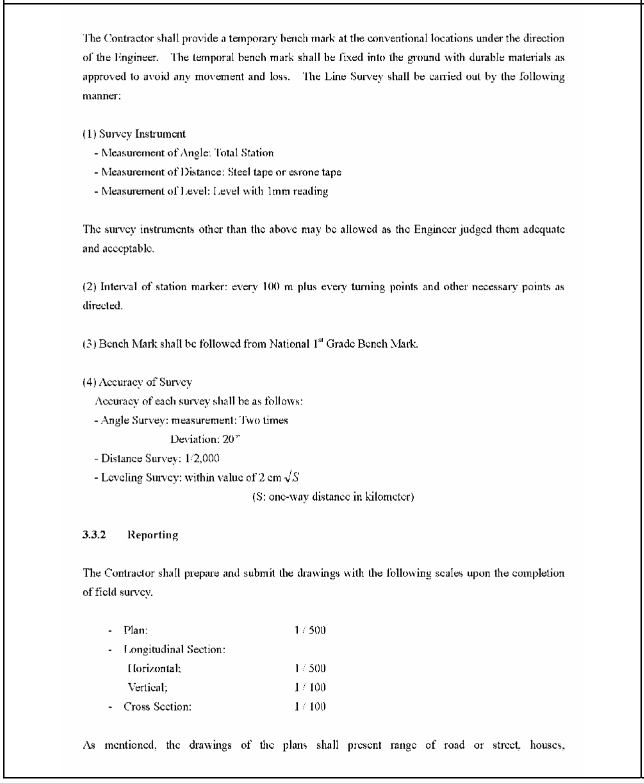
3.3 SCOPE OF WORKS

Location of the Work shall be done for the route of a treated water transmission pipeline. The route is along the main road from the Sumung WWTP. located at Jl. Bypass Ngurah Rai No.90, Suwung Denpasar, to the Reservoir UPA Nusa Dua, located at Jl. Siligita, Nusa Dua. Total length of the route is about 16 km. Approximate survey route for the treated water transmission pipeline is shown in the location map of Figure 1. The line survey also includes some spot surveys to measure the locations and the levels of three points of borehole sites at the Suwung WWTP and four corners of reservoir structure at the Reservoir UPA, as directed by the Engineer. The Work comprises the following schedule:

Schedule 3.3.1: Line Survey
Schedule 3.3.2: Reporting

3.3.1 Line Survey

The Line Survey is composed of centerline survey and profile survey along the pipeline alignment as directed by the Engineer. The centerline survey is to measure distance at every station markers and angle at each turning point along the pipeline alignment. Width and depth of culvert and rivers/streams if any along the route shall be measured. Along the route of line survey, features of land use such as houses, buildings, sidewalks, electric poles. signboards, traffic lights, ditches, cultivated land etc., shall be investigated and marked with their limit. The range of cross section survey shall be not less than 20 meter from the centerline at its both sides. The profile survey is to measure ground level at every station markers and points directed by the Engineer.



The Contractor shall provide a temporary bench mark at the conventional locations under the direction of the Engineer. The temporal bench mark shall be fixed into the ground with durable materials as approved to avoid any movement and loss. The Line Survey shall be carried out by the following manner:

(1) Survey Instrument
- Measurement of Angle: Total Station
- Measurement of Distance: Steel tape or esrone tape
- Measurement of Level: Level with 1mm reading

The survey instruments other than the above may be allowed as the Engineer judged them adequate and acceptable.

(2) Interval of station marker: every 100 m plus every turning points and other necessary points as directed.

(3) Bench Mark shall be followed from National 1st Grade Bench Mark.

(4) Accuracy of Survey
Accuracy of each survey shall be as follows:
- Angle Survey: measurement: Two times
Deviation: 20"
- Distance Survey: 1/2,000
- Leveling Survey: within value of 2 cm $\sqrt{S}$
(S: one-way distance in kilometer)

3.3.2 Reporting

The Contractor shall prepare and submit the drawings with the following scales upon the completion of field survey.

- Plan:	1 / 500
- Longitudinal Section:	
Horizontal;	1 / 500
Vertical;	1 / 100
- Cross Section:	1 / 100

As mentioned, the drawings of the plans shall present range of road or street, houses,

rivers/streams/watercourses, factories, concrete shelters, buildings, and any features of land use and along the routes of treated water transmission pipeline.

The drawings shall be printed out and digital files of drawings with format of AUTOCAD 2009 or later release shall be submitted. Font size of information and notes in the drawings shall be readable when the drawings are printed out in A3 size.

In addition to the above drawings, the Contractor shall submit daily work records describing time, climate and incidents/trouble with the land owner or people living in the vicinity if any, all survey data including field notes, photographs of site survey, other obtained during field surveys.

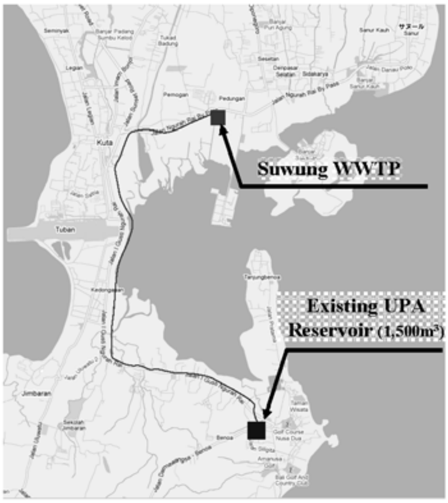
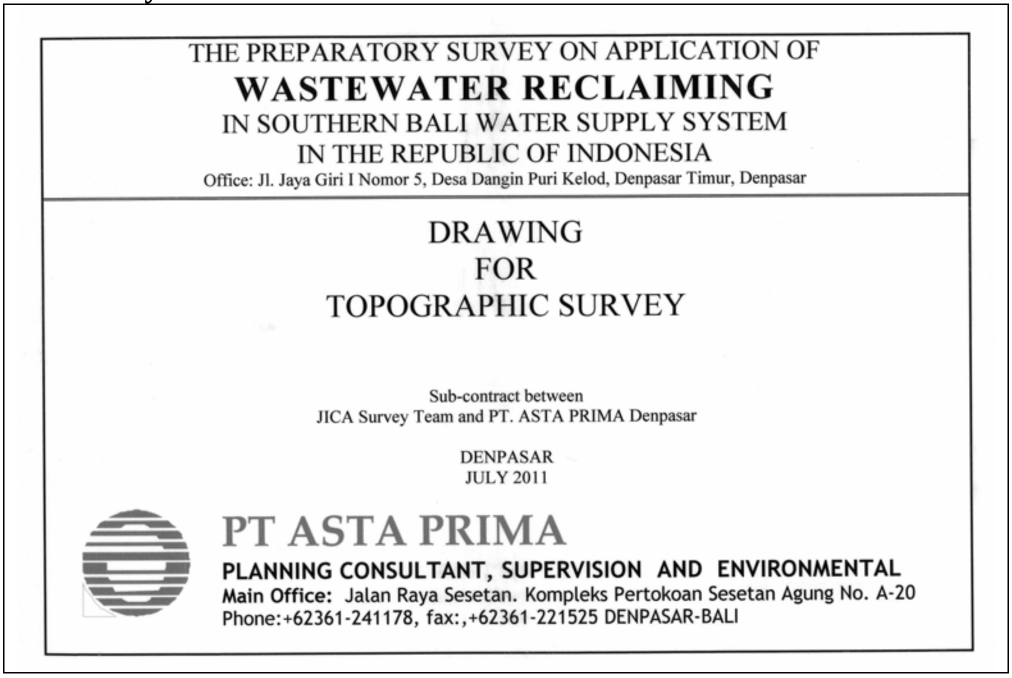


Figure 1 Locations of Topographic Surveys

3.b Survey Photo

3.c Survey Result



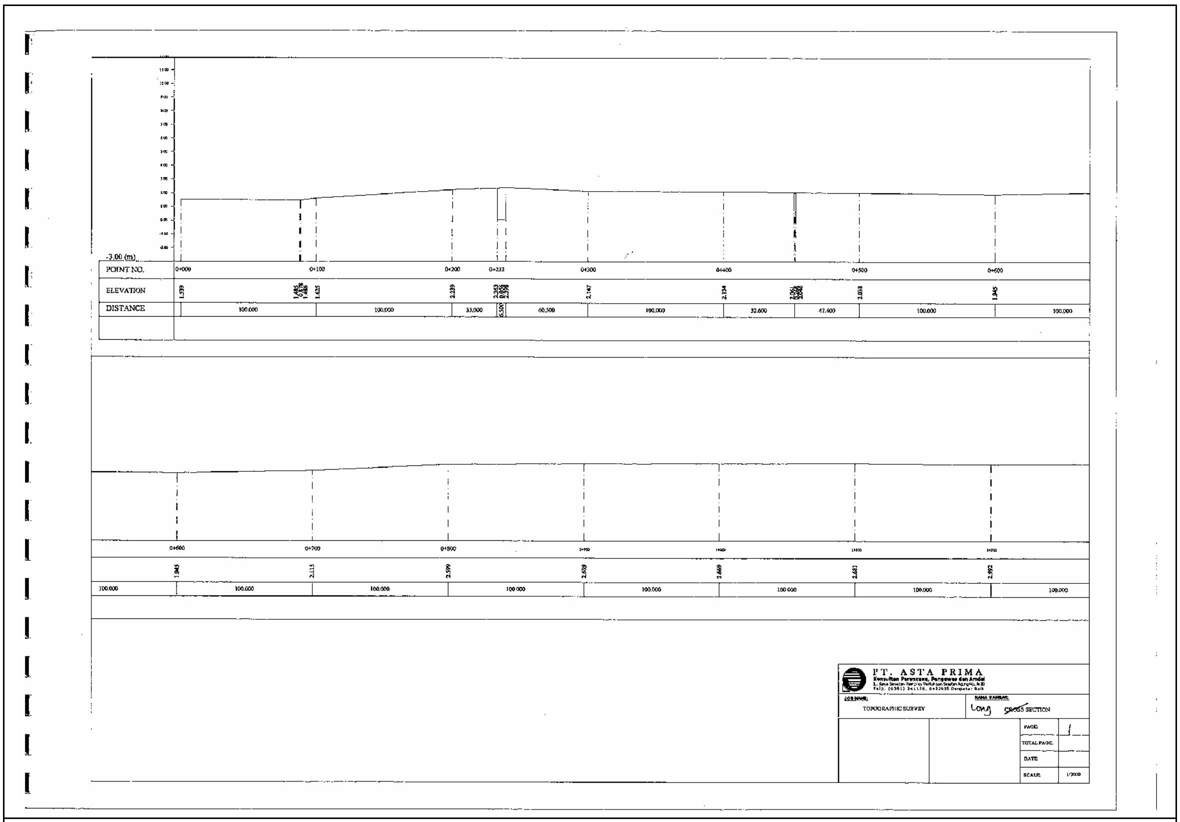
THE PREPARATORY SURVEY ON APPLICATION OF
WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM
IN THE REPUBLIC OF INDONESIA
Office: Jl. Jaya Giri I Nomor 5, Desa Dangin Puri Kelod, Denpasar Timur, Denpasar

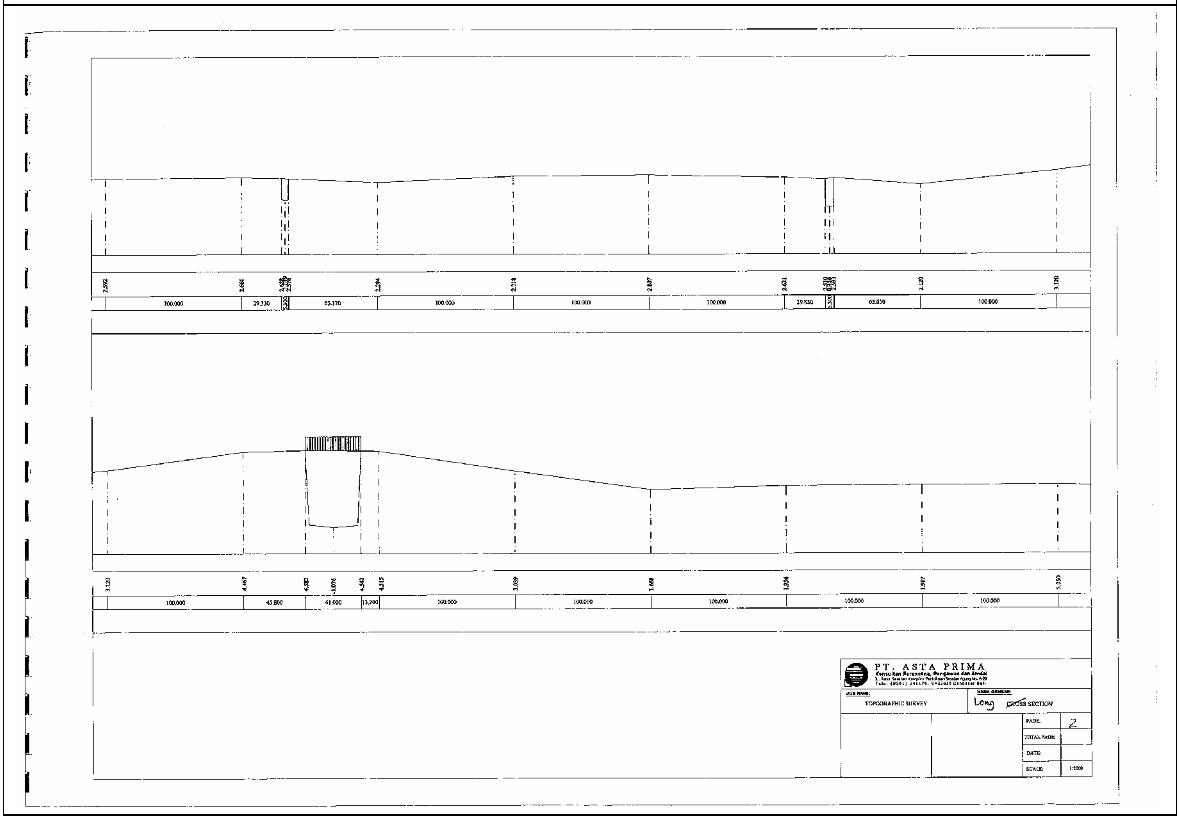
DRAWING
FOR
TOPOGRAPHIC SURVEY

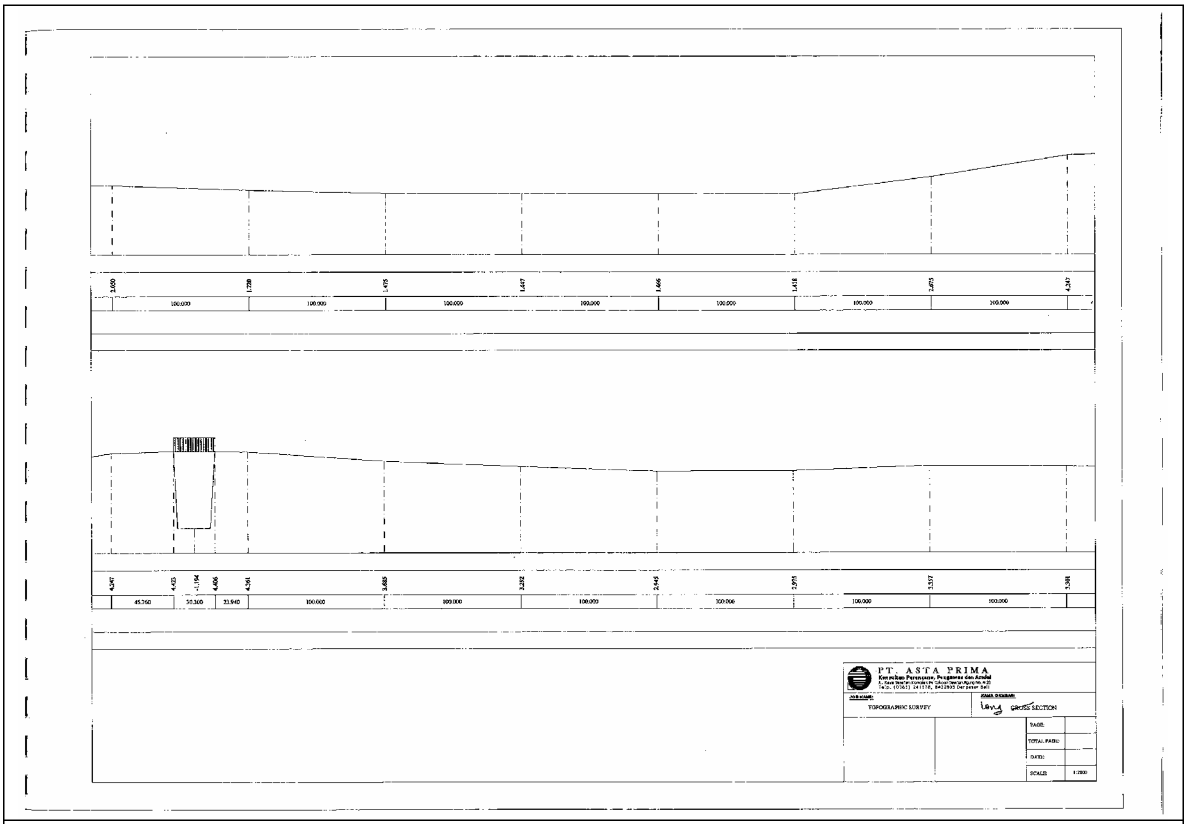
Sub-contract between
JICA Survey Team and PT. ASTA PRIMA Denpasar

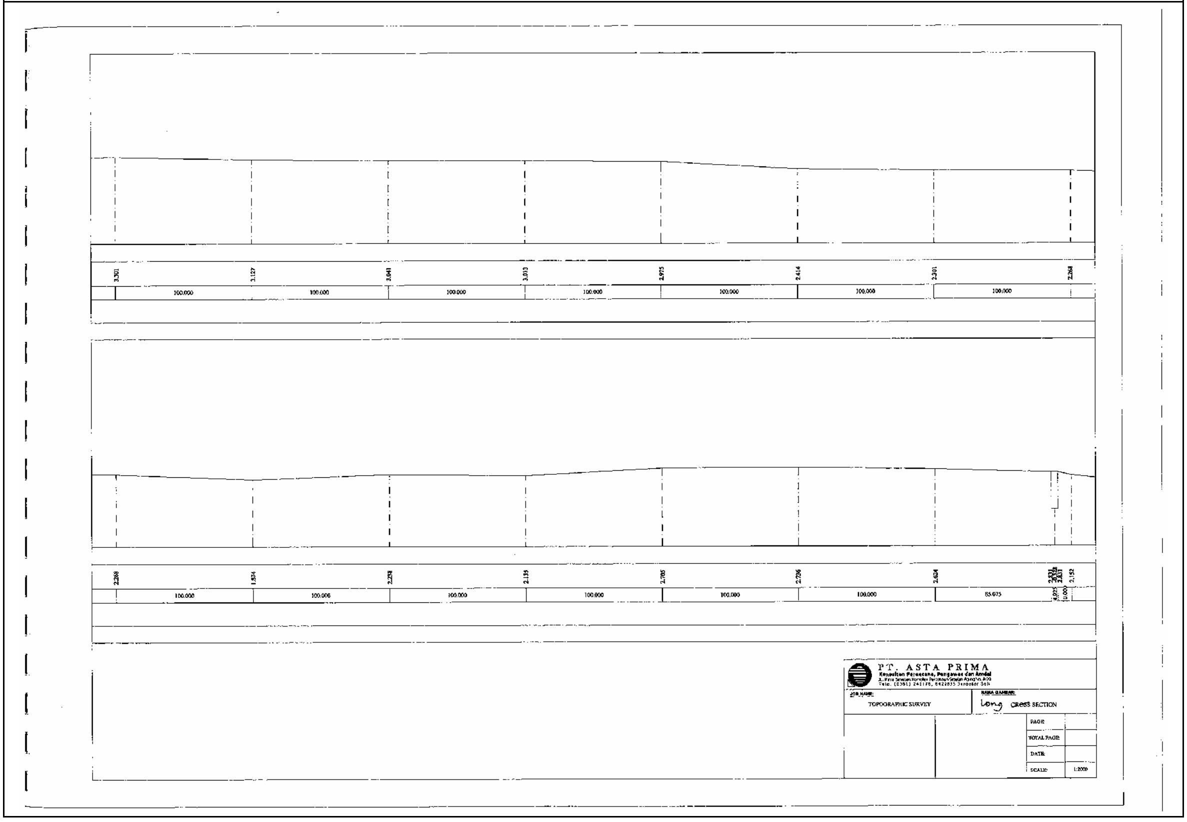
DENPASAR
JULY 2011

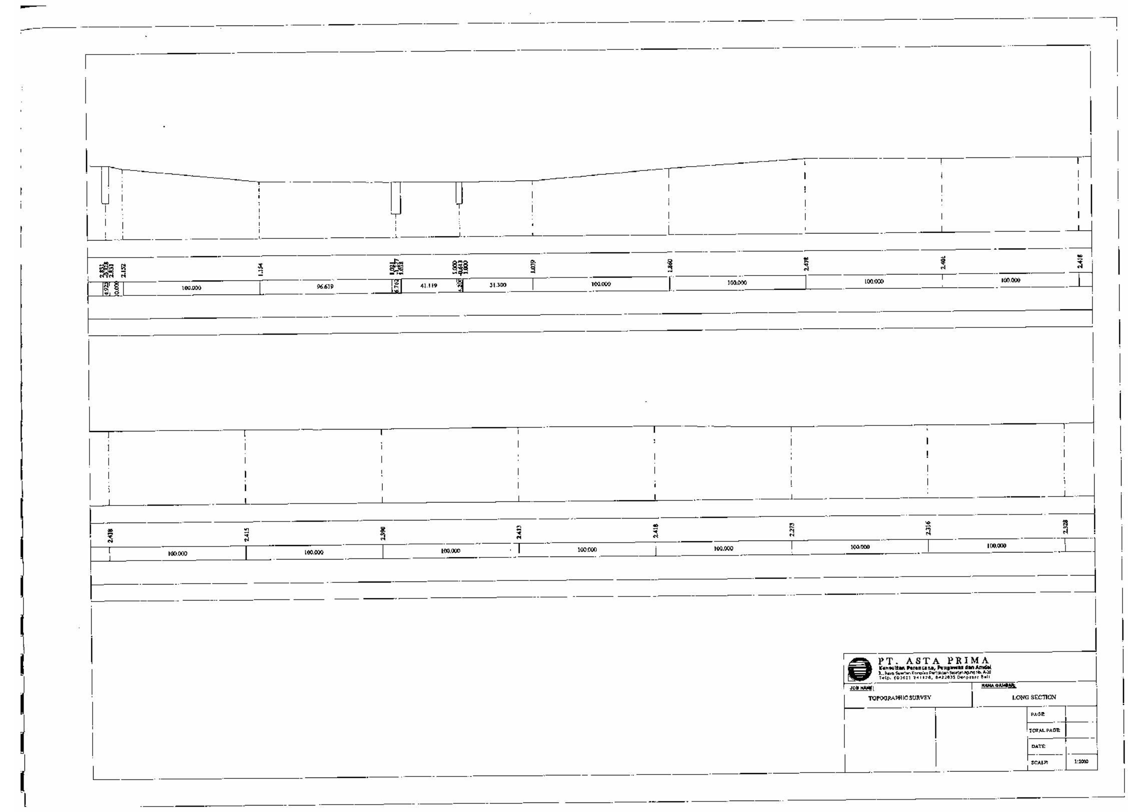
PT ASTA PRIMA
PLANNING CONSULTANT, SUPERVISION AND ENVIRONMENTAL
Main Office: Jalan Raya Sesetan. Kompleks Pertokoan Sesetan Agung No. A-20
Phone:+62361-241178, fax:,+62361-221525 DENPASAR-BALI

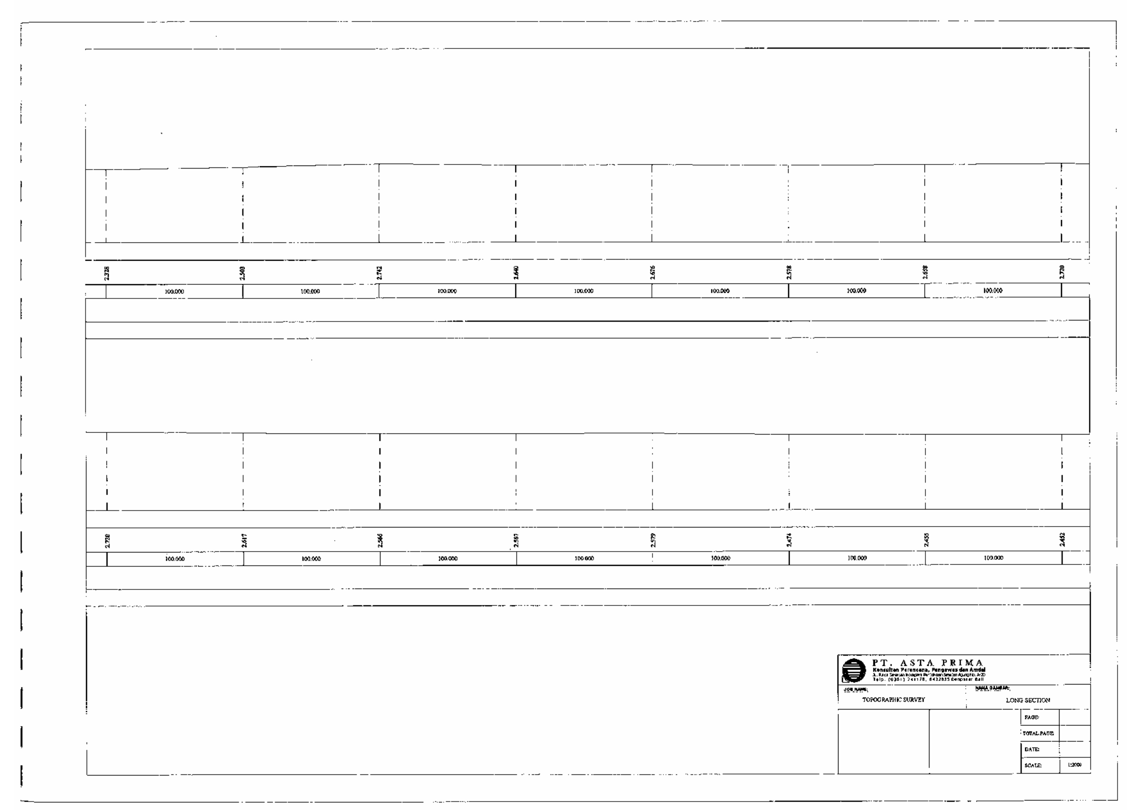

-3.00 (m)
POINT NO.
ELEVATION
DISTANCE
0+000
0+100
0+200
0+233
0+300
0+400
0+500
0+600
1.539
1.485
0.878
1.486
1.625
2.239
2.363
0.058
2.398
2.147
2.134
2.061
2.040
2.038
1.945
100.000
33.000
6.500
60.500
52.600
47.400
0+700
0+800
2.115
2.599
2.639
2.669
2.681
2.992
PT. ASTA PRIMA
Konsultan Perencana, Pengawas dan Amdal
Telp. (0361) 241178, 8432635 Denpasar Bali
JOB NAME:
TOPOGRAPHIC SURVEY
NAMA GAMBAR:
Long ~~CROSS~~ SECTION
PAGE:
1
TOTAL PAGE:
DATE:
SCALE:
1/2000

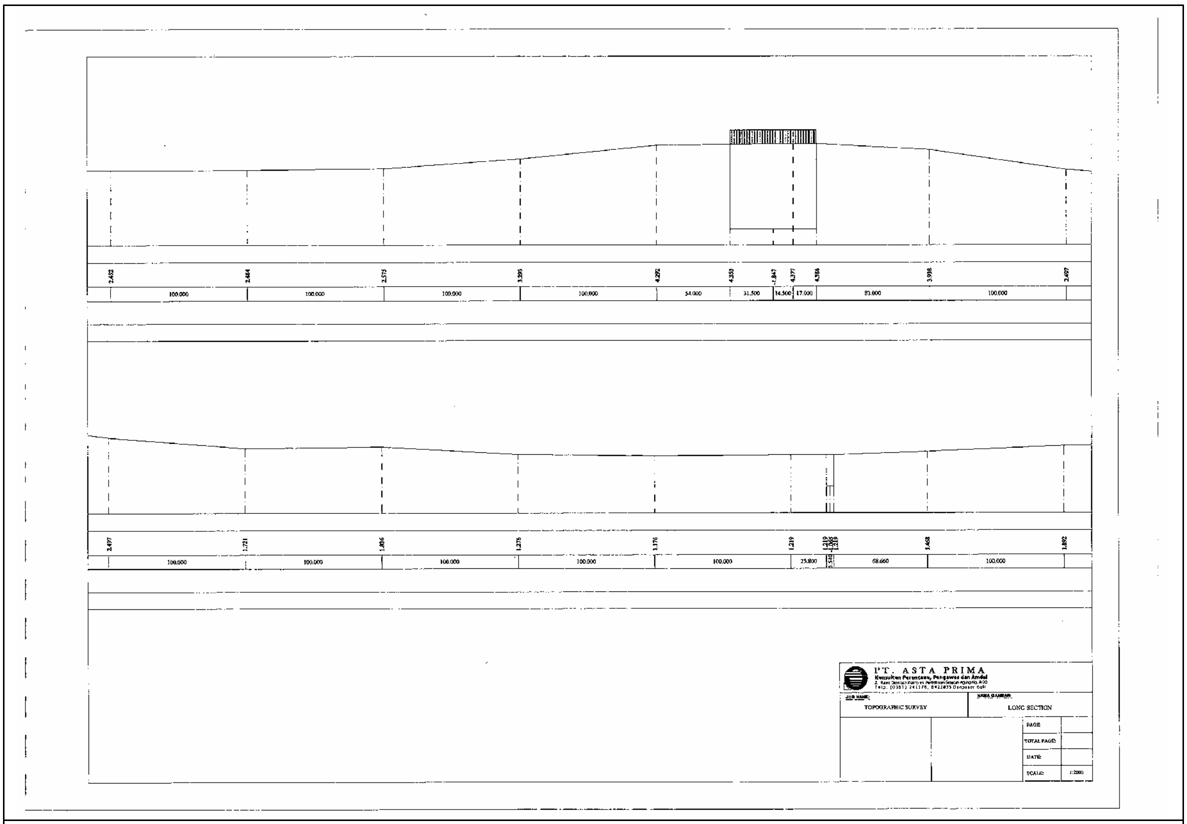

2.592
2.660
2.376
2.294
2.718
2.807
2.621
2.510
2.383
2.120
3.120
100.000
29.330
5.300
65.370
29.850
63.650
4.467
4.582
-1.076
4.542
4.515
3.039
1.668
1.954
1.987
2.050
45.800
41.000
13.200
PT. ASTA PRIMA
Konsultan Perencana, Pengawas dan Amdal
JOB NAME:
TOPOGRAPHIC SURVEY
NAMA GAMBAR:
Long ~~CROSS~~ SECTION
PAGE:
2
TOTAL PAGE:
DATE:
SCALE:
1/2000

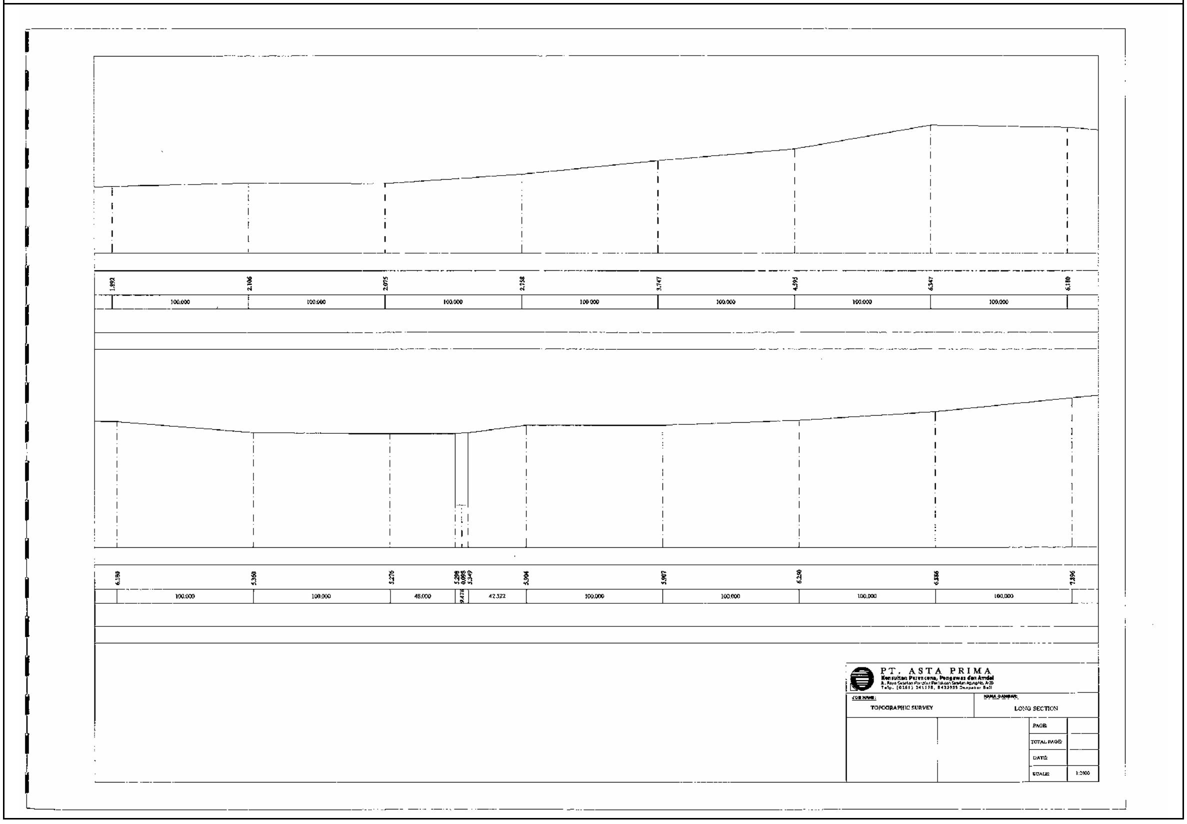

2.050
1.720
1.475
1.447
1.466
1.418
2.675
4.247
100.000
100.000
100.000
100.000
100.000
100.000
100.000
4.247
4.423
-1.194
4.406
4.361
3.685
3.292
2.945
2.975
3.357
3.301
45.760
30.300
23.940
100.000
100.000
100.000
100.000
100.000
100.000
PT. ASTA PRIMA
Konsultan Perencana, Pengawas dan Amdal
Telp. (0361) 241578, 8422035 Denpasar Bali
JOB NAME:
TOPOGRAPHIC SURVEY
NAMA GAMBAR:
long ~~CROSS~~ SECTION
PAGE:
TOTAL PAGE:
DATE:
SCALE:
1:2000

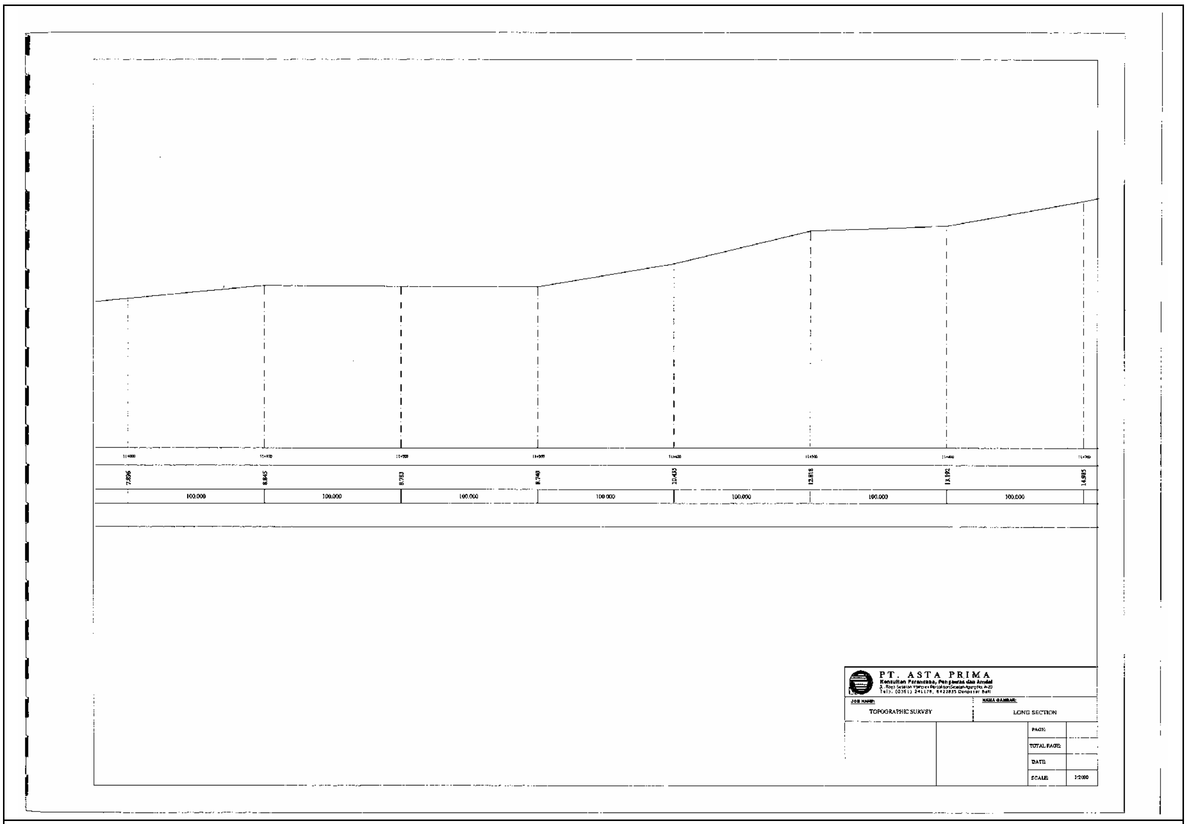

3.301
3.127
3.041
3.013
2.975
2.414
2.301
2.268
100.000
100.000
100.000
100.000
100.000
100.000
100.000
2.268
1.874
2.238
2.135
2.705
2.726
2.624
2.831
2.152
100.000
100.000
100.000
100.000
100.000
100.000
85.075
4.925
10.000
PT. ASTA PRIMA
Konsultan Perencana, Pengawas dan Amdal
Telp. (0361) 241578, 8422035 Denpasar Bali
JOB NAME:
TOPOGRAPHIC SURVEY
NAMA GAMBAR:
long ~~CROSS~~ SECTION
PAGE:
TOTAL PAGE:
DATE:
SCALE:
1:2000

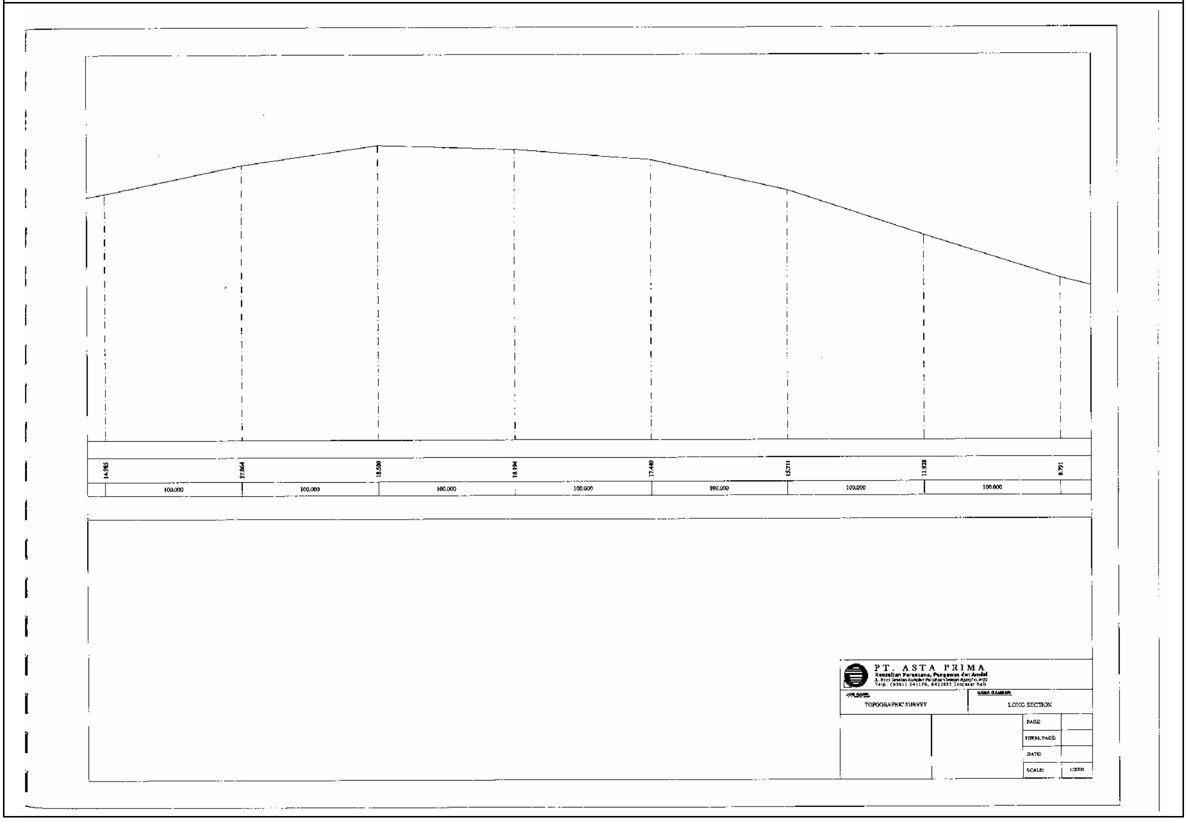

PT. ASTA PRIMA
Konsultan Perencana, Pengawas dan Amdal
JOB NAME:
TOPOGRAPHIC SURVEY
NAMA GAMBAR:
LONG SECTION
PAGE
TOTAL PAGE
DATE
SCALE
1:2000
100.000
96.619
41.119
31.300

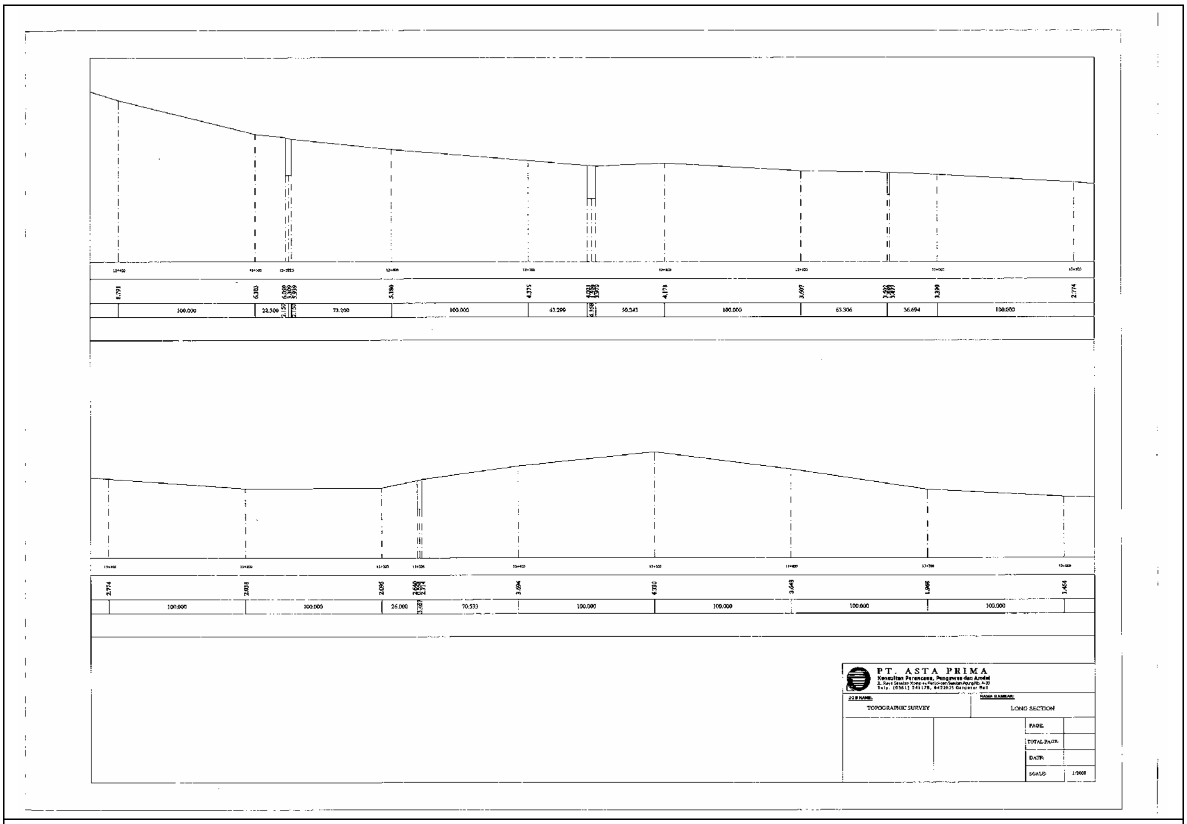

PT. ASTA PRIMA
Konsultan Perencana, Pengawas dan Amdal
JOB NAME:
TOPOGRAPHIC SURVEY
NAMA GAMBAR:
LONG SECTION
PAGE
TOTAL PAGE
DATE
SCALE
1:2000
100.000

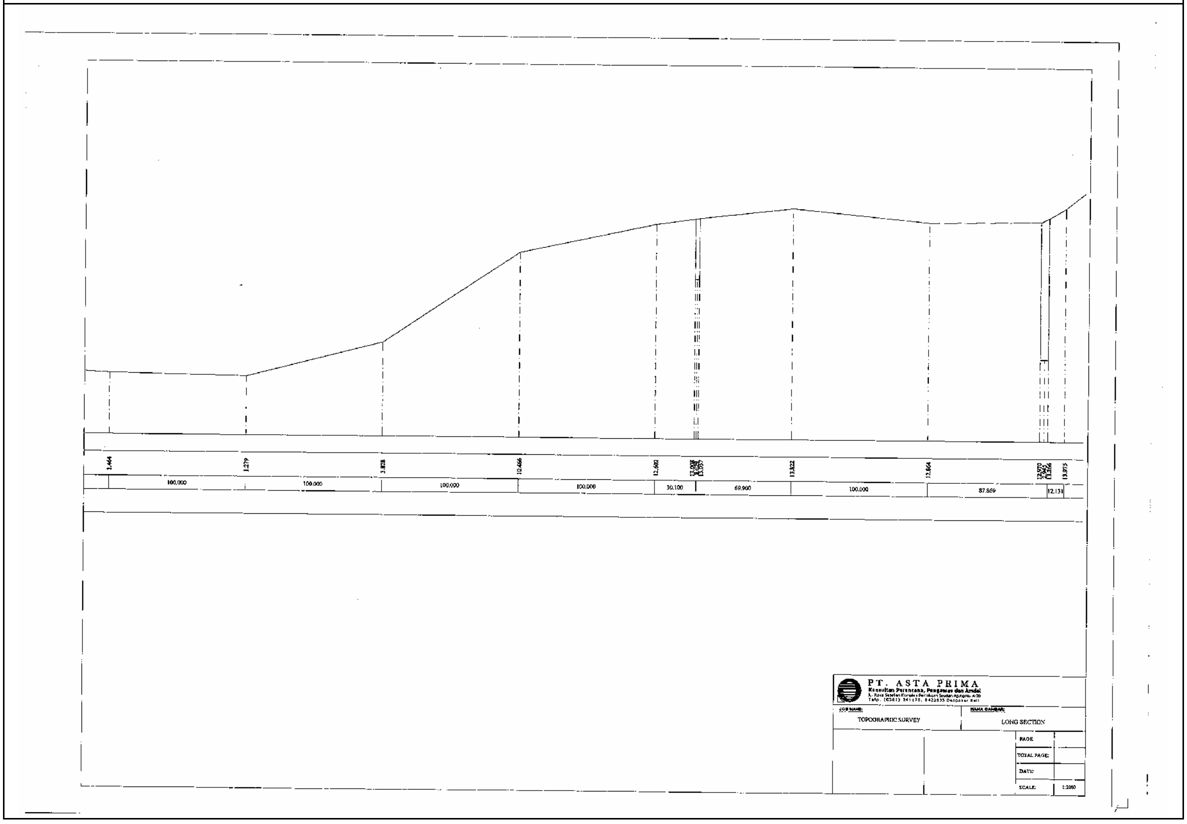

2.452
2.484
2.575
3.293
4.292
4.353
-1.847
4.377
4.386
3.938
2.497
100.000
100.000
100.000
100.000
54.000
31.500
14.500
17.000
83.000
100.000
2.497
1.721
1.836
1.276
1.176
1.219
1.219
-1.065
1.319
1.468
1.892
100.000
100.000
100.000
100.000
100.000
25.800
5.540
68.660
100.000
PT. ASTA PRIMA
Konsultan Perencana, Pengawas dan Amdal
JOB NAME:
TOPOGRAPHIC SURVEY
NAMA GAMBAR:
LONG SECTION
PAGE
TOTAL PAGE
DATE
SCALE
1:2000

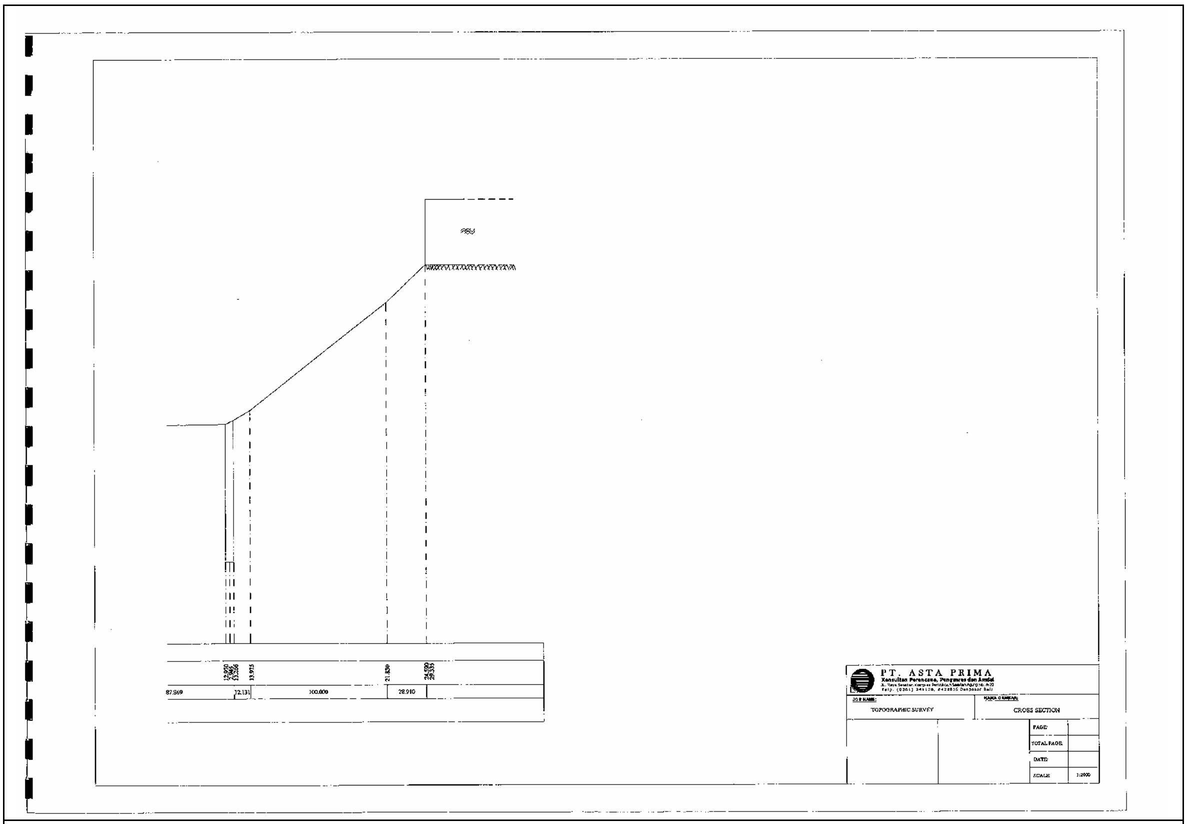

1.892
2.106
2.075
2.758
3.747
4.595
6.347
6.180
100.000
100.000
100.000
100.000
100.000
100.000
100.000
6.180
5.360
5.276
5.298
0.098
5.349
5.904
5.907
6.250
6.886
7.896
100.000
100.000
48.000
9.478
42.522
100.000
100.000
100.000
100.000
PT. ASTA PRIMA
Konsultan Perencana, Pengawas dan Amdal
JOB NAME:
TOPOGRAPHIC SURVEY
NAMA GAMBAR:
LONG SECTION
PAGE
TOTAL PAGE
DATE
SCALE
1:2000

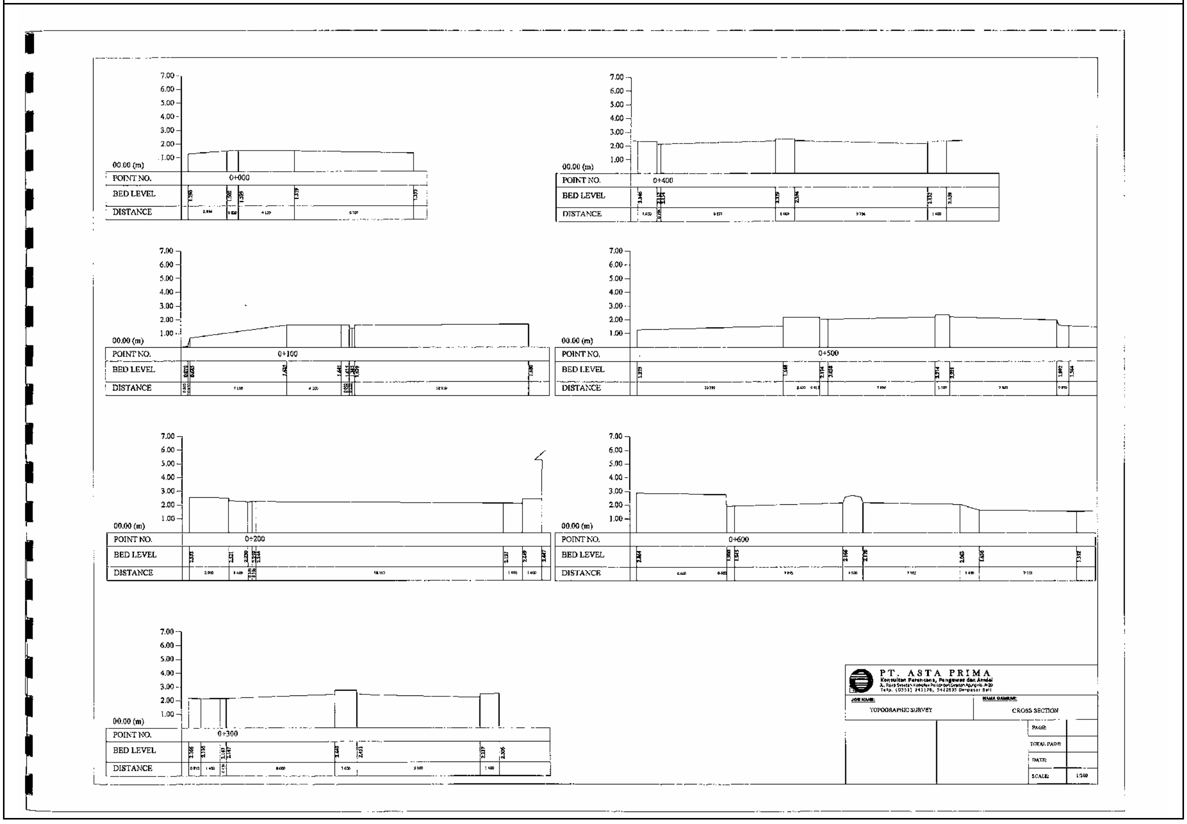

7.896
8.845
8.783
8.740
10.435
12.818
13.192
14.985
100.000
100.000
100.000
100.000
100.000
100.000
100.000
PT. ASTA PRIMA
Konsultan Perencana, Pengawas dan Amdal
Telp. (0361) 241178, 8422835 Denpasar Bali
JOB NAME:
TOPOGRAPHIC SURVEY
NAMA GAMBAR:
LONG SECTION
PAGE:
TOTAL PAGE:
DATE:
SCALE:
1:2000

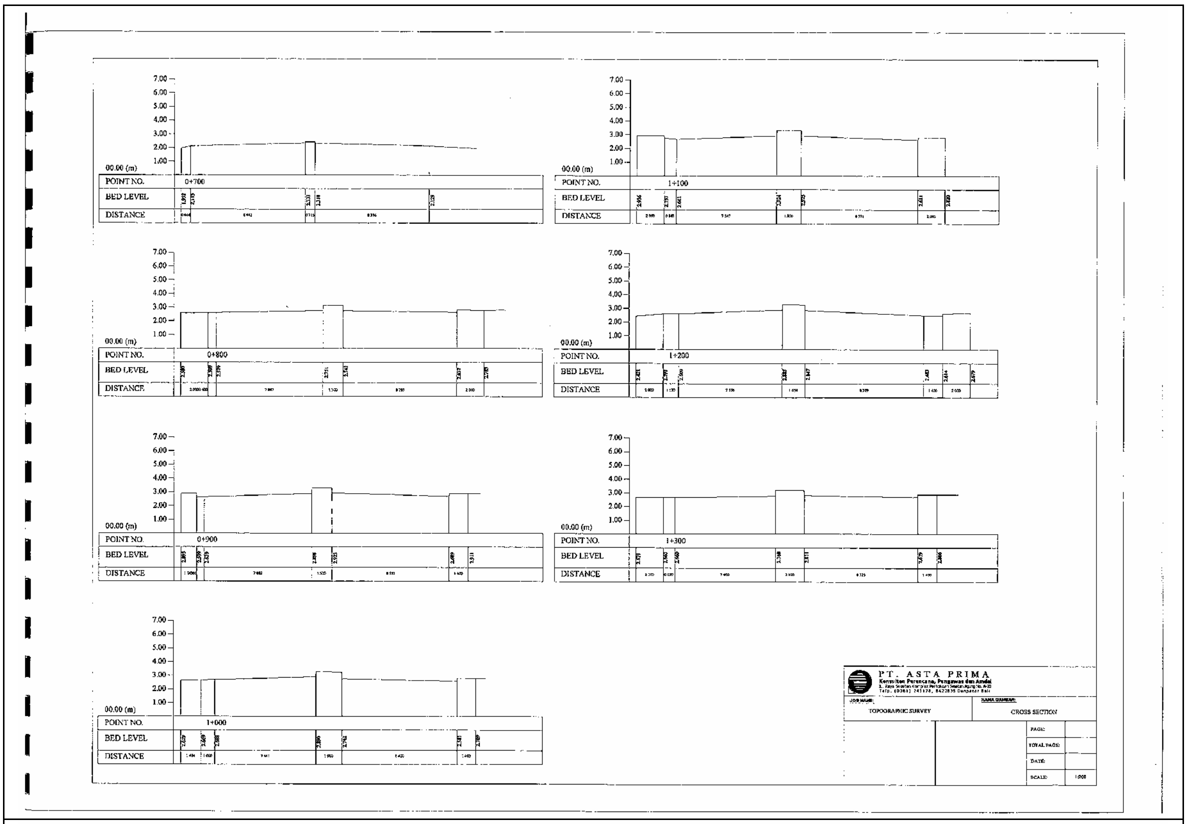

14.985
17.064
18.500
18.194
17.440
15.211
11.928
8.791
100.000
100.000
100.000
100.000
100.000
100.000
100.000
PT. ASTA PRIMA
Konsultan Perencana, Pengawas dan Amdal
Telp. (0361) 241178, 8422835 Denpasar Bali
JOB NAME:
TOPOGRAPHIC SURVEY
NAMA GAMBAR:
LONG SECTION
PAGE:
TOTAL PAGE:
DATE:
SCALE:
1:2000

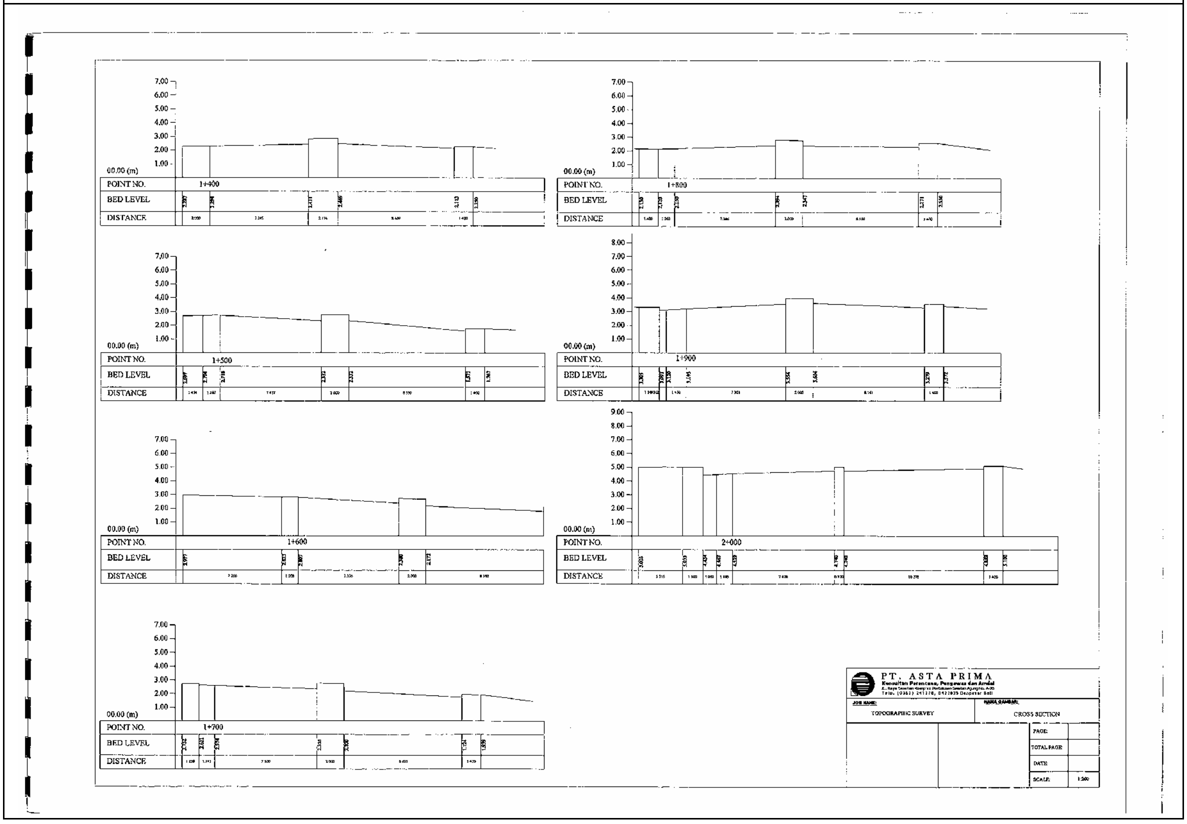

12+400
12+600
12+700
12+800
12+900
13+000
13+100
8.791
6.303
6.069
3.309
5.939
5.180
4.375
4.021
4.178
3.607
3.390
2.774
100.000
22.500
2.150
2.150
73.200
100.000
43.299
6.358
50.343
100.000
63.306
36.694
100.000
13+100
13+200
13+300
13+326
13+400
13+500
13+600
13+700
13+800
2.774
2.038
2.095
2.714
3.694
4.730
3.648
1.968
1.464
100.000
100.000
26.000
3.467
70.533
100.000
100.000
100.000
100.000
PT. ASTA PRIMA
Konsultan Perencana, Pengawas dan Amdal
Jl. Raya Sesetan Komplek Pertokoan Sesetan Agung No. A-20
Telp. (0361) 241178, 6422835 Denpasar Bali
JOB NAME:
TOPOGRAPHIC SURVEY
NAMA GAMBAR:
LONG SECTION
PAGE:
TOTAL PAGE:
DATE:
SCALE:
1:5000

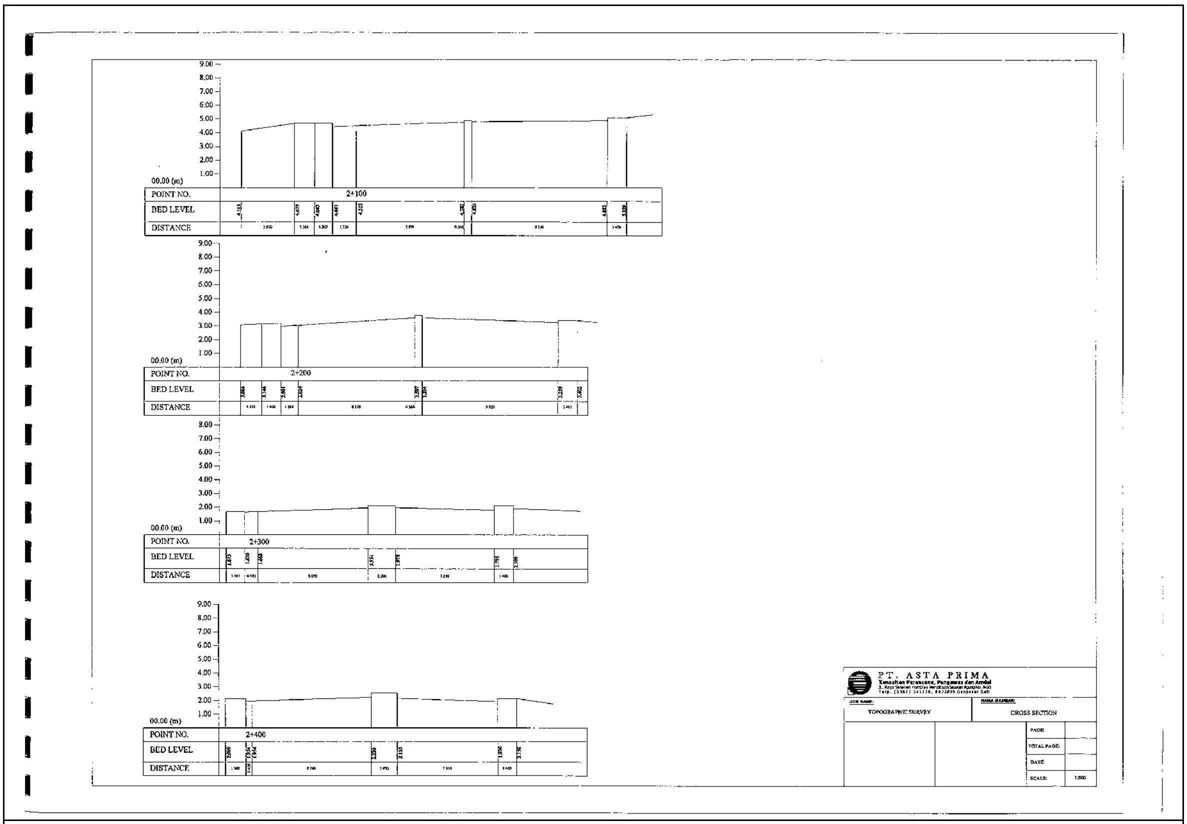

1.464
1.279
3.828
10.466
12.602
13.057
13.822
12.864
12.970
13.266
13.975
100.000
100.000
100.000
100.000
30.100
69.900
100.000
87.869
12.131
PT. ASTA PRIMA
Konsultan Perencana, Pengawas dan Amdal
Jl. Raya Sesetan Komplek Pertokoan Sesetan Agung No. A-20
Telp. (0361) 241178, 6422835 Denpasar Bali
JOB NAME:
TOPOGRAPHIC SURVEY
NAMA GAMBAR:
LONG SECTION
PAGE:
TOTAL PAGE:
DATE:
SCALE:
1:2000

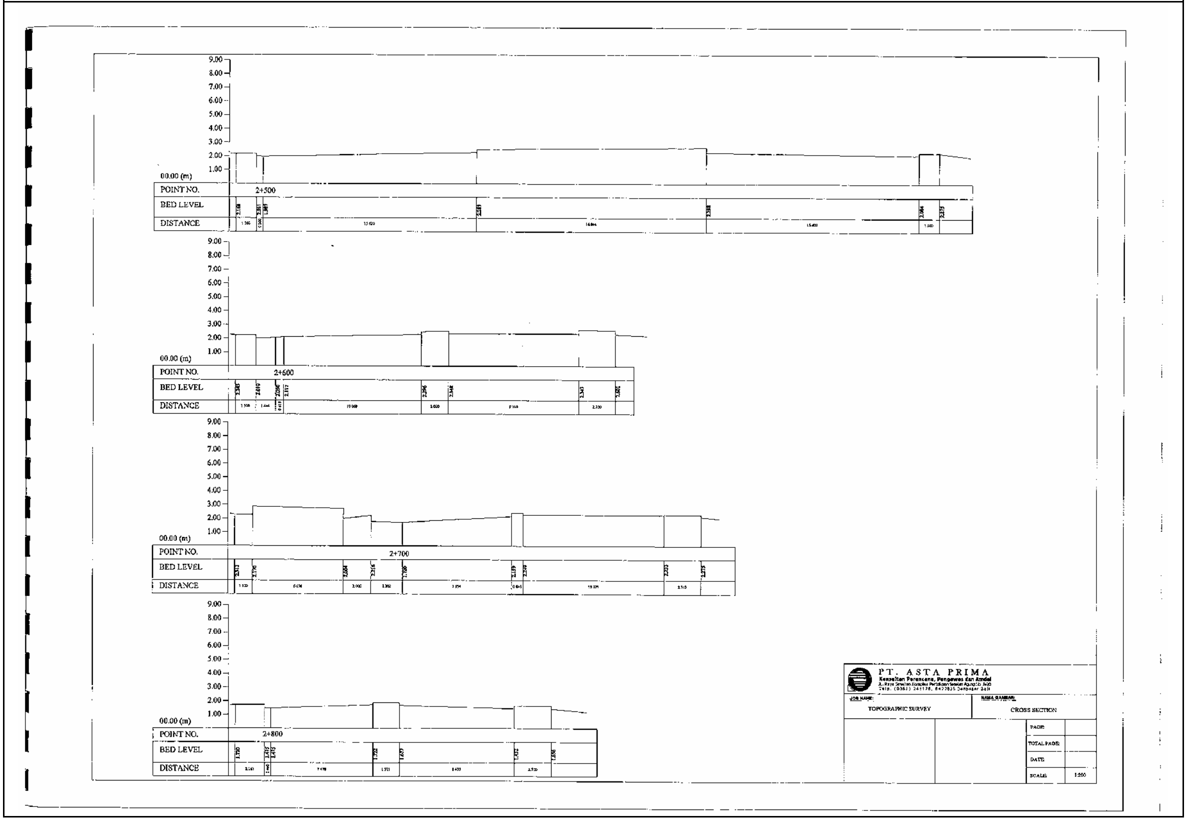

87.869
72.131
100.000
28.910
PT. ASTA PRIMA
Konsultan Perencana, Pengawas dan Amdal
JOB NAME:
TOPOGRAPHIC SURVEY
CROSS SECTION
PAGE:
TOTAL PAGE:
DATE:
SCALE:
1:2000

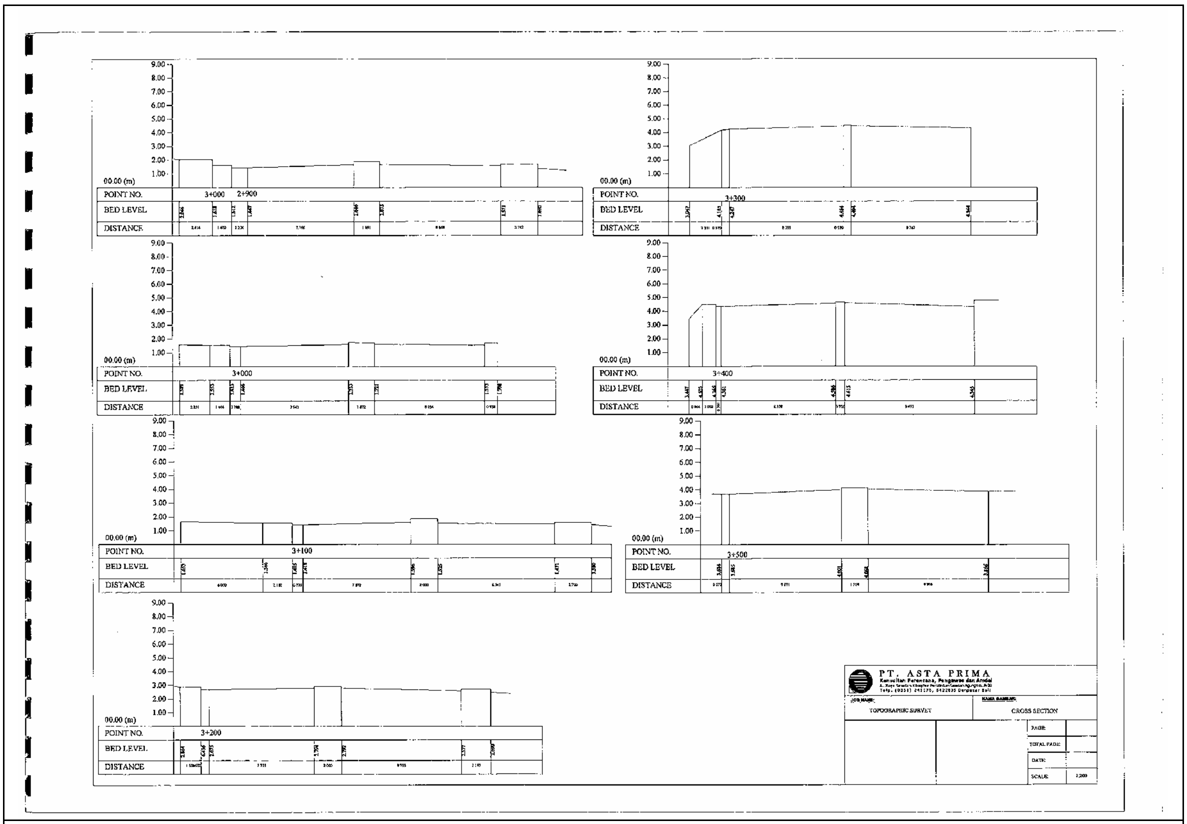

7.00
6.00
5.00
4.00
3.00
2.00
1.00
00.00 (m)
POINT NO.
BED LEVEL
DISTANCE
0+000
0+100
0+200
0+300
0+400
0+500
0+600
PT. ASTA PRIMA
Konsultan Perencana, Pengawas dan Amdal
TOPOGRAPHIC SURVEY
CROSS SECTION
PAGE:
TOTAL PAGE:
DATE:
SCALE:

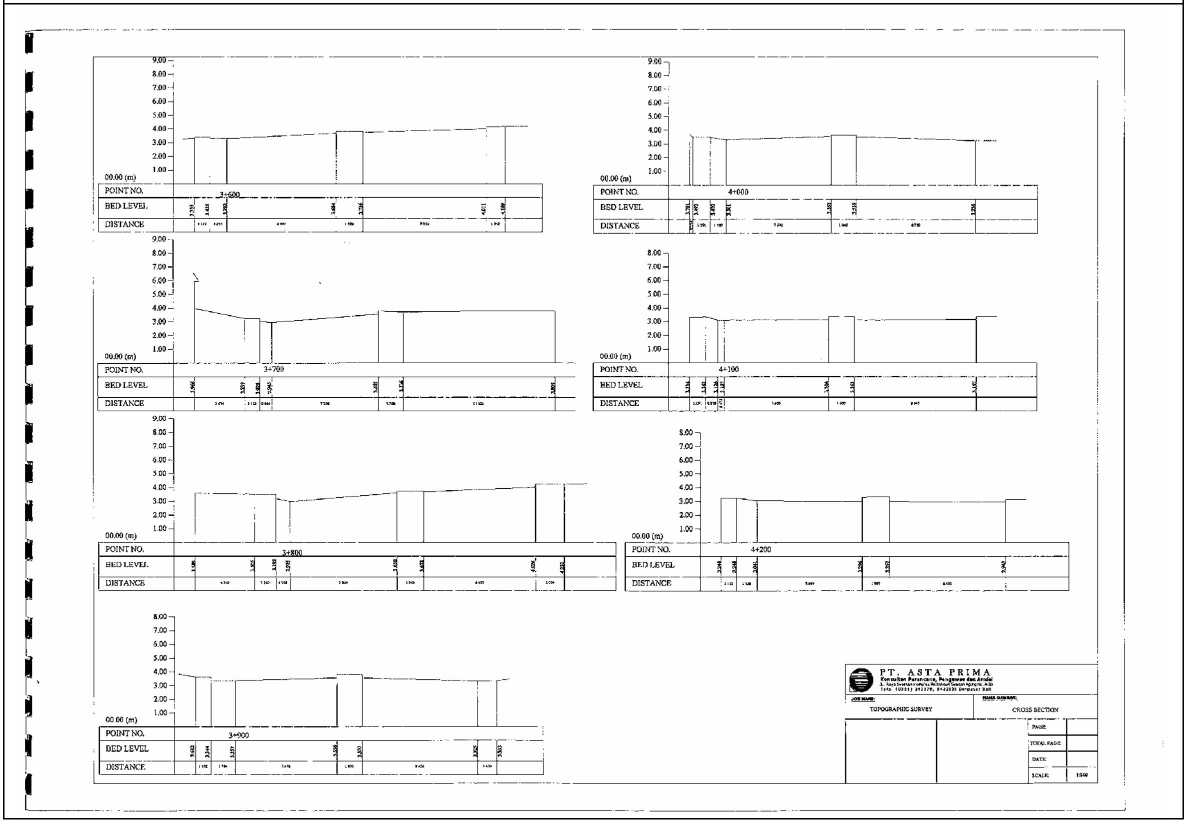

0+700
0+800
0+900
1+000
1+100
1+200
1+300
POINT NO.
BED LEVEL
DISTANCE
00.00 (m)
PT. ASTA PRIMA
TOPOGRAPHIC SURVEY
CROSS SECTION
PAGE
TOTAL PAGE
DATE
SCALE

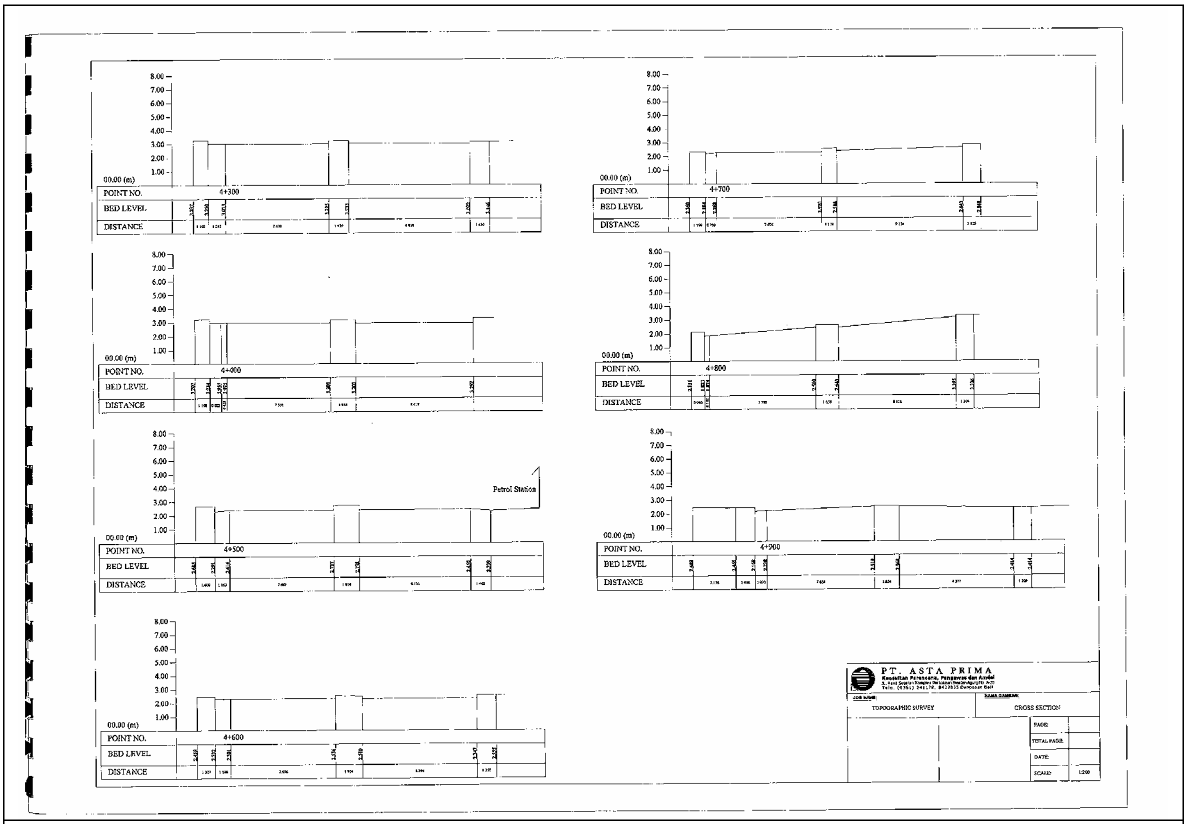

1+400
1+500
1+600
1+700
1+800
1+900
2+000
POINT NO.
BED LEVEL
DISTANCE
00.00 (m)
PT. ASTA PRIMA
TOPOGRAPHIC SURVEY
CROSS SECTION
PAGE
TOTAL PAGE
DATE
SCALE

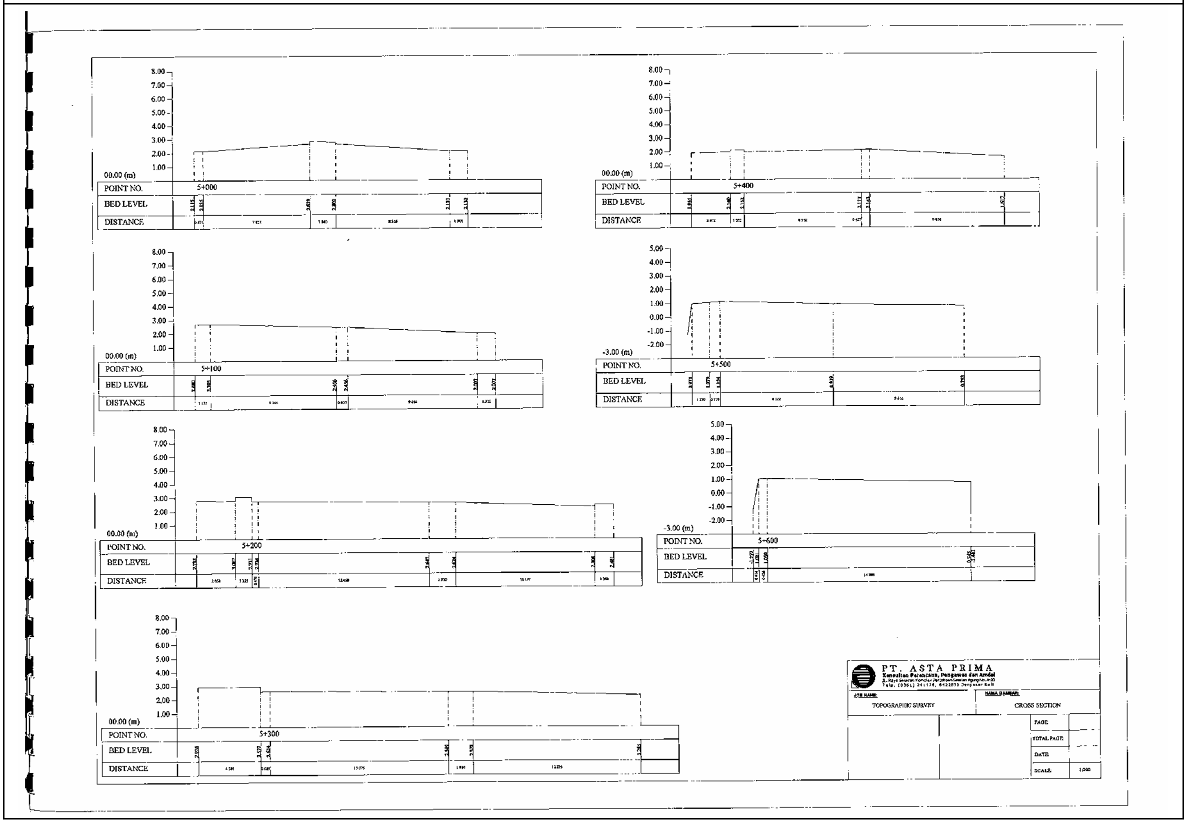

9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
00.00 (m)
POINT NO.
BED LEVEL
DISTANCE
2+100
2+200
2+300
2+400
PT. ASTA PRIMA
Konsultan Perencana, Pengawas dan Amdal
JOB NAME:
TOPOGRAPHIC SURVEY
NAMA GAMBAR:
CROSS SECTION
PAGE:
TOTAL PAGE:
DATE:
SCALE:

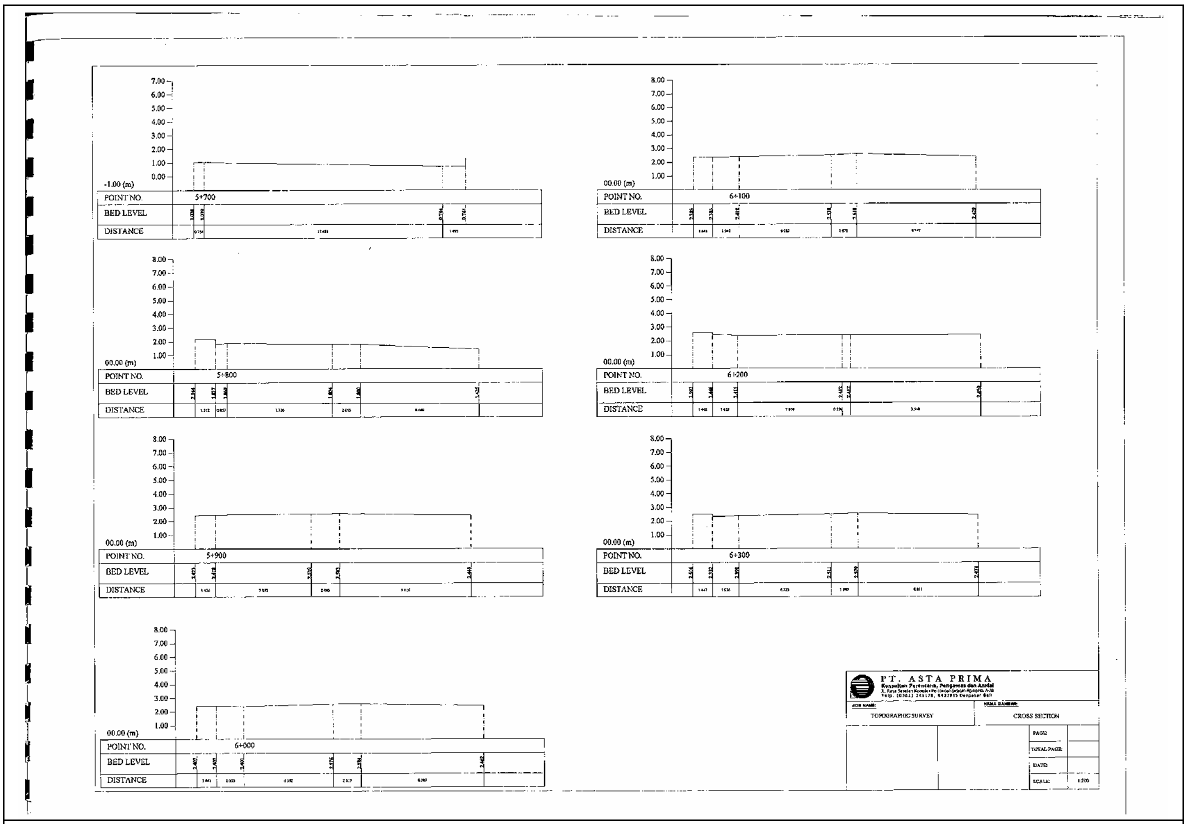

9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
00.00 (m)
POINT NO.
BED LEVEL
DISTANCE
2+500
2+600
2+700
2+800
PT. ASTA PRIMA
Konsultan Perencana, Pengawas dan Amdal
JOB NAME:
TOPOGRAPHIC SURVEY
NAMA GAMBAR:
CROSS SECTION
PAGE:
TOTAL PAGE:
DATE:
SCALE:

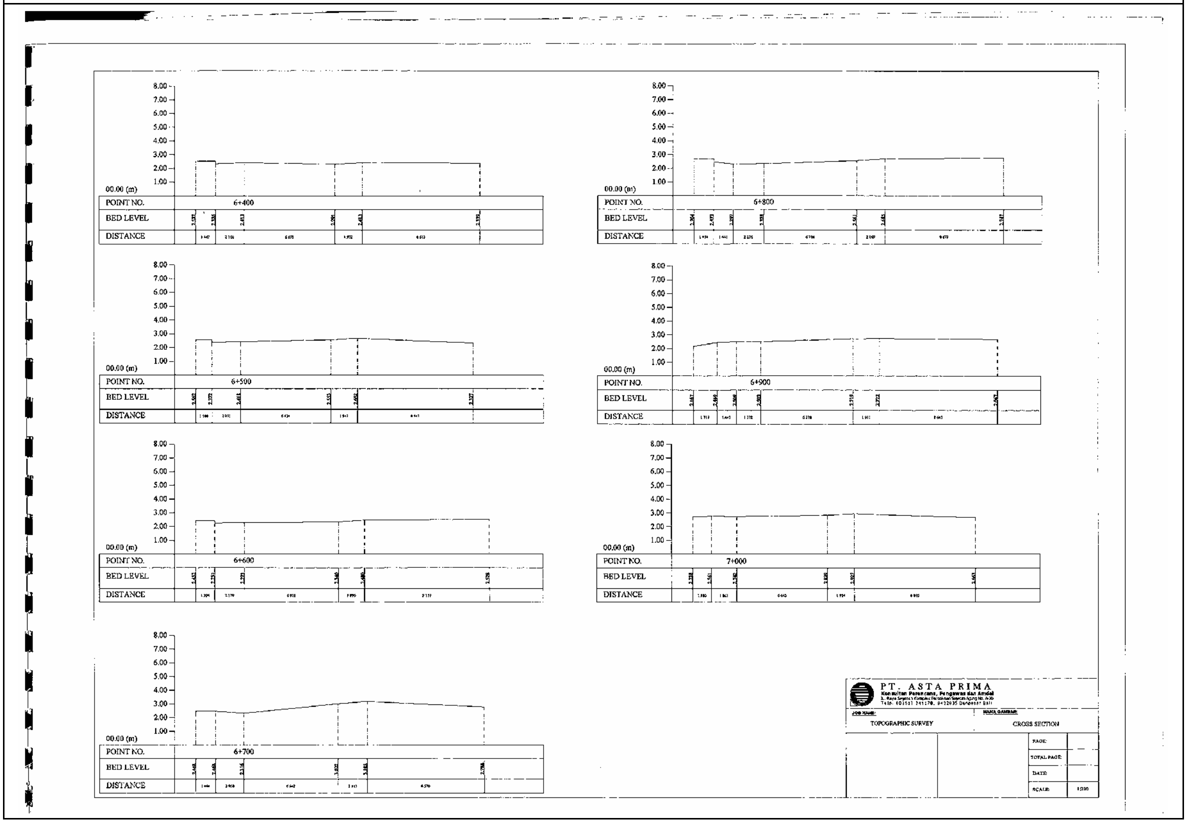

2+900
3+300
3+000
3+400
3+100
3+500
3+200
POINT NO.
BED LEVEL
DISTANCE
00.00 (m)
PT. ASTA PRIMA
Konsultan Perencana, Pengawas dan Amdal
Telp. (0361) 241170, 8422035 Denpasar Bali
JOB NAME:
TOPOGRAPHIC SURVEY
NAMA GAMBAR:
CROSS SECTION
PAGE:
TOTAL PAGE:
DATE:
SCALE:
1:200

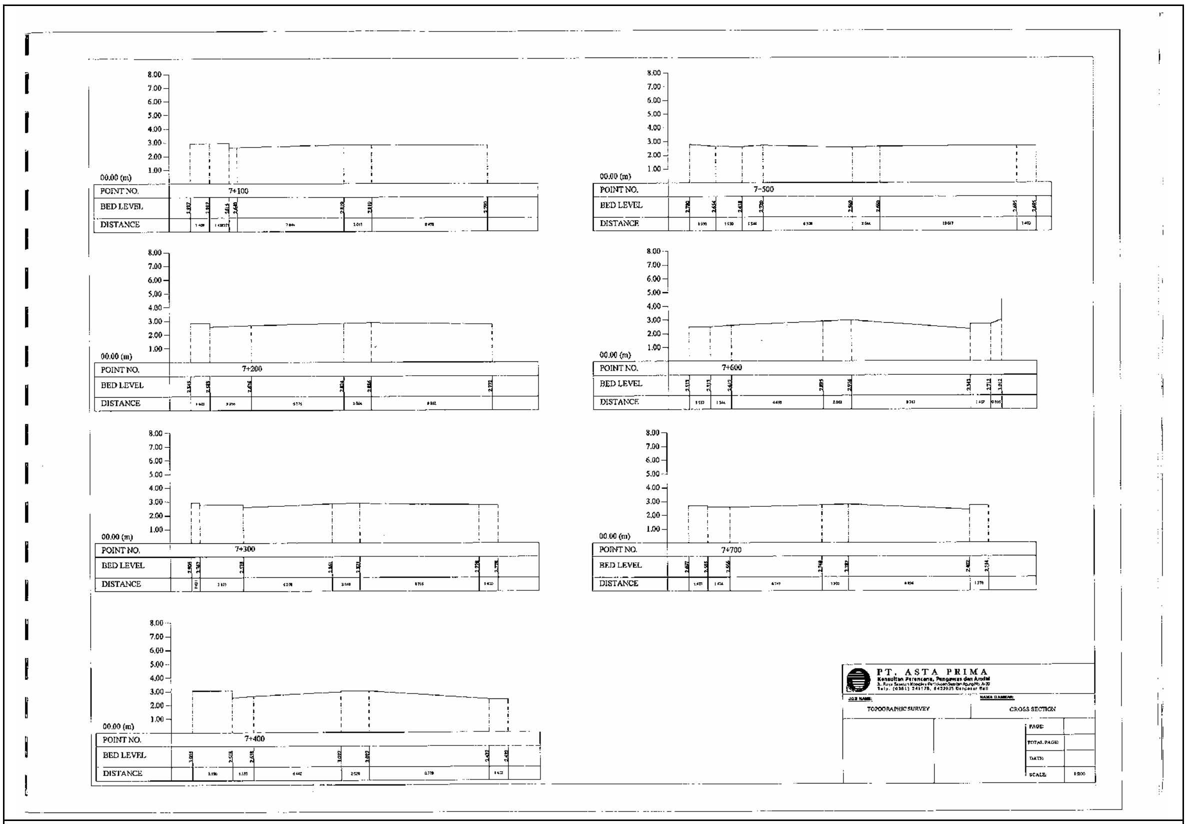

3+600
4+000
3+700
4+100
3+800
4+200
3+900
POINT NO.
BED LEVEL
DISTANCE
00.00 (m)
PT. ASTA PRIMA
Konsultan Perencana, Pengawas dan Amdal
Telp. (0361) 241170, 8422035 Denpasar Bali
JOB NAME:
TOPOGRAPHIC SURVEY
NAMA GAMBAR:
CROSS SECTION
PAGE:
TOTAL PAGE:
DATE:
SCALE:
1:200

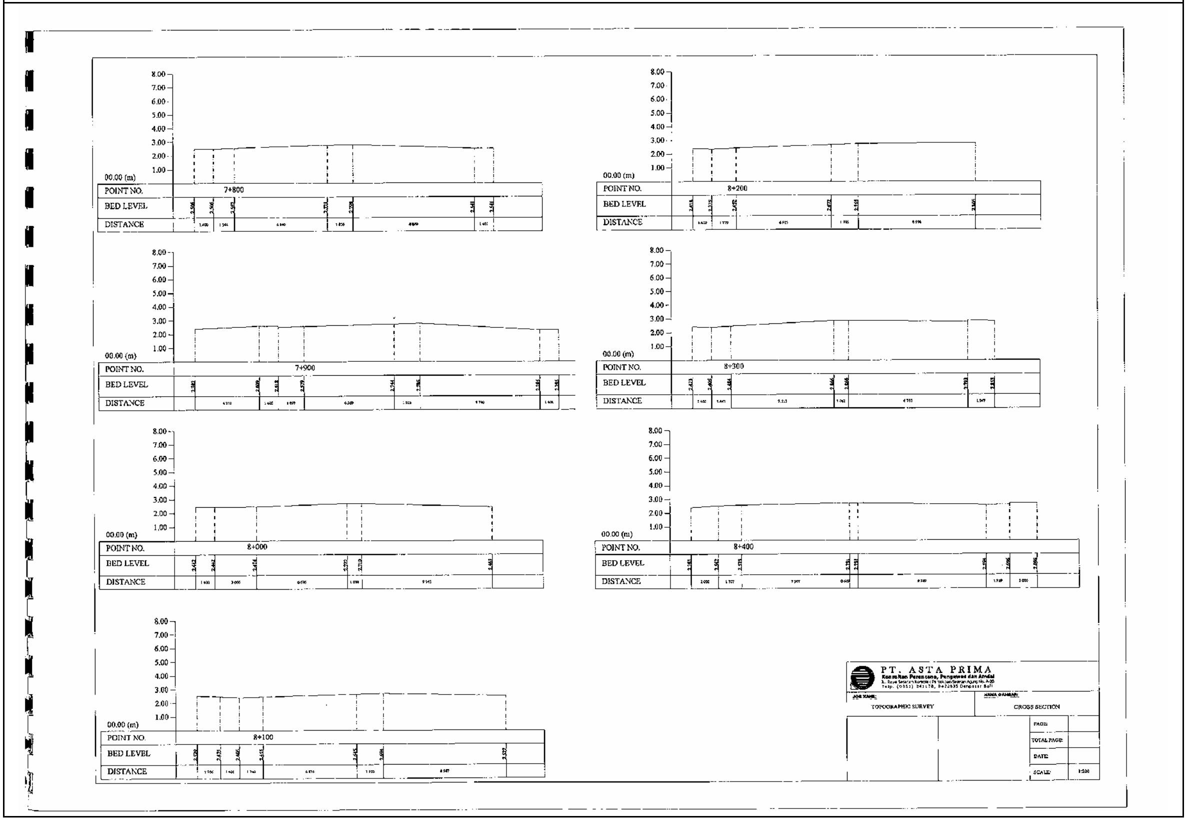

4+300
4+700
4+400
4+800
4+500
Petrol Station
4+900
4+600
POINT NO.
BED LEVEL
DISTANCE
00.00 (m)
PT. ASTA PRIMA
TOPOGRAPHIC SURVEY
CROSS SECTION
PAGE
TOTAL PAGE
DATE
SCALE

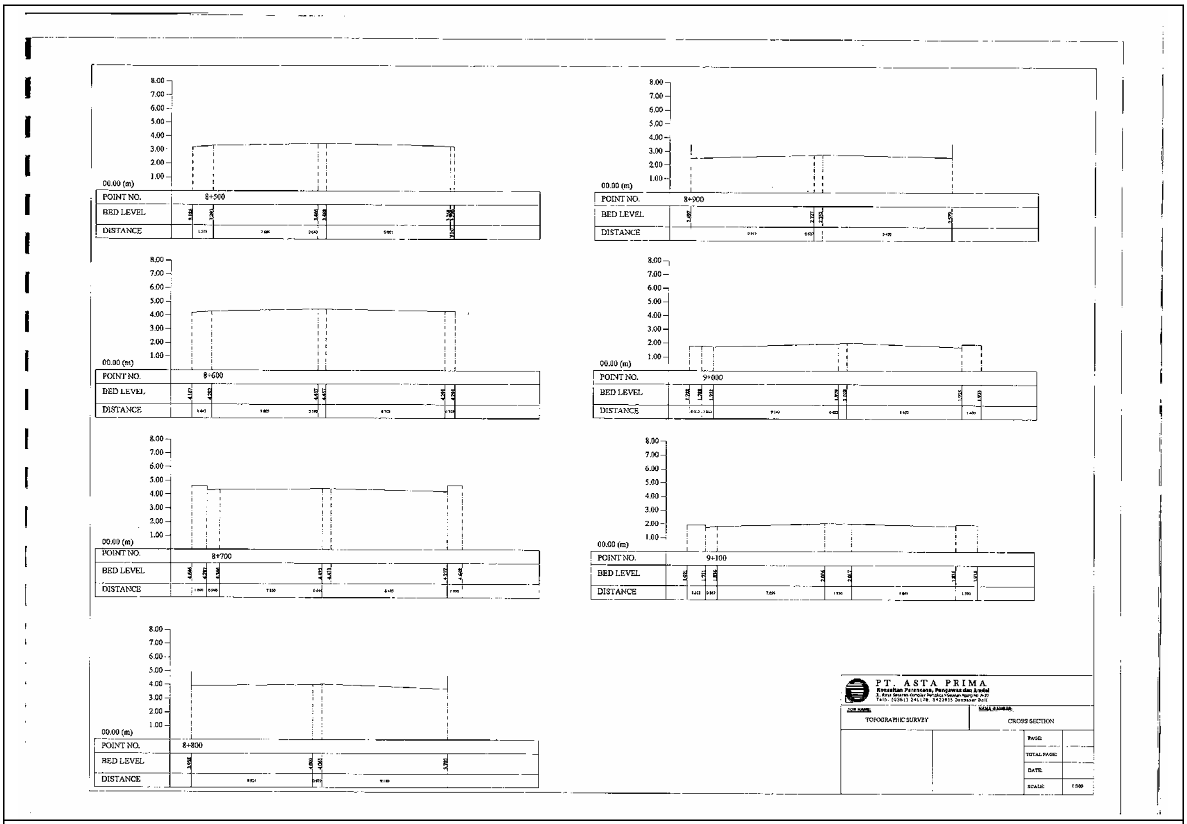

5+000
5+400
5+100
5+500
5+200
5+600
5+300
POINT NO.
BED LEVEL
DISTANCE
00.00 (m)
-3.00 (m)
PT. ASTA PRIMA
TOPOGRAPHIC SURVEY
CROSS SECTION
PAGE
TOTAL PAGE
DATE
SCALE

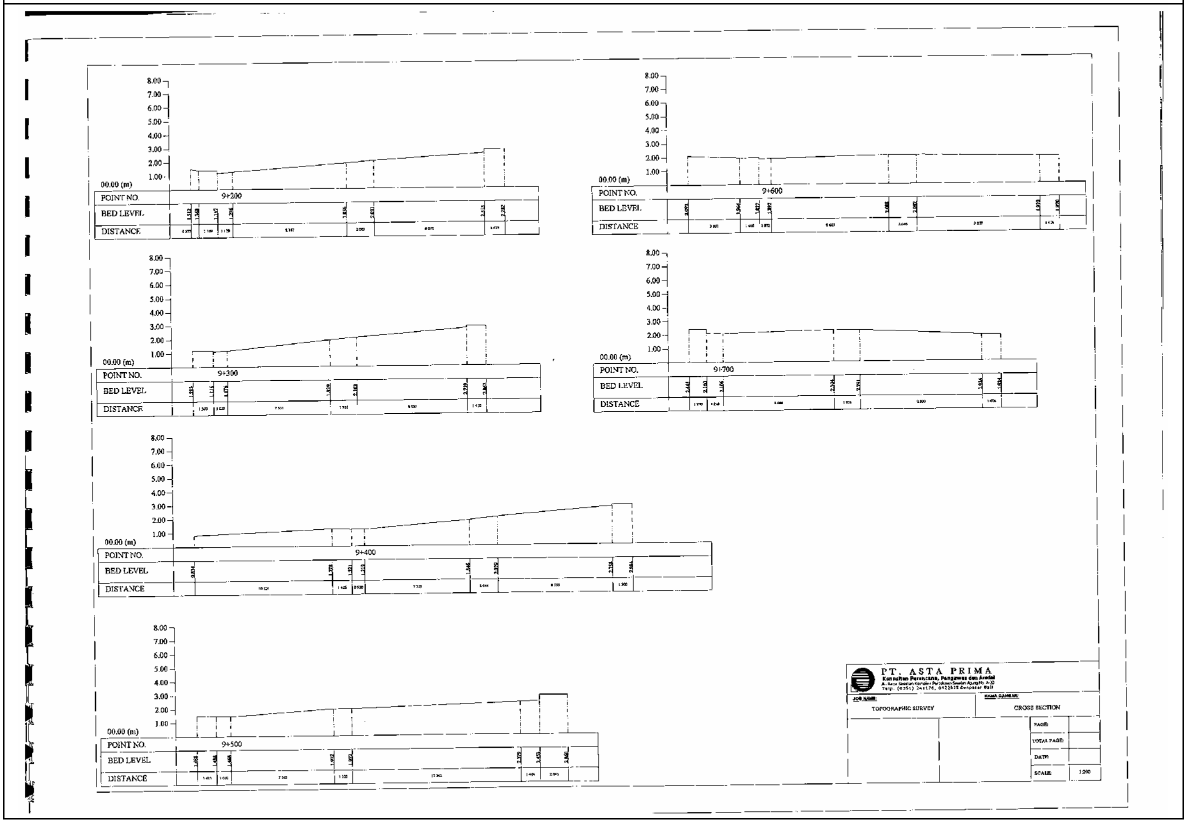

POINT NO.
BED LEVEL
DISTANCE
5+700
6+100
5+800
6+200
5+900
6+300
6+000
PT. ASTA PRIMA
TOPOGRAPHIC SURVEY
CROSS SECTION

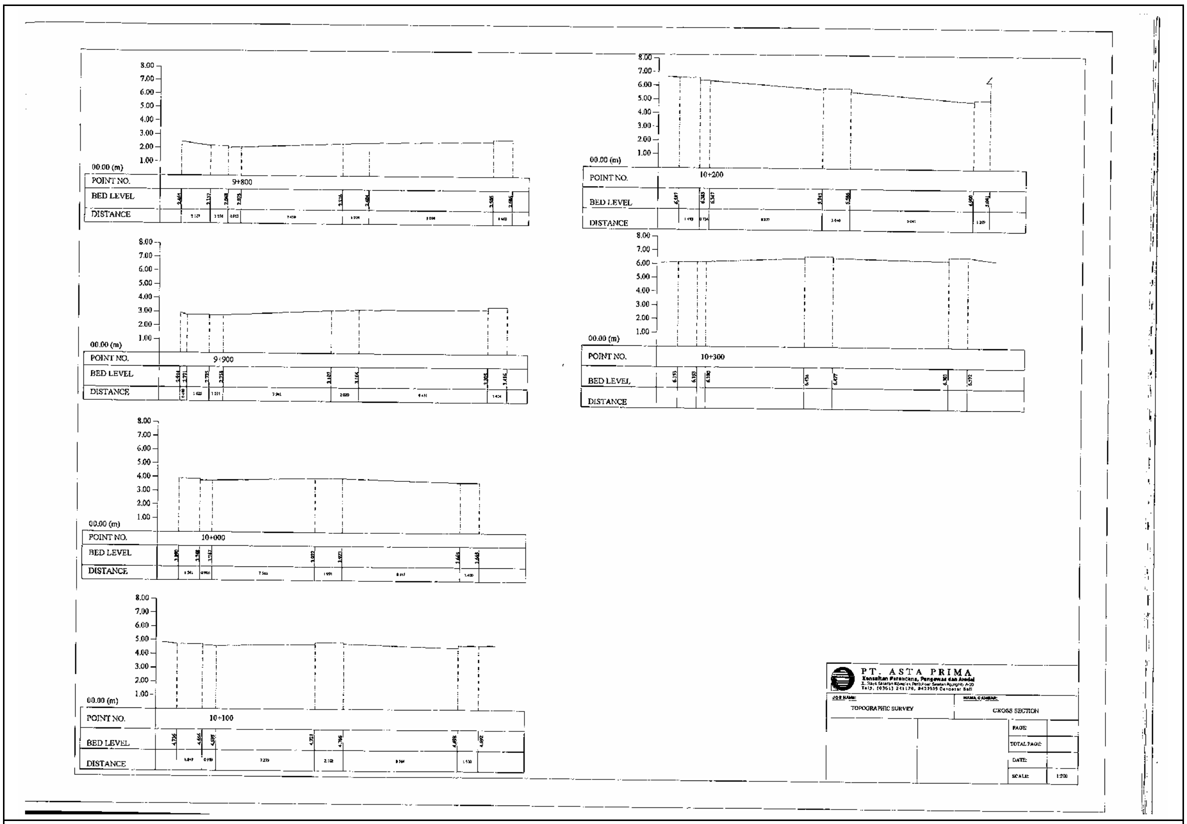

POINT NO.
BED LEVEL
DISTANCE
6+400
6+800
6+500
6+900
6+600
7+000
6+700
PT. ASTA PRIMA
TOPOGRAPHIC SURVEY
CROSS SECTION

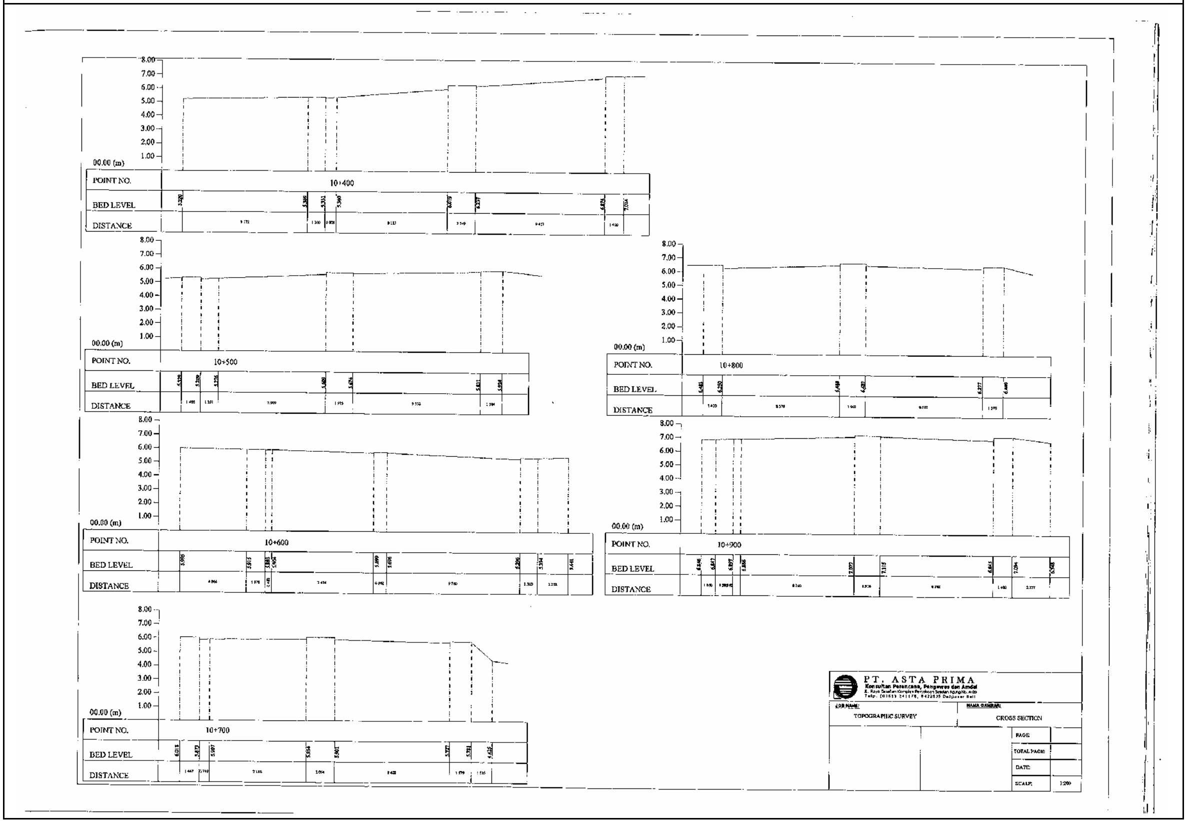

7+100
7+500
7+200
7+600
7+300
7+700
7+400
POINT NO.
BED LEVEL
DISTANCE
00.00 (m)
PT. ASTA PRIMA
Konsultan Perencana, Pengawas dan Amdal
TOPOGRAPHIC SURVEY
CROSS SECTION
PAGE
TOTAL PAGE
DATE
SCALE

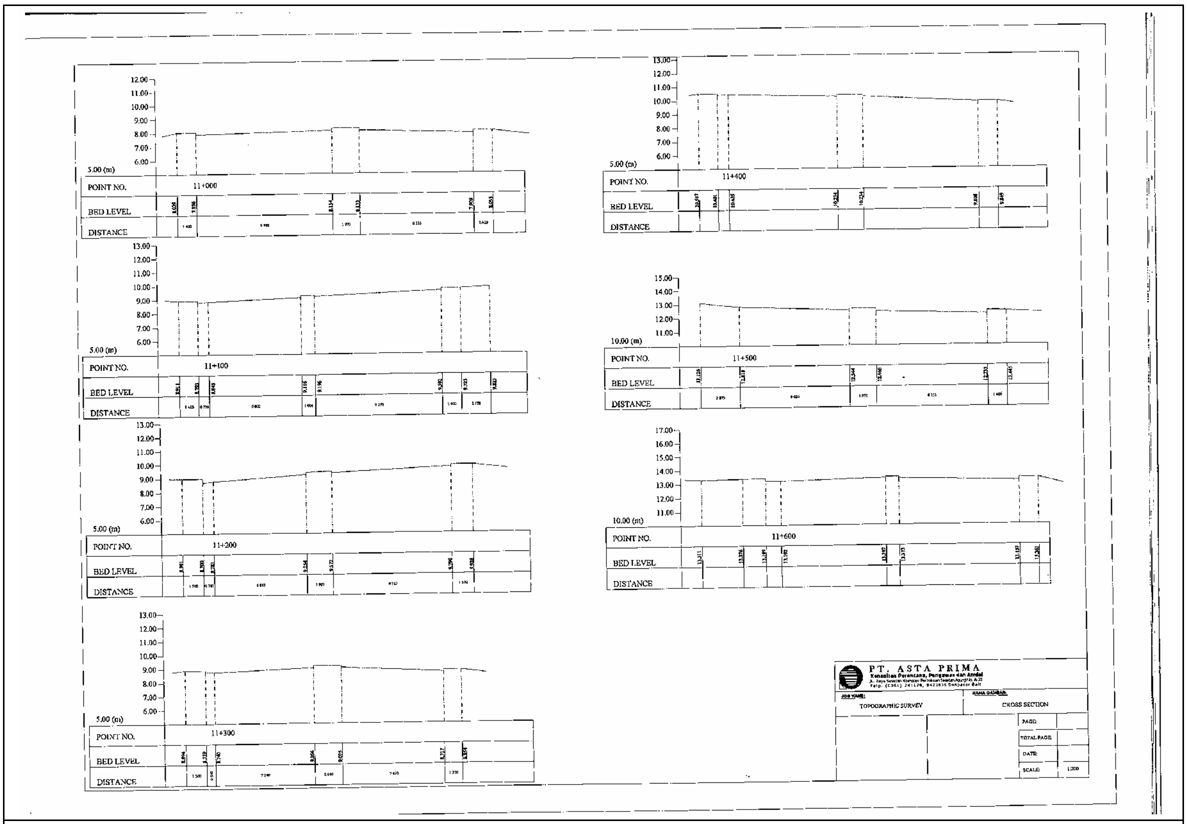

7+800
8+200
7+900
8+300
8+000
8+400
8+100
POINT NO.
BED LEVEL
DISTANCE
00.00 (m)
PT. ASTA PRIMA
Konsultan Perencana, Pengawas dan Amdal
TOPOGRAPHIC SURVEY
CROSS SECTION
PAGE
TOTAL PAGE
DATE
SCALE

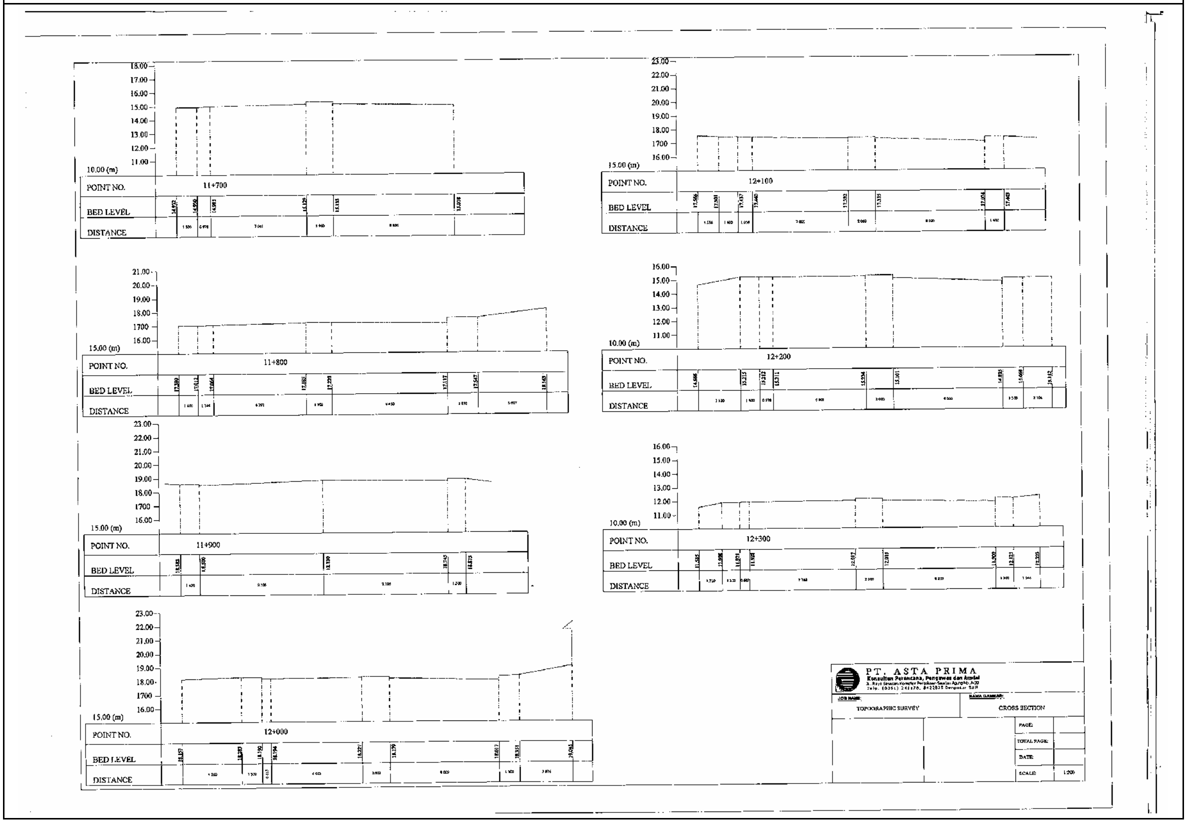

8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
00.00 (m)
POINT NO.
BED LEVEL
DISTANCE
8+500
8+600
8+700
8+800
8+900
9+000
9+100
PT. ASTA PRIMA
TOPOGRAPHIC SURVEY
CROSS SECTION
PAGE:
TOTAL PAGE:
DATE:
SCALE:

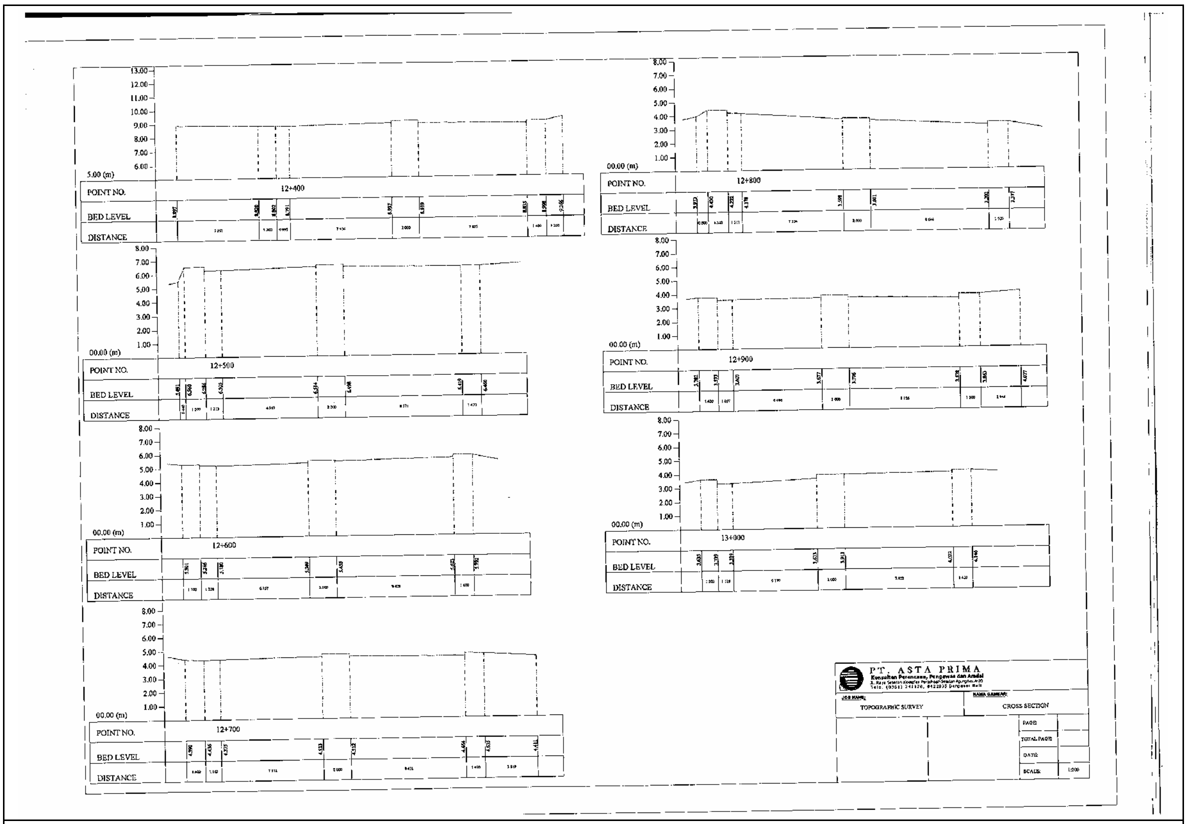

8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
00.00 (m)
POINT NO.
BED LEVEL
DISTANCE
9+200
9+300
9+400
9+500
9+600
9+700
PT. ASTA PRIMA
TOPOGRAPHIC SURVEY
CROSS SECTION
PAGE:
TOTAL PAGE:
DATE:
SCALE:
1:200

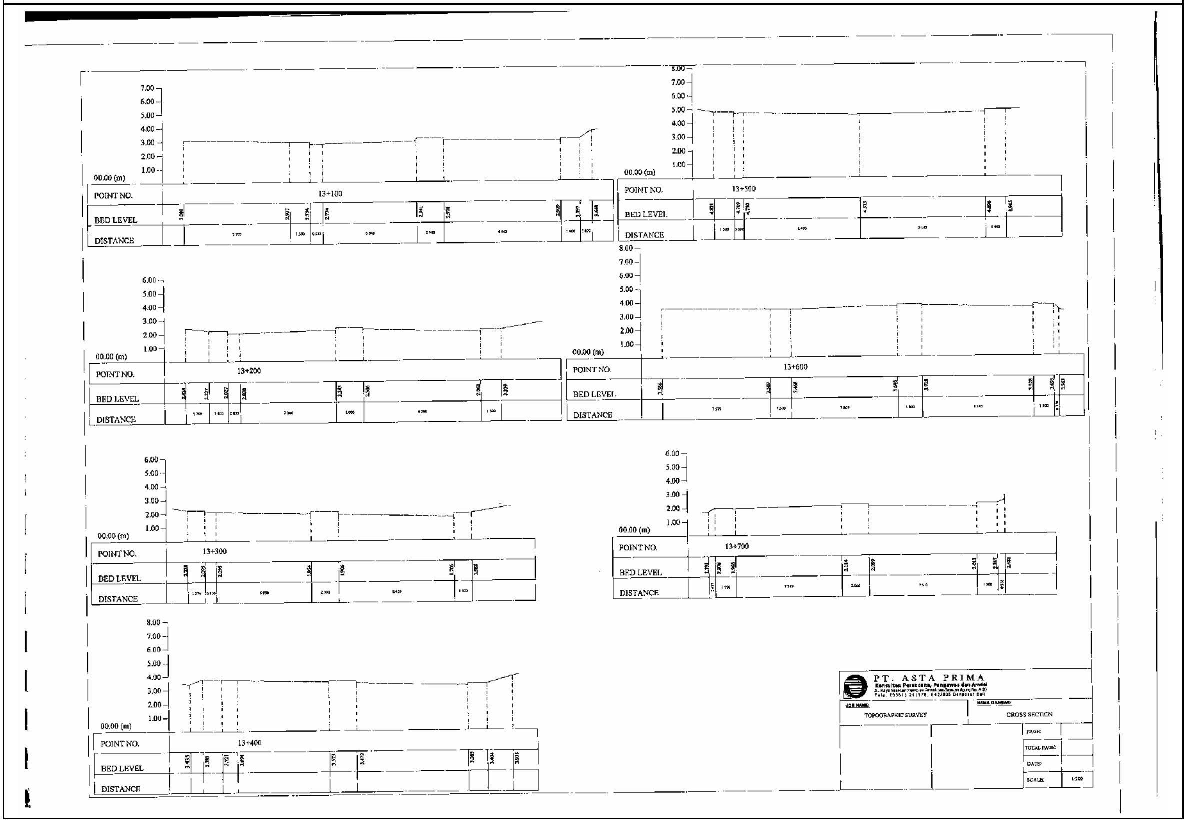

8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
00.00 (m)
POINT NO.
BED LEVEL
DISTANCE
9+800
9+900
10+000
10+100
10+200
10+300
PT. ASTA PRIMA
Konsultan Perencana, Pengawas dan Amdal
TOPOGRAPHIC SURVEY
CROSS SECTION
PAGE
TOTAL PAGE
DATE
SCALE

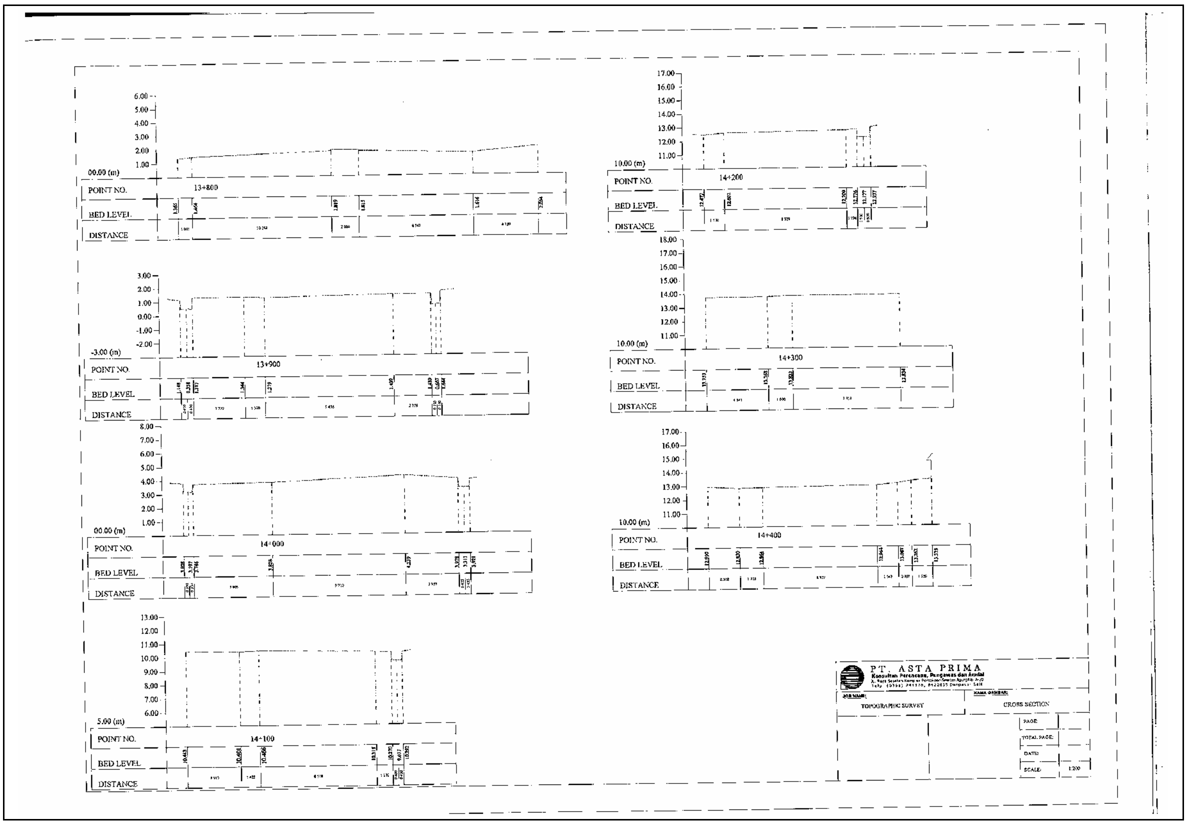

8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
00.00 (m)
POINT NO.
BED LEVEL
DISTANCE
10+400
10+500
10+600
10+700
10+800
10+900
PT. ASTA PRIMA
Konsultan Perencana, Pengawas dan Amdal
TOPOGRAPHIC SURVEY
CROSS SECTION
PAGE
TOTAL PAGE
DATE
SCALE


11+000
11+100
11+200
11+300
11+400
11+500
11+600
POINT NO.
BED LEVEL
DISTANCE
PT. ASTA PRIMA
TOPOGRAPHIC SURVEY
CROSS SECTION
PAGE:
TOTAL PAGE:
DATE:
SCALE:
1:200


11+700
11+800
11+900
12+000
12+100
12+200
12+300
POINT NO.
BED LEVEL
DISTANCE
PT. ASTA PRIMA
TOPOGRAPHIC SURVEY
CROSS SECTION
PAGE:
TOTAL PAGE:
DATE:
SCALE:
1:200


12+400
12+500
12+600
12+700
12+800
12+900
13+000
POINT NO.
BED LEVEL
DISTANCE
PT. ASTA PRIMA
Konsultan Perencana, Pengawas dan Amdal
TOPOGRAPHIC SURVEY
CROSS SECTION
PAGE
TOTAL PAGE
DATE
SCALE
1:200


13+100
13+200
13+300
13+400
13+500
13+600
13+700
POINT NO.
BED LEVEL
DISTANCE
PT. ASTA PRIMA
Konsultan Perencana, Pengawas dan Amdal
TOPOGRAPHIC SURVEY
CROSS SECTION
PAGE
TOTAL PAGE
DATE
SCALE
1:200


13+800
14+200
13+900
14+300
14+000
14+400
14+100
POINT NO.
BED LEVEL
DISTANCE
00.00 (m)
10.00 (m)
-3.00 (m)
5.00 (m)
PT. ASTA PRIMA
Konsultan Perencana, Pengawas dan Amdal
JOB NAME:
TOPOGRAPHIC SURVEY
NAMA GAMBAR:
CROSS SECTION
PAGE:
TOTAL PAGE:
DATE:
SCALE:
1:200

APPENDIX 4

GEOTECHNICAL SURVEY

APPENDIX 4 GEOTECHNICAL SURVEY

4.a Terms of Reference

Geotechnical survey for the construction site of the reclaimed water treatment plant (located at the Denpasar WWTP expansion site) was carried out with the following specifications.

Specifications of Geotechnical Survey

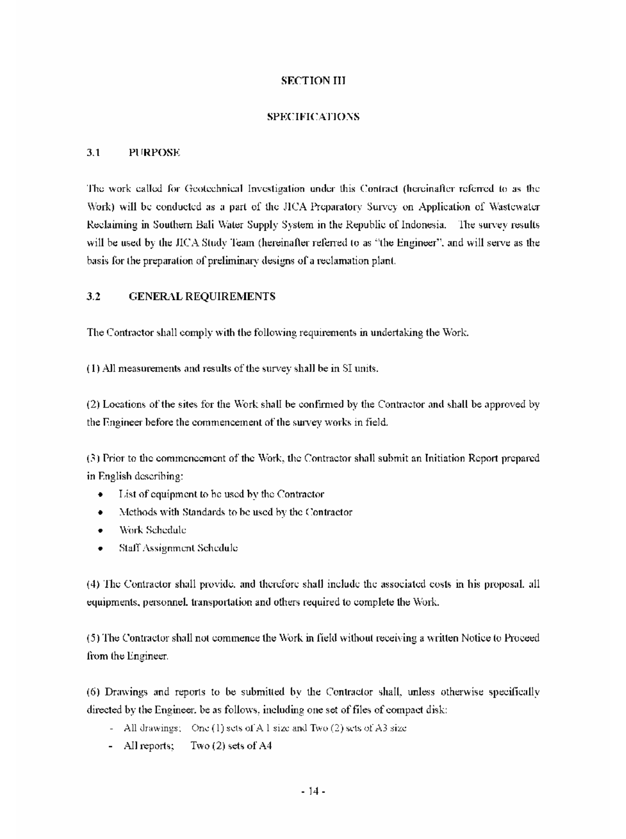
Item	Specification
Number of boring	3
Maximum depth	40m
Total depth	120m

Test item and sampling number is shown below

Test Item and Sampling Number

Item	Specification
1. Standard penetration test	Every 1.0m interval
2. Sampling	Every 10 meters interval and the bottom
3. Laboratory Test	1) Specific gravity
	2) Water content
	3) Particle size distribution
	4) Unconfined compressive strength

Terms of Reference



SECTION III

SPECIFICATIONS

3.1 PURPOSE

The work called for Geotechnical Investigation under this Contract (hereinafter referred to as the Work) will be conducted as a part of the JICA Preparatory Survey on Application of Wastewater Reclaiming in Southern Bali Water Supply System in the Republic of Indonesia. The survey results will be used by the JICA Study Team (hereinafter referred to as "the Engineer". and will serve as the basis for the preparation of preliminary designs of a reclamation plant.

3.2 GENERAL REQUIREMENTS

The Contractor shall comply with the following requirements in undertaking the Work.

(1) All measurements and results of the survey shall be in SI units.

(2) Locations of the sites for the Work shall be confirmed by the Contractor and shall be approved by the Engineer before the commencement of the survey works in field.

(3) Prior to the commencement of the Work, the Contractor shall submit an Initiation Report prepared in English describing:

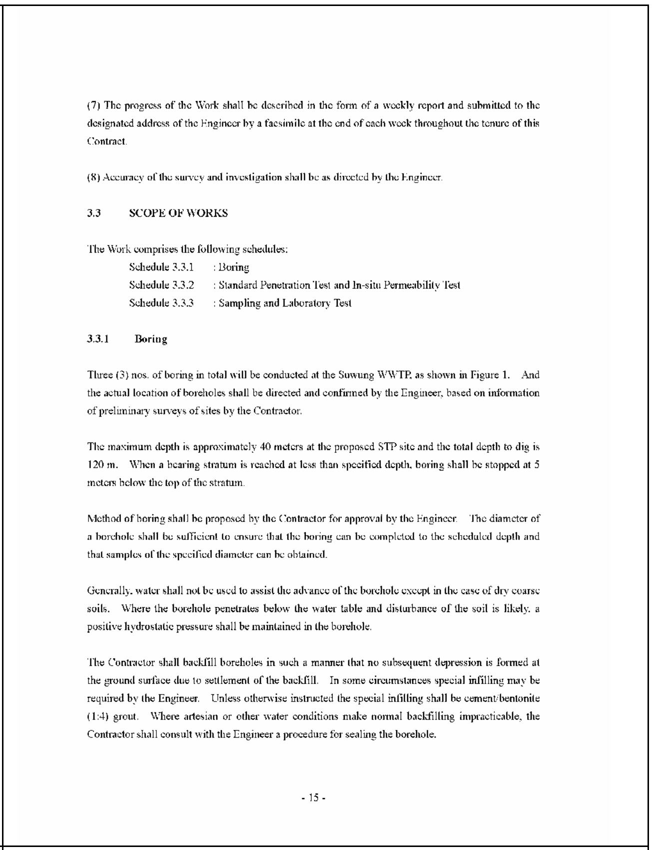
- List of equipment to be used by the Contractor
- Methods with Standards to be used by the Contractor
- Work Schedule
- Staff Assignment Schedule

(4) The Contractor shall provide. and therefore shall include the associated costs in his proposal. all equipments, personnel. transportation and others required to complete the Work.

(5) The Contractor shall not commence the Work in field without receiving a written Notice to Proceed from the Engineer.

(6) Drawings and reports to be submitted by the Contractor shall, unless otherwise specifically directed by the Engineer. be as follows, including one set of files of compact disk:

- All drawings; One (1) sets of A 1 size and Two (2) sets of A3 size
- All reports; Two (2) sets of A4



(7) The progress of the Work shall be described in the form of a weekly report and submitted to the designated address of the Engineer by a facsimile at the end of each week throughout the tenure of this Contract.

(8) Accuracy of the survey and investigation shall be as directed by the Engineer.

3.3 SCOPE OF WORKS

The Work comprises the following schedules:

Schedule 3.3.1 : Boring
Schedule 3.3.2 : Standard Penetration Test and In-situ Permeability Test
Schedule 3.3.3 : Sampling and Laboratory Test

3.3.1 Boring

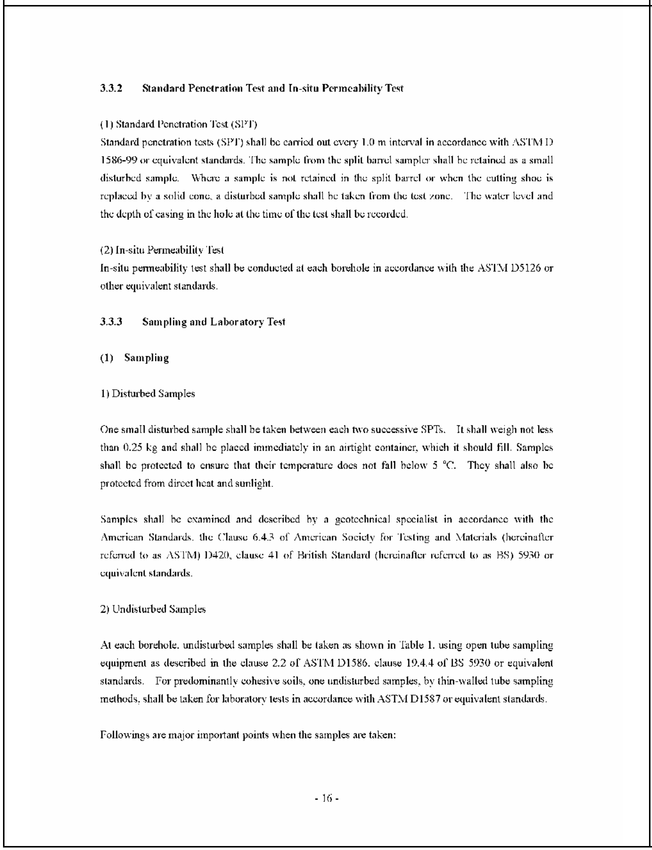
Three (3) nos. of boring in total will be conducted at the Suwung WWTP, as shown in Figure 1. And the actual location of boreholes shall be directed and confirmed by the Engineer, based on information of preliminary surveys of sites by the Contractor.

The maximum depth is approximately 40 meters at the proposed STP site and the total depth to dig is 120 m. When a bearing stratum is reached at less than specified depth. boring shall be stopped at 5 meters below the top of the stratum.

Method of boring shall be proposed by the Contractor for approval by the Engineer. The diameter of a borehole shall be sufficient to ensure that the boring can be completed to the scheduled depth and that samples of the specified diameter can be obtained.

Generally. water shall not be used to assist the advance of the borehole except in the case of dry coarse soils. Where the borehole penetrates below the water table and disturbance of the soil is likely. a positive hydrostatic pressure shall be maintained in the borehole.

The Contractor shall backfill boreholes in such a manner that no subsequent depression is formed at the ground surface due to settlement of the backfill. In some circumstances special infilling may be required by the Engineer. Unless otherwise instructed the special infilling shall be cement/bentonite (1:4) grout. Where artesian or other water conditions make normal backfilling impracticable, the Contractor shall consult with the Engineer a procedure for sealing the borehole.



3.3.2 Standard Penetration Test and In-situ Permeability Test

(1) Standard Penetration Test (SPT)
Standard penetration tests (SPT) shall be carried out every 1.0 m interval in accordance with ASTM D 1586-99 or equivalent standards. The sample from the split barrel sampler shall be retained as a small disturbed sample. Where a sample is not retained in the split barrel or when the cutting shoe is replaced by a solid cone, a disturbed sample shall be taken from the test zone. The water level and the depth of casing in the hole at the time of the test shall be recorded.

(2) In-situ Permeability Test
In-situ permeability test shall be conducted at each borehole in accordance with the ASTM D5126 or other equivalent standards.

3.3.3 Sampling and Laboratory Test

(1) Sampling

1) Disturbed Samples

One small disturbed sample shall be taken between each two successive SPTs. It shall weigh not less than 0.25 kg and shall be placed immediately in an airtight container, which it should fill. Samples shall be protected to ensure that their temperature does not fall below 5 °C. They shall also be protected from direct heat and sunlight.

Samples shall be examined and described by a geotechnical specialist in accordance with the American Standards. the Clause 6.4.3 of American Society for Testing and Materials (hereinafter referred to as ASTM) D420, clause 41 of British Standard (hereinafter referred to as BS) 5930 or equivalent standards.

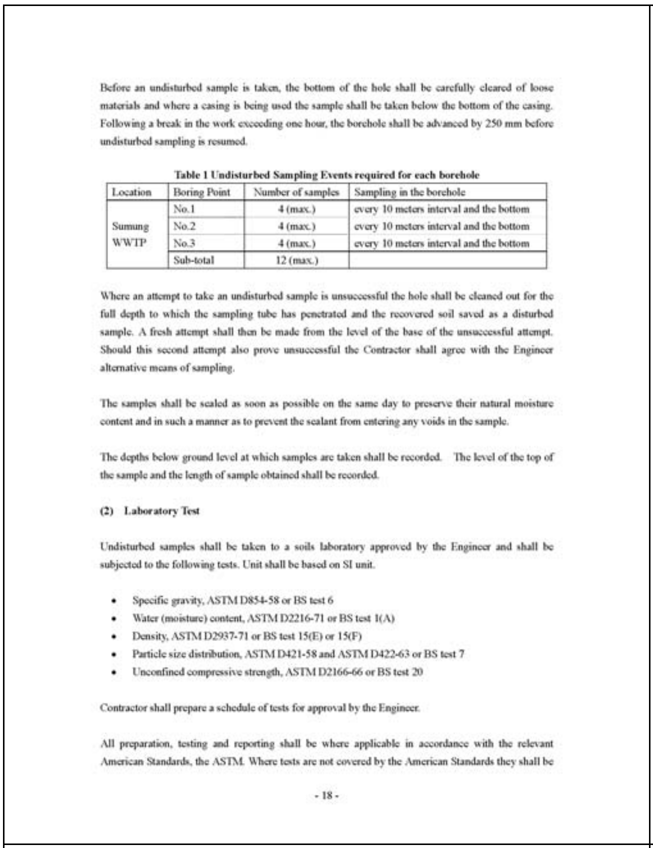
2) Undisturbed Samples

At each borehole. undisturbed samples shall be taken as shown in Table 1. using open tube sampling equipment as described in the clause 2.2 of ASTM D1586. clause 19.4.4 of BS 5930 or equivalent standards. For predominantly cohesive soils, one undisturbed samples, by thin-walled tube sampling methods, shall be taken for laboratory tests in accordance with ASTM D1587 or equivalent standards.

Followings are major important points when the samples are taken:

Source BLUPAL

Figure 1 Boring and Sampling Locations at the Suwung WWTP



Before an undisturbed sample is taken, the bottom of the hole shall be carefully cleared of loose materials and where a casing is being used the sample shall be taken below the bottom of the casing. Following a break in the work exceeding one hour, the borehole shall be advanced by 250 mm before undisturbed sampling is resumed.

Table 1 Undisturbed Sampling Events required for each borehole

Location	Boring Point	Number of samples	Sampling in the borehole
Sumung WWTP	No.1	4 (max.)	every 10 meters interval and the bottom
	No.2	4 (max.)	every 10 meters interval and the bottom
	No.3	4 (max.)	every 10 meters interval and the bottom
	Sub-total	12 (max.)	

Where an attempt to take an undisturbed sample is unsuccessful the hole shall be cleaned out for the full depth to which the sampling tube has penetrated and the recovered soil saved as a disturbed sample. A fresh attempt shall then be made from the level of the base of the unsuccessful attempt. Should this second attempt also prove unsuccessful the Contractor shall agree with the Engineer alternative means of sampling.

The samples shall be sealed as soon as possible on the same day to preserve their natural moisture content and in such a manner as to prevent the sealant from entering any voids in the sample.

The depths below ground level at which samples are taken shall be recorded. The level of the top of the sample and the length of sample obtained shall be recorded.

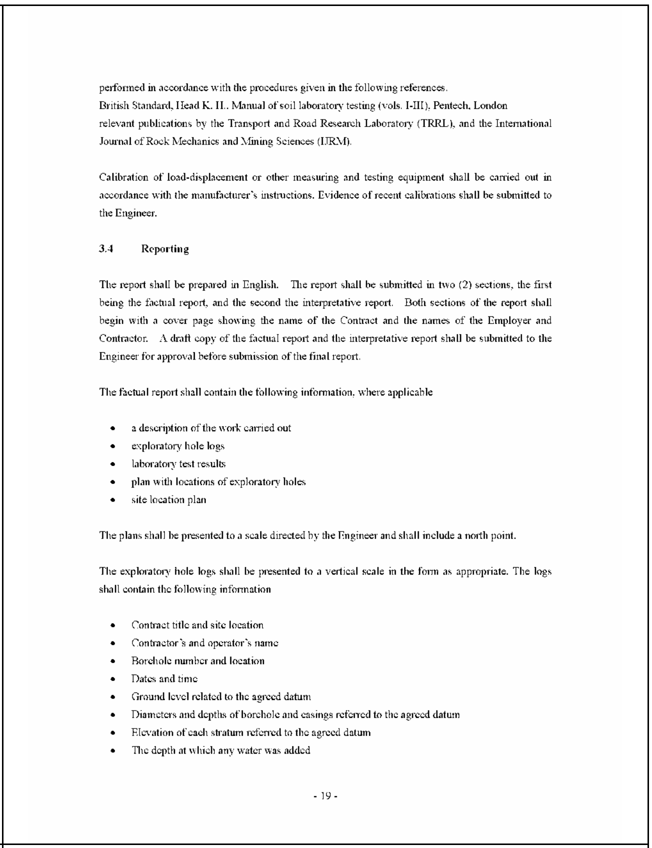
(2) Laboratory Test

Undisturbed samples shall be taken to a soils laboratory approved by the Engineer and shall be subjected to the following tests. Unit shall be based on SI unit.

- Specific gravity, ASTM D854-58 or BS test 6
- Water (moisture) content, ASTM D2216-71 or BS test 1(A)
- Density, ASTM D2937-71 or BS test 15(E) or 15(F)
- Particle size distribution, ASTM D421-58 and ASTM D422-63 or BS test 7
- Unconfined compressive strength, ASTM D2166-66 or BS test 20

Contractor shall prepare a schedule of tests for approval by the Engineer.

All preparation, testing and reporting shall be where applicable in accordance with the relevant American Standards, the ASTM. Where tests are not covered by the American Standards they shall be



performed in accordance with the procedures given in the following references.
British Standard, Head K. H.. Manual of soil laboratory testing (vols. I-III), Pentech, London
relevant publications by the Transport and Road Research Laboratory (TRRL), and the International Journal of Rock Mechanics and Mining Sciences (IJRM).

Calibration of load-displacement or other measuring and testing equipment shall be carried out in accordance with the manufacturer's instructions. Evidence of recent calibrations shall be submitted to the Engineer.

3.4 Reporting

The report shall be prepared in English. The report shall be submitted in two (2) sections, the first being the factual report, and the second the interpretative report. Both sections of the report shall begin with a cover page showing the name of the Contract and the names of the Employer and Contractor. A draft copy of the factual report and the interpretative report shall be submitted to the Engineer for approval before submission of the final report.

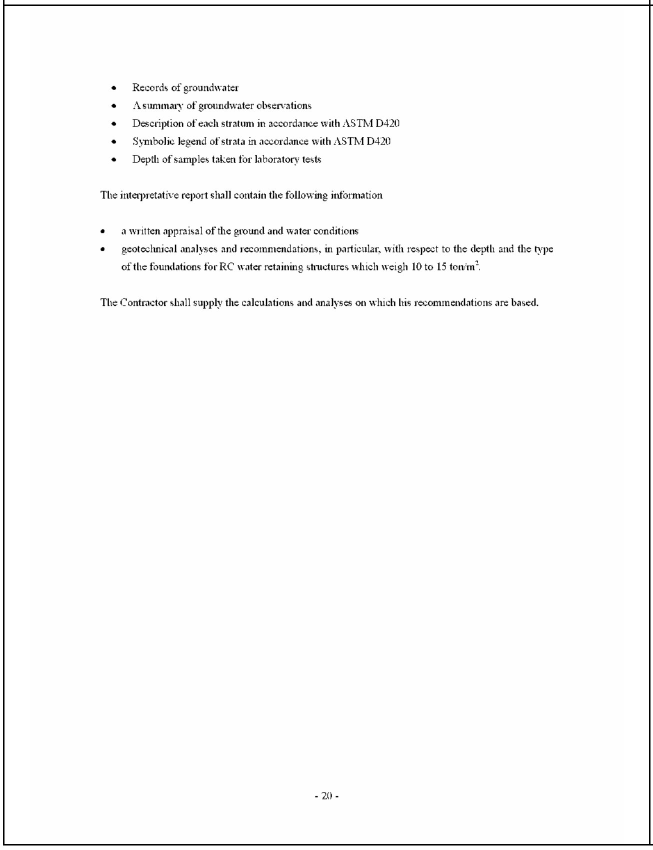
The factual report shall contain the following information, where applicable

- a description of the work carried out
- exploratory hole logs
- laboratory test results
- plan with locations of exploratory holes
- site location plan

The plans shall be presented to a scale directed by the Engineer and shall include a north point.

The exploratory hole logs shall be presented to a vertical scale in the form as appropriate. The logs shall contain the following information

- Contract title and site location
- Contractor's and operator's name
- Borehole number and location
- Dates and time
- Ground level related to the agreed datum
- Diameters and depths of borehole and casings referred to the agreed datum
- Elevation of each stratum referred to the agreed datum
- The depth at which any water was added



- Records of groundwater
- A summary of groundwater observations
- Description of each stratum in accordance with ASTM D420
- Symbolic legend of strata in accordance with ASTM D420
- Depth of samples taken for laboratory tests

The interpretative report shall contain the following information

- a written appraisal of the ground and water conditions
- geotechnical analyses and recommendations, in particular, with respect to the depth and the type of the foundations for RC water retaining structures which weigh 10 to 15 ton/m^2.

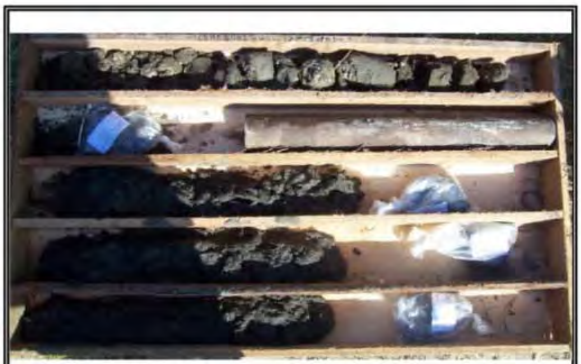
The Contractor shall supply the calculations and analyses on which his recommendations are based.

4.b Survey Photo

PHOTO DOCUMENTATION (BH 1)

PROJECT : SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM
LOCATION : BALI
CLIENT : NIHON SUIDO CONSULTANT

DRILLING AT BH-1



COREBOX 1 (0 - 5 M)

COREBOX 2 (5 - 10 M)

COREBOX 3 (10 - 15 M)

COREBOX 4 (15 - 20 M)

COREBOX 5 (20 - 25 M)

PHOTO DOCUMENTATION (BH 1)

PROJECT : SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM
LOCATION : BALI
CLIENT : NIHON SUIDO CONSULTANT

COREBOX 6 (25 - 30 M)

COREBOX 7 (30 - 35 M)

COREBOX 8 (35 - 40 M)

PHOTO DOCUMENTATION (BH 2)

PROJECT : **SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM**
LOCATION : **BALI**
CLIENT : **NIHON SUIDO CONSULTANT**

DRILLING AT BH-2

COREBOX 1 (0 - 5 M)

COREBOX 2 (5 - 10 M)

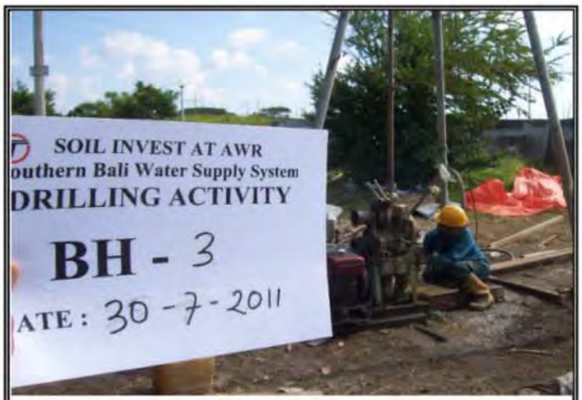
COREBOX 3 (10 - 15 M)

COREBOX 4 (15 - 20 M)

COREBOX 5 (20 - 25 M)

PHOTO DOCUMENTATION (BH 3)

PROJECT : **SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM**
LOCATION : **BALI**
CLIENT : **NIHON SUIDO CONSULTANT**



DRILLING AT BH-3

COREBOX 1 (0 - 5 M)

COREBOX 2 (5 - 10 M)

COREBOX 3 (10 - 15 M)

COREBOX 4 (15 - 20 M)

COREBOX 5 (20 - 25 M)

PHOTO DOCUMENTATION (BH 3)

PROJECT : **SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM**
LOCATION : **BALI**
CLIENT : **NIHON SUIDO CONSULTANT**

COREBOX 6 (25 - 30 M)

SPT ACTIVITY

PHOTO DOCUMENTATION (BH 4)

PROJECT : **SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM**
LOCATION : **BALI**
CLIENT : **NIHON SUIDO CONSULTANT**

DRILLING AT BH-4

COREBOX 1 (0 - 5 M)

COREBOX 2 (5 - 10 M)

COREBOX 3 (10 - 15 M)

COREBOX 4 (15 - 20 M)

COREBOX 5 (20 - 25 M)

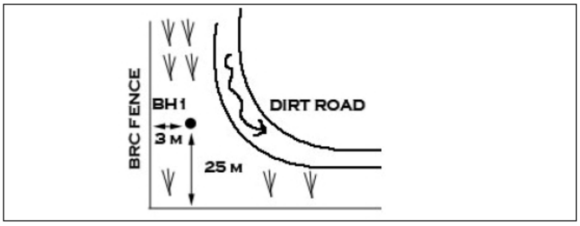
4.c Survey Result

BOREHOLE LOGS

BORING NUMBER BH-01

PAGE 1 OF 2

PT. Tigenco Graha Persada
Jl. Pahlawan Revolusi 100BJakarta Timur 14340
Telephone: (62) 21 86600710



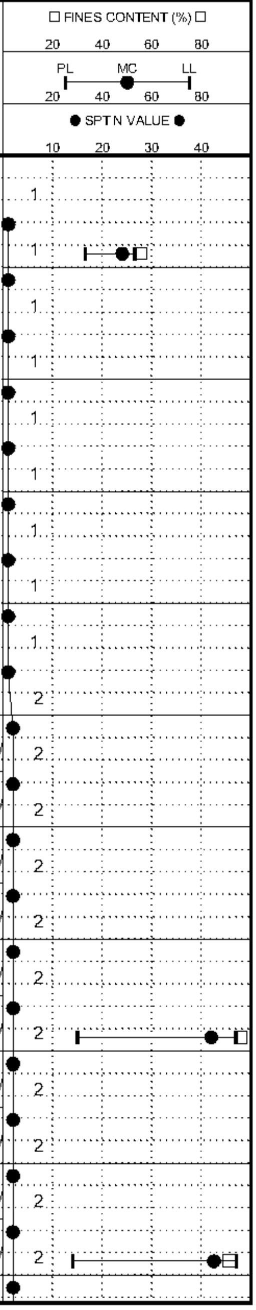
PROJECT Wastewater Reclaiming in Southern Bali Water Supply System
LOCATION IPAL SUWUNG
CLIENT NIHON SUIDO CONSULTANTS
DATE STARTED 7/20/11 **COMPLETED** 7/24/11
X,Y,Z 302509.706 , 9035534.116 , 4.976 m
DRILLER Waluyo
GROUND WATER LEVELS, AVERAGE: 1.31
DRILLING METHOD Continuous Coring NQ Size - 76mm
LOGGED BY Harris **CHECKED BY** Andrianto
STATION

DATE	START	END	DATE	START	END
20/07/2011	0.60 m	0.60 m	21/07/2011	0.95 m	0.75 m
22/07/2011	0.70 m	2.80 m	23/07/2011	1.20 m	2.10 m
24/07/2011	1.20 m	2.20 m			

DEPTH SCALE (m): 2, 4, 6, 8, 10, 12, 14, 16, 18, 20

ELEVATION SCALE (m): 4, 2, 0, -2, -4, -6, -8, -10, -12, -14

LITHOLOGY DESCRIPTION	LAYER THICKNESS (M)	SAMPLE TYPE NUMBER	SAMPLE DEPTH (M)	BLOW COUNTS (N VALUE)
0.0 silty CLAY with little fine sand, grey, high plasticity, very soft	9			
▼		SPT 1	1 1.45	
		UD 1	1.45 1.5	
		SPT 2	2 2.45	
		SPT 3	3 3.45	
		SPT 4	4 4.45	
		SPT 5	5 5.45	
		SPT 6	6 6.45	
		SPT 7	7 7.45	
8.0 grades, with coarse sand		SPT 8	8 8.45	
9.0 fine SAND, dark grey to black, very loose	6	SPT 9	9 9.45	
		SPT 10	10 10.45	2-1-1/20 (2)
11.0 grades, coarse SAND, black		SPT 11	11 11.45	1-1-1/20 (2)
		SPT 12	12 12.45	1-1-1/20 (2)
13.0 grades, fine SAND		SPT 13	13 13.45	1-1-1/20 (2)
		SPT 14	14 14.45	1-1-1/20 (2)
15.0 ORGANIC CLAY, grey, very soft to soft, high plasticity	5	SPT 15	15 15.45	1-1-1/20 (2)
		UD 2	15.45 15.5	
		SPT 16	16 16.45	1-1-1/20 (2)
		SPT 17	17 17.45	1-1-1/20 (2)
		SPT 18	18 18.45	1-1-1/20 (2)
		SPT 19	19 19.45	1-1-1/20 (2)
		UD 3	19.45 19.5	
20.0			20	1-1-1/20



(Continued Next Page)

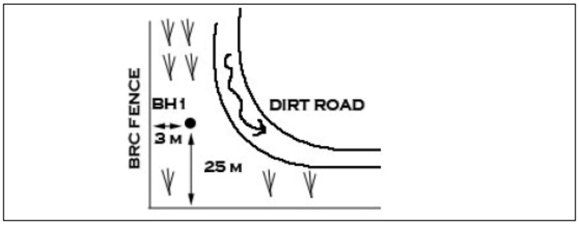
GEOTECH BH PLOTS NISSUICON-DENPASAR.GPJ TIGENCO-RAILWAY.GDT 9/12/11

BORING NUMBER BH-01

PAGE 2 OF 2

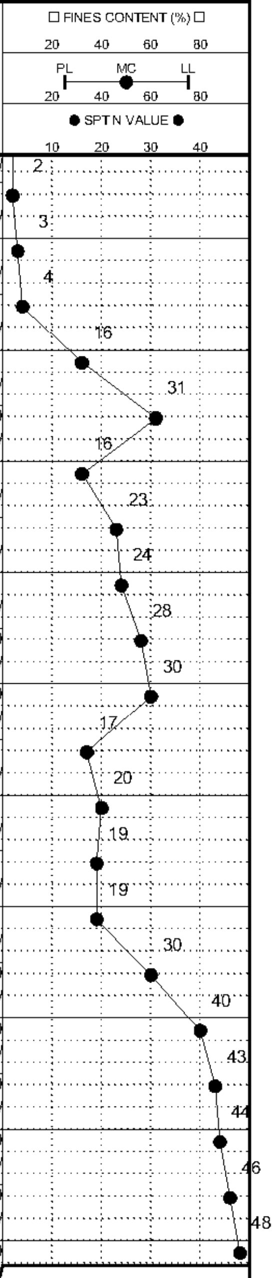
PT. Tigenco Graha Persada
Jl. Pahlawan Revolusi 100BJakarta Timur 14340
Telephone: (62) 21 86600710

PROJECT Wastewater Reclaiming in Southern Bali Water Supply System
LOCATION IPAL SUWUNG
CLIENT NIHON SUIDO CONSULTANTS



DEPTH SCALE (m)	ELEVATION SCALE (m)	LITHOLOGY DESCRIPTION	LAYER THICKNESS (M)	SAMPLE TYPE NUMBER	SAMPLE DEPTH (M)	BLOW COUNTS (N VALUE)
	-16	silty CLAY with little fine sand, dark grey, high plasticity, very soft *(continued)*	3	SPT 20	20.45	(2)
				SPT 21	21 21.45	1-1-1/20 (2)
22				SPT 22	22 22.45	1-1-2/20 (3)
	-18	23.0				
		silty CLAY with little coarse sand, dark grey, soft to medium stiff, high plasticity	7.5	SPT 23	23 23.45	1-2-2/20 (4)
24		24.0 grades, brownish to grey		SPT 24	24 24.45	5-7-9/20 (16)
	-20	25.0 grades, hard		SPT 25	25 25.45	10-14-17/20 (31)
26		26.0 silty CLAY with coral deposits, brown to gray, medium plasticiy		SPT 26	26 26.45	6-7-9/20 (16)
	-22	27.0 grades, with fine sand, high plasticity		SPT 27	27 27.45	8-8-15/20 (23)
28		28.0 grades, medium plasticity		SPT 28	28 28.45	8-8-16/20 (24)
	-24			SPT 29	29 29.45	10-12-16/20 (28)
30		30.0 30.5 grades, very stiff to hard		SPT 30	30 30.45	10-12-18/20 (30)
	-26	31.0 silty CLAY with LIMESTONE, light grey to white, high plasticity grades, very stiff to hard	9.95	SPT 31	31 31.45	6-6-11/20 (17)
32				SPT 32	32 32.45	7-8-12/20 (20)
	-28			SPT 33	33 33.45	6-7-12/20 (19)
34				SPT 34	34 34.45	7-7-12/20 (19)
	-30			SPT 35	35 35.45	12-13-17/20 (30)
36		36.0 grades, milky white		SPT 36	36 36.45	16-20-20/20 (40)
	-32			SPT 37	37 37.45	16-20-23/20 (43)
38				SPT 38	38 38.45	16-20-24/20 (44)
	-34			SPT 39	39 39.45	16-21-25/20 (46)
40				SPT 40	40 40.45	17-21-27/20 (48)

Bottom of borehole at 40.45 meters.

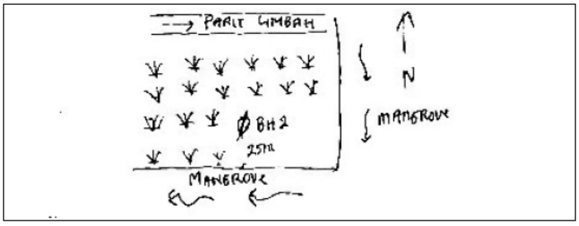


GEOTECH BH PLOTS NISSUICON-DENPASAR.GPJ TIGENCO-RAILWAY.GDT 9/12/11

BORING NUMBER BH-02

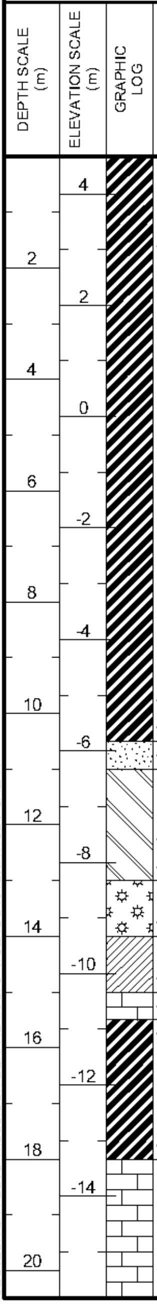
PAGE 1 OF 2

PT. Tigenco Graha Persada
Jl. Pahlawan Revolusi 100BJakarta Timur 14340
Telephone: (62) 21 86600710



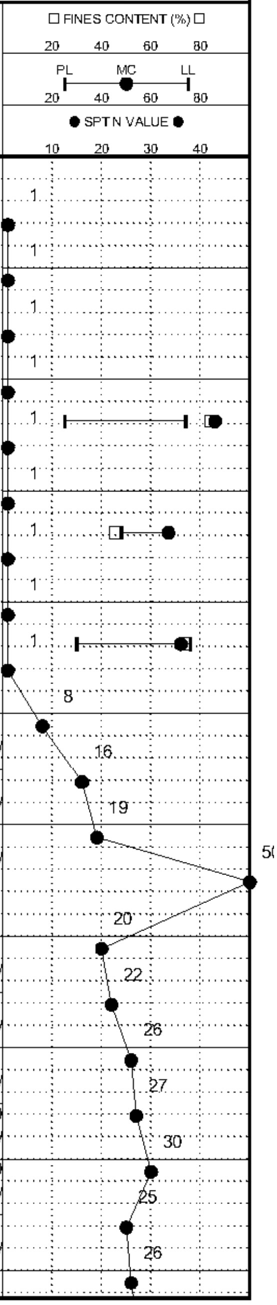
PROJECT Wastewater Reclaiming in Southern Bali Water Supply System
LOCATION IPAL SUWUNG
CLIENT NIHON SUIDO CONSULTANTS
DATE STARTED 7/25/11 **COMPLETED** 7/28/11
DRILLER Waluyo
DRILLING METHOD Continuous Coring NQ Size - 76mm
LOGGED BY Harris **CHECKED BY** Andrianto
STATION
X,Y,Z 302694.95 , 9035462.004 , 4.67 m
GROUND WATER LEVELS, AVERAGE: 1.605

DATE	START	END	DATE	START	END
25/07/2011	2.00 m	2.00 m	26/07/2011	1.30 m	1.70 m
27/07/2011	1.20 m	1.70 m	28/07/2011	1.20 m	1.70 m



LITHOLOGY DESCRIPTION		LAYER THICKNESS (M)
0.0	silty CLAY with SAND, dark grey to brown, very soft, high plasticity	10.5
10.0		
10.5	grades, with coral deposits	
11.0	coarse SAND with coral deposits	0.5
	silty CLAY with coral deposits, dark gray, very stiff, medium plasticiy	2
12.5		
13.0	grades, with limestone, brownish white	
	CORALS, white, hard	1
14.0	silty CLAY with corals, white, very stiff, low plasticity	1
15.0		
15.5	LIMESTONE, light grey to white, very stiff, non plastic	0.5
16.0	silty CLAY with fine sand, light grey mottled light brown, very stiff, high plasticity grades, with limestone, light grey to white	2.5
18.0	LIMESTONE, light grey to white, very stiff to hard, medium plastic	

SAMPLE TYPE NUMBER	SAMPLE DEPTH (M)	BLOW COUNTS (N VALUE)
SPT 1	1 1.45	
SPT 2	2 2.45	
SPT 3	3 3.45	
SPT 4	4 4.45	
UD 1	4.5 5	
SPT 5	5 5.45	
SPT 6	6 6.45	
UD 2	6.5 7	
SPT 7	7 7.45	
SPT 8	8 8.45	
UD 3	8.5 9	
SPT 9	9 9.45	
SPT 10	10 10.45	3-4-4/20 (8)
SPT 11	11 11.45	5-7-9/20 (16)
SPT 12	12 12.45	5-7-12/20 (19)
SPT 13	13 13.05	
SPT 14	14 14.45	9-10-10/20 (20)
SPT 15	15 15.45	9-10-12/20 (22)
SPT 16	16 16.45	9-12-14/20 (26)
SPT 17	17 17.45	11-12-15/20 (27)
SPT 18	18 18.45	11-15-15/20 (30)
SPT 19	19 19.45	9-11-14/20 (25)
SPT	20	9-12-14/20



(Continued Next Page)

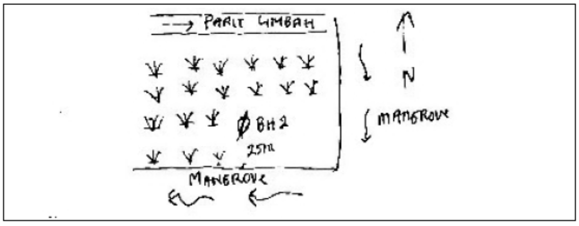
GEOTECH BH PLOTS NISSUICON-DENPASAR.GPJ TIGENCO-RALWAY.GDT 9/12/11

BORING NUMBER BH-02

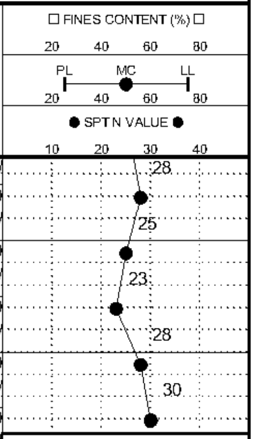
PAGE 2 OF 2

PT. Tigenco Graha Persada
Jl. Pahlawan Revolusi 100BJakarta Timur 14340
Telephone: (62) 21 86600710

PROJECT Wastewater Reclaiming in Southern Bali Water Supply System
LOCATION IPAL SUWUNG
CLIENT NIHON SUIDO CONSULTANTS



DEPTH SCALE (m)	ELEVATION SCALE (m)	GRAPHIC LOG	LITHOLOGY DESCRIPTION	LAYER THICKNESS (M)	SAMPLE TYPE NUMBER	SAMPLE DEPTH (M)	BLOW COUNTS (N VALUE)
			LIMESTONE, light grey to white, very stiff to hard, medium plastic *(continued)*	7.45	20	20.45	(26)
22					SPT 21	21 21.45	10-14-14/20 (28)
	-18				SPT 22	22 22.45	10-12-13/20 (25)
24					SPT 23	23 23.45	10-10-13/20 (23)
	-20				SPT 24	24 24.45	12-14-14/20 (28)
					SPT 25	25 25.45	12-14-16/20 (30)



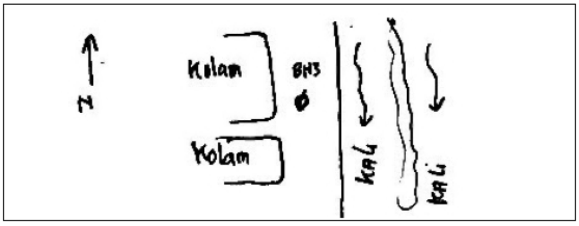
Bottom of borehole at 25.45 meters.

GEOTECH BH PLOTS NISSUICON-DENPASAR.GPJ TIGENCO-RAILWAY.GDT 9/12/11

BORING NUMBER BH-03

PAGE 1 OF 2

PT. Tigenco Graha Persada
Jl. Pahlawan Revolusi 100BJakarta Timur 14340
Telephone: (62) 21 86600710



PROJECT Wastewater Reclaiming in Southern Bali Water Supply System
LOCATION IPAL SUWUNG
CLIENT NIHON SUIDO CONSULTANTS

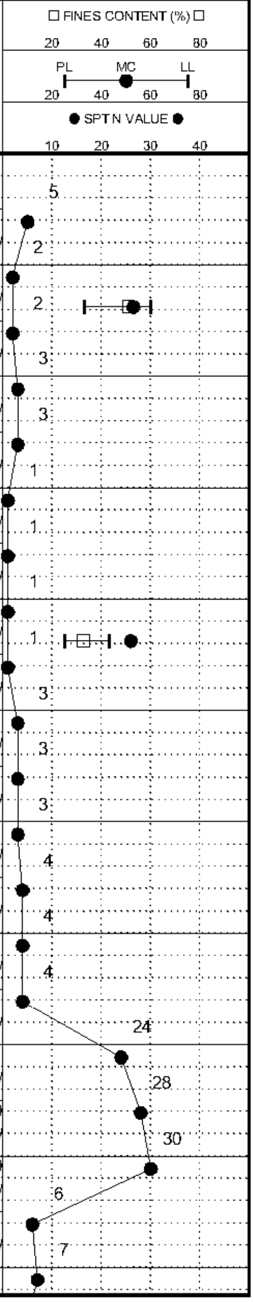
DATE STARTED 7/30/11 **COMPLETED** 8/2/11
DRILLER Waluyo
DRILLING METHOD Continuous Coring NQ Size - 76mm
LOGGED BY Harris **CHECKED BY** Andrianto
STATION

X,Y,Z 302762.208 , 9035677.517 , 5.086 m
GROUND WATER LEVELS, AVERAGE: 1.875

DATE	START	END	DATE	START	END
30/07/2011	2.80 m	2.80 m	31/07/2011	1.20 m	1.90 m
01/08/2011	1.50 m	1.20 m	02/08/2011	1.30 m	2.30 m

DEPTH SCALE (m)	ELEVATION SCALE (m)	LITHOLOGY DESCRIPTION	LAYER THICKNESS (M)
		0.0	
	4	silty CLAY with limestone, dark brown, mottled white, medium plasticity 1.0	1
2	2	coarse to fine SAND, black, loose ▼ 3.0	2
		3.5 silty CLAY with little fine sand, dark grey, very soft to soft, high plasticity	0.5
4	0	CORALS, fine sand, white, dark grey dots, soft 6.0	2.5
6, 8	-2, -4	silty CLAY with corals, grey, very soft, high plasticity 9.0	3
		9.5 fine SAND with corals, very loose	0.5
10, 12, 14	-6, -8, -10	10.0 CORALS, white, light grey spots grades, with shell, very loose 15.5	6
16		16.0 silty CLAY with coarse SAND, brownish grey mottled grey, medium plasticity	0.5
	-12	coarse SAND, brownish white, medium dense 17.5	1.5
18		18.0 CORALS, dark grey to white	0.5
		18.5 coarse SAND, brownish white, medium dense	0.5
	-14	19.0 silty CLAY with fine SAND mix with corals, white, light grey dots, high plasticity	0.5
20		coarse SAND with corals, brownish grey, loose, low plasticity 20.5	1.5

SAMPLE TYPE NUMBER	SAMPLE DEPTH (M)	BLOW COUNTS (N VALUE)
SPT 1	1 1.45	2-2-3/20 (5)
SPT 2	2 2.45	1-1-1/20 (2)
UD 1	2.5	
SPT 3	3 3.45	1-1-1/20 (2)
SPT 4	4 4.45	1-1-2/20 (3)
SPT 5	5 5.45	1-1-2/20 (3)
SPT 6	6 6.45	1/45 (1)
SPT 7	7 7.45	1/45 (1)
SPT 8	8 8.45	1/45 (1)
UD 2	8.5	
SPT 9	9 9.45	1/45 (1)
SPT 10	10 10.45	1-1-2/20 (3)
SPT 11	11 11.45	1-1-2/20 (3)
SPT 12	12 12.45	1-1-2/20 (3)
SPT 13	13 13.45	1-2-2/20 (4)
SPT 14	14 14.45	1-2-2/20 (4)
SPT 15	15 15.45	2-2-2/20 (4)
SPT 16	16 16.45	8-11-13/20 (24)
SPT 17	17 17.45	10-13-15/20 (28)
SPT 18	18 18.45	10-14-16/20 (30)
SPT 19	19 19.45	3-3-3/20 (6)
SPT	20	3-3-4/20



GEOTECH BH PLOTS NISSUICON-DENPASAR.GPJ TIGENCO-RAILWAY.GDT 9/12/11

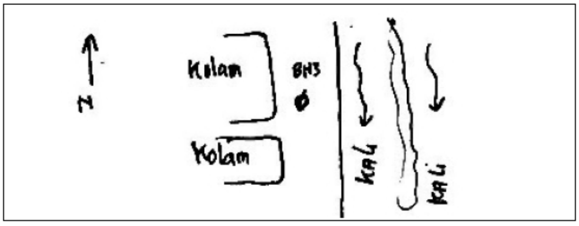
(Continued Next Page)

BORING NUMBER BH-03

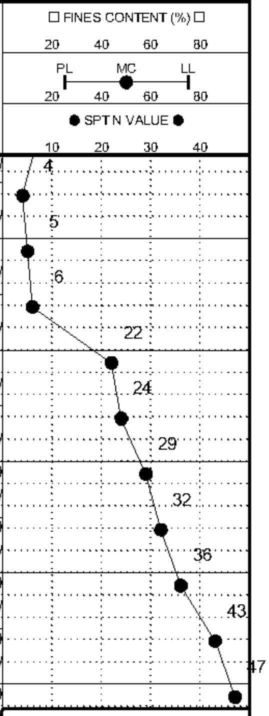
PAGE 2 OF 2

PT. Tigenco Graha Persada
Jl. Pahlawan Revolusi 100BJakarta Timur 14340
Telephone: (62) 21 86600710

PROJECT Wastewater Reclaiming in Southern Bali Water Supply System
LOCATION IPAL SUWUNG
CLIENT NIHON SUIDO CONSULTANTS



DEPTH SCALE (m)	ELEVATION SCALE (m)	GRAPHIC LOG	LITHOLOGY DESCRIPTION	LAYER THICKNESS (M)	SAMPLE TYPE NUMBER	SAMPLE DEPTH (M)	BLOW COUNTS (N VALUE)
	-16		21.0 CORALS mix with limestone, dark grey mottled white	0.5	20	20.45	(7)
			21.5 fine SAND, with some limestone, white, light grey dots, very loose, low plasticity	0.5	SPT 21	21 21.45	3-2-2/20 (4)
22			LIMESTONE, white, light grey dots, medium plasticity		SPT 22	22 22.45	2-2-3/20 (5)
	-18				SPT 23	23 23.45	2-2-4/20 (6)
24					SPT 24	24 24.45	7-10-12/20 (22)
	-20		25.5 grades, white, brownish white dots		SPT 25	25 25.45	7-10-14/20 (24)
26				8.95	SPT 26	26 26.45	10-12-17/20 (29)
	-22				SPT 27	27 27.45	10-15-17/20 (32)
28					SPT 28	28 28.45	12-15-21/20 (36)
	-24				SPT 29	29 29.45	12-18-25/20 (43)
30					SPT 30	30 30.45	14-20-27/20 (47)



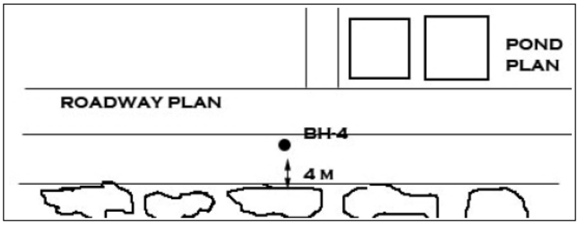
Bottom of borehole at 30.45 meters.

GEOTECH BH PLOTS NISSUICON-DENPASAR.GPJ TIGENCO-RAILWAY.GDT 9/12/11

BORING NUMBER BH-04

PAGE 1 OF 2

PT. Tigenco Graha Persada
Jl. Pahlawan Revolusi 100BJakarta Timur 14340
Telephone: (62) 21 86600710



PROJECT Wastewater Reclaiming in Southern Bali Water Supply System
LOCATION IPAL SUWUNG
CLIENT NIHON SUIDO CONSULTANTS

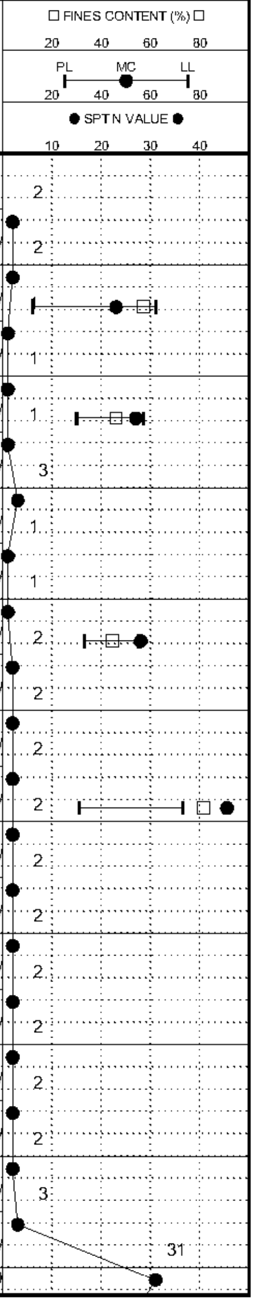
DATE STARTED 8/4/11 **COMPLETED** 8/5/11
DRILLER Waluyo
DRILLING METHOD Continuous Coring NQ Size - 76mm
LOGGED BY Harris **CHECKED BY** Andrianto
STATION

X,Y,Z 302601.196 , 9035490.905 , 4.569 m
GROUND WATER LEVELS, AVERAGE: 1.9

DATE	START	END	DATE	START	END
04/08/2011	1.70 m	1.70 m	05/08/2011	1.50 m	2.70 m

LITHOLOGY DESCRIPTION	LAYER THICKNESS (M)	SAMPLE TYPE NUMBER	SAMPLE DEPTH (M)	BLOW COUNTS (N VALUE)
0.0 silty CLAY, dark brown, high plasticity	1			
1.0 silty CLAY with fine sand, dark grey, very soft to soft, medium to high plasticity ▼	5	SPT 1	1 1.45	1-1-1/20 (2)
		SPT 2	2 2.45	1-1-1/20 (2)
		UD 1	2.5	
		SPT 3	3 3.45	1/45 (1)
		SPT 4	4 4.45	1/45 (1)
		UD 2	4.5	
		SPT 5	5 5.45	1/45 (1)
6.0 fine SAND, black, very loose	2	SPT 6	6 6.45	1-1-2/20 (3)
		SPT 7	7 7.45	1/45 (1)
8.0 silty CLAY, dark grey, very soft to soft, high plasticity	8	SPT 8	8 8.45	1/45 (1)
		UD 3	8.5	
		SPT 9	9 9.45	1-1-1/20 (2)
		SPT 10	10 10.45	1-1-1/20 (2)
		SPT 11	11 11.45	1-1-1/20 (2)
		UD 4	11.5	
		SPT 12	12 12.45	1-1-1/20 (2)
		SPT 13	13 13.45	1-1-1/20 (2)
		SPT 14	14 14.45	1-1-1/20 (2)
		SPT 15	15 15.45	1-1-1/20 (2)
16.0 silty CLAY with coarse SAND, dark grey, very soft to soft, high plasticity	2	SPT 16	16 16.45	1-1-1/20 (2)
		SPT 17	17 17.45	1-1-1/20 (2)
18.0 fine SAND, dark grey, very loose	0.5	SPT 18	18 18.45	1-1-1/20 (2)
18.5 silty CLAY with fine sand, dark grey, soft, high plasticity	1	SPT 19	19 19.45	1-1-2/20 (3)
19.5 LIMESTONE, light grey to white, dotted white, low medium plasticity		SPT	20	10-14-17/20

DEPTH SCALE (m): 2, 4, 6, 8, 10, 12, 14, 16, 18, 20
ELEVATION SCALE (m): 4, 2, 0, -2, -4, -6, -8, -10, -12, -14
GRAPHIC LOG



(Continued Next Page)

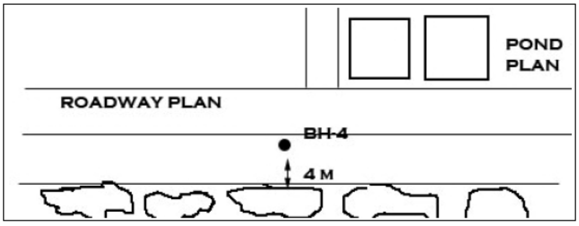
GEOTECH BH PLOTS NISSUICON-DENPASAR.GPJ TIGENCO-RAILWAY.GDT 9/12/11

BORING NUMBER BH-04

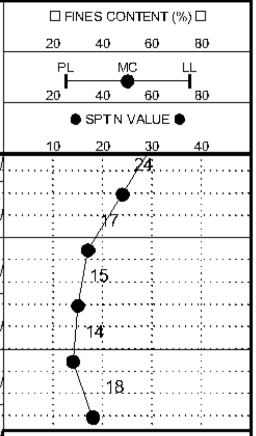
PAGE 2 OF 2

PT. Tigenco Graha Persada
Jl. Pahlawan Revolusi 100BJakarta Timur 14340
Telephone: (62) 21 86600710

PROJECT Wastewater Reclaiming in Southern Bali Water Supply System
LOCATION IPAL SUWUNG
CLIENT NIHON SUIDO CONSULTANTS



DEPTH SCALE (m)	ELEVATION SCALE (m)	GRAPHIC LOG	LITHOLOGY DESCRIPTION	LAYER THICKNESS (M)	SAMPLE TYPE NUMBER	SAMPLE DEPTH (M)	BLOW COUNTS (N VALUE)
			LIMESTONE, light grey to white, dotted white, low medium plasticity *(continued)*	5.95	20	20.45	(31)
22					SPT 21	21 21.45	9-12-12/20 (24)
	-18				SPT 22	22 22.45	7-7-10/20 (17)
24					SPT 23	23 23.45	7-7-8/20 (15)
	-20				SPT 24	24 24.45	7-7-7/20 (14)
					SPT 25	25 25.45	8-9-9/20 (18)



Bottom of borehole at 25.45 meters.

GEOTECH BH PLOTS NISSUICON-DENPASAR.GPJ TIGENCO-RAILWAY.GDT 9/12/11

LAB TEST RESULTS

- Specific Gravity Test
- Moisture Content Test
- Density Test
- Sieve Analysis
- Hydrometer Analysis
- Unconfined Compression Test
- Atterberg Limits

PT. TIGENCO GRAHA PERSADA	Project	SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM		
	Client	NIHON SUIDOI CONSULTANT	Date	28-Jul-2011
	Tested By	Benny	Checked By	M. Iqbal, ST

INDEX PROPERTIES

Location : Bali

Bore Hole No		BH - 01		BH - 01		BH - 01		BH - 02	
Depth	meter	1.50 - 2.00		15.50 - 16.00		19.50 - 20.00		4.50 - 5.00	
Sample Type		UDS		UDS		UDS		UDS	
SPECIFIC GRAVITY TEST (ASTM D - 854)									
Pycnometer No.		T15	T14	T6	T16	T8	T29	T28	T13
Wt. Of dry Soil (A)	g	17.91	17.67	14.18	14.22	14.00	14.21	16.02	15.45
Temperature (T)	^{0}C	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00
Wt. Pycnometer + Water + Soil (B)	g	169.55	158.46	163.98	156.79	163.57	169.52	172.62	161.23
Wt Pycnometer + Water at T ^{0}C (C)	g	158.47	147.52	155.24	147.95	154.90	160.65	162.69	151.65
A+(C-B)	g	6.83	6.73	5.44	5.38	5.33	5.34	6.09	5.87
Specific Gravity (Gs)		2.618	2.621	2.602	2.639	2.622	2.657	2.626	2.628
SPECIFIC GRAVITY Average (Gs)		**2.619**		**2.620**		**2.639**		**2.627**	
MOISTURE CONTENT TEST (BS 1377 : 1975)									
No. Container		R.1	D.60	R.12	D.55	F.36	D.3	E.33	E.6
Wt. Container + Wet Soil	g	163.80	30.05	144.56	46.52	141.09	46.81	34.40	33.47
Wt. Container + Dry Soil	g	116.34	21.86	87.44	27.51	84.12	27.51	20.87	20.42
Wt. Container	g	17.58	5.05	19.71	4.88	17.43	4.85	5.16	5.27
Wt. Water	g	47.46	8.19	57.12	19.01	56.97	19.30	13.53	13.05
Wt. Dry Soil	g	98.76	16.81	67.73	22.63	66.69	22.66	15.71	15.15
Moisture Content (w)	%	48.06	48.72	84.33	84.00	85.43	85.17	86.12	86.14
MOISTURE CONTENT Average (w)	%	**48.39**		**84.17**		**85.30**		**86.13**	
DENSITY TEST (BS 1377 : 1975)									
No. Ring		A		A		A		A	
Wt. Ring + Wet Soil	g	75.95		71.75		70.55		71.27	
Wt. Ring	g	43.38		43.38		43.38		43.38	
Vol. Wet Soil (= Vol. Ring)	cm^3	19.24		19.24		19.24		19.24	
BULK DENSITY (γm)	Mg/m^3	**1.693**		**1.475**		**1.412**		**1.450**	

DRY DENSITY (γd)	Mg/m^3	**1.141**	**0.801**	**0.762**	**0.779**
VOID RATIO (e)		**1.296**	**2.273**	**2.463**	**2.373**
POROSITY (n)		**0.564**	**0.694**	**0.711**	**0.704**
DEGREE OF SATURATION (Sr)	%	**97.792**	**97.038**	**91.396**	**95.347**

PT. TIGENCO GRAHA PERSADA	Project	SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM		
	Client	NIHON SUIDOI CONSULTANT	Date	28-Jul-2011
	Tested By	Benny	Checked By	M. Iqbal, ST

INDEX PROPERTIES

Location : Bali

Bore Hole No		BH - 02		BH - 02		BH - 03		BH - 03	
Depth	meter	6.50 - 7.00		8.50 - 9.00		2.50 - 3.00		8.50 - 9.00	
Sample Type		UDS		UDS		UDS		UDS	
SPECIFIC GRAVITY TEST (ASTM D - 854)									
Pycnometer No.		T12	T18	T15	T11	T11	T27	T21	T26
Wt. Of dry Soil (A)	g	16.35	15.54	14.91	14.64	16.34	16.00	16.71	16.23
Temperature (T)	^{0}C	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00
Wt. Pycnometer + Water + Soil (B)	g	165.90	161.12	167.68	161.13	162.28	155.87	155.96	162.10
Wt Pycnometer + Water at T ^{0}C (C)	g	155.82	151.51	158.47	152.07	152.18	145.94	145.54	151.99
A+(C-B)	g	6.27	5.93	5.70	5.58	6.24	6.07	6.29	6.12
Specific Gravity (Gs)		2.603	2.616	2.611	2.619	2.614	2.631	2.652	2.647
SPECIFIC GRAVITY Average (Gs)		**2.610**		**2.615**		**2.623**		**2.650**	
MOISTURE CONTENT TEST (BS 1377 : 1975)									
No. Container		E.31	E.23	E.15	E.21	E.15	E.21	E.31	E.23
Wt. Container + Wet Soil	g	31.56	31.24	30.39	30.40	30.01	30.03	30.49	30.40
Wt. Container + Dry Soil	g	20.93	20.86	20.03	19.79	21.66	21.37	21.81	21.82
Wt. Container	g	5.04	5.49	5.41	5.32	5.32	5.41	5.01	5.49
Wt. Water	g	10.63	10.38	10.36	10.61	8.35	8.66	8.68	8.58
Wt. Dry Soil	g	15.89	15.37	14.62	14.47	16.34	15.96	16.80	16.33
Moisture Content (w)	%	66.90	67.53	70.86	73.32	51.10	54.26	51.67	52.54
MOISTURE CONTENT Average (w)	%	**67.22**		**72.09**		**52.68**		**52.10**	
DENSITY TEST (BS 1377 : 1975)									
No. Ring		A		A		A		A	
Wt. Ring + Wet Soil	g	72.70		74.12		75.11		79.33	
Wt. Ring	g	43.38		43.38		43.38		43.38	
Vol. Wet Soil (= Vol. Ring)	cm^3	19.24		19.24		19.24		19.24	
BULK DENSITY (γm)	Mg/m^3	**1.524**		**1.598**		**1.649**		**1.869**	
DRY DENSITY (γd)	Mg/m^3	**0.911**		**0.928**		**1.080**		**1.228**	
VOID RATIO (e)		**1.864**		**1.817**		**1.428**		**1.157**	
POROSITY (n)		**0.651**		**0.645**		**0.588**		**0.536**	
DEGREE OF SATURATION (Sr)	%	**94.128**		**100.000**		**96.746**		**100.000**	

PT. TIGENCO GRAHA PERSADA	Project	SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM		
	Client	NIHON SUIDOI CONSULTANT	Date	28-Jul-2011
	Tested By	Benny	Checked By	M. Iqbal, ST

INDEX PROPERTIES

Location : Bali

Bore Hole No		BH - 04		BH - 04		BH - 04		BH - 04	
Depth	meter	2.50 - 3.00		4.50 - 5.00		8.50 - 9.00		11.50 - 12.00	
Sample Type		UDS		UDS		UDS		UDS	
SPECIFIC GRAVITY TEST (ASTM D - 854)									
Pycnometer No.		T14	T15	T23	T31	T22	T20	T29	T16
Wt. Of dry Soil (A)	g	18.68	19.24	19.50	25.33	16.71	16.23	16.34	16.00
Temperature (T)	^{0}C	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00
Wt. Pycnometer + Water + Soil (B)	g	158.99	165.84	166.19	162.71	166.30	169.03	170.74	157.78
Wt Pycnometer + Water at T ^{0}C (C)	g	147.51	154.00	154.12	146.96	155.93	159.00	160.65	147.86
A+(C-B)	g	7.20	7.40	7.43	9.58	6.34	6.20	6.25	6.08
Specific Gravity (Gs)		2.590	2.596	2.620	2.640	2.631	2.613	2.610	2.627
SPECIFIC GRAVITY Average (Gs)		**2.593**		**2.630**		**2.622**		**2.619**	
MOISTURE CONTENT TEST (BS 1377 : 1975)									
No. Container		E.20	E.15	E.25	E.19	F.11	F.10	E.34	E.8
Wt. Container + Wet Soil	g	33.01	33.21	35.57	34.58	31.59	32.41	30.25	30.37
Wt. Container + Dry Soil	g	24.13	24.55	24.90	24.48	21.91	22.81	18.27	18.57
Wt. Container	g	5.41	5.32	5.44	5.16	5.08	5.21	5.30	5.30
Wt. Water	g	8.88	8.66	10.67	10.10	9.68	9.60	11.98	11.80
Wt. Dry Soil	g	18.72	19.23	19.46	19.32	16.83	17.60	12.97	13.27
Moisture Content (w)	%	47.44	45.03	54.83	52.28	57.52	54.55	92.37	88.92
MOISTURE CONTENT Average (w)	%	**46.23**		**53.55**		**56.03**		**90.64**	
DENSITY TEST (BS 1377 : 1975)									
No. Ring		A		A		A		A	
Wt. Ring + Wet Soil	g	76.17		73.62		73.23		71.23	
Wt. Ring	g	43.38		43.38		43.38		43.38	
Vol. Wet Soil (= Vol. Ring)	cm^3	19.24		19.24		19.24		19.24	
BULK DENSITY (γm)	Mg/m^3	**1.704**		**1.572**		**1.551**		**1.448**	
DRY DENSITY (γd)	Mg/m^3	**1.165**		**1.024**		**0.994**		**0.759**	
VOID RATIO (e)		**1.225**		**1.569**		**1.637**		**2.449**	
POROSITY (n)		**0.551**		**0.611**		**0.621**		**0.710**	
DEGREE OF SATURATION (Sr)	%	**97.878**		**89.747**		**89.743**		**96.929**	

Project	**SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM**			
Client	NIHON SUIDOI CONSULTANT			
Location	Bali	Date	28-Jul-11	
Tested By	Ria Irmawan	Checked By	M.Iqbal, ST	

PARTICLE SIZE DISTRIBUTION ANALYSIS

Hole No. : BH - 01
Depth : 1.50 - 2.00 m
Sample Type : UDS
Sample Description : silty CLAY

SIEVE ANALYSIS (ASTM D 422)

Initial weight of dry soil : 43.36 g

Sieve No.	Sieve Opening mm	Wt. Soil Retained	Percent Retained %	Cumulative Percent Retained %	Percent Finer %
3"	101.600	0.000	0.00	0.00	100.00
2"	75.000	0.000	0.00	0.00	100.00
1 1/2"	38.100	0.000	0.00	0.00	100.00
1"	25.400	0.000	0.00	0.00	100.00
3/4"	19.050	0.000	0.00	0.00	100.00
1/2"	12.700	0.000	0.00	0.00	100.00
3/8"	9.525	0.000	0.00	0.00	100.00
4	4.760	0.810	1.87	1.87	98.13
8	2.380	1.170	2.70	4.57	95.43
20	0.840	2.250	5.19	9.76	90.24
40	0.420	3.300	7.61	17.37	82.63
80	0.177	6.260	14.44	31.80	68.20
100	0.149	1.570	3.62	35.42	64.58
200	0.074	4.000	9.23	44.65	55.35
Pan		19.36	44.65	89.30	

HYDROMETER ANALYSIS (BS 1377 : 1975)

Weight of soil : 60.00 g
Specific Gravity (Gs) : 2.595
Meniscus Correction,c : -2.00
Viscosity of water : 0.8711
Tube No. : 1
Hydrometer No. : A1
Temperature Correction, mt : 1.01
Dispersant Correction, x : 4

Time	Elapsed Time t min	Hydrometer reading R'h	TRUE Reading Rh	Effective depth HR mm	Fully Corrected Reading	Particle Diameter D mm	Percentage Finer Than D K %
	0	0.0	0.0	0.000	0.0	0.0000	0.00
	0.5	24.0	22.0	138.77	22.2	0.0608	52.13
	1	23.0	21.0	140.33	21.2	0.0432	49.78
	2	22.0	20.0	141.89	20.2	0.0307	47.44
	5	20.0	18.0	145.01	18.2	0.0197	42.75
	15	17.0	15.0	149.69	15.2	0.0115	35.71
	30	15.0	13.0	152.81	13.2	0.0082	31.02
	60	14.0	12.0	154.37	12.2	0.0059	28.67
	240	12.5	10.5	156.71	10.7	0.0029	25.16
	1440	11.0	9.0	159.05	9.2	0.0012	21.64

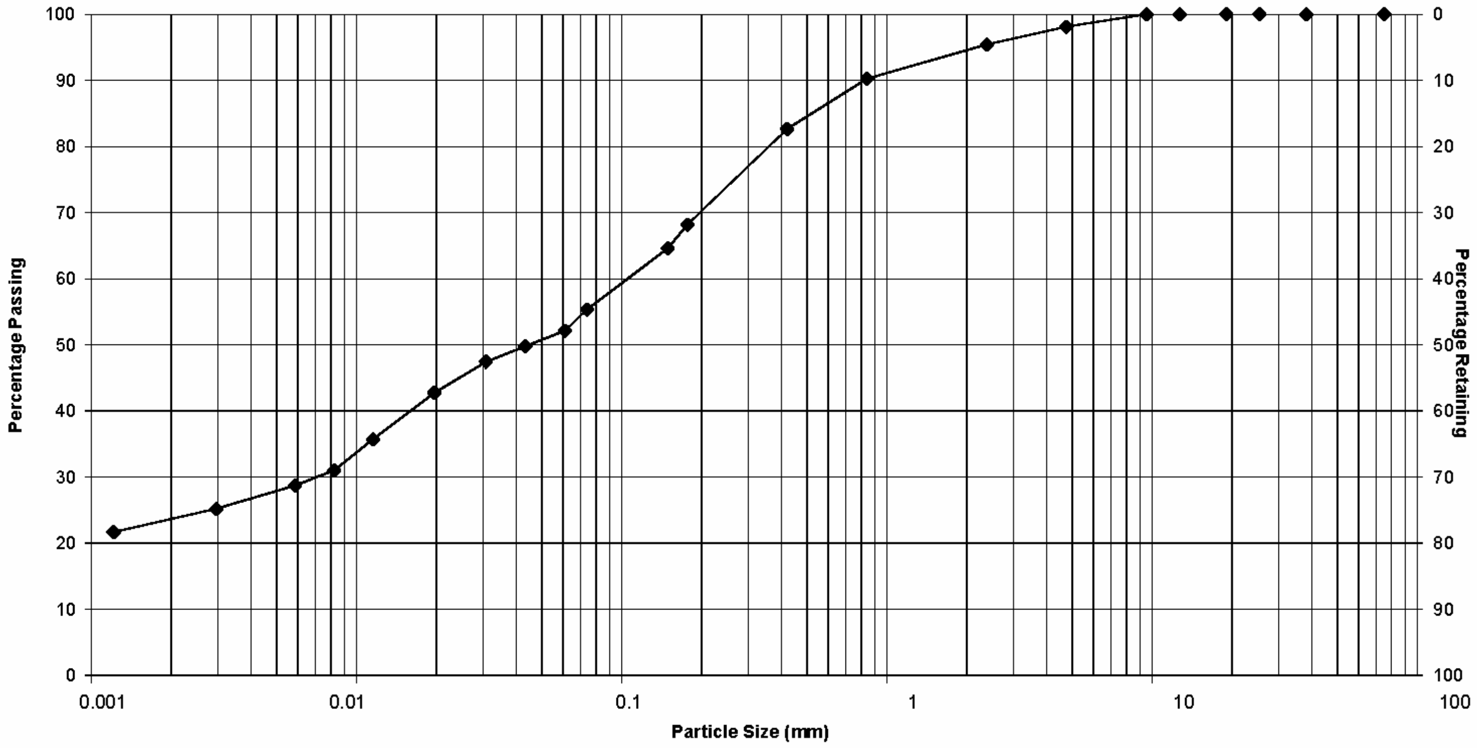
NOTES :

PARTICLE SIZE DISTRIBUTION ANALYSIS (ASTM D 422)

Project : **SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM**
Client : NIHON SUIDOI CONSULTANT
Location : Bali
Tested by : Ria Irmawan
Date : 28-Jul-11

Hole No. : BH - 01
Depth : 1.50 - 2.00 m

Sample Type : UDS
Sample Description : silty CLAY



CLAY	SILT	FINE	MEDIUM	COARSE	GRAVEL	COBBLES
		SAND				
27.86%	27.67%	42.59%			1.88%	0.00%

Project	**SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM**	
Client	NIHON SUIDOI CONSULTANT	
Location	Bali	Date: 28-Jul-11
Tested By	Ria Irmawan	Checked By: M.Iqbal, ST

PARTICLE SIZE DISTRIBUTION ANALYSIS

Hole No. : BH - 01 Sample Type : UDS
Depth : 15.50 - 16.00 m Sample Description : silty CLAY

SIEVE ANALYSIS (ASTM D 422)

Initial weight of dry soil : 29.32 g

Sieve No.	Sieve Opening mm	Wt. Soil Retained	Percent Retained %	Cumulative Percent Retained %	Percent Finer %
3"	101.600	0.000	0.00	0.00	100.00
2"	75.000	0.000	0.00	0.00	100.00
1 1/2"	38.100	0.000	0.00	0.00	100.00
1"	25.400	0.000	0.00	0.00	100.00
3/4"	19.050	0.000	0.00	0.00	100.00
1/2"	12.700	0.000	0.00	0.00	100.00
3/8"	9.525	0.000	0.00	0.00	100.00
4	4.760	0.000	0.00	0.00	100.00
8	2.380	0.000	0.00	0.00	100.00
20	0.840	0.000	0.00	0.00	100.00
40	0.420	0.380	1.30	1.30	98.70
80	0.177	0.370	1.26	2.56	97.44
100	0.149	0.080	0.27	2.83	97.17
200	0.074	0.490	1.67	4.50	95.50
Pan		1.32	4.50	9.00	

HYDROMETER ANALYSIS (BS 1377 : 1975)

Weight of soil : 60.00 g Tube No. : 1
Specific Gravity (Gs) : 2.595 Hydrometer No. : A1
Meniscus Correction,c : -2.00 Temperature Correction, mt : 1.01
Viscosity of water : 0.8711 Dispersant Correction, x : 4

Time	Elapsed Time t min	Hydrometer reading R'h	TRUE Reading Rh	Effective depth HR mm	Fully Corrected Reading	Particle Diameter D mm	Percentage Finer Than D K %
	0	0.0	0.0	0.000	0.0	0.0000	0.00
	0.5	28.0	26.0	132.53	26.2	0.0594	90.96
	1	27.5	25.5	133.31	25.7	0.0422	89.22
	2	26.0	24.0	135.65	24.2	0.0301	84.02
	5	24.0	22.0	138.77	22.2	0.0192	77.09
	15	21.0	19.0	143.45	19.2	0.0113	66.68
	30	20.0	18.0	145.01	18.2	0.0080	63.21
	60	19.0	17.0	146.57	17.2	0.0057	59.75
	240	17.0	15.0	149.69	15.2	0.0029	52.81
	1440	14.0	12.0	154.37	12.2	0.0012	42.41

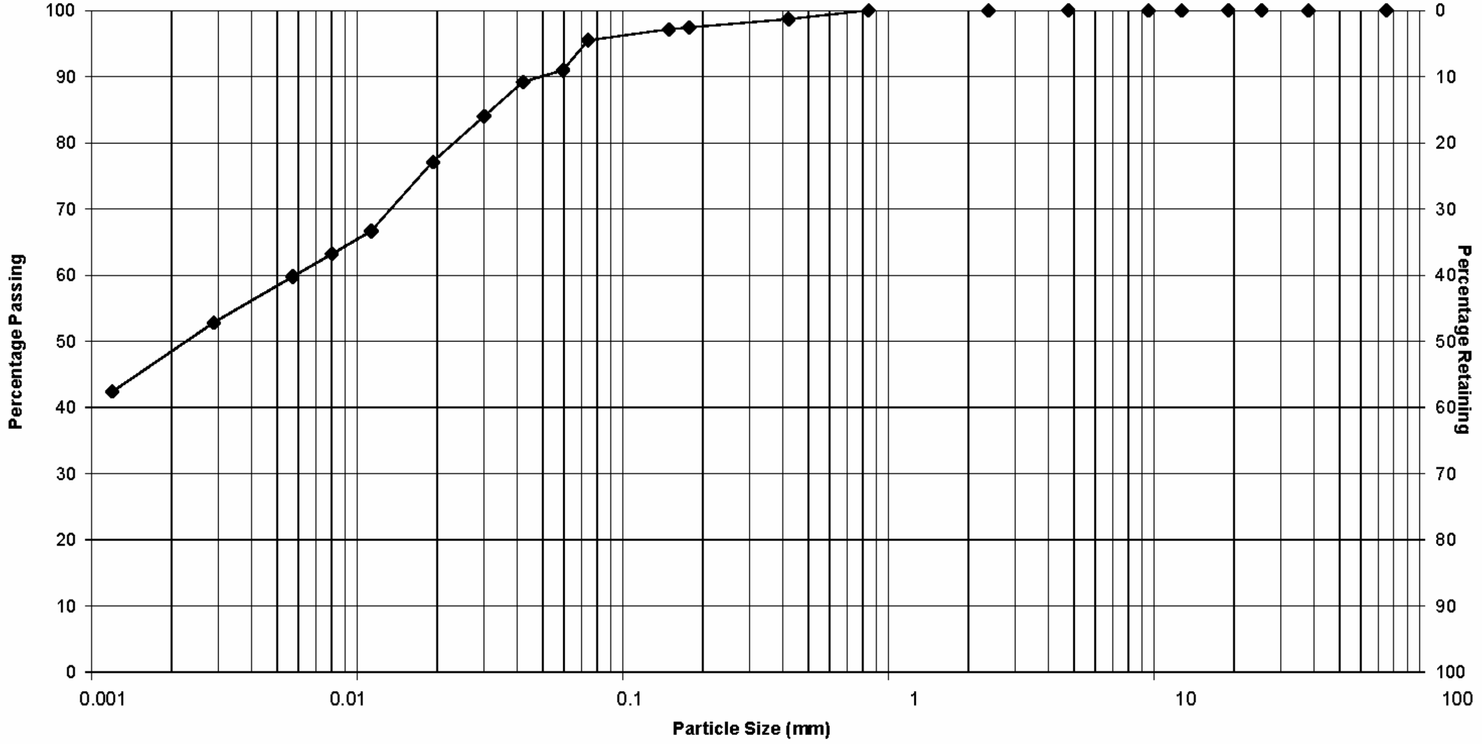
NOTES :

PARTICLE SIZE DISTRIBUTION ANALYSIS (ASTM D 422)

Project : SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM
Client : NIHON SUIDOI CONSULTANT
Location : Bali
Tested by : Ria Irmawan
Date : 28-Jul-11

Hole No. : BH - 01
Depth : 15.50 - 16.00 m

Sample Type : UDS
Sample Description : silty CLAY



CLAY	SILT	SAND FINE / MEDIUM / COARSE	GRAVEL	COBBLES
58.40%	37.13%	4.47%	0.00%	0.00%

	Project	**SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM**		
	Client	NIHON SUIDOI CONSULTANT		
	Location	Bali	Date	28-Jul-11
	Tested By	Ria Irmawan	Checked By	M.Iqbal, ST

PARTICLE SIZE DISTRIBUTION ANALYSIS

Hole No. : BH - 01
Depth : 19.50 - 20.00 m
Sample Type : UDS
Sample Description : silty CLAY

SIEVE ANALYSIS (ASTM D 422)

Initial weight of dry soil : 33.95 g

Sieve No.	Sieve Opening mm	Wt. Soil Retained	Percent Retained %	Cumulative Percent Retained %	Percent Finer %
3"	101.600	0.000	0.00	0.00	100.00
2"	75.000	0.000	0.00	0.00	100.00
1 1/2"	38.100	0.000	0.00	0.00	100.00
1"	25.400	0.000	0.00	0.00	100.00
3/4"	19.050	0.000	0.00	0.00	100.00
1/2"	12.700	0.000	0.00	0.00	100.00
3/8"	9.525	0.000	0.00	0.00	100.00
4	4.760	0.000	0.00	0.00	100.00
8	2.380	0.420	1.24	1.24	98.76
20	0.840	0.780	2.30	3.53	96.47
40	0.420	0.350	1.03	4.57	95.43
80	0.177	0.340	1.00	5.57	94.43
100	0.149	0.060	0.18	5.74	94.26
200	0.074	1.000	2.95	8.69	91.31
Pan		2.95	8.69	17.38	

HYDROMETER ANALYSIS (BS 1377 : 1975)

Weight of soil : 60.00 g
Specific Gravity (Gs) : 2.595
Meniscus Correction,c : -2.00
Viscosity of water : 0.8711
Tube No. : 1
Hydrometer No. : A1
Temperature Correction, mt : 1.01
Dispersant Correction, x : 4

Time	Elapsed Time t min	Hydrometer reading R'h	TRUE Reading Rh	Effective depth HR mm	Fully Corrected Reading	Particle Diameter D mm	Percentage Finer Than D K %
	0	0.0	0.0	0.000	0.0	0.0000	0.00
	0.5	31.0	29.0	127.85	29.2	0.0584	87.54
	1	30.0	28.0	129.41	28.2	0.0415	84.54
	2	29.0	27.0	130.97	27.2	0.0295	81.55
	5	27.0	25.0	134.09	25.2	0.0189	75.56
	15	25.0	23.0	137.21	23.2	0.0110	69.57
	30	23.0	21.0	140.33	21.2	0.0079	63.58
	60	21.0	19.0	143.45	19.2	0.0056	57.59
	240	18.0	16.0	148.13	16.2	0.0029	48.60
	1440	15.0	13.0	152.81	13.2	0.0012	39.62

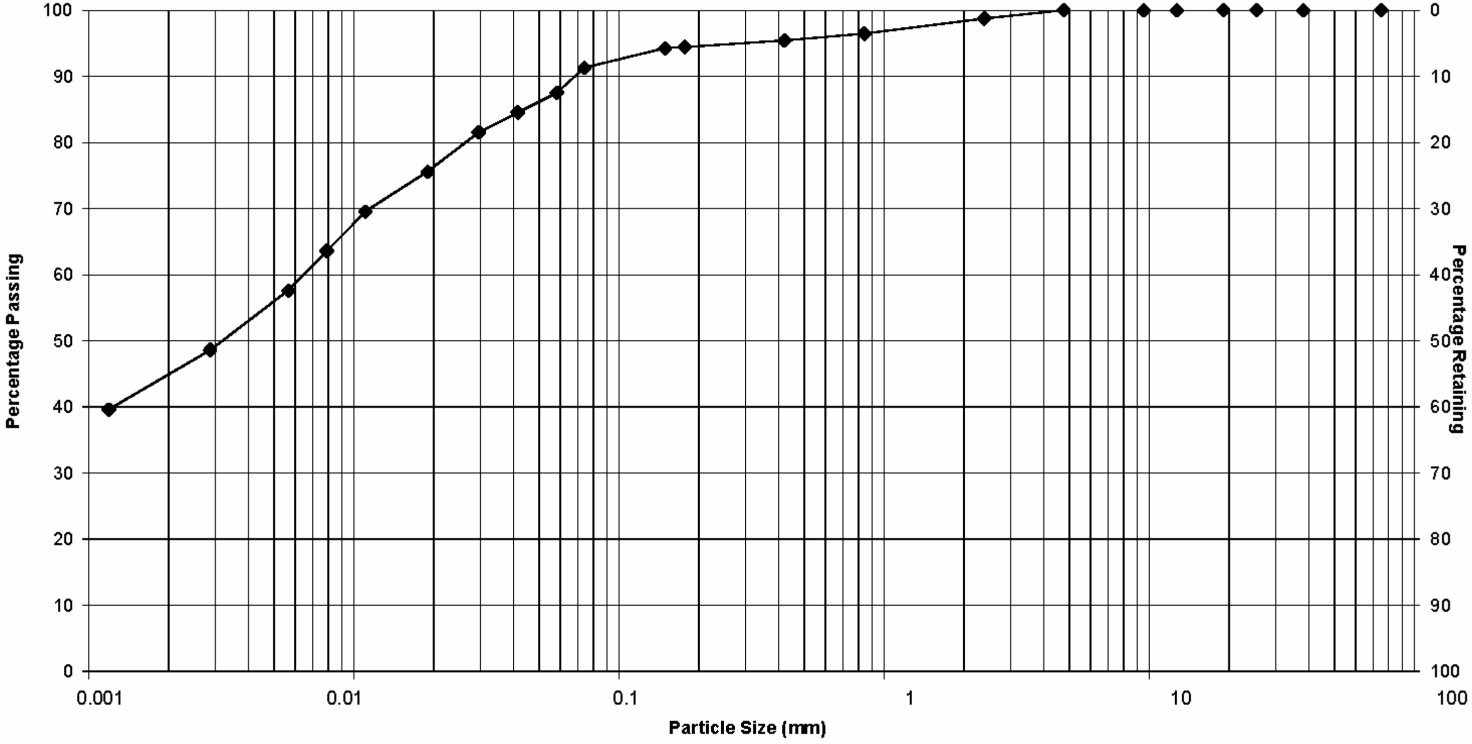
NOTES :

PARTICLE SIZE DISTRIBUTION ANALYSIS (ASTM D 422)

Project : SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM
Client : NIHON SUIDOI CONSULTANT
Location : Bali
Tested by : Ria Irmawan
Date : 28-Jul-11

Hole No. : BH - 01
Depth : 19.50 - 20.00 m

Sample Type : UDS
Sample Description : silty CLAY



CLAY	SILT	SAND FINE / MEDIUM / COARSE	GRAVEL	COBBLES
55.98%	35.39%	8.63%	0.00%	0.00%

Project	SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM		
Client	NIHON SUIDOI CONSULTANT		
Location	Bali	Date	2-Aug-11
Tested By	Ria Irmawan	Checked By	M.Iqbal, ST

PARTICLE SIZE DISTRIBUTION ANALYSIS

Hole No. : BH - 02 Sample Type : UDS
Depth : 4.50 - 5.00 Sample Description : silty CLAY

SIEVE ANALYSIS (ASTM D 422)

Initial weight of dry soil : 34.51 g

Sieve No.	Sieve Opening mm	Wt. Soil Retained	Percent Retained %	Cumulative Percent Retained %	Percent Finer %
3"	101.600	0.000	0.00	0.00	100.00
2"	75.000	0.000	0.00	0.00	100.00
1 1/2"	38.100	0.000	0.00	0.00	100.00
1"	25.400	0.000	0.00	0.00	100.00
3/4"	19.050	0.000	0.00	0.00	100.00
1/2"	12.700	0.000	0.00	0.00	100.00
3/8"	9.525	0.000	0.00	0.00	100.00
4	4.760	0.000	0.00	0.00	100.00
8	2.380	0.000	0.00	0.00	100.00
20	0.840	0.020	0.06	0.06	99.94
40	0.420	0.040	0.12	0.17	99.83
80	0.177	0.450	1.30	1.48	98.52
100	0.149	0.440	1.27	2.75	97.25
200	0.074	4.560	13.21	15.97	84.03
Pan		5.51	15.97	31.93	

HYDROMETER ANALYSIS (BS 1377 : 1975)

Weight of soil : 60.00 g
Specific Gravity (Gs) : 2.623
Meniscus Correction,c : -2.00
Viscosity of water : 0.8711

Tube No. : 1
Hydrometer No. : A1
Temperature Correction, mt : 1.01
Dispersant Correction, x : 4

Time	Elapsed Time t min	Hydrometer reading R'h	TRUE Reading Rh	Effective depth HR mm	Fully Corrected Reading	Particle Diameter D mm	Percentage Finer Than D K %
	0	0.0	0.0	0.000	0.0	0.0000	0.00
	0.5	29.0	27.0	130.97	27.2	0.0586	79.69
	1	27.0	25.0	134.09	25.2	0.0419	73.84
	2	26.0	24.0	135.65	24.2	0.0298	70.91
	5	25.0	23.0	137.21	23.2	0.0190	67.98
	15	22.0	20.0	141.89	20.2	0.0111	59.20
	30	20.0	18.0	145.01	18.2	0.0080	53.35
	60	18.0	16.0	148.13	16.2	0.0057	47.50
	240	16.0	14.0	151.25	14.2	0.0029	41.64
	1440	13.0	11.0	155.93	11.2	0.0012	32.86

NOTES :

PARTICLE SIZE DISTRIBUTION ANALYSIS (ASTM D 422)

Project : **SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM**

Client : NIHON SUIDOI CONSULTANT

Location : Bali

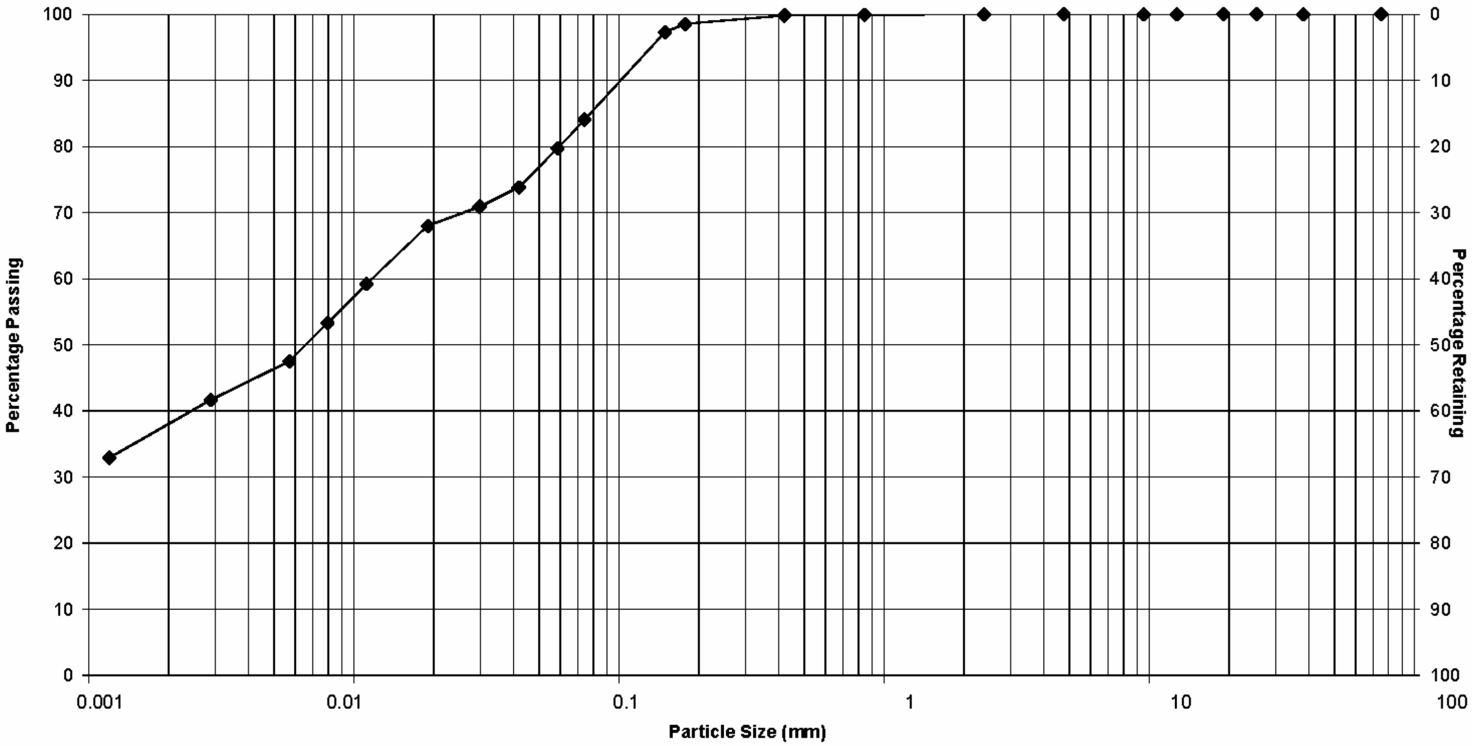
Tested by : Ria Irmawan   Date : 2-Aug-11

Hole No. : BH - 02

Depth : 4.50 - 5.00

Sample Type : UDS

Sample Description : silty CLAY



CLAY	SILT	SAND FINE / MEDIUM / COARSE	GRAVEL	COBBLES
46.39%	37.90%	15.71%	0.00%	0.00%

Project	**SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM**			
Client	NIHON SUIDOI CONSULTANT			
Location	Bali	Date	2-Aug-11	
Tested By	Ria Irmawan	Checked By	M.Iqbal, ST	

PARTICLE SIZE DISTRIBUTION ANALYSIS

Hole No. : BH - 02
Depth : 6.50 - 7.00 m
Sample Type : UDS
Sample Description : clayey SAND

SIEVE ANALYSIS (ASTM D 422)

Initial weight of dry soil : 39.69 g

Sieve No.	Sieve Opening mm	Wt. Soil Retained	Percent Retained %	Cumulative Percent Retained %	Percent Finer %
3"	101.600	0.000	0.00	0.00	100.00
2"	75.000	0.000	0.00	0.00	100.00
1 1/2"	38.100	0.000	0.00	0.00	100.00
1"	25.400	0.000	0.00	0.00	100.00
3/4"	19.050	0.000	0.00	0.00	100.00
1/2"	12.700	0.000	0.00	0.00	100.00
3/8"	9.525	0.000	0.00	0.00	100.00
4	4.760	0.000	0.00	0.00	100.00
8	2.380	0.260	0.66	0.66	99.34
20	0.840	1.290	3.25	3.91	96.09
40	0.420	3.380	8.52	12.42	87.58
80	0.177	8.480	21.37	33.79	66.21
100	0.149	2.330	5.87	39.66	60.34
200	0.074	5.950	14.99	54.65	45.35
Pan		21.69	54.65	109.30	

HYDROMETER ANALYSIS (BS 1377 : 1975)

Weight of soil : 60.00 g
Specific Gravity (Gs) : 2.653
Meniscus Correction,c : -2.00
Viscosity of water : 0.8711
Tube No. : 1
Hydrometer No. : A1
Temperature Correction, mt : 1.01
Dispersant Correction, x : 4

Time	Elapsed Time t min	Hydrometer reading R'h	TRUE Reading Rh	Effective depth HR mm	Fully Corrected Reading	Particle Diameter D mm	Percentage Finer Than D K %
	0	0.0	0.0	0.000	0.0	0.0000	0.00
	0.5	18.0	16.0	148.13	16.2	0.0617	41.01
	1	17.0	15.0	149.69	15.2	0.0439	38.48
	2	16.0	14.0	151.25	14.2	0.0312	35.96
	5	14.0	12.0	154.37	12.2	0.0199	30.90
	15	14.0	12.0	154.37	12.2	0.0115	30.90
	30	13.0	11.0	155.93	11.2	0.0082	28.38
	60	12.0	10.0	157.49	10.2	0.0058	25.85
	240	11.0	9.0	159.05	9.2	0.0029	23.32
	1440	10.0	8.0	160.61	8.2	0.0012	20.79

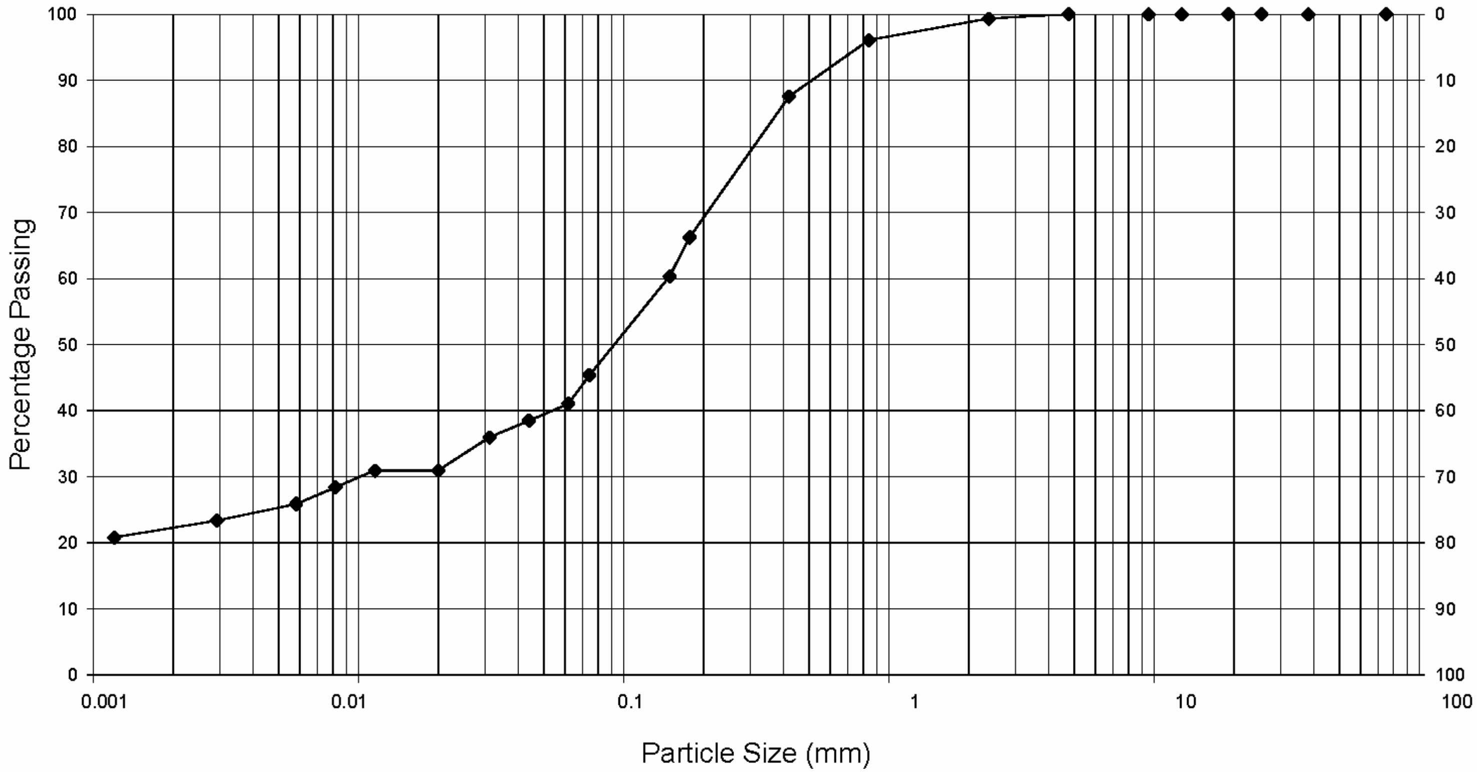
NOTES :

PARTICLE SIZE DISTRIBUTION ANALYSIS (ASTM D 422)

Project : **SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM**
Client : NIHON SUIDOI CONSULTANT
Location : Bali
Tested by : Ria Irmawan
Date : 2-Aug-11

Hole No. : BH - 02
Depth : 6.50 - 7.00 m

Sample Type : UDS
Sample Description : clayey SAND



CLAY	SILT	SAND			GRAVEL	COBBLES
		FINE	MEDIUM	COARSE		
25.30%	20.34%	54.36%			0.00%	0.00%

Project	SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM			
Client	NIHON SUIDOI CONSULTANT			
Location	Bali	Date	2-Aug-11	
Tested By	Ria Irmawan	Checked By	M.Iqbal, ST	

PARTICLE SIZE DISTRIBUTION ANALYSIS

Hole No. : BH - 02 Sample Type : UDS
Depth : 8.50 - 9.00 m Sample Description : silty CLAY

SIEVE ANALYSIS (ASTM D 422)

Initial weight of dry soil : 33.98 g

Sieve No.	Sieve Opening mm	Wt. Soil Retained	Percent Retained %	Cumulative Percent Retained %	Percent Finer %
3"	101.600	0.000	0.00	0.00	100.00
2"	75.000	0.000	0.00	0.00	100.00
1 1/2"	38.100	0.000	0.00	0.00	100.00
1"	25.400	0.000	0.00	0.00	100.00
3/4"	19.050	0.000	0.00	0.00	100.00
1/2"	12.700	0.000	0.00	0.00	100.00
3/8"	9.525	0.000	0.00	0.00	100.00
4	4.760	0.090	0.26	0.26	99.74
8	2.380	0.470	1.38	1.65	98.35
20	0.840	1.200	3.53	5.18	94.82
40	0.420	1.450	4.27	9.45	90.55
80	0.177	2.310	6.80	16.24	83.76
100	0.149	0.580	1.71	17.95	82.05
200	0.074	2.880	8.48	26.43	73.57
Pan		8.98	26.43	52.85	

HYDROMETER ANALYSIS (BS 1377 : 1975)

Weight of soil : 60.00 g
Specific Gravity (Gs) : 2.653
Meniscus Correction,c : -2.00
Viscosity of water : 0.8711

Tube No. : 1
Hydrometer No. : A1
Temperature Correction, mt : 1.01
Dispersant Correction, x : 4

Time	Elapsed Time t min	Hydrometer reading R'h	TRUE Reading Rh	Effective depth HR mm	Fully Corrected Reading	Particle Diameter D mm	Percentage Finer Than D K %
	0	0.0	0.0	0.000	0.0	0.0000	0.00
	0.5	25.0	23.0	137.21	23.2	0.0594	68.57
	1	24.0	22.0	138.77	22.2	0.0422	65.62
	2	22.0	20.0	141.89	20.2	0.0302	59.71
	5	20.0	18.0	145.01	18.2	0.0193	53.81
	15	18.0	16.0	148.13	16.2	0.0113	47.90
	30	17.0	15.0	149.69	15.2	0.0080	44.95
	60	16.0	14.0	151.25	14.2	0.0057	42.00
	240	14.0	12.0	154.37	12.2	0.0029	36.10
	1440	12.0	10.0	157.49	10.2	0.0012	30.19

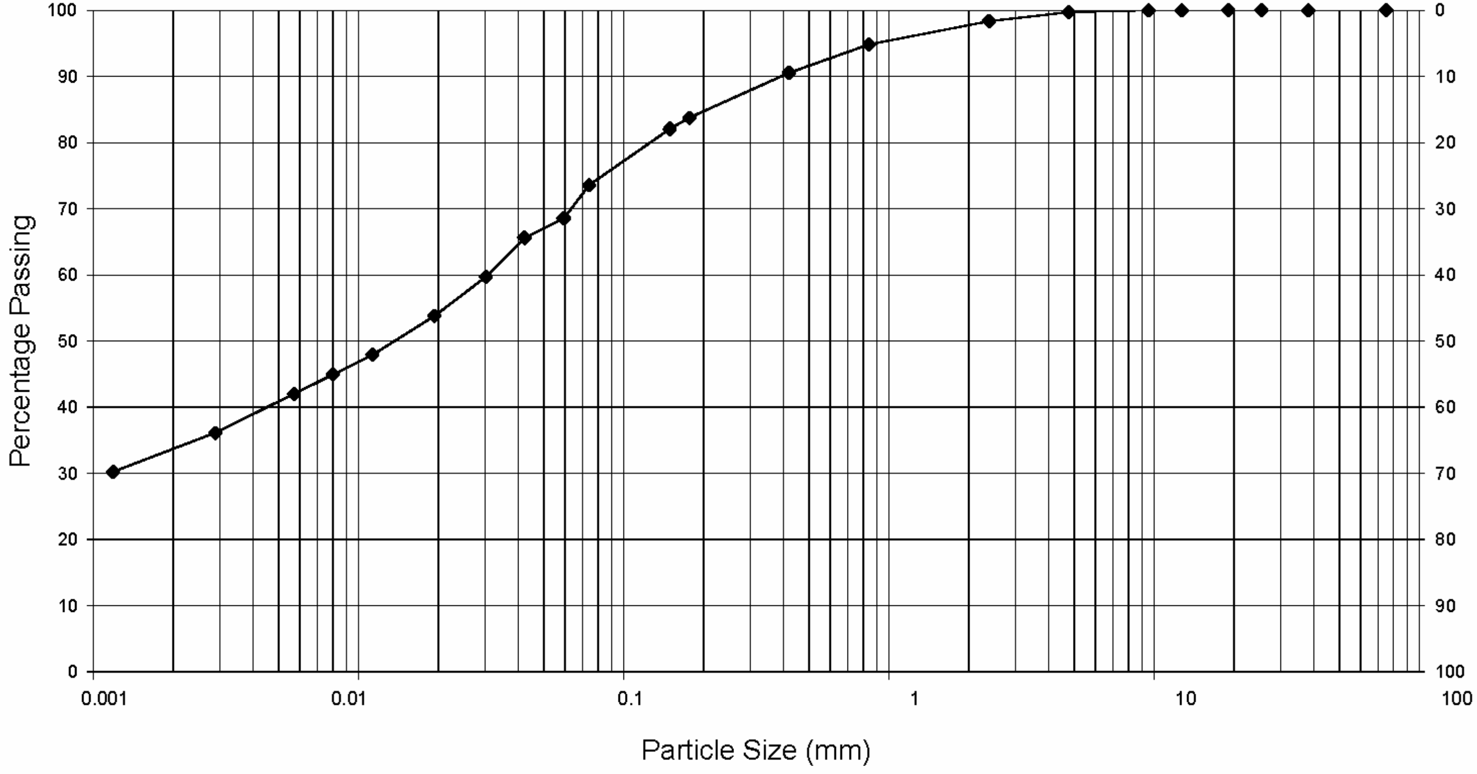
NOTES :

PARTICLE SIZE DISTRIBUTION ANALYSIS (ASTM D 422)

Project : **SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM**
Client : NIHON SUIDOI CONSULTANT
Location : Bali
Tested by : Ria Irmawan
Date : 2-Aug-11

Hole No. : BH - 02
Depth : 8.50 - 9.00 m

Sample Type : UDS
Sample Description : silty CLAY



CLAY	SILT	FINE	MEDIUM	COARSE	GRAVEL	COBBLES
		SAND				
40.88%	32.86%	25.99%			0.27%	0.00%

Project	**SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM**			
Client	NIHON SUIDOI CONSULTANT			
Location	Bali	Date	3-Aug-11	
Tested By	Ria Irmawan	Checked By	M.Iqbal, ST	

PARTICLE SIZE DISTRIBUTION ANALYSIS

Hole No.	: BH - 03	Sample Type :	UDS
Depth	: 2.50 - 3.00 m	Sample Description :	silty CLAY

SIEVE ANALYSIS (ASTM D 422)

Initial weight of dry soil : 39.33 g

Sieve No.	Sieve Opening mm	Wt. Soil Retained	Percent Retained %	Cumulative Percent Retained %	Percent Finer %
3"	101.600	0.000	0.00	0.00	100.00
2"	75.000	0.000	0.00	0.00	100.00
1 1/2"	38.100	0.000	0.00	0.00	100.00
1"	25.400	0.000	0.00	0.00	100.00
3/4"	19.050	0.000	0.00	0.00	100.00
1/2"	12.700	0.000	0.00	0.00	100.00
3/8"	9.525	0.000	0.00	0.00	100.00
4	4.760	1.900	4.83	4.83	95.17
8	2.380	1.120	2.85	7.68	92.32
20	0.840	2.720	6.92	14.59	85.41
40	0.420	3.450	8.77	23.37	76.63
80	0.177	5.750	14.62	37.99	62.01
100	0.149	1.350	3.43	41.42	58.58
200	0.074	3.040	7.73	49.15	50.85
Pan		19.33	49.15	98.30	

HYDROMETER ANALYSIS (BS 1377 : 1975)

Weight of soil :	60.00	g	Tube No.	: 1
Specific Gravity (Gs) :	2.653		Hydrometer No.	: A1
Meniscus Correction,c :	-2.00		Temperature Correction, mt	: 1.01
Viscosity of water :	0.8711		Dispersant Correction, x	: 4

Time	Elapsed Time t min	Hydrometer reading R'h	TRUE Reading Rh	Effective depth HR mm	Fully Corrected Reading	Particle Diameter D mm	Percentage Finer Than D K %
	0	0.0	0.0	0.000	0.0	0.0000	0.00
	0.5	20.0	18.0	145.01	18.2	0.0611	46.49
	1	19.0	17.0	146.57	17.2	0.0434	43.94
	2	18.0	16.0	148.13	16.2	0.0309	41.39
	5	16.0	14.0	151.25	14.2	0.0197	36.29
	15	15.0	13.0	152.81	13.2	0.0114	33.74
	30	14.0	12.0	154.37	12.2	0.0081	31.19
	60	13.0	11.0	155.93	11.2	0.0058	28.63
	240	12.0	10.0	157.49	10.2	0.0029	26.08
	1440	10.0	8.0	160.61	8.2	0.0012	20.98

NOTES :

PARTICLE SIZE DISTRIBUTION ANALYSIS (ASTM D 422)

Project : **SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM**

Client : NIHON SUIDOI CONSULTANT

Location : Bali

Tested by : Ria Irmawan

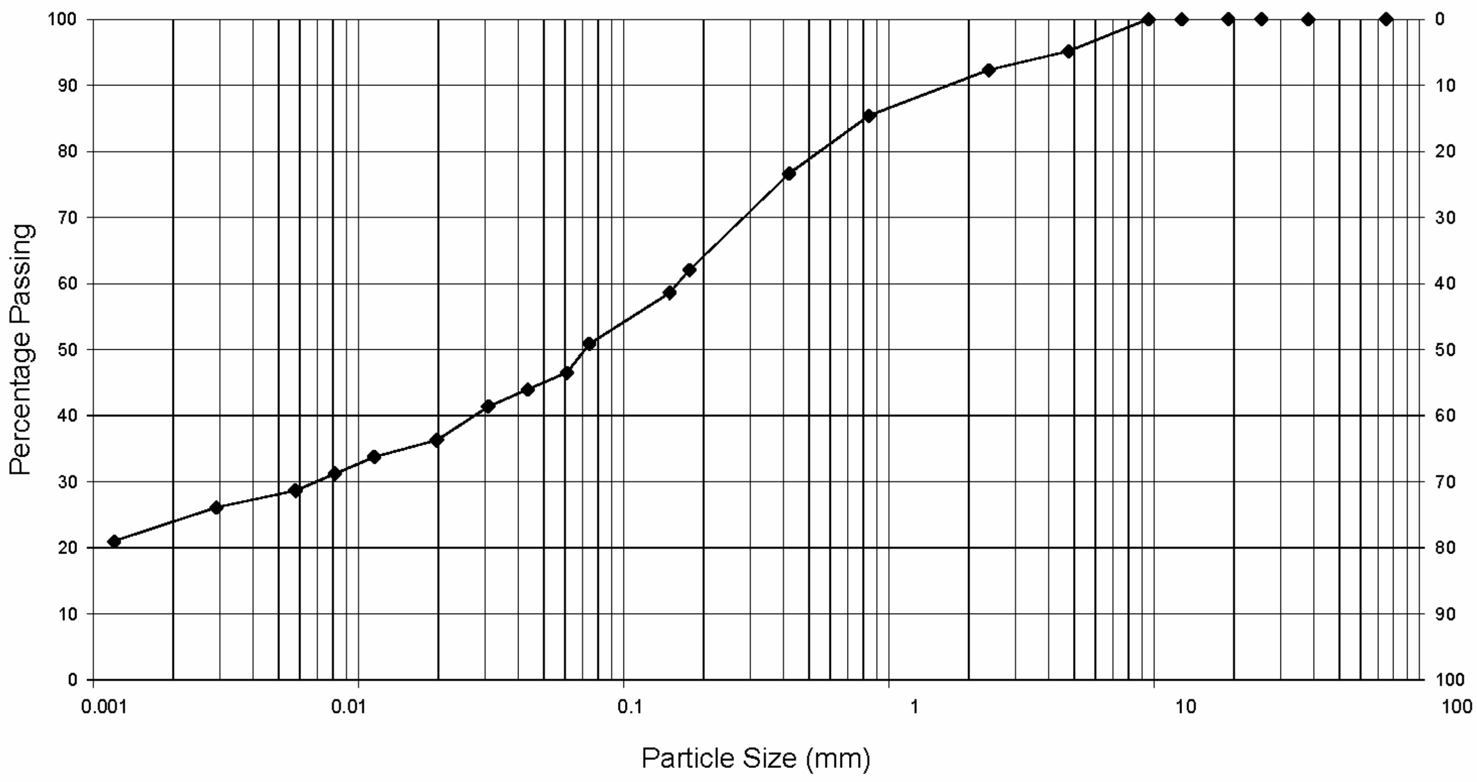
Date : 3-Aug-11

Hole No. : BH - 03

Depth : 2.50 - 3.00 m

Sample Type : UDS

Sample Description : silty CLAY



CLAY	SILT	SAND FINE / MEDIUM / COARSE	GRAVEL	COBBLES
28.10%	22.90%	44.16%	4.84%	0.00%

Project	**SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM**		
Client	NIHON SUIDOI CONSULTANT		
Location	Bali	Date	3-Aug-11
Tested By	Ria Irmawan	Checked By	M.Iqbal, ST

PARTICLE SIZE DISTRIBUTION ANALYSIS

Hole No. : BH - 03
Depth : 8.50 - 9.00 m
Sample Type : UDS
Sample Description : silty SAND

SIEVE ANALYSIS (ASTM D 422)

Initial weight of dry soil : 40.14 g

Sieve No.	Sieve Opening mm	Wt. Soil Retained	Percent Retained %	Cumulative Percent Retained %	Percent Finer %
3"	101.600	0.000	0.00	0.00	100.00
2"	75.000	0.000	0.00	0.00	100.00
1 1/2"	38.100	0.000	0.00	0.00	100.00
1"	25.400	0.000	0.00	0.00	100.00
3/4"	19.050	0.000	0.00	0.00	100.00
1/2"	12.700	0.000	0.00	0.00	100.00
3/8"	9.525	0.000	0.00	0.00	100.00
4	4.760	5.060	12.61	12.61	87.39
8	2.380	4.130	10.29	22.89	77.11
20	0.840	3.920	9.77	32.66	67.34
40	0.420	3.140	7.82	40.48	59.52
80	0.177	4.000	9.97	50.45	49.55
100	0.149	1.810	4.51	54.96	45.04
200	0.074	5.080	12.66	67.61	32.39
Pan		27.14	67.61	135.23	

HYDROMETER ANALYSIS (BS 1377 : 1975)

Weight of soil : 60.00 g
Specific Gravity (Gs) : 2.653
Meniscus Correction,c : -2.00
Viscosity of water : 0.8711
Tube No. : 1
Hydrometer No. : A1
Temperature Correction, mt : 1.01
Dispersant Correction, x : 4

Time	Elapsed Time t min	Hydrometer reading R'h	TRUE Reading Rh	Effective depth HR mm	Fully Corrected Reading	Particle Diameter D mm	Percentage Finer Than D K %
	0	0.0	0.0	0.000	0.0	0.0000	0.00
	0.5	13.0	11.0	155.93	11.2	0.0633	28.06
	1	12.0	10.0	157.49	10.2	0.0450	25.56
	2	11.0	9.0	159.05	9.2	0.0320	23.06
	5	10.5	8.5	159.83	8.7	0.0203	21.81
	15	10.0	8.0	160.61	8.2	0.0117	20.56
	30	8.0	6.0	163.73	6.2	0.0084	15.56
	60	6.0	4.0	166.85	4.2	0.0060	10.56
	240	3.0	1.0	171.53	1.2	0.0030	3.07
	1440	0.0	-2.0	176.21	-1.8	0.0013	-4.43

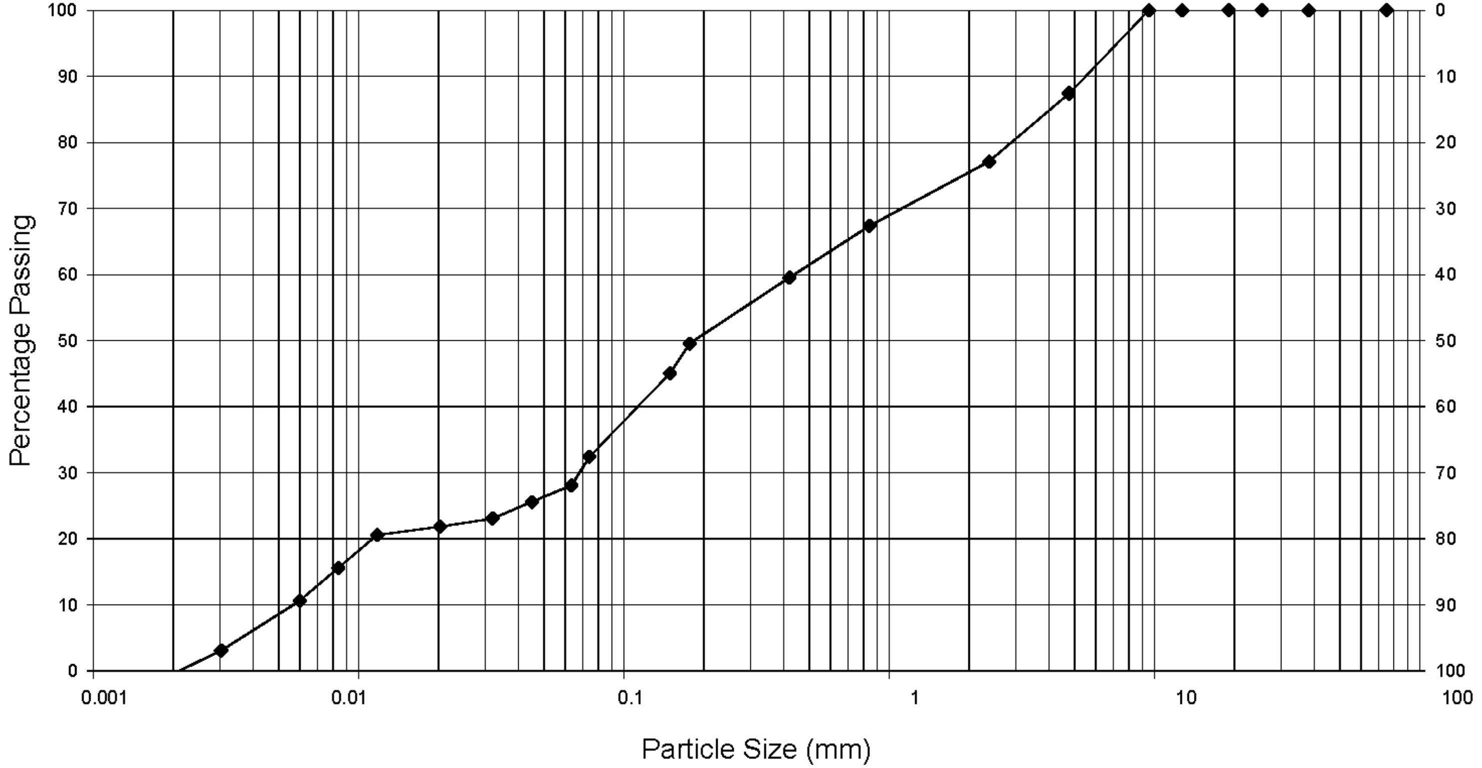
NOTES :

PARTICLE SIZE DISTRIBUTION ANALYSIS (ASTM D 422)

Project : **SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM**
Client : NIHON SUIDOI CONSULTANT
Location : Bali
Tested by : Ria Irmawan
Date : 3-Aug-11

Hole No. : BH - 03
Depth : 8.50 - 9.00 m

Sample Type : UDS
Sample Description : silty SAND



CLAY	SILT	SAND			GRAVEL	COBBLES
		FINE	MEDIUM	COARSE		
8.59%	24.04%	54.73%			12.64%	0.00%

	Project	SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM		
	Client	NIHON SUIDOI CONSULTANT		
	Location	Bali	Date	11-Aug-11
	Tested By	Ria Irmawan	Checked By	M.Iqbal, ST

PARTICLE SIZE DISTRIBUTION ANALYSIS

Hole No. : BH - 04
Depth : 2.50 - 3.00
Sample Type : UDS
Sample Description : silty CLAY

SIEVE ANALYSIS (ASTM D 422)

Initial weight of dry soil : 43.04 g

Sieve No.	Sieve Opening mm	Wt. Soil Retained	Percent Retained %	Cumulative Percent Retained %	Percent Finer %
3"	101.600	0.000	0.00	0.00	100.00
2"	75.000	0.000	0.00	0.00	100.00
1 1/2"	38.100	0.000	0.00	0.00	100.00
1"	25.400	0.000	0.00	0.00	100.00
3/4"	19.050	0.000	0.00	0.00	100.00
1/2"	12.700	0.000	0.00	0.00	100.00
3/8"	9.525	0.000	0.00	0.00	100.00
4	4.760	2.040	4.74	4.74	95.26
8	2.380	0.560	1.30	6.04	93.96
20	0.840	2.110	4.90	10.94	89.06
40	0.420	3.380	7.85	18.80	81.20
80	0.177	5.600	13.01	31.81	68.19
100	0.149	1.290	3.00	34.80	65.20
200	0.074	3.560	8.27	43.08	56.92
Pan		18.54	43.08	86.15	

HYDROMETER ANALYSIS (BS 1377 : 1975)

Weight of soil : 60.00 g
Specific Gravity (Gs) : 2.653
Meniscus Correction,c : -2.00
Viscosity of water : 0.8711
Tube No. : 1
Hydrometer No. : A1
Temperature Correction, mt : 1.01
Dispersant Correction, x : 4

Time	Elapsed Time t min	Hydrometer reading R'h	TRUE Reading Rh	Effective depth HR mm	Fully Corrected Reading	Particle Diameter D mm	Percentage Finer Than D K %
	0	0.0	0.0	0.000	0.0	0.0000	0.00
	0.5	24.5	22.5	137.99	22.7	0.0596	52.97
	1	23.0	21.0	140.33	21.2	0.0425	49.47
	2	22.0	20.0	141.89	20.2	0.0302	47.14
	5	21.5	19.5	142.67	19.7	0.0192	45.98
	15	19.5	17.5	145.79	17.7	0.0112	41.32
	30	18.0	16.0	148.13	16.2	0.0080	37.82
	60	17.0	15.0	149.69	15.2	0.0057	35.49
	240	15.5	13.5	152.03	13.7	0.0029	31.99
	1440	13.5	11.5	155.15	11.7	0.0012	27.33

NOTES :

PARTICLE SIZE DISTRIBUTION ANALYSIS (ASTM D 422)

Project : **SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM**

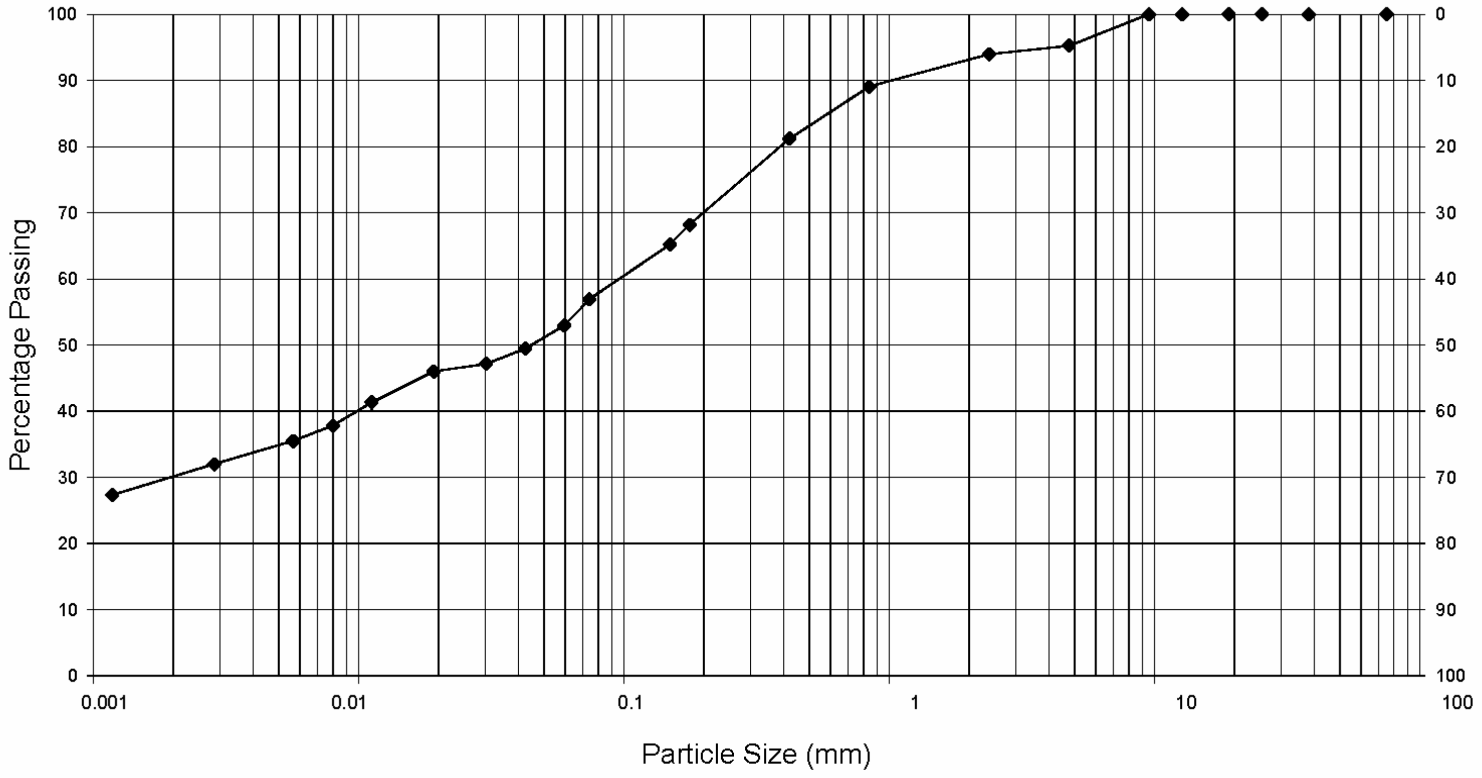
Client : NIHON SUIDOI CONSULTANT

Location : Bali

Tested by : Ria Irmawan   Date : 11-Aug-11

Hole No. : BH - 04
Depth : 2.50 - 3.00

Sample Type : UDS
Sample Description : silty CLAY



CLAY	SILT	SAND FINE · MEDIUM · COARSE	GRAVEL	COBBLES
34.85%	22.23%	38.18%	4.74%	0.00%

Project	**SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM**			
Client	NIHON SUIDOI CONSULTANT			
Location	Bali	Date	11-Aug-11	
Tested By	Ria Irmawan	Checked By	M.Iqbal, ST	

PARTICLE SIZE DISTRIBUTION ANALYSIS

Hole No. : BH - 04
Depth : 4.50 - 5.00
Sample Type : UDS
Sample Description : clayey SAND

SIEVE ANALYSIS (ASTM D 422)

Initial weight of dry soil : 41.60 g

Sieve No.	Sieve Opening mm	Wt. Soil Retained	Percent Retained %	Cumulative Percent Retained %	Percent Finer %
3"	101.600	0.000	0.00	0.00	100.00
2"	75.000	0.000	0.00	0.00	100.00
1 1/2"	38.100	0.000	0.00	0.00	100.00
1"	25.400	0.000	0.00	0.00	100.00
3/4"	19.050	0.000	0.00	0.00	100.00
1/2"	12.700	0.000	0.00	0.00	100.00
3/8"	9.525	0.000	0.00	0.00	100.00
4	4.760	0.130	0.31	0.31	99.69
8	2.380	0.120	0.29	0.60	99.40
20	0.840	1.180	2.84	3.44	96.56
40	0.420	3.780	9.09	12.52	87.48
80	0.177	8.580	20.63	33.15	66.85
100	0.149	3.320	7.98	41.13	58.87
200	0.074	5.490	13.20	54.33	45.67
Pan		22.60	54.33	108.65	

HYDROMETER ANALYSIS (BS 1377 : 1975)

Weight of soil : 60.00 g
Specific Gravity (Gs) : 2.653
Meniscus Correction,c : -2.00
Viscosity of water : 0.8711
Tube No. : 1
Hydrometer No. : A1
Temperature Correction, mt : 1.01
Dispersant Correction, x : 4

Time	Elapsed Time t min	Hydrometer reading R'h	TRUE Reading Rh	Effective depth HR mm	Fully Corrected Reading	Particle Diameter D mm	Percentage Finer Than D K %
	0	0.0	0.0	0.000	0.0	0.0000	0.00
	0.5	19.0	17.0	146.57	17.2	0.0614	41.54
	1	18.5	16.5	147.35	16.7	0.0435	40.33
	2	18.0	16.0	148.13	16.2	0.0309	39.13
	5	17.0	15.0	149.69	15.2	0.0196	36.72
	15	16.0	14.0	151.25	14.2	0.0114	34.31
	30	14.5	12.5	153.59	12.7	0.0081	30.69
	60	14.0	12.0	154.37	12.2	0.0058	29.48
	240	12.0	10.0	157.49	10.2	0.0029	24.66
	1440	10.0	8.0	160.61	8.2	0.0012	19.84

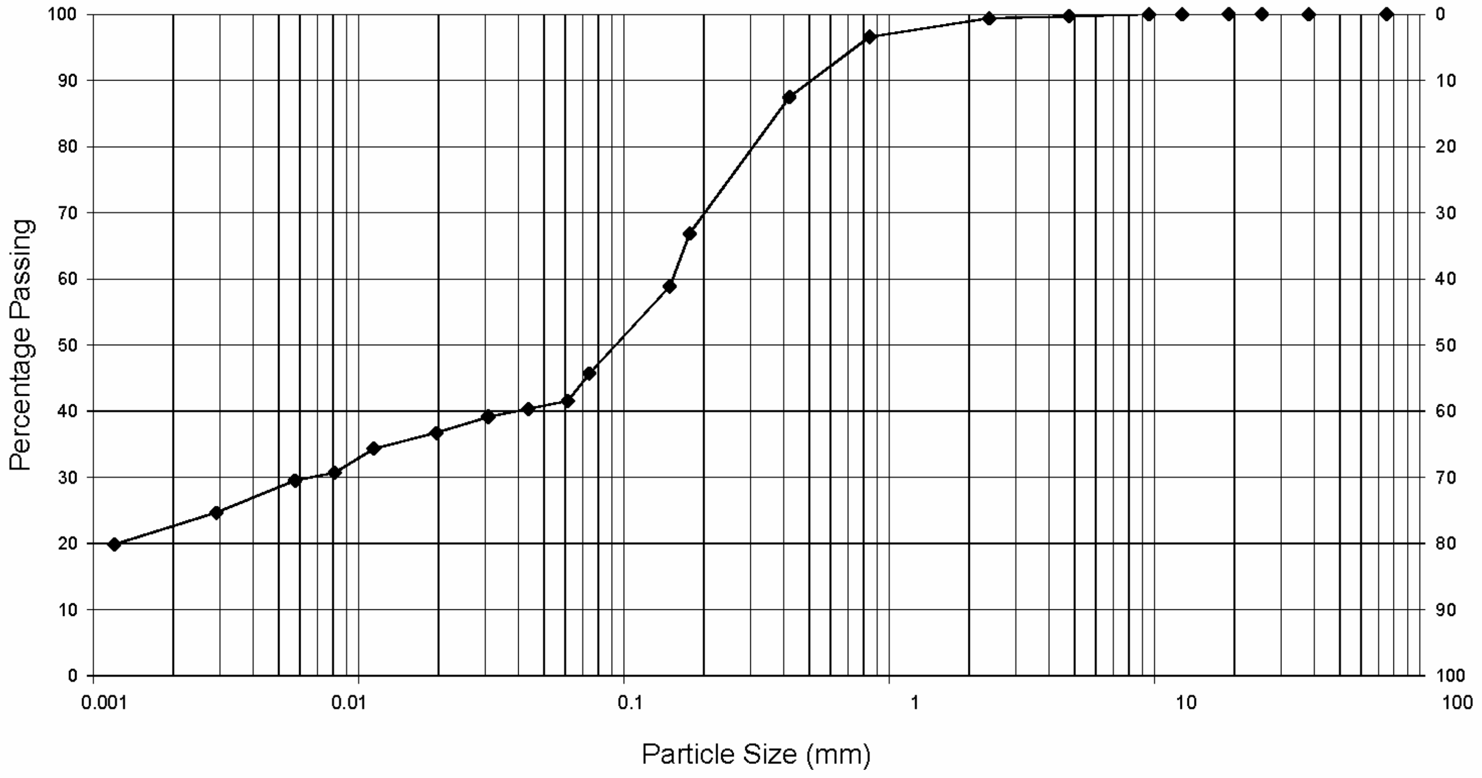
NOTES :

PARTICLE SIZE DISTRIBUTION ANALYSIS (ASTM D 422)

Project : **SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM**
Client : NIHON SUIDOI CONSULTANT
Location : Bali
Tested by : Ria Irmawan
Date : 11-Aug-11

Hole No. : BH - 04
Depth : 4.50 - 5.00

Sample Type : UDS
Sample Description : clayey SAND



CLAY	SILT	SAND FINE / MEDIUM / COARSE	GRAVEL	COBBLES
28.49%	17.44%	53.76%	0.31%	0.00%

Project	**SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM**			
Client	NIHON SUIDOI CONSULTANT			
Location	Bali	Date	11-Aug-11	
Tested By	Ria Irmawan	Checked By	M.Iqbal, ST	

PARTICLE SIZE DISTRIBUTION ANALYSIS

Hole No. : BH - 04
Depth : 8.50 - 9.00
Sample Type : UDS
Sample Description : clayey SAND

SIEVE ANALYSIS (ASTM D 422)

Initial weight of dry soil : 38.45 g

Sieve No.	Sieve Opening mm	Wt. Soil Retained	Percent Retained %	Cumulative Percent Retained %	Percent Finer %
3"	101.600	0.000	0.00	0.00	100.00
2"	75.000	0.000	0.00	0.00	100.00
1 1/2"	38.100	0.000	0.00	0.00	100.00
1"	25.400	0.000	0.00	0.00	100.00
3/4"	19.050	0.000	0.00	0.00	100.00
1/2"	12.700	0.000	0.00	0.00	100.00
3/8"	9.525	0.000	0.00	0.00	100.00
4	4.760	0.670	1.74	1.74	98.26
8	2.380	1.220	3.17	4.92	95.08
20	0.840	2.240	5.83	10.74	89.26
40	0.420	7.750	20.16	30.90	69.10
80	0.177	5.750	14.95	45.85	54.15
100	0.149	1.650	4.29	50.14	49.86
200	0.074	2.170	5.64	55.79	44.21
Pan		21.45	55.79	111.57	

HYDROMETER ANALYSIS (BS 1377 : 1975)

Weight of soil : 60.00 g
Specific Gravity (Gs) : 2.653
Meniscus Correction,c : -2.00
Viscosity of water : 0.8711
Tube No. : 1
Hydrometer No. : A1
Temperature Correction, mt : 1.01
Dispersant Correction, x : 4

Time	Elapsed Time t min	Hydrometer reading R'h	TRUE Reading Rh	Effective depth HR mm	Fully Corrected Reading	Particle Diameter D mm	Percentage Finer Than D K %
	0	0.0	0.0	0.000	0.0	0.0000	0.00
	0.5	17.0	15.0	149.69	15.2	0.0620	39.73
	1	16.0	14.0	151.25	14.2	0.0441	37.12
	2	16.0	14.0	151.25	14.2	0.0312	37.12
	5	15.0	13.0	152.81	13.2	0.0198	34.51
	15	14.0	12.0	154.37	12.2	0.0115	31.90
	30	13.0	11.0	155.93	11.2	0.0082	29.29
	60	12.0	10.0	157.49	10.2	0.0058	26.68
	240	11.0	9.0	159.05	9.2	0.0029	24.07
	1440	9.0	7.0	162.17	7.2	0.0012	18.85

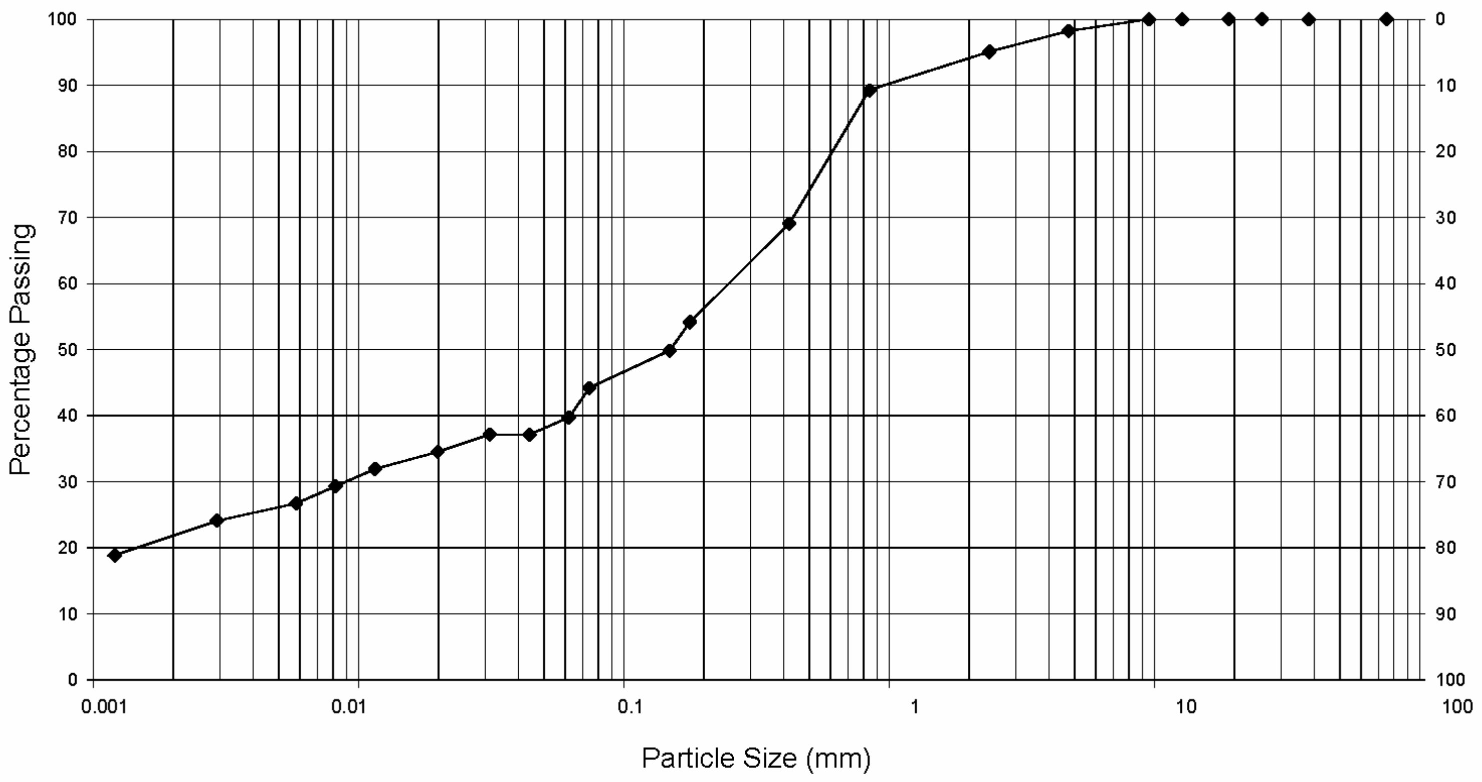
NOTES :

PARTICLE SIZE DISTRIBUTION ANALYSIS (ASTM D 422)

Project : **SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM**
Client : NIHON SUIDOI CONSULTANT
Location : Bali
Tested by : Ria Irmawan
Date : 11-Aug-11

Hole No. : BH - 04
Depth : 8.50 - 9.00

Sample Type : UDS
Sample Description : clayey SAND



CLAY	SILT	SAND			GRAVEL	COBBLES
		FINE	MEDIUM	COARSE		
26.11%	18.21%	53.93%			1.75%	0.00%

Project	SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM		
Client	NIHON SUIDOI CONSULTANT		
Location	Bali	Date	11-Aug-11
Tested By	Ria Irmawan	Checked By	M.Iqbal, ST

PARTICLE SIZE DISTRIBUTION ANALYSIS

Hole No. : BH - 04

Depth : 11.50 - 12.00

Sample Type : UDS

Sample Description : silty CLAY

SIEVE ANALYSIS (ASTM D 422)

Initial weight of dry soil : 34.52 g

Sieve No.	Sieve Opening mm	Wt. Soil Retained	Percent Retained %	Cumulative Percent Retained %	Percent Finer %
3"	101.600	0.000	0.00	0.00	100.00
2"	75.000	0.000	0.00	0.00	100.00
1 1/2"	38.100	0.000	0.00	0.00	100.00
1"	25.400	0.000	0.00	0.00	100.00
3/4"	19.050	0.000	0.00	0.00	100.00
1/2"	12.700	0.000	0.00	0.00	100.00
3/8"	9.525	0.000	0.00	0.00	100.00
4	4.760	0.000	0.00	0.00	100.00
8	2.380	0.000	0.00	0.00	100.00
20	0.840	0.020	0.06	0.06	99.94
40	0.420	0.250	0.72	0.78	99.22
80	0.177	0.580	1.68	2.46	97.54
100	0.149	0.660	1.91	4.37	95.63
200	0.074	5.010	14.51	18.89	81.11
Pan		6.52	18.89	37.78	

HYDROMETER ANALYSIS (BS 1377 : 1975)

Weight of soil : 60.00 g

Specific Gravity (Gs) : 2.653

Meniscus Correction,c : -2.00

Viscosity of water : 0.8711

Tube No. : 1

Hydrometer No. : A1

Temperature Correction, mt : 1.01

Dispersant Correction, x : 4

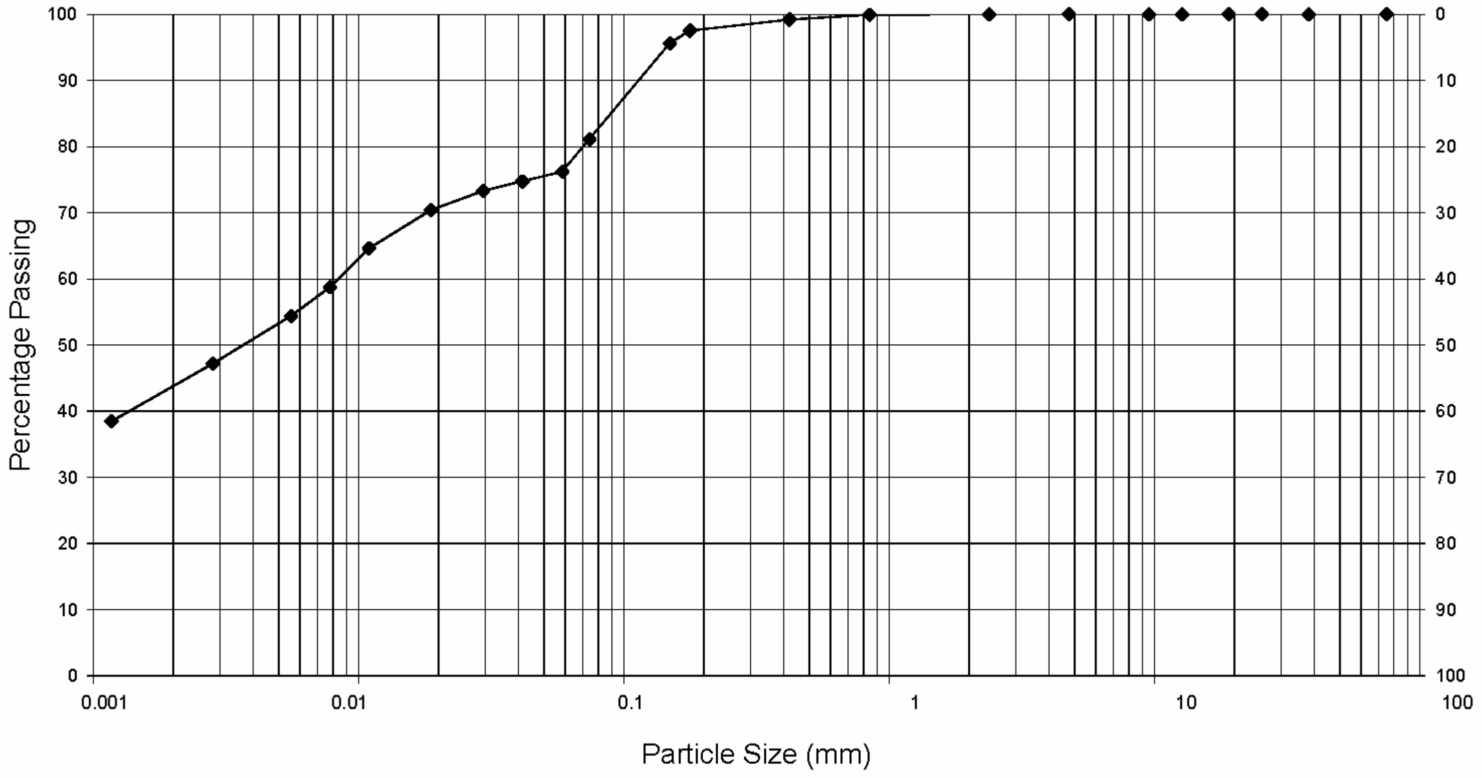
Time	Elapsed Time t min	Hydrometer reading R'h	TRUE Reading Rh	Effective depth HR mm	Fully Corrected Reading	Particle Diameter D mm	Percentage Finer Than D K %
	0	0.0	0.0	0.000	0.0	0.0000	0.00
	0.5	28.0	26.0	132.53	26.2	0.0584	76.21
	1	27.5	25.5	133.31	25.7	0.0414	74.76
	2	27.0	25.0	134.09	25.2	0.0294	73.31
	5	26.0	24.0	135.65	24.2	0.0187	70.40
	15	24.0	22.0	138.77	22.2	0.0109	64.59
	30	22.0	20.0	141.89	20.2	0.0078	58.78
	60	20.5	18.5	144.23	18.7	0.0056	54.42
	240	18.0	16.0	148.13	16.2	0.0028	47.15
	1440	15.0	13.0	152.81	13.2	0.0012	38.44

NOTES :

	PARTICLE SIZE DISTRIBUTION ANALYSIS (ASTM D 422)	Project : SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM Client : NIHON SUIDOI CONSULTANT Location : Bali Tested by : Ria Irmawan Date : 11-Aug-11

Hole No. : BH - 04
Depth : 11.50 - 12.00

Sample Type : UDS
Sample Description : silty CLAY



CLAY	SILT	SAND FINE / MEDIUM / COARSE	GRAVEL	COBBLES
53.28%	28.11%	18.61%	0.00%	0.00%

Project	SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM		
Job No.	-	Date	28-Jul-11
Tested By	Beny	Checked By	M.Iqbal, ST

UNCONFINED COMPRESSION TEST

REMOLTED

Location : Bali
Boring no : BH - 1
Depth : 1.50 - 2.00

Sample type : UDS
Soil description :
Sample no. :

Preparation

Specimen details	Initial	After test	
Diameter Dmm	38.00	Mass g	
Area Ao mm2	1134.11	Dry mass g	
Length Lo mm	76.00	W %	
Volume cm3	86.19		
Mass g	144.23		
Density Mg/m3	1.673		

Machine details		
Machine no		
Rate of deformation	mm/min	1.088
PR Calibration	N/div	0.080

Compression test Single stage

REMOLTED

Deformation gauge reading	Compression of specimen (δ L) (mm)	Strain (%)	Force gauge reading (div)	Axial force (N)	Corrected Area (mm^2)	Deviator stress (kg/cm2)
0	0	0	0	0	1134.11	0.000
20	0.20	0.26	1.5	0.001	1137.11	0.011
40	0.40	0.53	3.0	0.002	1140.12	0.021
60	0.60	0.79	4.0	0.003	1143.14	0.028
80	0.80	1.05	5.5	0.004	1146.18	0.038
100	1.00	1.32	7.0	0.006	1149.24	0.049
120	1.20	1.58	8.0	0.006	1152.31	0.056
140	1.40	1.84	9.0	0.007	1155.40	0.062
160	1.60	2.11	10.0	0.008	1158.50	0.069
180	1.80	2.37	11.5	0.009	1161.63	0.079
200	2.00	2.63	12.5	0.010	1164.77	0.086
220	2.20	2.89	13.0	0.010	1167.92	0.089
240	2.40	3.16	14.0	0.011	1171.10	0.096
260	2.60	3.42	15.0	0.012	1174.29	0.102
280	2.80	3.68	15.5	0.012	1177.50	0.105
300	3.00	3.95	16.0	0.013	1180.72	0.108
320	3.20	4.21	17.0	0.014	1183.97	0.115
340	3.40	4.47	17.5	0.014	1187.23	0.118
360	3.60	4.74	18.0	0.014	1190.51	0.121
380	3.80	5.00	18.5	0.015	1193.81	0.124
400	4.00	5.26	19.0	0.015	1197.12	0.127
420	4.20	5.53	19.5	0.016	1200.46	0.130
440	4.40	5.79	20.5	0.016	1203.81	0.136
460	4.60	6.05	21.0	0.017	1207.18	0.139
480	4.80	6.32	20.0	0.016	1210.57	0.132
500	5.00	6.58	19.5	0.016	1213.98	0.129
520	5.20	6.84	19.0	0.015	1217.41	0.125
540	5.40	7.11	18.0	0.014	1220.86	0.118
560	5.60	7.37	17.0	0.014	1224.33	0.111
580	5.80	7.63	16.0	0.013	1227.82	0.104
600	6.00	7.89	15.0	0.012	1231.32	0.097

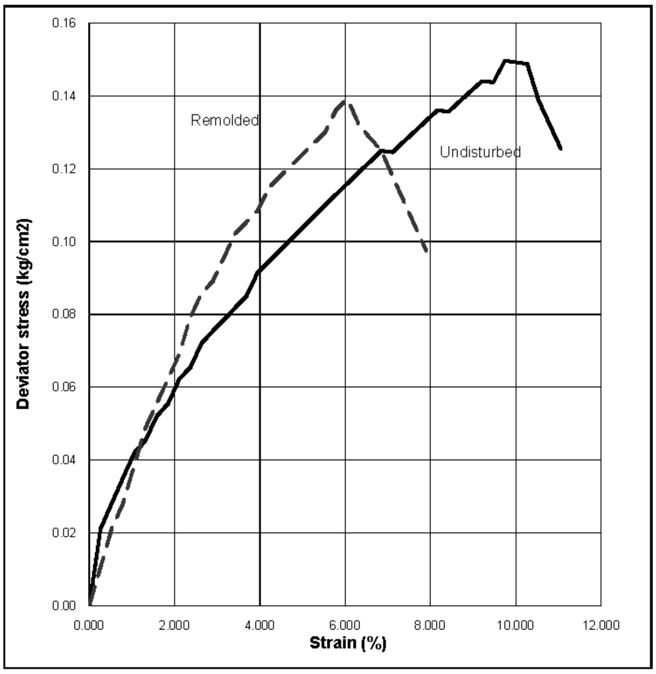
	Project	**SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM**		
	Job No.	-	Date	7/28/2011
	Tested By	Beny	Checked By	M.Iqbal, ST

UNCONFINED COMPRESSION TEST

Location : Bali
Boring no : BH - 1
Depth : 1.50 - 2.00

Sample type : UDS
Soil description :

TEST RESULT

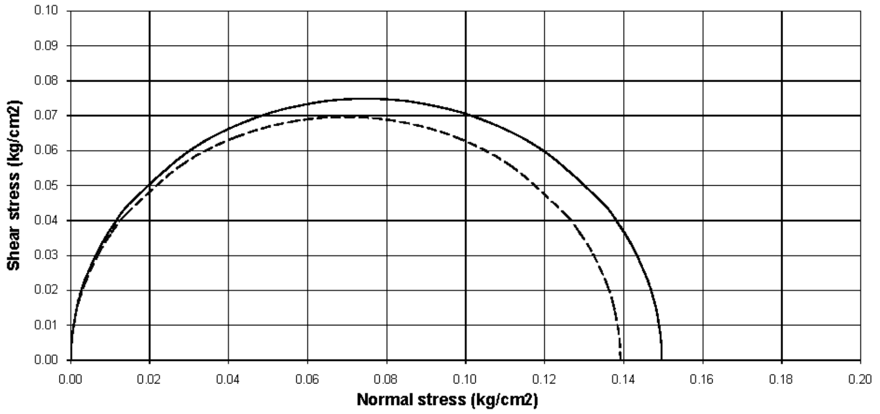


Sample	At failure	
	qu kg/cm2	Strain %
Undisturbed	0.150	9.737
Remolded	0.139	6.053
Sensitivity	1.075	

Mode of failure

Undisturb	Remolded

MOHR CIRCLES



	Project	SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM		
	Job No.	-	Date	28-Jul-11
	Tested By	Beny	Checked By	M.Iqbal, ST

UNCONFINED COMPRESSION TEST

REMOLTED

Location : Bali
Boring no : BH - 1
Depth : 15.50 - 16.00

Sample type : UDS
Soil description :
Sample no. :

Preparation

Specimen details		Initial	After test	
Diameter	Dmm	38.00	Mass g	
Area	Ao mm2	1134.11	Dry mass g	
Length	Lo mm	76.00	W %	
Volume	cm3	86.19		
Mass	g	122.08		
Density	Mg/m3	1.416		

Machine details		
Machine no		
Rate of deformation	mm/min	1.088
PR Calibration	N/div	0.080

Compression test Single stage

REMOLTED

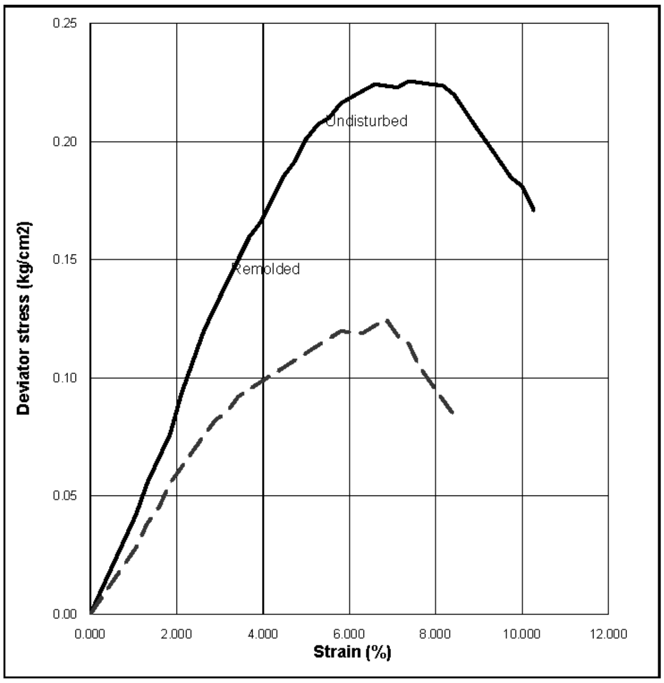
Deformation gauge reading	Compression of specimen (δ L) (mm)	Strain (%)	Force gauge reading (div)	Axial force (N)	Corrected Area (mm^2)	Deviator stress (kg/cm2)
0	0	0	0	0	1134.11	0.000
20	0.20	0.26	1.0	0.001	1137.11	0.007
40	0.40	0.53	2.0	0.002	1140.12	0.014
60	0.60	0.79	3.0	0.002	1143.14	0.021
80	0.80	1.05	4.0	0.003	1146.18	0.028
100	1.00	1.32	5.5	0.004	1149.24	0.038
120	1.20	1.58	6.5	0.005	1152.31	0.045
140	1.40	1.84	8.0	0.006	1155.40	0.055
160	1.60	2.11	9.0	0.007	1158.50	0.062
180	1.80	2.37	10.0	0.008	1161.63	0.069
200	2.00	2.63	11.0	0.009	1164.77	0.076
220	2.20	2.89	12.0	0.010	1167.92	0.082
240	2.40	3.16	12.5	0.010	1171.10	0.085
260	2.60	3.42	13.5	0.011	1174.29	0.092
280	2.80	3.68	14.0	0.011	1177.50	0.095
300	3.00	3.95	14.5	0.012	1180.72	0.098
320	3.20	4.21	15.0	0.012	1183.97	0.101
340	3.40	4.47	15.5	0.012	1187.23	0.104
360	3.60	4.74	16.0	0.013	1190.51	0.108
380	3.80	5.00	16.5	0.013	1193.81	0.111
400	4.00	5.26	17.0	0.014	1197.12	0.114
420	4.20	5.53	17.5	0.014	1200.46	0.117
440	4.40	5.79	18.0	0.014	1203.81	0.120
460	4.60	6.05	18.0	0.014	1207.18	0.119
480	4.80	6.32	18.0	0.014	1210.57	0.119
500	5.00	6.58	18.5	0.015	1213.98	0.122
520	5.20	6.84	19.0	0.015	1217.41	0.125
540	5.40	7.11	18.0	0.014	1220.86	0.118
560	5.60	7.37	17.5	0.014	1224.33	0.114
580	5.80	7.63	16.0	0.013	1227.82	0.104
600	6.00	7.89	15.0	0.012	1231.32	0.097
620	6.20	8.16	14.0	0.011	1234.85	0.091
640	6.40	8.42	13.0	0.010	1238.40	0.084

Project	**SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM**		
Job No.	-	Date	7/28/2011
Tested By	Beny	Checked By	M.Iqbal, ST

UNCONFINED COMPRESSION TEST

Location : Bali
Boring no : BH - 1
Depth : 15.50 - 16.00

Sample type : UDS
Soil description :



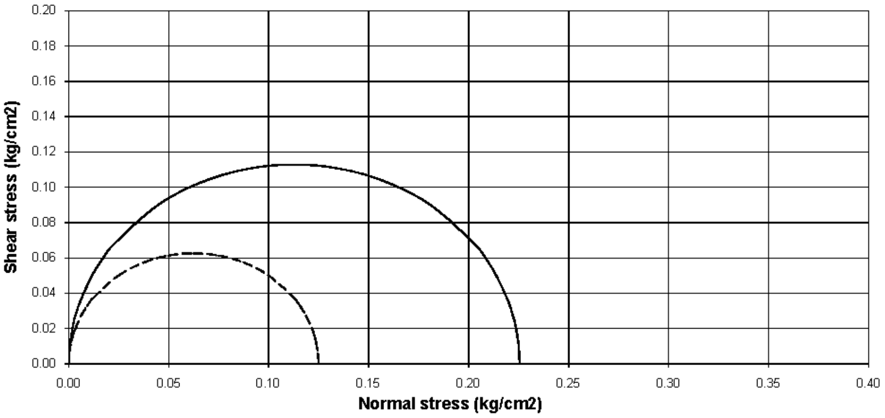
TEST RESULT

Sample	At failure	
	qu kg/cm2	Strain %
Undisturbed	0.225	7.632
Remolded	0.125	6.842
Sensitivity	1.806	

Mode of failure

Undisturb Remolded

MOHR CIRCLES



Project	**SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM**		
Client		Date	28-Jul-11
Tested By	Beny	Checked By	M.Iqbal, ST

UNCONFINED COMPRESSION TEST

UNDISTURBED

Location	: Bali	Sample type	: UDS
Boring no	: BH - 01	Soil description	:
Depth	: 19.50 - 20.00 m	Sample no.	:

Preparation

Specimen details	Initial	After test	
Diameter Dmm	38.00	Mass g	
Area Ao mm2	1134.11	Dry mass g	
Length Lo mm	76.00	W %	
Volume cm3	86.19		
Mass g	129.66		
Density Mg/m3	1.504		

Machine details		
Machine no		
Rate of deformation	mm/min	1.088
PR Calibration	N/div	0.080

Compression test Single stage

UNDISTURBED

Deformation gauge reading x 0.01mm	Compression of specimen (δ L) (mm)	Strain (%)	Force gauge reading (div)	Axial force (N)	Corrected Area (mm^2)	Deviator stress (kg/cm2)
0	0	0.000	0	0	1134.11	0.000
20	0.20	0.26	2.0	0.002	1137.11	0.014
40	0.40	0.53	2.5	0.002	1140.12	0.018
60	0.60	0.79	3.0	0.002	1143.14	0.021
80	0.80	1.05	3.0	0.002	1146.18	0.021
100	1.00	1.32	3.5	0.003	1149.24	0.024
120	1.20	1.58	4.0	0.003	1152.31	0.028
140	1.40	1.84	4.0	0.003	1155.40	0.028
160	1.60	2.11	4.5	0.004	1158.50	0.031
180	1.80	2.37	5.0	0.004	1161.63	0.034
200	2.00	2.63	5.0	0.004	1164.77	0.034
220	2.20	2.89	5.5	0.004	1167.92	0.038
240	2.40	3.16	6.0	0.005	1171.10	0.041
260	2.60	3.42	6.5	0.005	1174.29	0.044
300	3.00	3.95	7.0	0.006	1180.72	0.047
320	3.20	4.21	7.5	0.006	1183.97	0.051
340	3.40	4.47	8.0	0.006	1187.23	0.054
360	3.60	4.74	8.0	0.006	1190.51	0.054
380	3.80	5.00	8.5	0.007	1193.81	0.057
400	4.00	5.26	9.0	0.007	1197.12	0.060
420	4.20	5.53	9.5	0.008	1200.46	0.063
440	4.40	5.79	10.0	0.008	1203.81	0.066
460	4.60	6.05	10.0	0.008	1207.18	0.066
480	4.80	6.32	10.0	0.008	1210.57	0.066
500	5.00	6.58	11.0	0.009	1213.98	0.072
520	5.20	6.84	11.5	0.009	1217.41	0.076
540	5.40	7.11	12.0	0.010	1220.86	0.079
560	5.60	7.37	12.0	0.010	1224.33	0.078
580	5.80	7.63	12.0	0.010	1227.82	0.078
600	6.00	7.89	13.0	0.010	1231.32	0.084
620	6.20	8.16	13.0	0.010	1234.85	0.084
640	6.40	8.42	13.5	0.011	1238.40	0.087
660	6.60	8.68	13.5	0.011	1241.97	0.087
680	6.80	8.95	14.0	0.011	1245.56	0.090
700	7.00	9.21	14.0	0.011	1249.17	0.090
720	7.20	9.47	14.0	0.011	1252.80	0.089
740	7.40	9.74	15.0	0.012	1256.45	0.096
760	7.60	10.00	15.0	0.012	1260.13	0.095
780	7.80	10.26	15.5	0.012	1263.82	0.098
800	8.00	10.53	16.0	0.013	1267.54	0.101
820	8.20	10.79	16.0	0.013	1271.28	0.101
840	8.40	11.05	16.5	0.013	1275.04	0.104
860	8.60	11.32	16.5	0.013	1278.82	0.103
880	8.80	11.58	16.5	0.013	1282.63	0.103
900	9.00	11.84	17.0	0.014	1286.46	0.106
920	9.20	12.11	17.0	0.014	1290.31	0.105
940	9.40	12.37	17.0	0.014	1294.19	0.105
960	9.60	12.63	17.0	0.014	1298.08	0.105
980	9.80	12.89	17.5	0.014	1302.01	0.108
1000	10.00	13.16	18.0	0.014	1305.95	0.110
1020	10.20	13.42	18.0	0.014	1309.92	0.110
1040	10.40	13.68	18.0	0.014	1313.91	0.110
1060	10.60	13.95	18.0	0.014	1317.93	0.109
1080	10.80	14.21	18.0	0.014	1321.97	0.109
1100	11.00	14.47	18.0	0.014	1326.04	0.109

	Project	**SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM**		
	Client	**0**	**Date**	**28-Jul-11**
	Tested By	**Beny**	**Checked By**	**M.Iqbal, ST**

UNCONFINED COMPRESSION TEST

REMOLTED

Location	: Bali	Sample type	: UDS
Boring no	: BH - 01	Soil description	:
Depth	: 19.50 - 20.00 m	Sample no.	:

Preparation

Specimen details	Initial	After test	
Diameter Dmm	38.00	Mass g	
Area Ao mm2	1134.11	Dry mass g	
Length Lo mm	76.00	W %	
Volume cm3	86.19		
Mass g	147.09		
Density Mg/m3	1.707		

Machine details		
Machine no		
Rate of deformation	mm/min	1.088
PR Calibration	N/div	0.080

Compression test Single stage

REMOLTED

Deformation gauge reading	Compression of specimen (δ L) (mm)	Strain (%)	Force gauge reading (div)	Axial force (N)	Corrected Area (mm^2)	Deviator stress (kg/cm2)
0	0	0	0	0	1134.11	0.000
20	0.20	0.26	0.5	0.000	1137.11	0.004
40	0.40	0.53	1.0	0.001	1140.12	0.007
60	0.60	0.79	1.5	0.001	1143.14	0.010
80	0.80	1.05	2.0	0.002	1146.18	0.014
100	1.00	1.32	2.5	0.002	1149.24	0.017
120	1.20	1.58	3.0	0.002	1152.31	0.021
140	1.40	1.84	3.5	0.003	1155.40	0.024
160	1.60	2.11	4.0	0.003	1158.50	0.028
180	1.80	2.37	4.0	0.003	1161.63	0.028
200	2.00	2.63	4.5	0.004	1164.77	0.031
220	2.20	2.89	5.0	0.004	1167.92	0.034
240	2.40	3.16	5.5	0.004	1171.10	0.038
260	2.60	3.42	6.0	0.005	1174.29	0.041
280	2.80	3.68	6.5	0.005	1177.50	0.044
300	3.00	3.95	7.0	0.006	1180.72	0.047
320	3.20	4.21	7.5	0.006	1183.97	0.051
340	3.40	4.47	8.0	0.006	1187.23	0.054
360	3.60	4.74	8.5	0.007	1190.51	0.057
380	3.80	5.00	8.5	0.007	1193.81	0.057
400	4.00	5.26	9.0	0.007	1197.12	0.060
420	4.20	5.53	9.0	0.007	1200.46	0.060
440	4.40	5.79	8.5	0.007	1203.81	0.056
460	4.60	6.05	8.0	0.006	1207.18	0.053
480	4.80	6.32	7.5	0.006	1210.57	0.050
500	5.00	6.58	7.0	0.006	1213.98	0.046
520	5.20	6.84	6.5	0.005	1217.41	0.043
540	5.40	7.11	6.0	0.005	1220.86	0.039
560	5.60	7.37	5.5	0.004	1224.33	0.036
580	5.80	7.63	5.0	0.004	1227.82	0.033

	Project	**SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM**		
	Job No.	-	Date	28-Jul-11
	Tested By	Beny	Checked By	M.Iqbal, ST

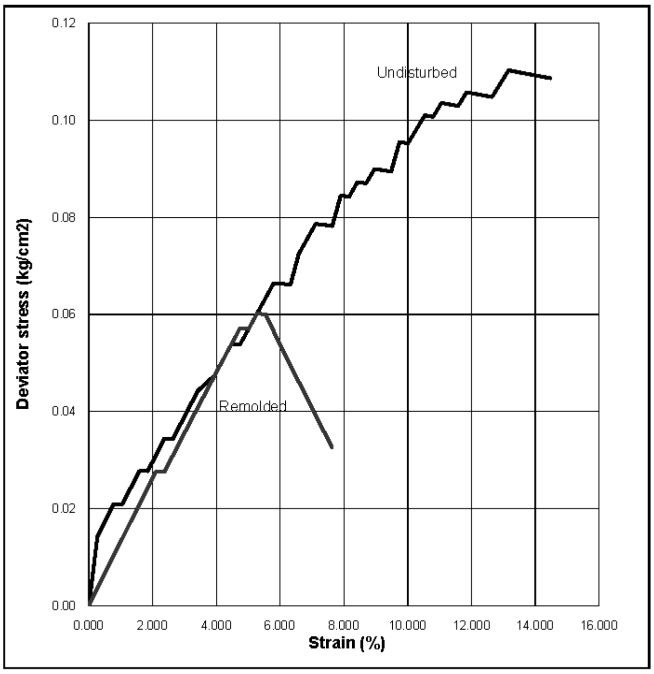
UNCONFINED COMPRESSION TEST

Location : Bali
Boring no : BH - 01
Depth : 19.50 - 20.00 m

Sample type : UDS
Soil description :

TEST RESULT

Sample	At failure	
	qu kg/cm2	Strain %
Undisturbed	0.084	8.158
Remolded	0.060	5.526
Sensitivity	1.404	

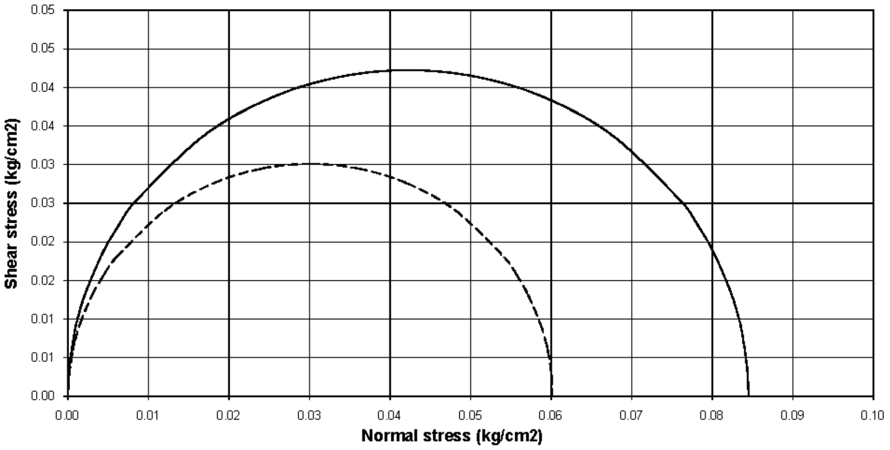


Mode of failure

Undisturb

Remolded

MOHR CIRCLES



	Project	SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM		
			Date	2-Aug-11
	Tested By	Beny	Checked By	M.Iqbal, ST

UNCONFINED COMPRESSION TEST

REMOLTED

Location	: Bali	Sample type	: UDS
Boring no	: BH - 02	Soil description	:
Depth	: 4.50 - 5.00	Sample no.	:

Preparation

Specimen details	Initial	After test	
Diameter Dmm	38.00	Mass g	
Area Ao mm2	1134.11	Dry mass g	
Length Lo mm	76.00	W %	
Volume cm3	86.19		
Mass g	115.82		
Density Mg/m3	1.344		

Machine details		
Machine no		
Rate of deformation	mm/min	1.088
PR Calibration	N/div	0.080

Compression test Single stage

REMOLTED

Deformation gauge reading	Compression of specimen (δ L) (mm)	Strain (%)	Force gauge reading (div)	Axial force (N)	Corrected Area (mm^2)	Deviator stress (kg/cm2)
0	0	0	0	0	1134.11	0.000
20	0.20	0.26	0.5	0.000	1137.11	0.004
40	0.40	0.53	1.0	0.001	1140.12	0.007
60	0.60	0.79	1.0	0.001	1143.14	0.007
80	0.80	1.05	1.0	0.001	1146.18	0.007
100	1.00	1.32	1.5	0.001	1149.24	0.010
120	1.20	1.58	2.0	0.002	1152.31	0.014
140	1.40	1.84	2.0	0.002	1155.40	0.014
160	1.60	2.11	2.0	0.002	1158.50	0.014
180	1.80	2.37	2.5	0.002	1161.63	0.017
200	2.00	2.63	2.5	0.002	1164.77	0.017
220	2.20	2.89	2.5	0.002	1167.92	0.017
240	2.40	3.16	2.5	0.002	1171.10	0.017
260	2.60	3.42	2.5	0.002	1174.29	0.017

	Project	**SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM**		
	Job No.	-	Date	8/2/2011
	Tested By	Beny	Checked By	M.Iqbal, ST

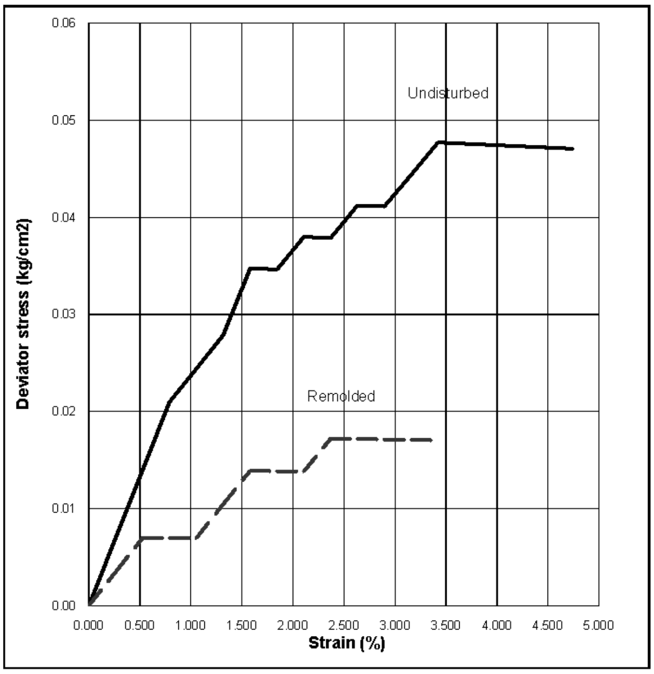
UNCONFINED COMPRESSION TEST

Location : Bali
Boring no : BH - 02
Depth : 4.50 - 5.00

Sample type : UDS
Soil description : 0

TEST RESULT

Sample	At failure	
	qu kg/cm2	Strain %
Undisturbed	0.048	3.684
Remolded	0.017	3.421
Sensitivity	2.770	

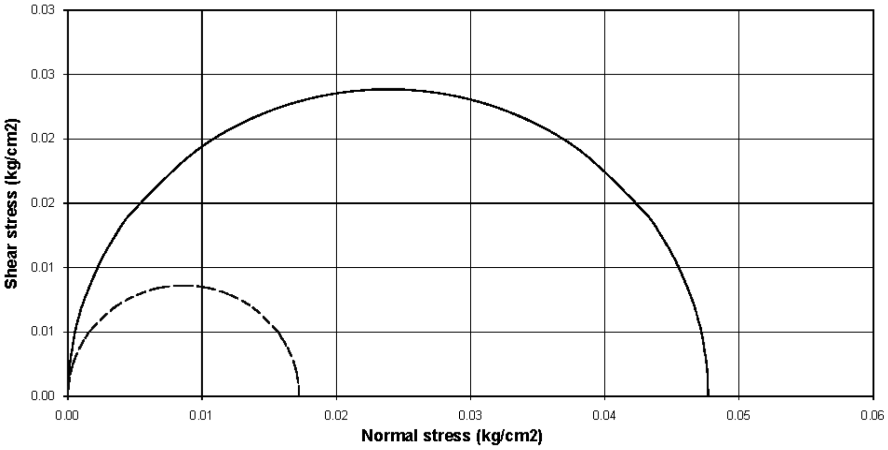


Mode of failure

Undisturb

Remolded

MOHR CIRCLES



Project	SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM

Job No.	-	Date	2-Aug-11
Tested By	Beny	Checked By	M.Iqbal, ST

UNCONFINED COMPRESSION TEST

REMOLTED

Location	: Bali	Sample type	: UDS
Boring no	: BH - 02	Soil description	: 0
Depth	: 6.50 - 7.00 m	Sample no.	:

Preparation

Specimen details	Initial	After test	
Diameter Dmm	38.00	Mass g	
Area Ao mm2	1134.11	Dry mass g	
Length Lo mm	76.00	W %	
Volume cm3	86.19		
Mass g	126.97		
Density Mg/m3	1.473		

Machine details		
Machine no		
Rate of deformation	mm/min	1.088
PR Calibration	N/div	0.080

Compression test **Single stage**

REMOLTED

Deformation gauge reading	Compression of specimen (δ L) (mm)	Strain (%)	Force gauge reading (div)	Axial force (N)	Corrected Area (mm^2)	Deviator stress (kg/cm2)
0	0	0	0	0	1134.11	0.000
20	0.20	0.26	0.5	0.000	1137.11	0.004
40	0.40	0.53	1.0	0.001	1140.12	0.007
60	0.60	0.79	1.5	0.001	1143.14	0.010
80	0.80	1.05	2.0	0.002	1146.18	0.014
100	1.00	1.32	2.0	0.002	1149.24	0.014
120	1.20	1.58	3.0	0.002	1152.31	0.021
140	1.40	1.84	3.5	0.003	1155.40	0.024
160	1.60	2.11	3.5	0.003	1158.50	0.024
180	1.80	2.37	4.0	0.003	1161.63	0.028
200	2.00	2.63	4.5	0.004	1164.77	0.031
220	2.20	2.89	5.0	0.004	1167.92	0.034
240	2.40	3.16	5.5	0.004	1171.10	0.038
260	2.60	3.42	5.5	0.004	1174.29	0.037
280	2.80	3.68	6.0	0.005	1177.50	0.041
300	3.00	3.95	6.0	0.005	1180.72	0.041
320	3.20	4.21	6.0	0.005	1183.97	0.041
340	3.40	4.47	6.0	0.005	1187.23	0.040
360	3.60	4.74	6.0	0.005	1190.51	0.040

Sketch of failure conditions

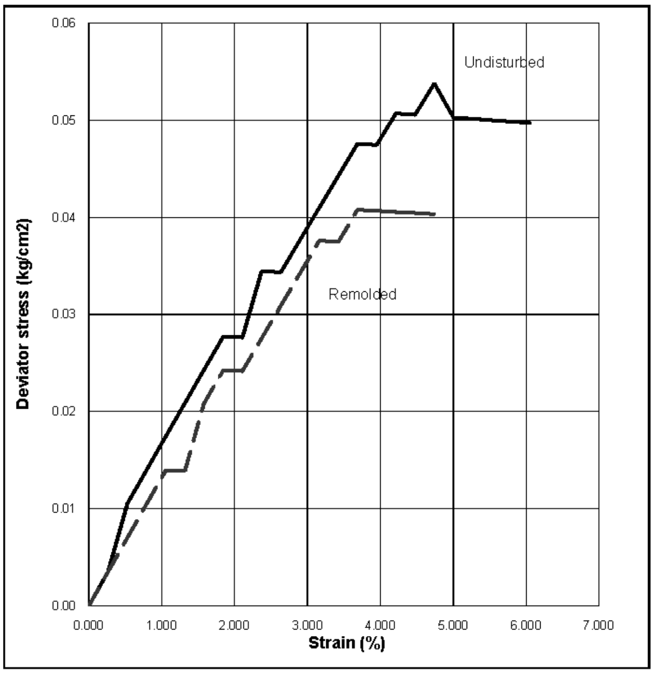
Project	**SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM**		
Job No.	-	Date	8/2/2011
Tested By	Beny	Checked By	M.Iqbal, ST

UNCONFINED COMPRESSION TEST

Location : Bali
Boring no : BH - 02
Depth : 6.50 - 7.00 m

Sample type : UDS
Soil description : 0

TEST RESULT



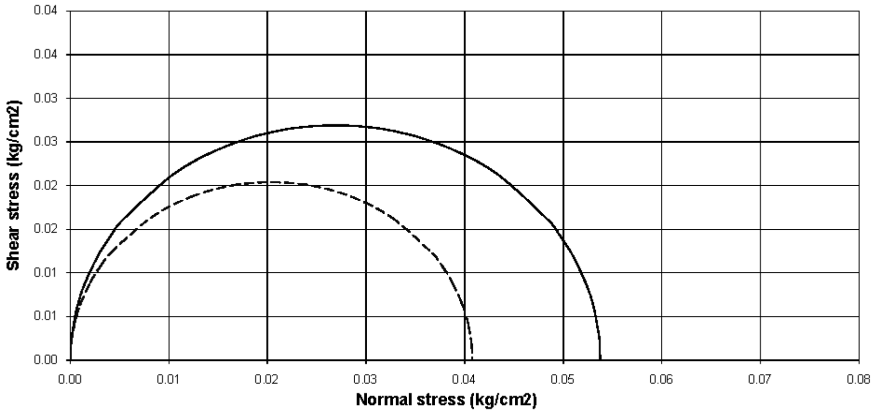
Sample	At failure	
	qu kg/cm2	Strain %
Undisturbed	0.054	4.737
Remolded	0.041	4.211
Sensitivity	1.319	

Mode of failure

Undisturb

Remolded

MOHR CIRCLES



Project	SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM		
Job No.	-	Date	2-Aug-11
Tested By	Beny	Checked By	M.Iqbal, ST

UNCONFINED COMPRESSION TEST

REMOLTED

Location : Bali
Boring no : BH - 02
Depth : 8.50 - 9.00 m

Sample type : UDS
Soil description : 0
Sample no. :

Preparation

Specimen details	Initial	After test	
Diameter Dmm	38.00	Mass g	
Area Ao mm2	1134.11	Dry mass g	
Length Lo mm	76.00	W %	
Volume cm3	86.19		
Mass g	132.19		
Density Mg/m3	1.534		

Machine details		
Machine no		
Rate of deformation	mm/min	1.088
PR Calibration	N/div	0.080

Compression test Single stage

REMOLTED

Deformation gauge reading	Compression of specimen (δ L) (mm)	Strain (%)	Force gauge reading (div)	Axial force (N)	Corrected Area (mm^2)	Deviator stress (kg/cm2)
0	0	0	0	0	1134.11	0.000
20	0.20	0.26	0.0	0.000	1137.11	0.000
40	0.40	0.53	1.0	0.001	1140.12	0.007
60	0.60	0.79	1.5	0.001	1143.14	0.010
80	0.80	1.05	1.5	0.001	1146.18	0.010
100	1.00	1.32	1.5	0.001	1149.24	0.010
120	1.20	1.58	2.0	0.002	1152.31	0.014
140	1.40	1.84	2.5	0.002	1155.40	0.017
160	1.60	2.11	3.0	0.002	1158.50	0.021
180	1.80	2.37	3.0	0.002	1161.63	0.021
200	2.00	2.63	3.0	0.002	1164.77	0.021
220	2.20	2.89	3.5	0.003	1167.92	0.024
240	2.40	3.16	3.5	0.003	1171.10	0.024
260	2.60	3.42	3.5	0.003	1174.29	0.024
280	2.80	3.68	4.0	0.003	1177.50	0.027
300	3.00	3.95	4.0	0.003	1180.72	0.027
320	3.20	4.21	4.0	0.003	1183.97	0.027
340	3.40	4.47	4.0	0.003	1187.23	0.027
360	3.60	4.74	4.5	0.004	1190.51	0.030
380	3.80	5.00	5.0	0.004	1193.81	0.034
400	4.00	5.26	5.0	0.004	1197.12	0.033
420	4.20	5.53	5.0	0.004	1200.46	0.033
440	4.40	5.79	5.0	0.004	1203.81	0.033
460	4.60	6.05	5.0	0.004	1207.18	0.033

Sketch of failure conditions

Project	SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM		
Job No.	-	Date	8/2/2011
Tested By	Beny	Checked By	M.Iqbal, ST

UNCONFINED COMPRESSION TEST

Location : Bali

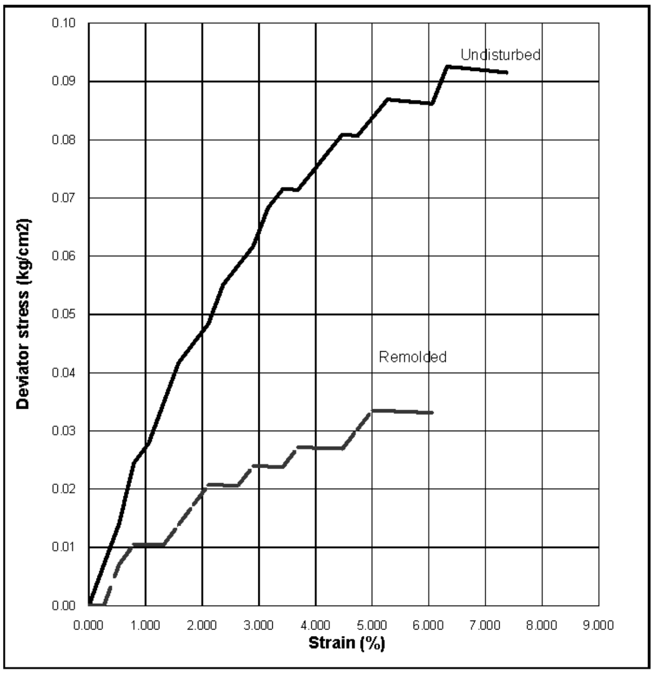
Boring no : BH - 02

Depth : 8.50 - 9.00 m

Sample type : UDS

Soil description : 0

TEST RESULT



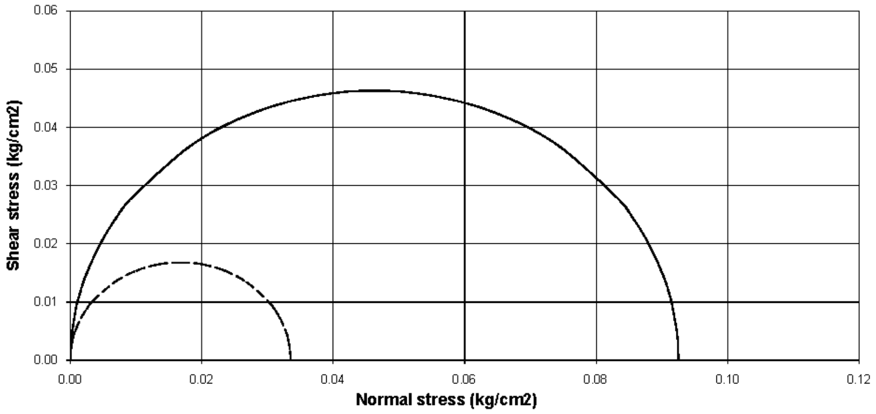
Sample	At failure	
	qu kg/cm2	Strain %
Undisturbed	0.093	6.316
Remolded	0.034	5.000
Sensitivity	2.761	

Mode of failure

Undisturb

Remolded

MOHR CIRCLES



Project	**SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM**		
Job No.	-	Date	3-Aug-11
Tested By	Beny	Checked By	M.Iqbal, ST

UNCONFINED COMPRESSION TEST

REMOLTED

Location : Bali
Boring no : BH - 03
Depth : 2.50 - 3.00 m

Sample type : UDS
Soil description : 0
Sample no. :

Preparation

Specimen details		Initial	After test	
Diameter	Dmm	38.00	Mass g	
Area	Ao mm2	1134.11	Dry mass g	
Length	Lo mm	76.00	W %	
Volume	cm3	86.19		
Mass	g	132.19		
Density	Mg/m3	1.534		

Machine details		
Machine no		
Rate of deformation	mm/min	1.088
PR Calibration	N/div	0.080

Compression test Single stage

REMOLTED

Deformation gauge reading	Compression of specimen (δ L) (mm)	Strain (%)	Force gauge reading (div)	Axial force (N)	Corrected Area (mm^2)	Deviator stress (kg/cm2)
0	0	0	0	0	1134.11	0.000
20	0.20	0.26	0.5	0.000	1137.11	0.004
40	0.40	0.53	1.0	0.001	1140.12	0.007
60	0.60	0.79	1.5	0.001	1143.14	0.010
80	0.80	1.05	2.0	0.002	1146.18	0.014
100	1.00	1.32	2.5	0.002	1149.24	0.017
120	1.20	1.58	3.0	0.002	1152.31	0.021
140	1.40	1.84	3.5	0.003	1155.40	0.024
160	1.60	2.11	3.5	0.003	1158.50	0.024
180	1.80	2.37	4.0	0.003	1161.63	0.028
200	2.00	2.63	5.0	0.004	1164.77	0.034
220	2.20	2.89	6.0	0.005	1167.92	0.041
240	2.40	3.16	6.0	0.005	1171.10	0.041
260	2.60	3.42	6.5	0.005	1174.29	0.044
280	2.80	3.68	7.0	0.006	1177.50	0.048
300	3.00	3.95	7.5	0.006	1180.72	0.051
320	3.20	4.21	8.0	0.006	1183.97	0.054
340	3.40	4.47	8.0	0.006	1187.23	0.054
360	3.60	4.74	8.5	0.007	1190.51	0.057
380	3.80	5.00	8.5	0.007	1193.81	0.057
400	4.00	5.26	9.0	0.007	1197.12	0.060
420	4.20	5.53	9.5	0.008	1200.46	0.063
440	4.40	5.79	9.5	0.008	1203.81	0.063
460	4.60	6.05	10.0	0.008	1207.18	0.066
480	4.80	6.32	10.0	0.008	1210.57	0.066
500	5.00	6.58	10.5	0.008	1213.98	0.069
520	5.20	6.84	11.0	0.009	1217.41	0.072
540	5.40	7.11	11.0	0.009	1220.86	0.072
560	5.60	7.37	11.0	0.009	1224.33	0.072
580	5.80	7.63	11.5	0.009	1227.82	0.075
600	6.00	7.89	11.5	0.009	1231.32	0.075
620	6.20	8.16	11.5	0.009	1234.85	0.075
640	6.40	8.42	11.5	0.009	1238.40	0.074
660	6.60	8.68	11.5	0.009	1241.97	0.074

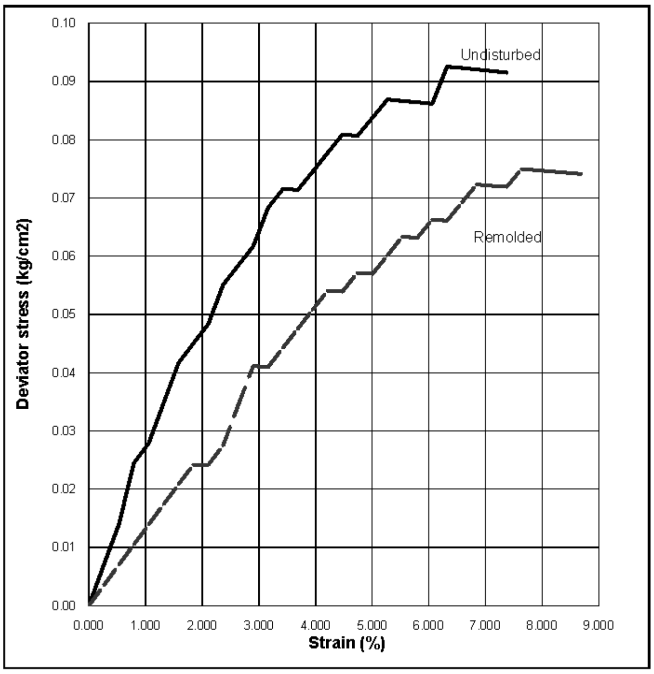
Project	SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM		
Job No.	-	Date	8/3/2011
Tested By	Beny	Checked By	M.Iqbal, ST

UNCONFINED COMPRESSION TEST

Location : Bali
Boring no : BH - 03
Depth : 2.50 - 3.00 m

Sample type : UDS
Soil description : 0

TEST RESULT



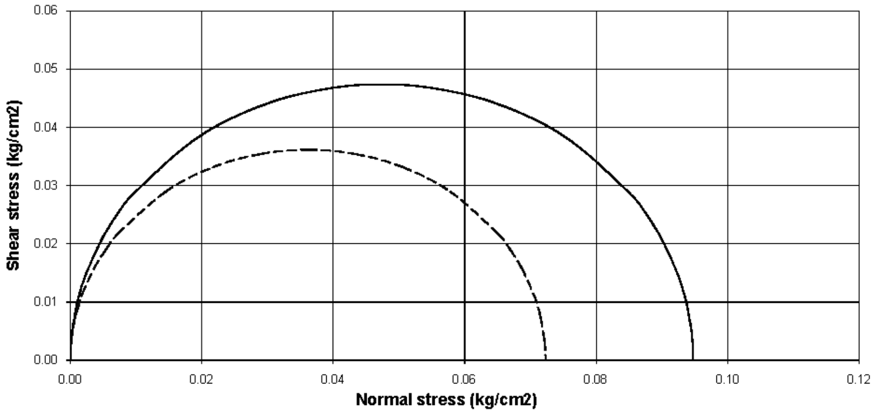
Sample	At failure	
	qu kg/cm2	Strain %
Undisturbed	0.095	7.368
Remolded	0.072	7.368
Sensitivity	1.311	

Mode of failure

Undisturb

Remolded

MOHR CIRCLES



Project	SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM		
Job No.	-	Date	3-Aug-11
Tested By	Beny	Checked By	M.Iqbal, ST

UNCONFINED COMPRESSION TEST

REMOLTED

Location : Bali
Boring no : BH - 03
Depth : 8.50 - 9.00 m

Sample type : UDS
Soil description : 0
Sample no. :

Preparation

Specimen details	Initial	After test	
Diameter Dmm	38.00	Mass g	
Area Ao mm2	1134.11	Dry mass g	
Length Lo mm	76.00	W %	
Volume cm3	86.19		
Mass g	132.19		
Density Mg/m3	1.534		

Machine details		
Machine no		
Rate of deformation	mm/min	1.088
PR Calibration	N/div	0.080

Compression test Single stage

REMOLTED

Deformation gauge reading	Compression of specimen (δ L) (mm)	Strain (%)	Force gauge reading (div)	Axial force (N)	Corrected Area (mm^2)	Deviator stress (kg/cm2)
0	0	0	0	0	1134.11	0.000
20	0.20	0.26	0.0	0.000	1137.11	0.000
40	0.40	0.53	0.5	0.000	1140.12	0.004
60	0.60	0.79	0.5	0.000	1143.14	0.003
80	0.80	1.05	0.5	0.000	1146.18	0.003
100	1.00	1.32	1.0	0.001	1149.24	0.007
120	1.20	1.58	1.5	0.001	1152.31	0.010
140	1.40	1.84	2.0	0.002	1155.40	0.014
160	1.60	2.11	2.0	0.002	1158.50	0.014
180	1.80	2.37	2.0	0.002	1161.63	0.014
200	2.00	2.63	2.5	0.002	1164.77	0.017
220	2.20	2.89	2.5	0.002	1167.92	0.017
240	2.40	3.16	2.5	0.002	1171.10	0.017
260	2.60	3.42	3.0	0.002	1174.29	0.020
280	2.80	3.68	3.0	0.002	1177.50	0.020
300	3.00	3.95	3.0	0.002	1180.72	0.020
320	3.20	4.21	3.0	0.002	1183.97	0.020
340	3.40	4.47	3.0	0.002	1187.23	0.020

Project	**SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM**		
Job No.	-	Date	8/3/2011
Tested By	Beny	Checked By	M.Iqbal, ST

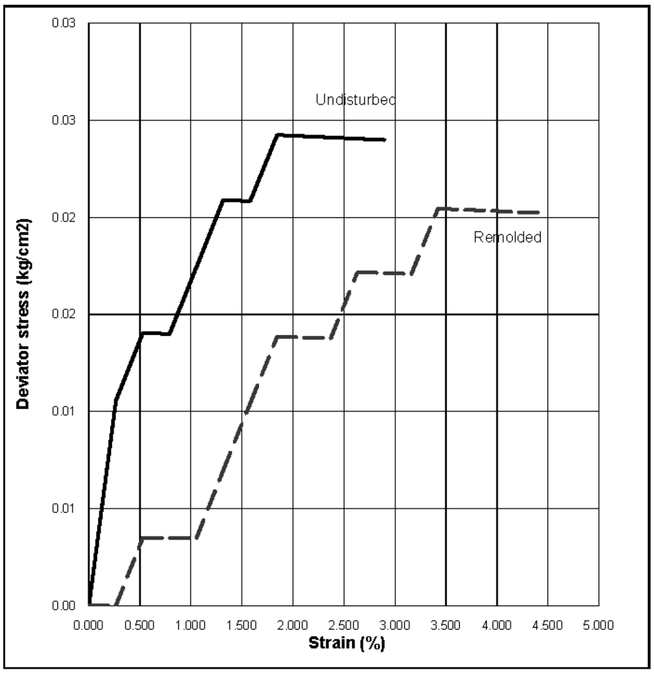
UNCONFINED COMPRESSION TEST

Location : Bali
Boring no : BH - 03
Depth : 8.50 - 9.00 m

Sample type : UDS
Soil description : 0

TEST RESULT

Sample	At failure	
	qu kg/cm2	Strain %
Undisturbed	0.024	2.895
Remolded	0.020	4.474
Sensitivity	1.186	

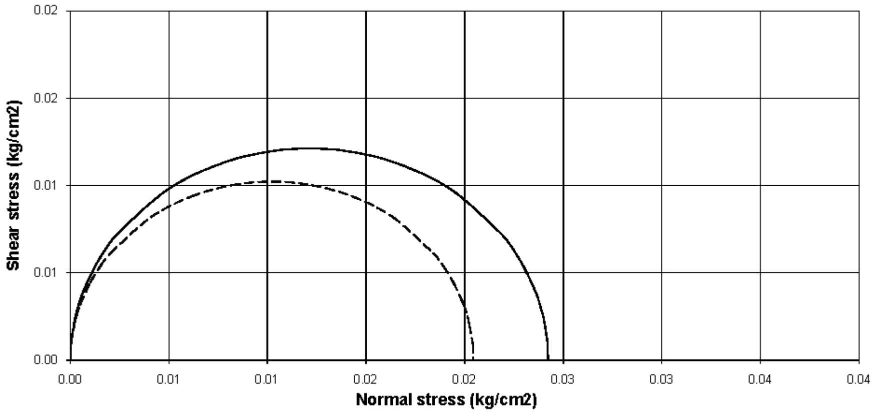


Mode of failure

Undisturb

Remolded

MOHR CIRCLES



Project	**SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM**		
Job No.	-	Date	13-Aug-11
Tested By	Benny	Checked By	M.Iqbal, ST

UNCONFINED COMPRESSION TEST

REMOLTED

Location : Bali
Boring no : BH - 04
Depth : 2.50 - 3.00 m

Sample type : UDS
Soil description : 0
Sample no. :

Preparation

Specimen details	Initial	After test	
Diameter Dmm	38.00	Mass g	
Area Ao mm2	1134.11	Dry mass g	
Length Lo mm	76.00	W %	
Volume cm3	86.19		
Mass g	140.62		
Density Mg/m3	1.631		

Machine details		
Machine no		
Rate of deformation	mm/min	1.088
PR Calibration	N/div	0.080

Compression test Single stage

REMOLTED

Deformation gauge reading	Compression of specimen (δ L) (mm)	Strain (%)	Force gauge reading (div)	Axial force (N)	Corrected Area (mm^2)	Deviator stress (kg/cm2)
0	0	0	0	0	1134.11	0.000
20	0.20	0.26	1.0	0.001	1137.11	0.007
40	0.40	0.53	2.0	0.002	1140.12	0.014
60	0.60	0.79	2.5	0.002	1143.14	0.017
80	0.80	1.05	3.5	0.003	1146.18	0.024
100	1.00	1.32	4.0	0.003	1149.24	0.028
120	1.20	1.58	5.0	0.004	1152.31	0.035
140	1.40	1.84	5.5	0.004	1155.40	0.038
160	1.60	2.11	6.5	0.005	1158.50	0.045
180	1.80	2.37	7.0	0.006	1161.63	0.048
200	2.00	2.63	8.5	0.007	1164.77	0.058
220	2.20	2.89	9.0	0.007	1167.92	0.062
240	2.40	3.16	10.0	0.008	1171.10	0.068
260	2.60	3.42	10.9	0.009	1174.29	0.074
280	2.80	3.68	11.5	0.009	1177.50	0.078
300	3.00	3.95	12.0	0.010	1180.72	0.081
320	3.20	4.21	12.5	0.010	1183.97	0.084
340	3.40	4.47	13.0	0.010	1187.23	0.088
360	3.60	4.74	13.0	0.010	1190.51	0.087
380	3.80	5.00	13.0	0.010	1193.81	0.087
400	4.00	5.26	13.0	0.010	1197.12	0.087
420	4.20	5.53	13.0	0.010	1200.46	0.087

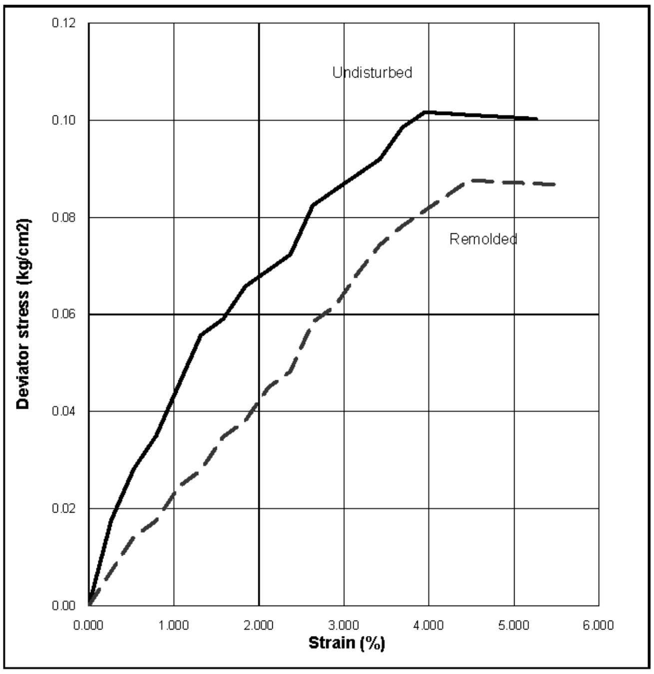
Project	SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM		
Job No.	-	Date	8/13/2011
Tested By	Benny	Checked By	M.Iqbal, ST

UNCONFINED COMPRESSION TEST

Location : Bali
Boring no : BH - 04
Depth : 2.50 - 3.00 m

Sample type : UDS
Soil description : 0

TEST RESULT



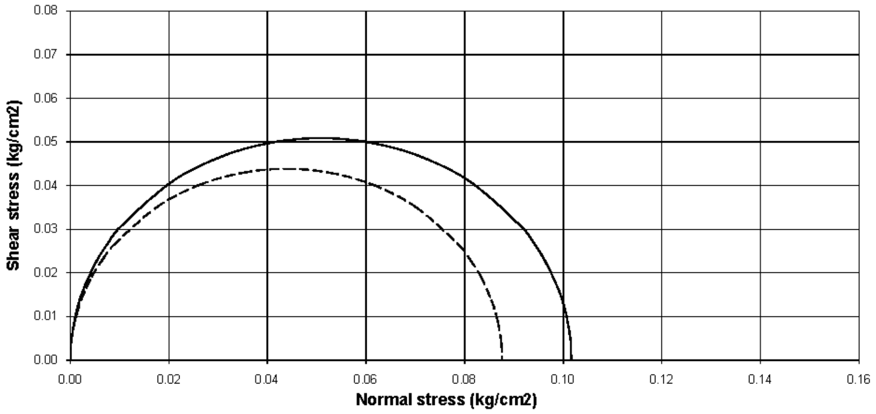
Sample	At failure	
	qu kg/cm2	Strain %
Undisturbed	0.102	0.000
Remolded	0.088	0.000
Sensitivity	1.160	

Mode of failure

Undisturb

Remolded

MOHR CIRCLES



Project	SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM		
Job No.	-	Date	13-Aug-11
Tested By	Benny	Checked By	M.Iqbal, ST

UNCONFINED COMPRESSION TEST

REMOLTED

Location : Bali
Boring no : BH - 04
Depth : 4.50 - 5.00 m

Sample type : UDS
Soil description : 0
Sample no. :

Preparation

Specimen details		Initial	After test		
Diameter	Dmm	38.00	Mass	g	
Area	Ao mm2	1134.11	Dry mass	g	
Length	Lo mm	76.00	W	%	
Volume	cm3	86.19			
Mass	g	140.62			
Density	Mg/m3	1.631			

Machine details		
Machine no		
Rate of deformation	mm/min	1.088
PR Calibration	N/div	0.080

Compression test Single stage

REMOLTED

Deformation gauge reading	Compression of specimen (δ L) (mm)	Strain (%)	Force gauge reading (div)	Axial force (N)	Corrected Area (mm^2)	Deviator stress (kg/cm2)
0	0	0	0	0	1134.11	0.000
20	0.20	0.26	0.0	0.000	1137.11	0.000
40	0.40	0.53	0.5	0.000	1140.12	0.004
60	0.60	0.79	1.0	0.001	1143.14	0.007
80	0.80	1.05	1.5	0.001	1146.18	0.010
100	1.00	1.32	1.8	0.001	1149.24	0.013
120	1.20	1.58	2.0	0.002	1152.31	0.014
140	1.40	1.84	2.0	0.002	1155.40	0.014
160	1.60	2.11	2.5	0.002	1158.50	0.017
180	1.80	2.37	2.8	0.002	1161.63	0.019
200	2.00	2.63	3.0	0.002	1164.77	0.021
220	2.20	2.89	3.0	0.002	1167.92	0.021
240	2.40	3.16	3.0	0.002	1171.10	0.020
260	2.60	3.42	3.0	0.002	1174.29	0.020
280	2.80	3.68	3.5	0.003	1177.50	0.024
300	3.00	3.95	4.0	0.003	1180.72	0.027
320	3.20	4.21	4.5	0.004	1183.97	0.030
340	3.40	4.47	5.0	0.004	1187.23	0.034
360	3.60	4.74	5.0	0.004	1190.51	0.034
380	3.80	5.00	5.5	0.004	1193.81	0.037
400	4.00	5.26	5.5	0.004	1197.12	0.037
420	4.20	5.53	5.5	0.004	1200.46	0.037
440	4.40	5.79	5.5	0.004	1203.81	0.037
460	4.60	6.05	5.5	0.004	1207.18	0.036

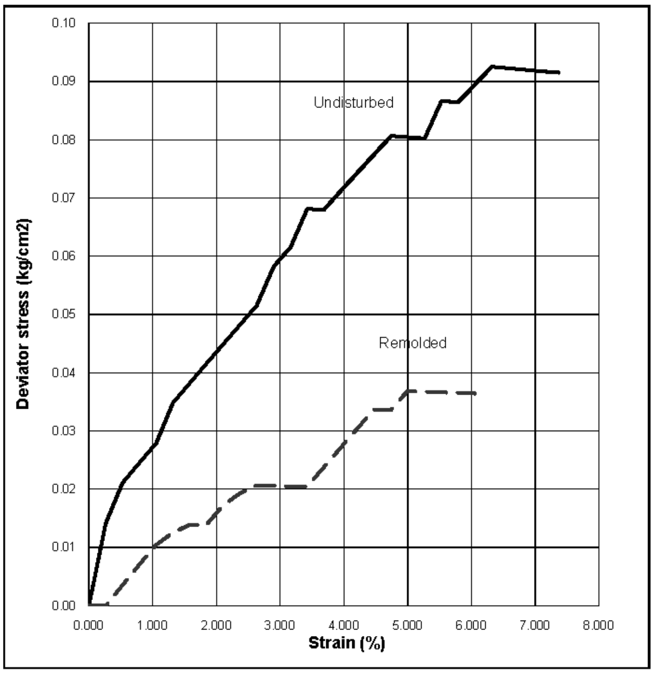
	Project	SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM		
	Job No.	-	Date	8/13/2011
	Tested By	Benny	Checked By	M.Iqbal, ST

UNCONFINED COMPRESSION TEST

Location : Bali
Boring no : BH - 04
Depth : 4.50 - 5.00 m

Sample type : UDS
Soil description : 0

TEST RESULT



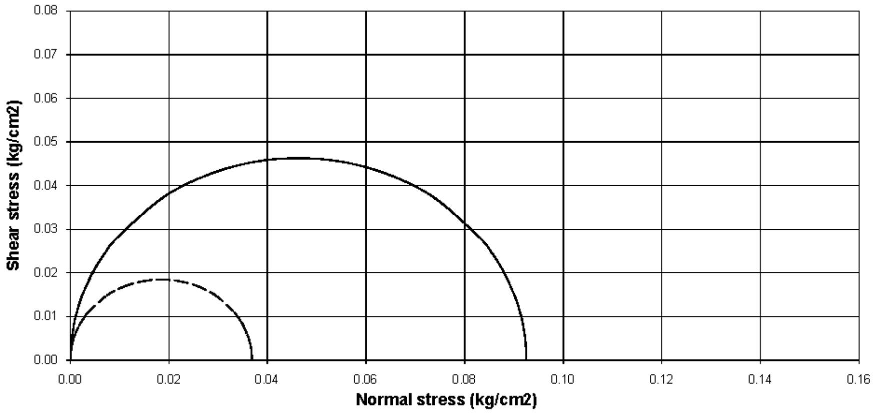
Sample	At failure	
	qu kg/cm2	Strain %
Undisturbed	0.093	6.316
Remolded	0.037	5.789
Sensitivity	2.510	

Mode of failure

Undisturb

Remolded

MOHR CIRCLES



	Project	SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM		
	Job No.	-	Date	13-Aug-11
	Tested By	Benny	Checked By	M.Iqbal, ST

UNCONFINED COMPRESSION TEST

REMOLTED

Location	: Bali	Sample type	: UDS
Boring no	: BH - 04	Soil description	: 0
Depth	: 8.50 - 9.00 m	Sample no.	:

Preparation

Specimen details		Initial	After test	
Diameter	Dmm	38.00	Mass g	
Area	Ao mm2	1134.11	Dry mass g	
Length	Lo mm	76.00	W %	
Volume	cm3	86.19		
Mass	g	132.56		
Density	Mg/m3	1.538		

Machine details		
Machine no		
Rate of deformation	mm/min	1.088
PR Calibration	N/div	0.080

Compression test **Single stage**

REMOLTED

Deformation gauge reading	Compression of specimen (δ L) (mm)	Strain (%)	Force gauge reading (div)	Axial force (N)	Corrected Area (mm^2)	Deviator stress (kg/cm2)
0	0	0	0	0	1134.11	0.000
20	0.20	0.26	0.5	0.000	1137.11	0.004
40	0.40	0.53	1.0	0.001	1140.12	0.007
60	0.60	0.79	1.5	0.001	1143.14	0.010
80	0.80	1.05	1.5	0.001	1146.18	0.010
100	1.00	1.32	1.5	0.001	1149.24	0.010
120	1.20	1.58	2.0	0.002	1152.31	0.014
140	1.40	1.84	2.0	0.002	1155.40	0.014
160	1.60	2.11	2.0	0.002	1158.50	0.014
180	1.80	2.37	2.5	0.002	1161.63	0.017
200	2.00	2.63	2.5	0.002	1164.77	0.017
220	2.20	2.89	2.5	0.002	1167.92	0.017
240	2.40	3.16	2.5	0.002	1171.10	0.017
260	2.60	3.42	2.5	0.002	1174.29	0.017

'LAB DATA/2003/PL 001/PAGAR DEWA/@BCL@FC08CE0F/BH4(8.5)

	Project	**SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM**		
	Job No.	-	Date	8/13/2011
	Tested By	Benny	Checked By	M.Iqbal, ST

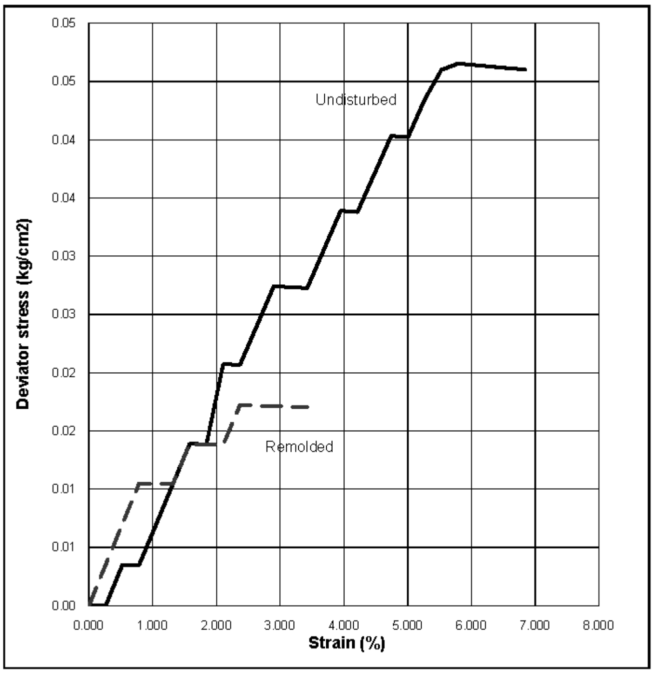
UNCONFINED COMPRESSION TEST

Location : Bali
Boring no : BH - 04
Depth : 8.50 - 9.00 m

Sample type : UDS
Soil description : 0

TEST RESULT

Sample	At failure	
	qu kg/cm2	Strain %
Undisturbed	0.047	2.895
Remolded	0.017	0.000
Sensitivity	2.702	

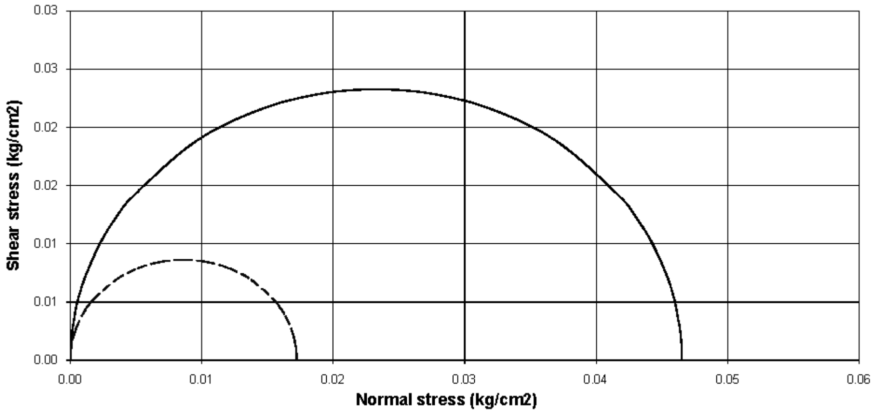


Mode of failure

Undisturb

Remolded

MOHR CIRCLES



Project	SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM		
Job No.	-	Date	13-Aug-11
Tested By	Benny	Checked By	M.Iqbal, ST

UNCONFINED COMPRESSION TEST

REMOLTED

Location	: Bali	Sample type	: UDS
Boring no	: BH - 04	Soil description	: 0
Depth	: 11.50 - 12.00 m	Sample no.	:

Preparation

Specimen details		Initial	After test	
Diameter	Dmm	38.00	Mass g	
Area	Ao mm2	1134.11	Dry mass g	
Length	Lo mm	76.00	W %	
Volume	cm3	86.19		
Mass	g	121.41		
Density	Mg/m3	1.409		

Machine details		
Machine no		
Rate of deformation	mm/min	1.088
PR Calibration	N/div	0.080

Compression test Single stage

REMOLTED

Deformation gauge reading	Compression of specimen (δ L) (mm)	Strain (%)	Force gauge reading (div)	Axial force (N)	Corrected Area (mm^2)	Deviator stress (kg/cm2)
0	0	0	0	0	1134.11	0.000
20	0.20	0.26	0.5	0.000	1137.11	0.004
40	0.40	0.53	1.0	0.001	1140.12	0.007
60	0.60	0.79	1.5	0.001	1143.14	0.010
80	0.80	1.05	2.0	0.002	1146.18	0.014
100	1.00	1.32	2.0	0.002	1149.24	0.014
120	1.20	1.58	2.5	0.002	1152.31	0.017
140	1.40	1.84	3.0	0.002	1155.40	0.021
160	1.60	2.11	3.5	0.003	1158.50	0.024
180	1.80	2.37	4.0	0.003	1161.63	0.028
200	2.00	2.63	4.0	0.003	1164.77	0.027
220	2.20	2.89	5.0	0.004	1167.92	0.034
240	2.40	3.16	4.5	0.004	1171.10	0.031
260	2.60	3.42	4.5	0.004	1174.29	0.031
280	2.80	3.68	4.5	0.004	1177.50	0.031
300	3.00	3.95	5.0	0.004	1180.72	0.034
320	3.20	4.21	5.0	0.004	1183.97	0.034
340	3.40	4.47	5.0	0.004	1187.23	0.034
360	3.60	4.74	5.5	0.004	1190.51	0.037
380	3.80	5.00	6.0	0.005	1193.81	0.040
400	4.00	5.26	6.0	0.005	1197.12	0.040
420	4.20	5.53	6.0	0.005	1200.46	0.040
440	4.40	5.79	6.5	0.005	1203.81	0.043
460	4.60	6.05	7.0	0.006	1207.18	0.046
480	4.80	6.32	7.0	0.006	1210.57	0.046
500	5.00	6.58	7.0	0.006	1213.98	0.046
520	5.20	6.84	7.0	0.006	1217.41	0.046
540	5.40	7.11	7.0	0.006	1220.86	0.046

	Project	SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM		
	Job No.	-	Date	8/13/2011
	Tested By	Benny	Checked By	M.Iqbal, ST

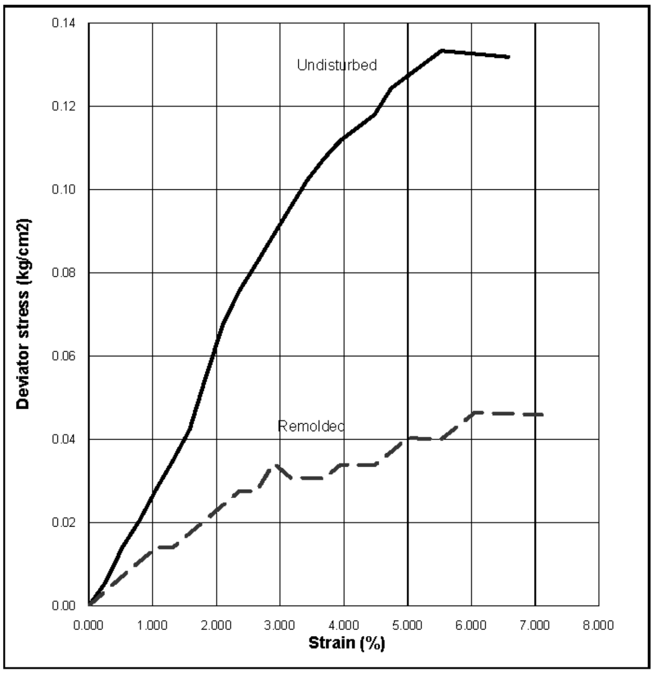
UNCONFINED COMPRESSION TEST

Location : Bali
Boring no : BH - 04
Depth : 11.50 - 12.00 m

Sample type : UDS
Soil description : 0

TEST RESULT

Sample	At failure	
	qu kg/cm2	Strain %
Undisturbed	0.133	6.053
Remolded	0.046	7.105
Sensitivity	2.873	

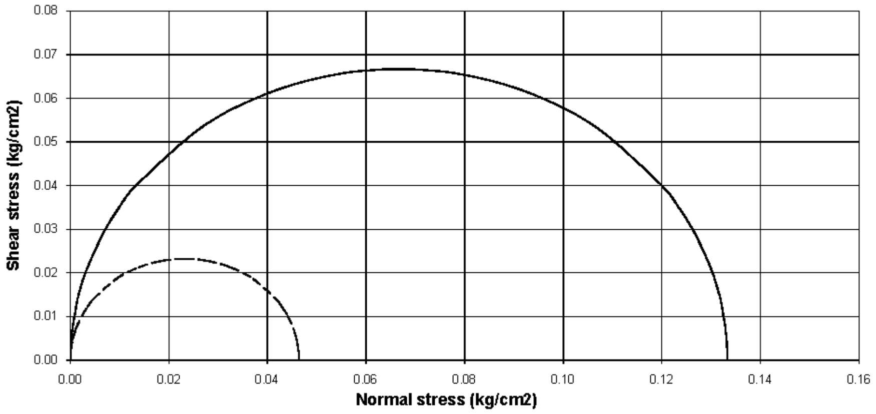


<u>Mode of failure</u>

Undisturb

Remolded

MOHR CIRCLES



PT. TIGENCO GRAHA PERSADA

PROJECT : SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM
LOCATION : BALI

SUMMARY OF SOIL MECHANIC LABORATORY TEST

No	BORE HOLE	DEPTH	TYPE SOIL	CLASSIFICATION	Index Properties															Engineering Properties				
					Determination of dry density & moisture content						SPECIFIC GRAFITY	ATTERBERG LIMITS			GRAIN SIZE					TRIAXIAL UU		UNCONFINED COMPRESSION TEST		
		(meter)		USCS	Wn (%)	γn (gr/cm³)	γd (gr/cm³)	Void Ratio e	Porosity n	Sr (%)	Gs	WL (%)	WP (%)	IP (%)	GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)	% finer by weight passing no. 200 sieve	Ø degree	C kg/cm2	quu kg / cm2	qur kg / cm2	si
1	BH - 1	1.50 - 2.00	UDS	MH	48.39	1.693	1.141	1.296	0.564	97.82	2.619	52.75	32.78	19.97	1.88	42.59	27.67	27.86	55.53	-	-	0.150	0.139	1.075
2	BH - 1	15.50 - 16.00	UDS	CH	84.17	1.475	0.801	2.271	0.694	97.09	2.620	94.46	30.10	64.36	0.00	4.47	37.13	58.40	95.53	-	-	0.225	0.125	1.806
3	BH - 1	19.50 - 20.00	UDS	CH	85.30	1.412	0.762	2.463	0.711	91.39	2.639	93.52	28.22	65.30	0.00	8.63	35.39	55.98	91.37	-	-	0.084	0.060	1.404
4	BH - 2	4.50 - 5.00	UDS	CH	86.13	1.450	0.779	2.372	0.703	95.38	2.627	74.12	24.87	49.25	0.00	15.71	37.90	46.39	84.29	-	-	0.048	0.017	2.770
5	BH - 2	6.50 - 7.00	UDS	SC	67.22	1.524	0.911	1.864	0.651	94.13	2.610	67.36	47.68	19.68	0.00	54.36	20.34	25.30	45.64	-	-	0.054	0.041	1.319
6	BH - 2	8.50 - 9.00	UDS	CH	72.09	1.598	0.929	1.816	0.645	100.00	2.615	75.84	29.58	46.26	0.27	25.99	32.86	40.88	73.74	-	-	0.093	0.034	2.761
7	BH - 3	2.50 - 3.00	UDS	SC	52.68	1.649	1.080	1.429	0.588	96.722	2.623	59.65	33.20	26.45	4.84	44.16	22.90	28.10	51.00	-	-	0.095	0.072	1.311
8	BH - 3	8.50 - 9.00	UDS	SC	52.10	1.869	1.229	1.157	0.536	100.000	2.650	42.85	25.30	17.55	12.64	54.73	24.04	8.59	32.63	-	-	0.024	0.020	1.186
9	BH - 4	2.50 - 3.00	UDS	CH	46.23	1.704	1.165	1.225	0.551	97.84	2.593	62.42	11.76	50.66	4.74	38.18	22.23	34.85	57.08	-	-	0.102	0.088	1.160
10	BH - 4	4.50 - 5.00	UDS	SC	53.55	1.572	1.024	1.569	0.611	89.766	2.630	56.55	30.12	26.43	0.31	53.76	17.44	28.49	45.93	-	-	0.093	0.037	2.510
11	BH - 4	8.50 - 9.00	UDS	SC	56.03	1.551	0.994	1.638	0.621	89.70	2.622	54.99	33.4	21.59	1.75	53.93	18.21	26.11	44.32	-	-	0.047	0.017	2.702
12	BH - 4	11.50 - 12.00	UDS	CH	90.64	1.448	0.760	2.448	0.710	96.967	2.619	73.38	30.77	42.61	0.00	18.61	28.11	53.28	81.39	-	-	0.133	0.046	2.873

PT. TIGENCO GRAHA PERSADA	Project	SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM		
	Client	NIHON SUIDOI CONSULTANT	Date	16-Aug-11
	Tested By	Ria Irmawan	Checked By	M.Iqbal, ST

ATTERBERG LIMITS

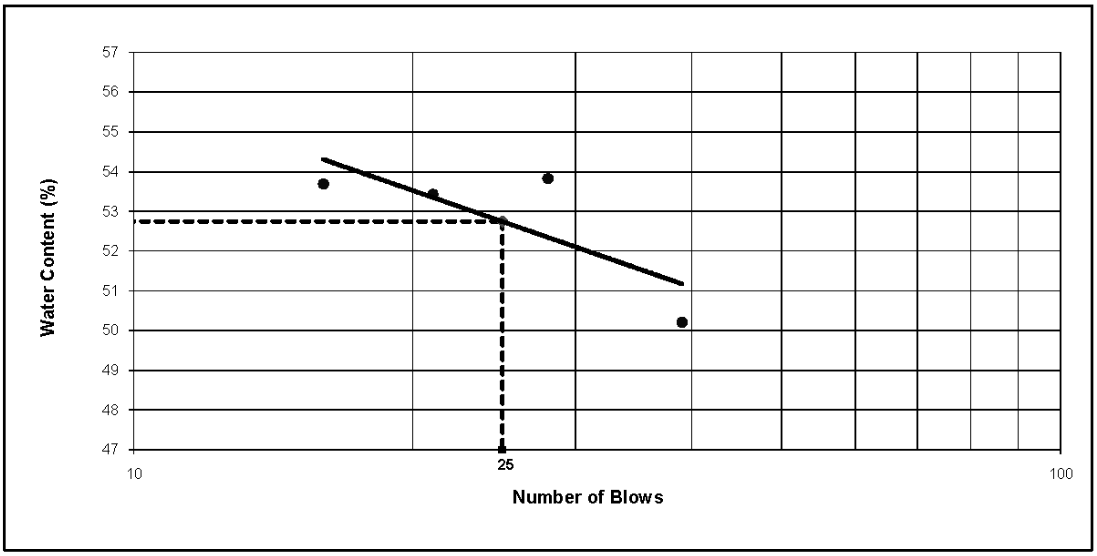
ASTM D 4318

Location	: Bali	Sample No.	: -
Hole No.	: BH - 01	Sample Type	: UDS
Depth	: 1.50 - 2.00 m	Soil Description	: -

LIQUID LIMIT **PLASTIC LIMIT**

No. of Blows		39	28	21	16		
Container No.		C.25	C.34	C.15	C.26	A.27	A.28
Wt. Container + Wet Soil	g	11.34	12.23	12.97	13.50	21.55	22.24
Wt. Container + Dry Soil	g	9.00	9.49	10.02	10.30	19.21	19.87
Wt. Water	g	2.34	2.74	2.95	3.20	2.34	2.37
Wt. Container	g	4.34	4.40	4.50	4.34	12.01	12.70
Wt. Dry Soil (Ws)	g	4.66	5.09	5.52	5.96	7.20	7.17
Water Content (w)	%	50.21	53.83	53.44	53.69	32.50	33.05

FLOW CURVE



RESULT SUMMARY

LIQUID LIMIT	%	52.75
PLASTIC LIMIT	%	32.78
PLASTICITY INDEX	%	19.97
CLASSIFICATION		MH

PT. TIGENCO GRAHA PERSADA	Project	SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM		
	Client	NIHON SUIDOI CONSULTANT	Date	29-Jul-11
	Tested By	Ria Irmawan	Checked By	M.Iqbal, ST

ATTERBERG LIMITS

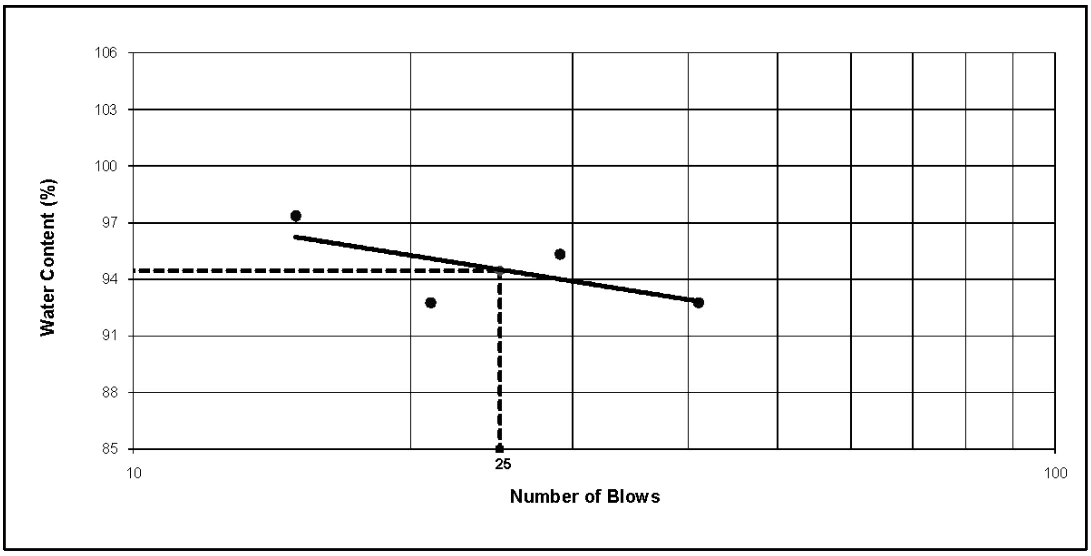
ASTM D 4318

Location : Bali
Hole No. : BH - 01
Depth : 15.50 - 16.00 m

Sample No. : -
Sample Type : UDS
Soil Description : -

LIQUID LIMIT						PLASTIC LIMIT	
No. of Blows		41	29	21	15		
Container No.		C.5	C.13	C.24	C.18	A.1	A.2
Wt. Container + Wet Soil	g	10.21	10.61	11.54	12.53	21.73	21.76
Wt. Container + Dry Soil	g	7.39	7.55	8.08	8.50	19.58	19.72
Wt. Water	g	2.82	3.06	3.46	4.03	2.15	2.04
Wt. Container	g	4.35	4.34	4.35	4.36	12.49	12.89
Wt. Dry Soil (Ws)	g	3.04	3.21	3.73	4.14	7.09	6.83
Water Content (w)	%	92.76	95.33	92.76	97.34	30.32	29.87

FLOW CURVE



RESULT SUMMARY

LIQUID LIMIT	%	94.46
PLASTIC LIMIT	%	30.10
PLASTICITY INDEX	%	64.36
CLASSIFICATION		CH

PT. TIGENCO GRAHA PERSADA	Project	SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM		
	Client	NIHON SUIDOI CONSULTANT	Date	29-Jul-11
	Tested By	Ria Irmawan	Checked By	M.Iqbal, ST

ATTERBERG LIMITS

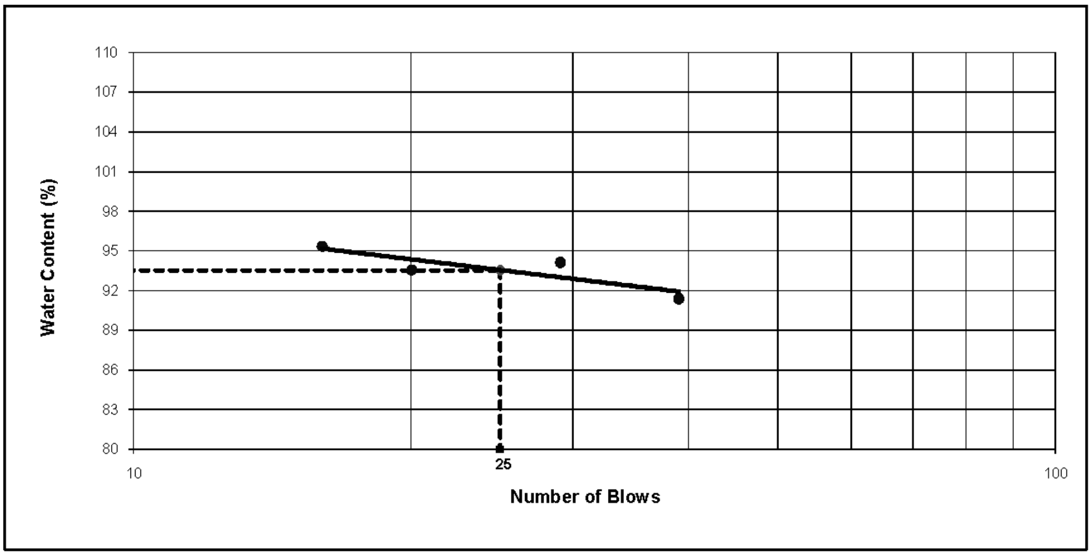
ASTM D 4318

Location : Bali
Hole No. : BH - 01
Depth : 19.50 - 20.00 m

Sample No. : -
Sample Type : UDS
Soil Description : -

LIQUID LIMIT						**PLASTIC LIMIT**	
No. of Blows		39	29	20	16		
Container No.		C.12	C.29	C.17	C.38	A.17	A.18
Wt. Container + Wet Soil	g	11.09	11.24	11.87	12.00	22.54	22.95
Wt. Container + Dry Soil	g	7.92	7.89	8.23	8.28	20.43	20.70
Wt. Water	g	3.17	3.35	3.64	3.72	2.11	2.25
Wt. Container	g	4.45	4.33	4.34	4.38	12.81	12.87
Wt. Dry Soil (Ws)	g	3.47	3.56	3.89	3.90	7.62	7.83
Water Content (w)	%	91.35	94.10	93.57	95.38	27.69	28.74

FLOW CURVE



RESULT SUMMARY

LIQUID LIMIT	%	93.52
PLASTIC LIMIT	%	28.22
PLASTICITY INDEX	%	65.30
CLASSIFICATION		CH

PT. TIGENCO GRAHA PERSADA	Project	SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM		
	Client	NIHON SUIDOI CONSULTANT	Date	2-Aug-11
	Tested By	Ria Irmawan	Checked By	M.Iqbal, ST

ATTERBERG LIMITS

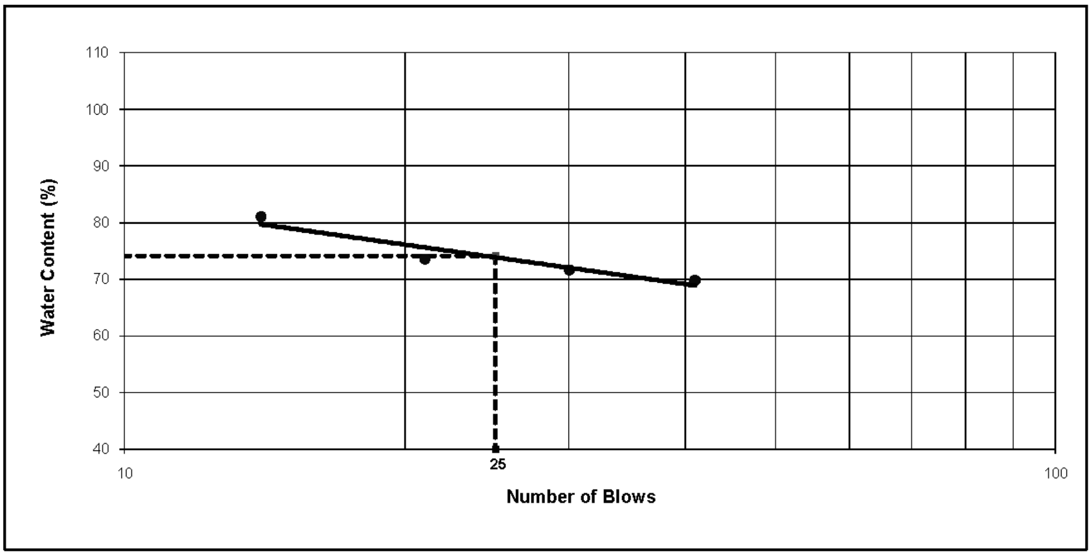
ASTM D 4318

Location	: Bali	Sample No.	: -
Hole No.	: BH - 02	Sample Type	: UDS
Depth	: 4.50 - 5.00 m	Soil Description	: -

LIQUID LIMIT **PLASTIC LIMIT**

No. of Blows		41	30	21	14		
Container No.		C.21	C.22	C.14	C.15	A.7	A.8
Wt. Container + Wet Soil	g	11.25	11.84	12.15	13.65	20.80	20.66
Wt. Container + Dry Soil	g	8.42	8.73	8.83	9.54	19.25	19.10
Wt. Water	g	2.83	3.11	3.32	4.11	1.55	1.56
Wt. Container	g	4.37	4.39	4.32	4.47	13.03	12.81
Wt. Dry Soil (Ws)	g	4.05	4.34	4.51	5.07	6.22	6.29
Water Content (w)	%	69.88	71.66	73.61	81.07	24.92	24.80

FLOW CURVE



RESULT SUMMARY

LIQUID LIMIT	%	74.12
PLASTIC LIMIT	%	24.87
PLASTICITY INDEX	%	49.25
CLASSIFICATION		CH

PT. TIGENCO GRAHA PERSADA	Project	SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM		
	Client	NIHON SUIDOI CONSULTANT	Date	2-Aug-11
	Tested By	Ria Irmawan	Checked By	M.Iqbal, ST

ATTERBERG LIMITS

ASTM D 4318

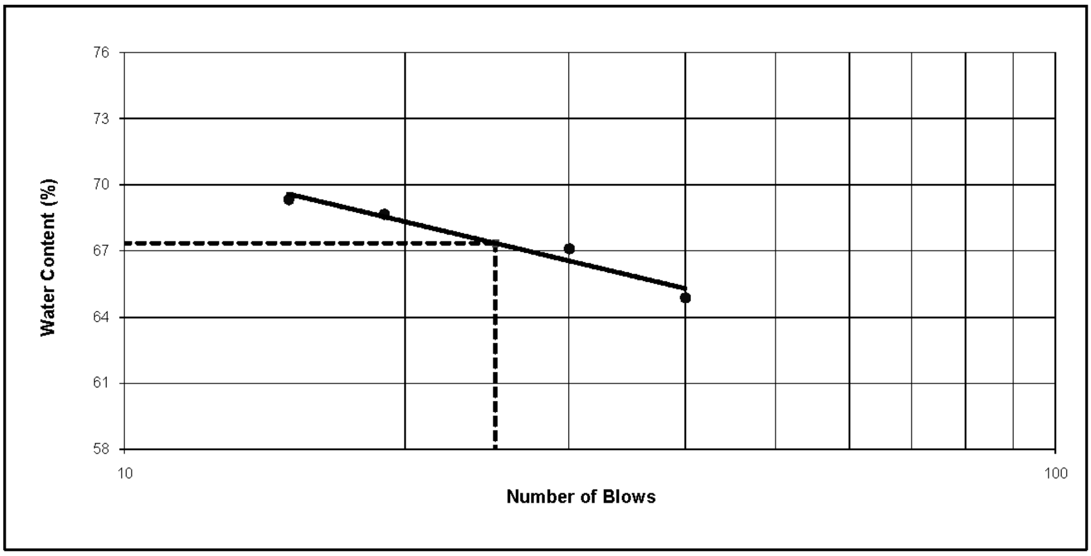
Location : Bali
Hole No. : BH - 02
Depth : 6.50 - 7.00 m

Sample No. : -
Sample Type : UDS
Soil Description : -

LIQUID LIMIT **PLASTIC LIMIT**

No. of Blows		40	30	19	15		
Container No.		C.4	C.22	C.3	C.6	A.25	A.26
Wt. Container + Wet Soil	g	11.80	12.01	12.43	13.02	21.97	20.56
Wt. Container + Dry Soil	g	8.88	8.93	9.14	9.54	19.03	18.00
Wt. Water	g	2.92	3.08	3.29	3.48	2.94	2.56
Wt. Container	g	4.38	4.34	4.35	4.52	12.77	12.71
Wt. Dry Soil (Ws)	g	4.50	4.59	4.79	5.02	6.26	5.29
Water Content (w)	%	64.89	67.10	68.68	69.32	46.96	48.39

FLOW CURVE



RESULT SUMMARY

LIQUID LIMIT	%	67.36
PLASTIC LIMIT	%	47.68
PLASTICITY INDEX	%	19.68
CLASSIFICATION		MH

PT. TIGENCO GRAHA PERSADA	Project	SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM			
	Client	NIHON SUIDOI CONSULTANT	Date	2-Aug-11	
	Tested By	Ria Irmawan	Checked By	M.Iqbal, ST	

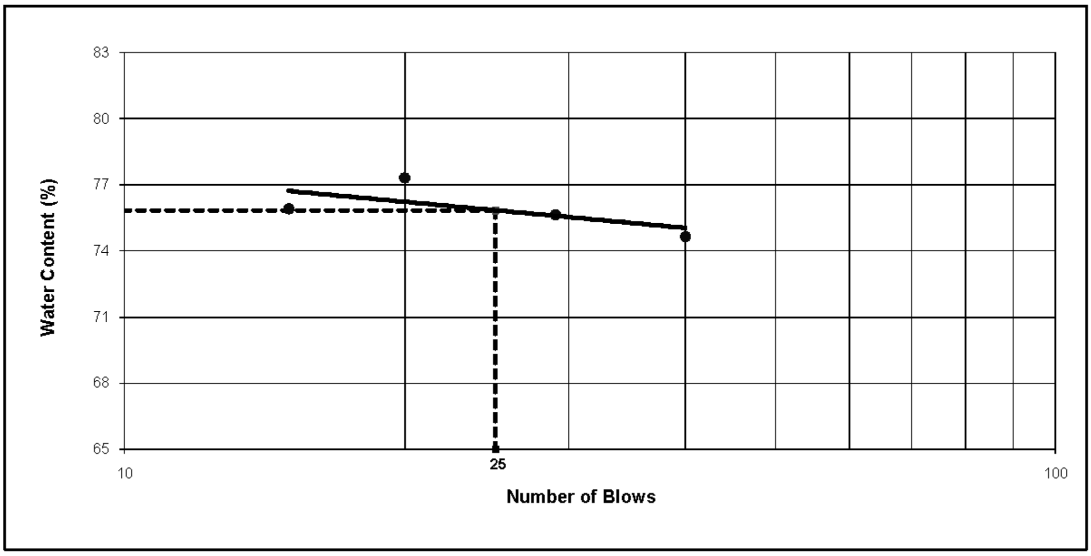
ATTERBERG LIMITS

ASTM D 4318

Location	: Bali	Sample No.	: -
Hole No.	: BH - 02	Sample Type	: UDS
Depth	: 8.50 - 9.00 m	Soil Description	: -

LIQUID LIMIT						PLASTIC LIMIT	
No. of Blows		40	29	20	15		
Container No.		C.36	C.40	C.42	C.39	A.31	A.32
Wt. Container + Wet Soil	g	11.05	11.16	12.21	12.45	23.10	22.80
Wt. Container + Dry Soil	g	8.22	8.21	8.80	8.95	20.88	20.66
Wt. Water	g	2.83	2.95	3.41	3.50	2.22	2.14
Wt. Container	g	4.43	4.31	4.39	4.34	13.42	13.38
Wt. Dry Soil (Ws)	g	3.79	3.90	4.41	4.61	7.46	7.28
Water Content (w)	%	74.67	75.64	77.32	75.92	29.76	29.40

FLOW CURVE



RESULT SUMMARY

LIQUID LIMIT	%	75.84
PLASTIC LIMIT	%	29.58
PLASTICITY INDEX	%	46.26
CLASSIFICATION		CH

PT. TIGENCO GRAHA PERSADA	Project	SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM		
	Client	NIHON SUIDOI CONSULTANT	Date	4-Aug-11
	Tested By	Ria Irmawan	Checked By	M.Iqbal, ST

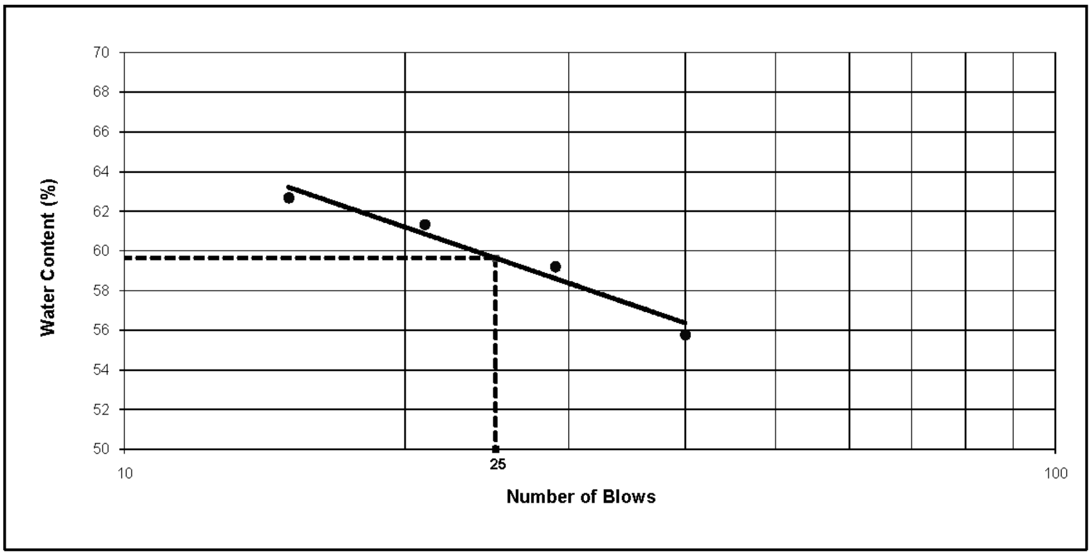
ATTERBERG LIMITS

ASTM D 4318

Location	: Bali	Sample No.	: -
Hole No.	: BH - 03	Sample Type	: UDS
Depth	: 2.50 - 3.00 m	Soil Description	: -

LIQUID LIMIT						PLASTIC LIMIT	
No. of Blows		40	29	21	15		
Container No.		C39	C40	C36	C37	A.15	A.16
Wt. Container + Wet Soil	g	11.35	12.19	13.53	14.21	22.08	22.69
Wt. Container + Dry Soil	g	8.84	9.26	10.07	10.43	19.74	20.23
Wt. Water	g	2.51	2.93	3.46	3.78	2.34	2.46
Wt. Container	g	4.34	4.31	4.43	4.40	12.72	12.79
Wt. Dry Soil (Ws)	g	4.50	4.95	5.64	6.03	7.02	7.44
Water Content (w)	%	55.78	59.19	61.35	62.69	33.33	33.06

FLOW CURVE



RESULT SUMMARY

LIQUID LIMIT	%	59.65
PLASTIC LIMIT	%	33.20
PLASTICITY INDEX	%	26.45
CLASSIFICATION		MH

PT. TIGENCO GRAHA PERSADA	Project	**SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM**		
	Client	NIHON SUIDOI CONSULTANT	Date	4-Aug-11
	Tested By	Ria Irmawan	Checked By	M.Iqbal, ST

ATTERBERG LIMITS
ASTM D 4318

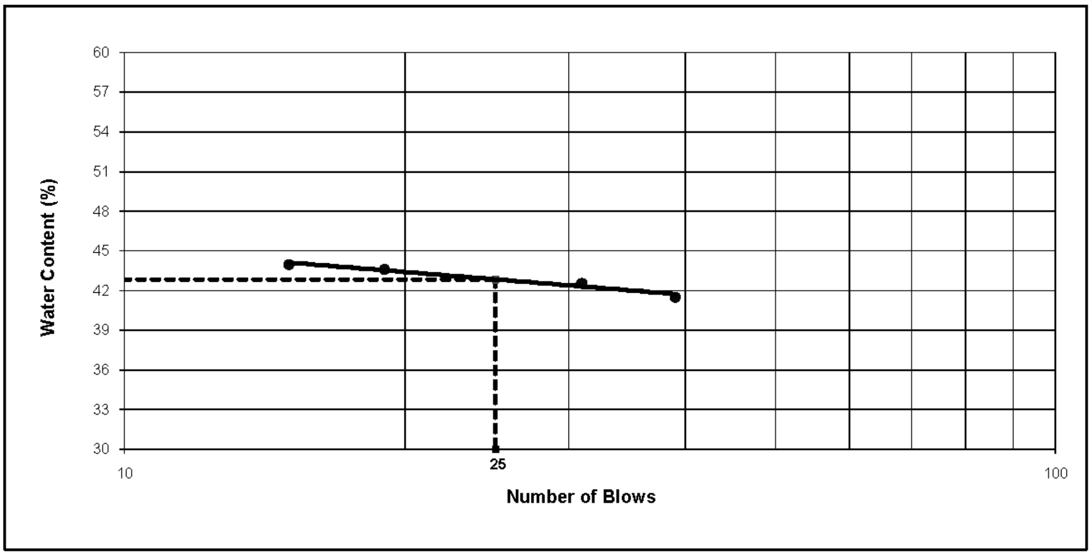
Location : Bali
Hole No. : BH - 03
Depth : 8.50 - 9.00 m

Sample No. : -
Sample Type : UDS
Soil Description : -

LIQUID LIMIT **PLASTIC LIMIT**

No. of Blows		39	31	19	15		
Container No.		C3	C42	C4	C22	A.29	A.30
Wt. Container + Wet Soil	g	12.70	13.50	14.29	15.60	20.64	20.00
Wt. Container + Dry Soil	g	10.25	10.78	11.28	12.16	19.00	18.47
Wt. Water	g	2.45	2.72	3.01	3.44	1.64	1.53
Wt. Container	g	4.35	4.39	4.38	4.34	12.53	12.41
Wt. Dry Soil (Ws)	g	5.90	6.39	6.90	7.82	6.47	6.06
Water Content (w)	%	41.53	42.57	43.62	43.99	25.35	25.25

FLOW CURVE



RESULT SUMMARY

LIQUID LIMIT	%	42.85
PLASTIC LIMIT	%	25.30
PLASTICITY INDEX	%	17.55
CLASSIFICATION		CL

PT. TIGENCO GRAHA PERSADA	Project	SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM		
	Client	NIHON SUIDOI CONSULTANT	Date	11-Aug-11
	Tested By	Ria Irmawan	Checked By	M.Iqbal, ST

ATTERBERG LIMITS
ASTM D 4318

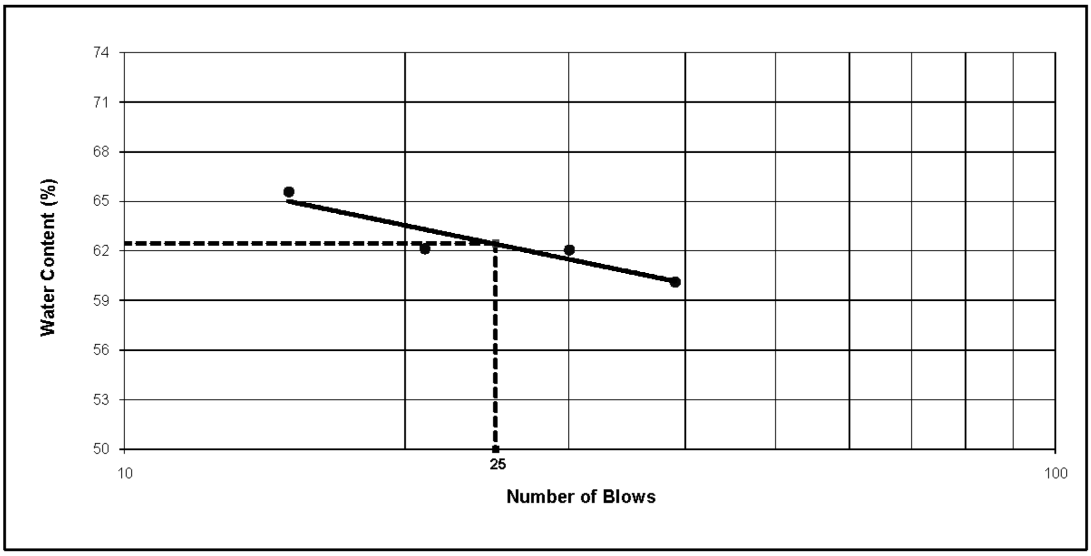
Location : Bali
Hole No. : BH - 04
Depth : 2.50 - 3.00 m

Sample No. : -
Sample Type : UDS
Soil Description : -

LIQUID LIMIT **PLASTIC LIMIT**

No. of Blows		39	30	21	15		
Container No.		C.36	C.42	C.40	C.39	A.5	A.6
Wt. Container + Wet Soil	g	11.62	11.57	11.38	11.03	22.25	20.67
Wt. Container + Dry Soil	g	8.92	8.82	8.67	8.38	21.26	19.79
Wt. Water	g	2.70	2.75	2.71	2.65	0.99	0.88
Wt. Container	g	4.43	4.39	4.31	4.34	12.68	12.44
Wt. Dry Soil (Ws)	g	4.49	4.43	4.36	4.04	8.58	7.35
Water Content (w)	%	60.13	62.08	62.16	65.59	11.54	11.97

FLOW CURVE



RESULT SUMMARY

LIQUID LIMIT	%	62.42
PLASTIC LIMIT	%	11.76
PLASTICITY INDEX	%	50.66
CLASSIFICATION		CH

PT. TIGENCO GRAHA PERSADA	Project	SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM		
	Client	NIHON SUIDOI CONSULTANT	Date	11-Aug-11
	Tested By	Ria Irmawan	Checked By	M.Iqbal, ST

ATTERBERG LIMITS

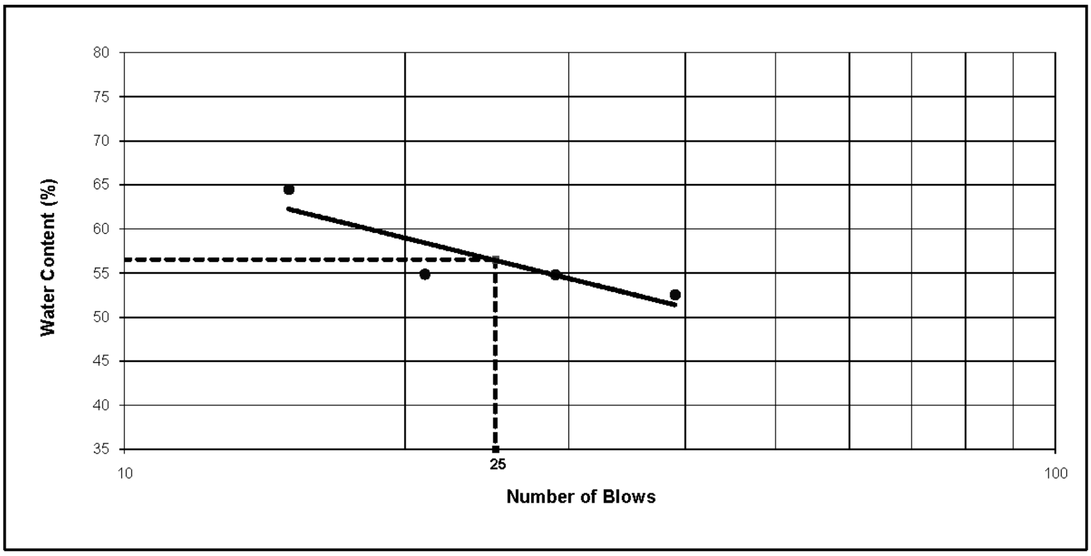
ASTM D 4318

Location : Bali
Hole No. : BH - 04
Depth : 4.50 - 5.00 m

Sample No. : -
Sample Type : UDS
Soil Description : -

LIQUID LIMIT						PLASTIC LIMIT	
No. of Blows		39	29	21	15		
Container No.		C.32	C.14	C.15	C.21	A.27	A.28
Wt. Container + Wet Soil	g	14.49	15.67	16.07	16.15	25.07	25.74
Wt. Container + Dry Soil	g	11.01	11.65	11.96	11.53	22.02	22.75
Wt. Water	g	3.48	4.02	4.11	4.62	3.05	2.99
Wt. Container	g	4.39	4.32	4.47	4.37	12.01	12.70
Wt. Dry Soil (Ws)	g	6.62	7.33	7.49	7.16	10.01	10.05
Water Content (w)	%	52.57	54.84	54.87	64.53	30.47	29.75

FLOW CURVE



RESULT SUMMARY

LIQUID LIMIT	%	56.55
PLASTIC LIMIT	%	30.12
PLASTICITY INDEX	%	26.43
CLASSIFICATION		MH

PT. TIGENCO GRAHA PERSADA	Project	SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM			
	Client	NIHON SUIDOI CONSULTANT	Date	11-Aug-11	
	Tested By	Ria Irmawan	Checked By	M.Iqbal, ST	

ATTERBERG LIMITS

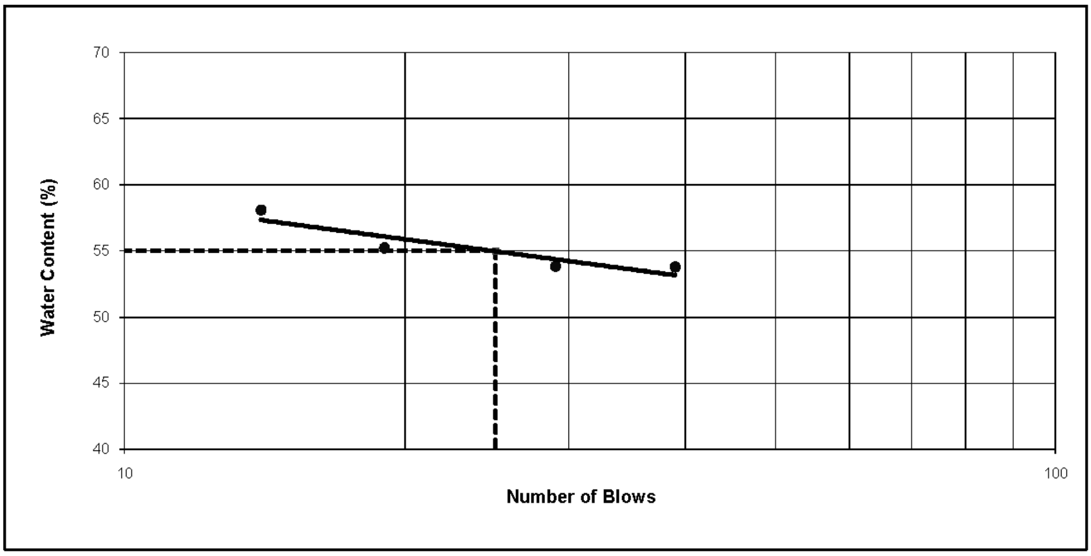
ASTM D 4318

Location : Bali
Hole No. : BH - 04
Depth : 8.50 - 9.00 m

Sample No. : -
Sample Type : UDS
Soil Description : -

LIQUID LIMIT						PLASTIC LIMIT	
No. of Blows		39	29	19	14		
Container No.		C.37	C.25	C.34	C.15	A.3	A.4
Wt. Container + Wet Soil	g	11.86	12.34	12.75	13.37	21.33	21.37
Wt. Container + Dry Soil	g	9.25	9.54	9.78	10.11	19.12	19.15
Wt. Water	g	2.61	2.80	2.97	3.26	2.21	2.22
Wt. Container	g	4.40	4.34	4.40	4.50	12.39	12.61
Wt. Dry Soil (Ws)	g	4.85	5.20	5.38	5.61	6.73	6.54
Water Content (w)	%	53.81	53.85	55.20	58.11	32.84	33.94

FLOW CURVE



RESULT SUMMARY

LIQUID LIMIT	%	54.99
PLASTIC LIMIT	%	33.40
PLASTICITY INDEX	%	21.59
CLASSIFICATION		MH

PT. TIGENCO GRAHA PERSADA	Project	SOIL INVESTIGATION FOR SOUTHERN BALI WATER SUPPLY SYSTEM		
	Client	NIHON SUIDOI CONSULTANT	Date	11-Aug-11
	Tested By	Ria Irmawan	Checked By	M.Iqbal, ST

ATTERBERG LIMITS

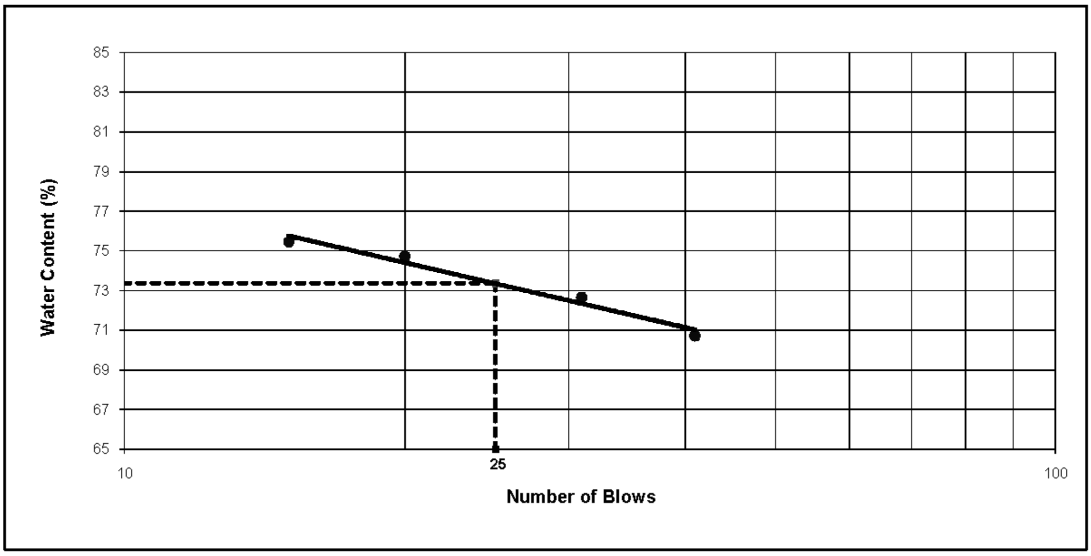
ASTM D 4318

Location : Bali
Hole No. : BH - 04
Depth : 11.50 - 12.00 m

Sample No. : -
Sample Type : UDS
Soil Description : -

LIQUID LIMIT						PLASTIC LIMIT	
No. of Blows		41	31	20	15		
Container No.		C.26	C.13	C.5	C.24	A.19	A.20
Wt. Container + Wet Soil	g	12.09	13.82	14.99	15.27	20.85	20.10
Wt. Container + Dry Soil	g	8.88	9.83	10.44	10.57	18.90	18.45
Wt. Water	g	3.21	3.99	4.55	4.70	1.95	1.65
Wt. Container	g	4.34	4.34	4.35	4.34	12.65	13.01
Wt. Dry Soil (Ws)	g	4.54	5.49	6.09	6.23	6.25	5.44
Water Content (w)	%	70.70	72.68	74.71	75.44	31.20	30.33

FLOW CURVE



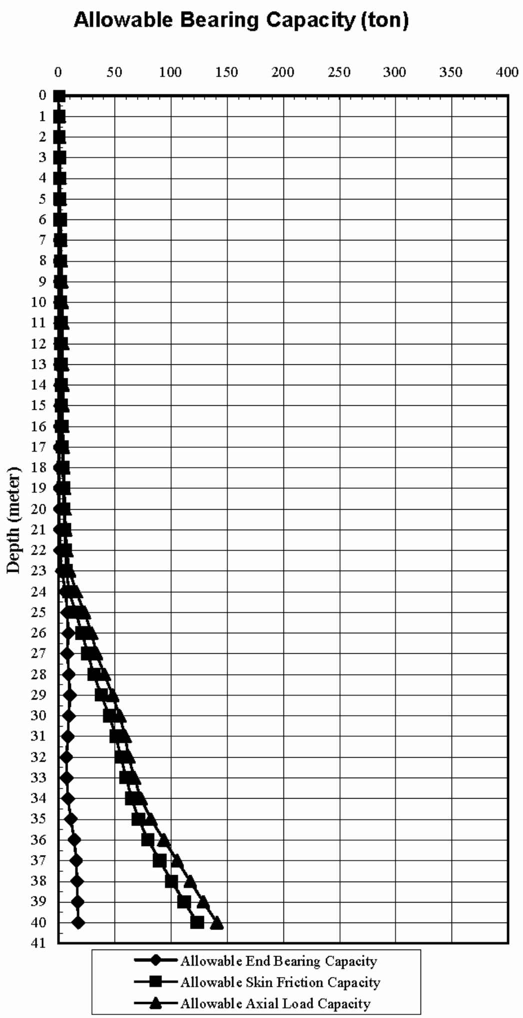
RESULT SUMMARY

LIQUID LIMIT	%	73.38
PLASTIC LIMIT	%	30.77
PLASTICITY INDEX	%	42.61
CLASSIFICATION		CH

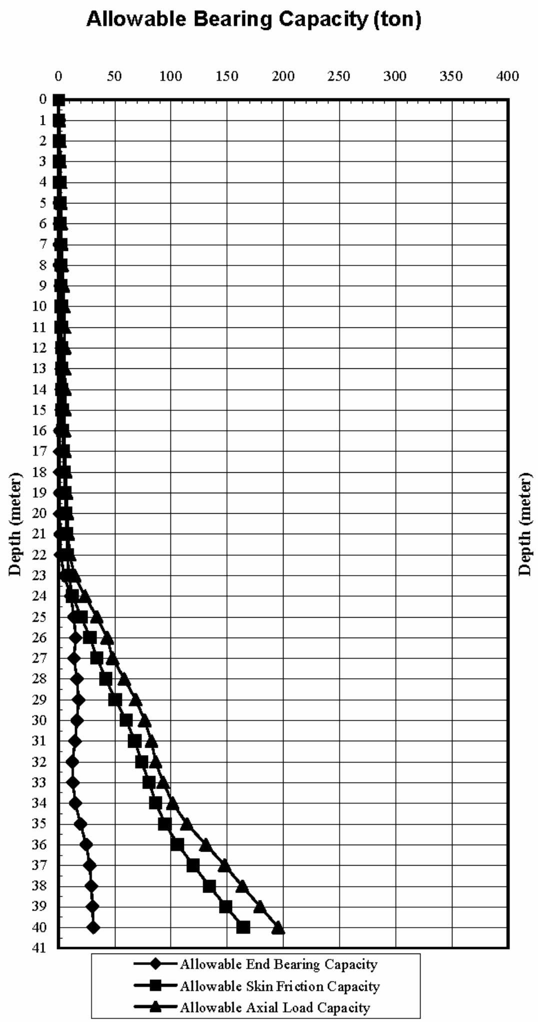
BEARING CAPACITY

PT. TIGENCO GRAHA PERSADA

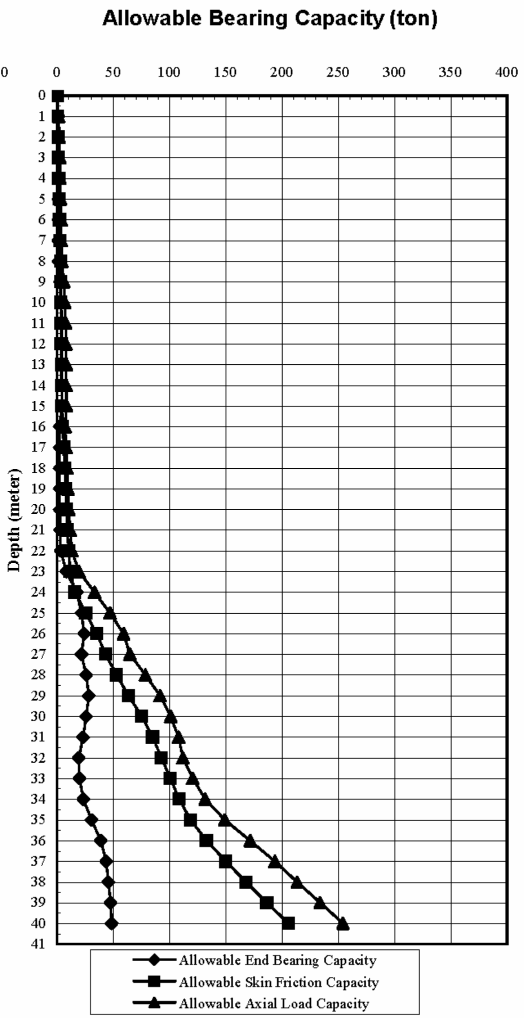
Graph 1 of Allowable Bearing Capacity of Round Driven Pile Based on N-SPT of BH1



Precast
0,3 Round



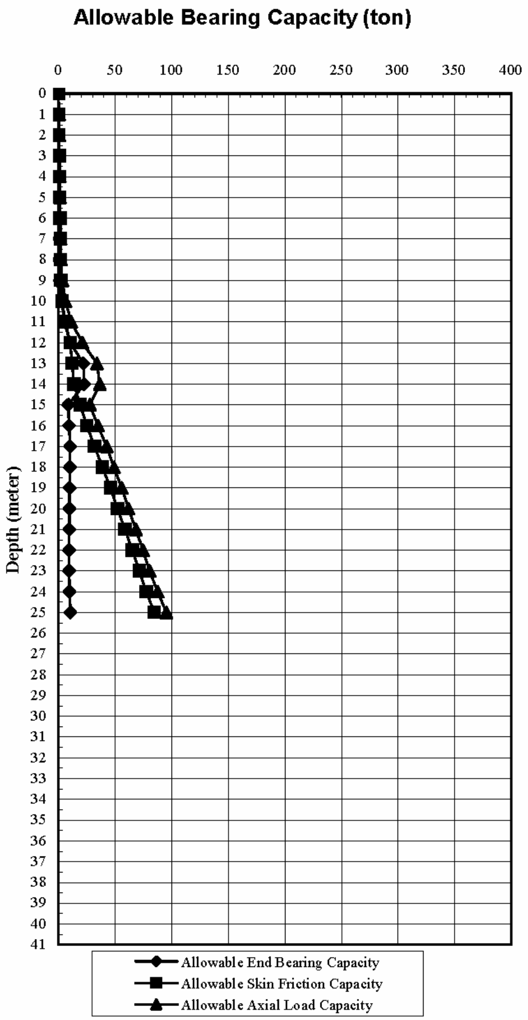
Precast
Round 0,4



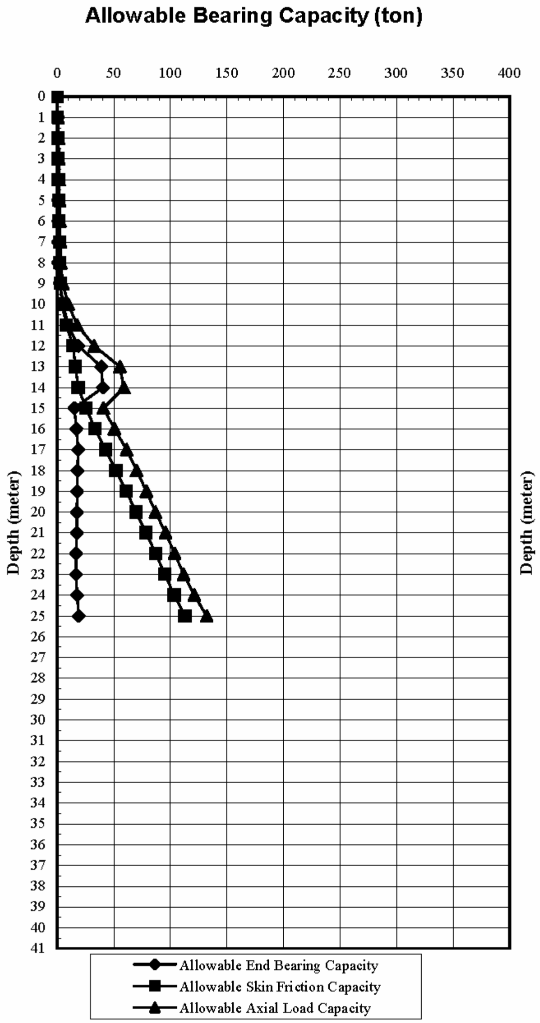
Precast
Round 0,5

PT. TIGENCO GRAHA PERSADA

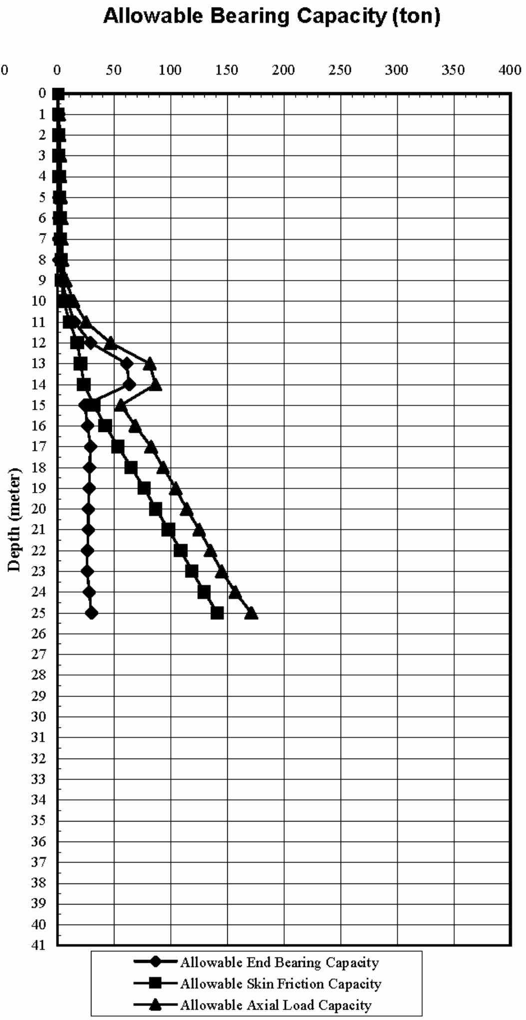
Graph 2 of Allowable Bearing Capacity of Round Driven Pile Based on N-SPT of BH2



Precast
0,3 Round



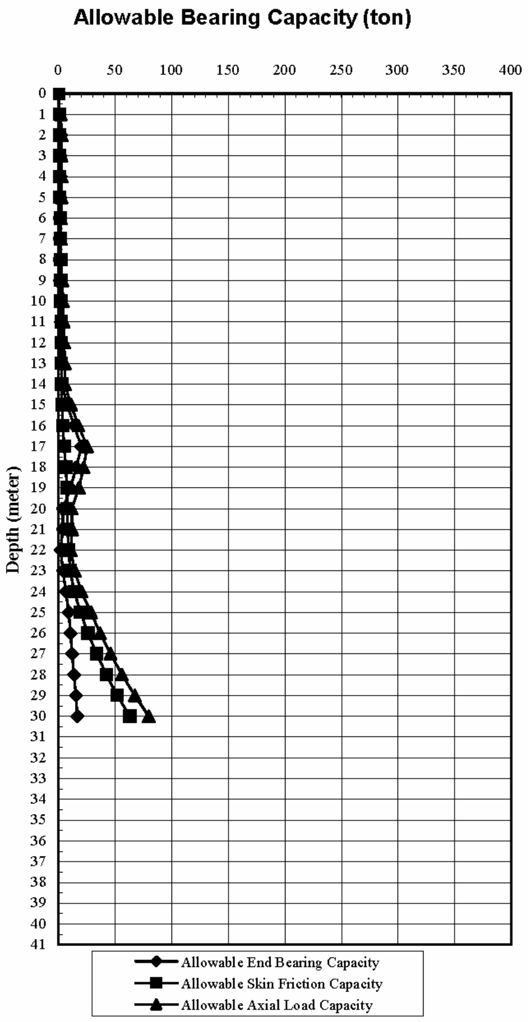
Precast
Round 0,4



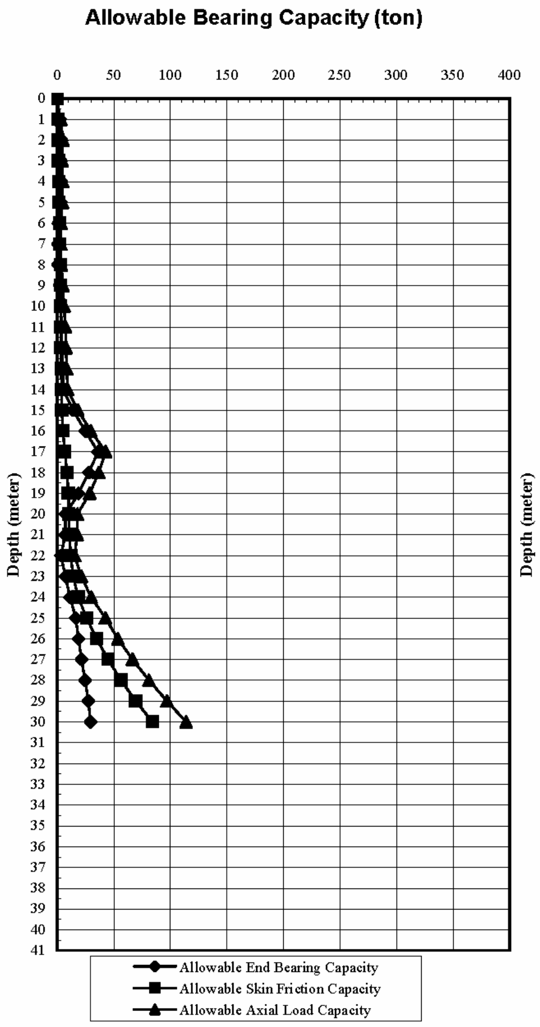
Precast
Round 0,5

PT. TIGENCO GRAHA PERSADA

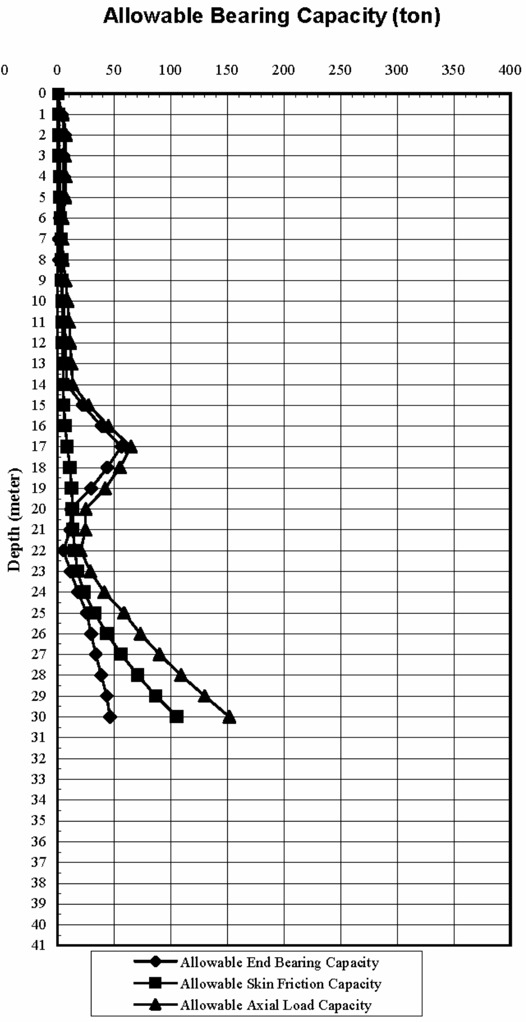
Graph 3 of Allowable Bearing Capacity of Round Driven Pile Based on N-SPT of BH3



Precast
0,3 Round



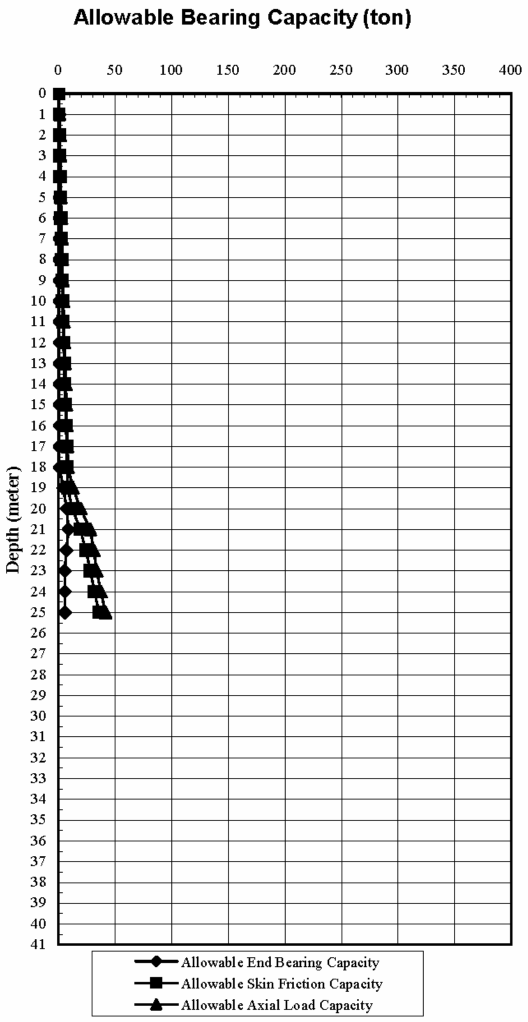
Precast
Round 0,4



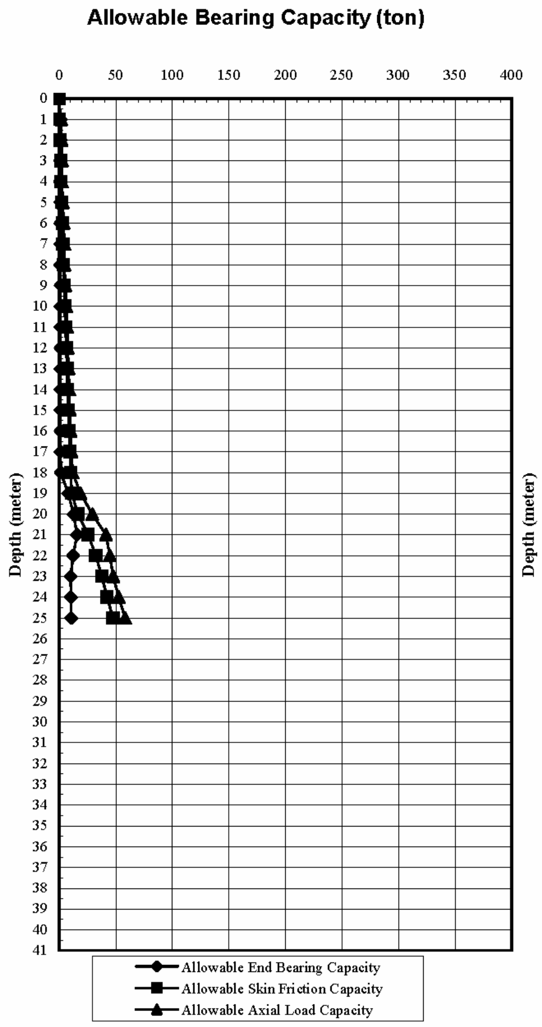
Precast
Round 0,5

PT. TIGENCO GRAHA PERSADA

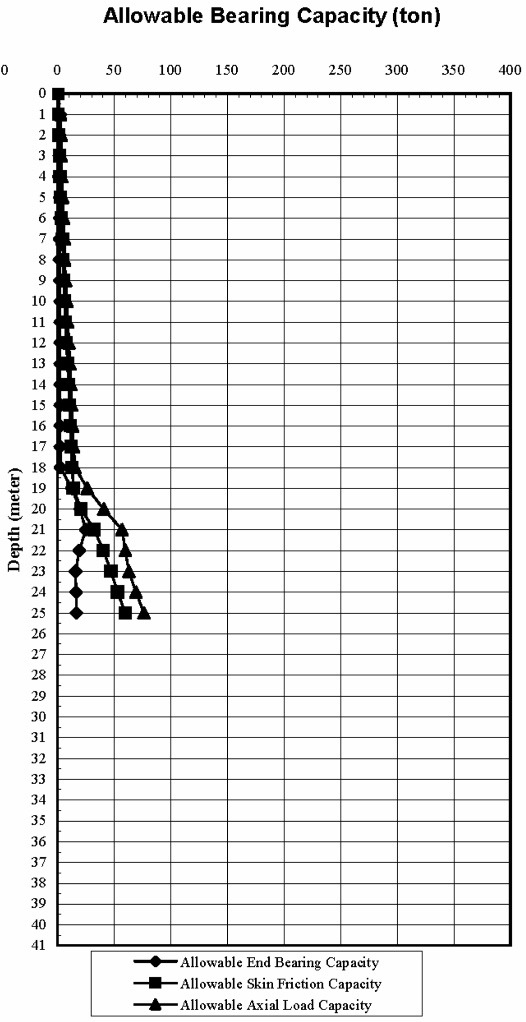
Graph 4 of Allowable Bearing Capacity of Round Driven Pile Based on N-SPT of BH4



Precast
0,3 Round



Precast
Round 0,4



Precast
Round 0,5

PILE CAPACITY CALCULATION FOR DRIVEN PILE (MEYERHOFF'S FORMULA)

PILE INFORMATION

Length :	**15**	m			
Pile type	**Precast**	Round	Area	0,0707	m2
Dimension	**0,30**	m	Perimeter	0,942477796	m

SOIL INFORMATION

DEPTH OF SOIL DATA :	**40,45**	m	BOREHOLE	BH1
SPT INTERVAL	**1**	m		

note : *soil type* *clay, silty clay (CH/CL), clayey silt (MH) = 2*
sand (SP/SW), silty sand (SM), sandy silt (ML) = 1

depth m	**NSPT**	**Corrected NSPT N70 --> N55**	**soil type**	**Pf ton**	**Pb ton**	**ultimate capacity Pf+Pb ton**	**allowable capacity Pa SF=3 ton**	**remarks Pullout Sf=3**
0	0		**2**					0
1	1	1	**2**	0	1	1	0	0
2	1	1	**2**	1	1	2	1	0
3	1	1	**2**	2	1	3	1	0
4	1	1	**2**	3	1	4	1	1
5	1	1	**2**	3	1	4	1	1
6	1	1	**2**	4	1	5	2	1
7	1	1	**2**	5	1	6	2	1
8	1	1	**2**	6	1	7	2	1
9	1	1	**1**	6	3	9	3	1
10	2	2	**1**	6	4	10	3	1
11	2	2	**1**	6	4	11	4	1
12	2	2	**1**	7	4	11	4	2
13	2	2	**1**	7	4	11	4	2
14	2	2	**1**	7	4	12	4	2
15	2	2	**1**	7	4	12	4	2
16	2	2	**2**	9	2	11	4	2
17	2	2	**2**	10	2	13	4	2
18	2	2	**2**	12	2	14	5	3
19	2	2	**2**	13	2	16	5	3
20	2	2	**2**	15	2	17	6	3
21	2	2	**2**	16	3	19	6	4
22	3	2	**2**	18	3	21	7	4
23	4	3	**2**	21	9	29	10	5

PILE CAPACITY CALCULATION FOR DRIVEN PILE (MEYERHOFF'S FORMULA)

PILE INFORMATION

Length : **15** m

Pile type **Precast** Round   Area 0,0707 m2

Dimension **0,30** m   Perimeter 0,942477796 m

SOIL INFORMATION

DEPTH OF SOIL DATA : **40,45** m   BOREHOLE BH1

SPT INTERVAL **1** m

note : *soil type clay, silty clay (CH/CL), clayey silt (MH) = 2*
sand (SP/SW), silty sand (SM), sandy silt (ML) = 1

depth m	**NSPT**	**Corrected NSPT N70 --> N55**	**soil type**	**Pf ton**	**Pb ton**	**ultimate capacity Pf+Pb ton**	**allowable capacity Pa SF=3 ton**	**remarks Pullout Sf=3**
24	16	13	**2**	28	19	47	16	7
25	31	24	**2**	46	23	69	23	11
26	16	13	**2**	63	26	89	30	15
27	23	18	**2**	77	23	101	34	18
28	24	19	**2**	95	28	123	41	22
29	28	22	**2**	114	30	144	48	27
30	30	24	**2**	136	28	163	54	32
31	17	13	**2**	153	25	178	59	36
32	20	16	**2**	167	21	187	62	39
33	19	15	**2**	181	21	203	68	42
34	19	15	**2**	195	25	220	73	46
35	30	24	**2**	213	33	246	82	50
36	40	31	**2**	239	42	281	94	56
37	43	34	**2**	270	47	317	106	63
38	44	35	**2**	302	49	351	117	70
39	46	36	**2**	335	51	387	129	78
40	48	38	**2**	370	52	422	141	86

PILE CAPACITY CALCULATION FOR DRIVEN PILE (MEYERHOFF'S FORMULA)

PILE INFORMATION

Length : **15** m

Pile type **Precast** Round — Area 0,1257 m2

Dimension **0,40** m — Perimeter 1,256637061 m

SOIL INFORMATION

DEPTH OF SOIL DATA : **40,45** m — BOREHOLE BH1

SPT INTERVAL **1** m

note : *soil type clay, silty clay (CH/CL), clayey silt (MH) = 2*
sand (SP/SW), silty sand (SM), sandy silt (ML) = 1

depth m	**NSPT**	**Corrected NSPT N70 --> N55**	**soil type**	**Pf ton**	**Pb ton**	**ultimate capacity Pf+Pb ton**	**allowable capacity Pa SF=3 ton**	**remarks Pullout Sf=3**
0	0		**2**					0
1	1	1	**2**	0	2	2	1	0
2	1	1	**2**	1	2	3	1	0
3	1	1	**2**	2	2	4	1	1
4	1	1	**2**	3	2	5	2	1
5	1	1	**2**	4	2	6	2	1
6	1	1	**2**	5	2	7	2	1
7	1	1	**2**	6	2	8	3	1
8	1	1	**2**	7	2	9	3	2
9	1	1	**1**	8	5	13	4	2
10	2	2	**1**	8	7	14	5	2
11	2	2	**1**	8	8	16	5	2
12	2	2	**1**	9	8	17	6	2
13	2	2	**1**	9	8	17	6	2
14	2	2	**1**	9	8	17	6	2
15	2	2	**1**	10	8	18	6	2
16	2	2	**2**	12	4	16	5	3
17	2	2	**2**	14	4	18	6	3
18	2	2	**2**	16	4	20	7	4
19	2	2	**2**	18	4	22	7	4
20	2	2	**2**	20	4	24	8	5
21	2	2	**2**	22	5	26	9	5
22	3	2	**2**	24	6	30	10	6
23	4	3	**2**	28	15	43	14	6

PILE CAPACITY CALCULATION FOR DRIVEN PILE (MEYERHOFF'S FORMULA)

PILE INFORMATION

Length :	**15**	m			
Pile type	**Precast**	Round	Area	0,1257	m2
Dimension	**0,40**	m	Perimeter	1,256637061	m

SOIL INFORMATION

DEPTH OF SOIL DATA :	**40,45**	m	BOREHOLE	BH1
SPT INTERVAL	**1**	m		

note : *soil type clay, silty clay (CH/CL), clayey silt (MH) = 2*
sand (SP/SW), silty sand (SM), sandy silt (ML) = 1

depth m	**NSPT**	**Corrected NSPT N70 --> N55**	**soil type**	**Pf ton**	**Pb ton**	**ultimate capacity Pf+Pb ton**	**allowable capacity Pa SF=3 ton**	**remarks Pullout Sf=3**
24	16	13	**2**	38	34	71	24	9
25	31	24	**2**	61	41	102	34	14
26	16	13	**2**	84	46	130	43	20
27	23	18	**2**	103	41	145	48	24
28	24	19	**2**	126	49	176	59	29
29	28	22	**2**	152	54	206	69	35
30	30	24	**2**	181	49	230	77	42
31	17	13	**2**	204	44	248	83	48
32	20	16	**2**	222	37	259	86	52
33	19	15	**2**	241	38	280	93	56
34	19	15	**2**	260	45	305	102	61
35	30	24	**2**	284	59	343	114	66
36	40	31	**2**	319	74	393	131	74
37	43	34	**2**	360	84	443	148	84
38	44	35	**2**	403	88	490	163	94
39	46	36	**2**	447	91	538	179	104
40	48	38	**2**	494	93	586	195	115

PILE CAPACITY CALCULATION FOR DRIVEN PILE (MEYERHOFF'S FORMULA)

PILE INFORMATION

Length : **15** m

Pile type **Precast** Round

Area 0,1963 m2

Dimension **0,50** m

Perimeter 1,571 m

SOIL INFORMATION

DEPTH OF SOIL DATA : **40,45** m

BOREHOLE BH1

SPT INTERVAL **1** m

note : *soil type* *clay, silty clay (CH/CL), clayey silt (MH) = 2*
sand (SP/SW), silty sand (SM), sandy silt (ML) = 1

depth m	**NSPT**	**Corrected NSPT N70 --> N55**	**soil type**	**Pf ton**	**Pb ton**	**ultimate capacity Pf+Pb ton**	**allowable capacity Pa SF=3 ton**	**remarks Pullout Sf=3**
0	0		**2**					0
1	1	1	**2**	1	3	4	1	0
2	1	1	**2**	2	3	5	2	0
3	1	1	**2**	3	3	6	2	1
4	1	1	**2**	4	3	7	2	1
5	1	1	**2**	6	3	9	3	1
6	1	1	**2**	7	3	10	3	2
7	1	1	**2**	8	3	11	4	2
8	1	1	**2**	9	3	12	4	2
9	1	1	**1**	10	8	18	6	2
10	2	2	**1**	10	10	20	7	2
11	2	2	**1**	10	12	23	8	2
12	2	2	**1**	11	12	23	8	3
13	2	2	**1**	11	12	24	8	3
14	2	2	**1**	12	12	24	8	3
15	2	2	**1**	12	12	25	8	3
16	2	2	**2**	15	6	21	7	3
17	2	2	**2**	17	6	23	8	4
18	2	2	**2**	20	6	26	9	5
19	2	2	**2**	22	6	28	9	5
20	2	2	**2**	25	6	31	10	6
21	2	2	**2**	27	7	34	11	6
22	3	2	**2**	30	9	39	13	7
23	4	3	**2**	35	24	58	19	8

PILE CAPACITY CALCULATION FOR DRIVEN PILE (MEYERHOFF'S FORMULA)

PILE INFORMATION

Length : **15** m

Pile type **Precast** Round

Area 0,1963 m2

Dimension **0,50** m

Perimeter 1,571 m

SOIL INFORMATION

DEPTH OF SOIL DATA : **40,45** m

BOREHOLE BH1

SPT INTERVAL **1** m

note : *soil type* *clay, silty clay (CH/CL), clayey silt (MH) = 2*
sand (SP/SW), silty sand (SM), sandy silt (ML) = 1

depth m	**NSPT**	**Corrected NSPT N70 --> N55**	**soil type**	**Pf ton**	**Pb ton**	**ultimate capacity Pf+Pb ton**	**allowable capacity Pa SF=3 ton**	**remarks Pullout Sf=3**
24	16	13	**2**	47	52	99	33	11
25	31	24	**2**	76	65	141	47	18
26	16	13	**2**	105	72	177	59	24
27	23	18	**2**	129	65	194	65	30
28	24	19	**2**	158	77	235	78	37
29	28	22	**2**	190	84	274	91	44
30	30	24	**2**	226	77	303	101	53
31	17	13	**2**	255	69	324	108	59
32	20	16	**2**	278	58	335	112	65
33	19	15	**2**	302	60	361	120	70
34	19	15	**2**	325	70	395	132	76
35	30	24	**2**	355	92	447	149	83
36	40	31	**2**	399	116	515	172	93
37	43	34	**2**	450	131	580	193	105
38	44	35	**2**	504	137	640	213	117
39	46	36	**2**	559	142	701	234	130
40	48	38	**2**	617	145	762	254	144

PILE CAPACITY CALCULATION FOR DRIVEN PILE (MEYERHOFF'S FORMULA)

PILE INFORMATION

Length :	**15** m			
Pile type	**Precast**	Round	Area	0,0707 m2
Dimension	**0,30** m		Perimeter	0,942477796 m

SOIL INFORMATION

DEPTH OF SOIL DATA :	**25,45** m	BOREHOLE	BH2
SPT INTERVAL	**1** m		

note : *soil type* *clay, silty clay (CH/CL), clayey silt (MH) = 2*
sand (SP/SW), silty sand (SM), sandy silt (ML) = 1

depth m	**NSPT**	**Corrected NSPT N70 --> N55**	**soil type**	**Pf ton**	**Pb ton**	**ultimate capacity Pf+Pb ton**	**allowable capacity Pa SF=3 ton**	**remarks Pullout Sf=3**
0	0		**2**					0
1	1	1	**2**	0	1	1	0	0
2	1	1	**2**	1	1	2	1	0
3	1	1	**2**	2	1	3	1	0
4	1	1	**2**	3	1	4	1	1
5	1	1	**2**	3	1	4	1	1
6	1	1	**2**	4	1	5	2	1
7	1	1	**2**	5	1	6	2	1
8	1	1	**2**	6	1	7	2	1
9	1	1	**2**	6	4	10	3	1
10	8	6	**2**	10	9	19	6	2
11	16	13	**2**	19	16	34	11	4
12	19	15	**2**	31	31	63	21	7
13	50	39	**1**	37	66	102	34	9
14	20	16	**1**	42	68	110	37	10
15	22	17	**2**	57	26	83	28	13
16	28	22	**2**	76	29	104	35	18
17	27	21	**2**	96	31	128	43	22
18	30	24	**2**	117	30	148	49	27
19	25	20	**2**	138	30	168	56	32
20	26	20	**2**	157	29	186	62	37
21	28	22	**2**	177	29	206	69	41
22	25	20	**2**	196	28	224	75	46
23	23	18	**2**	214	28	242	81	50
24	28	22	**2**	233	30	263	88	54
25	30	24	**2**	254	32	287	96	59

PILE CAPACITY CALCULATION FOR DRIVEN PILE (MEYERHOFF'S FORMULA)

PILE INFORMATION

Length : **15** m

Pile type **Precast** Round

Dimension **0,40** m

Area 0,1257 m2

Perimeter 1,256637061 m

SOIL INFORMATION

DEPTH OF SOIL DATA : **25,45** m

SPT INTERVAL **1** m

BOREHOLE BH2

note : *soil type* *clay, silty clay (CH/CL), clayey silt (MH) = 2*
sand (SP/SW), silty sand (SM), sandy silt (ML) = 1

depth m	**NSPT**	**Corrected NSPT N70 --> N55**	**soil type**	**Pf ton**	**Pb ton**	**ultimate capacity Pf+Pb ton**	**allowable capacity Pa SF=3 ton**	**remarks Pullout Sf=3**
0	0		**2**					0
1	1	1	**2**	0	2	2	1	0
2	1	1	**2**	1	2	3	1	0
3	1	1	**2**	2	2	4	1	1
4	1	1	**2**	3	2	5	2	1
5	1	1	**2**	4	2	6	2	1
6	1	1	**2**	5	2	7	2	1
7	1	1	**2**	6	2	8	3	1
8	1	1	**2**	7	2	9	3	2
9	1	1	**2**	8	7	15	5	2
10	8	6	**2**	13	16	29	10	3
11	16	13	**2**	25	28	53	18	6
12	19	15	**2**	42	56	98	33	10
13	50	39	**1**	49	117	166	55	11
14	20	16	**1**	56	121	177	59	13
15	22	17	**2**	76	46	122	41	18
16	28	22	**2**	101	51	152	51	24
17	27	21	**2**	128	56	184	61	30
18	30	24	**2**	156	54	210	70	36
19	25	20	**2**	184	53	237	79	43
20	26	20	**2**	209	52	261	87	49
21	28	22	**2**	235	52	287	96	55
22	25	20	**2**	262	50	312	104	61
23	23	18	**2**	285	50	335	112	67
24	28	22	**2**	310	53	364	121	72
25	30	24	**2**	339	57	396	132	79

PILE CAPACITY CALCULATION FOR DRIVEN PILE (MEYERHOFF'S FORMULA)

PILE INFORMATION

Length : **15** m

Pile type **Precast** Round Area 0,1963 m2

Dimension **0,50** m Perimeter 1,571 m

SOIL INFORMATION

DEPTH OF SOIL DATA : **25,45** m BOREHOLE BH2

SPT INTERVAL **1** m

note : *soil type clay, silty clay (CH/CL), clayey silt (MH) = 2*
sand (SP/SW), silty sand (SM), sandy silt (ML) = 1

depth m	**NSPT**	**Corrected NSPT N70 --> N55**	**soil type**	**Pf ton**	**Pb ton**	**ultimate capacity Pf+Pb ton**	**allowable capacity Pa SF=3 ton**	**remarks Pullout Sf=3**
0	0		**2**					0
1	1	1	**2**	1	3	4	1	0
2	1	1	**2**	2	3	5	2	0
3	1	1	**2**	3	3	6	2	1
4	1	1	**2**	4	3	7	2	1
5	1	1	**2**	6	3	9	3	1
6	1	1	**2**	7	3	10	3	2
7	1	1	**2**	8	3	11	4	2
8	1	1	**2**	9	3	12	4	2
9	1	1	**2**	10	10	21	7	2
10	8	6	**2**	16	26	42	14	4
11	16	13	**2**	31	44	75	25	7
12	19	15	**2**	52	87	140	47	12
13	50	39	**1**	61	183	244	81	14
14	20	16	**1**	70	189	259	86	16
15	22	17	**2**	96	72	168	56	22
16	28	22	**2**	126	79	206	69	29
17	27	21	**2**	160	87	248	83	37
18	30	24	**2**	195	84	280	93	46
19	25	20	**2**	229	83	313	104	54
20	26	20	**2**	261	81	342	114	61
21	28	22	**2**	294	81	375	125	69
22	25	20	**2**	327	78	405	135	76
23	23	18	**2**	357	78	435	145	83
24	28	22	**2**	388	83	471	157	91
25	30	24	**2**	424	89	513	171	99

PILE CAPACITY CALCULATION FOR DRIVEN PILE (MEYERHOFF'S FORMULA)

PILE INFORMATION

Length : **15** m

Pile type **Precast** Round Area 0,0707 m2

Dimension **0,30** m Perimeter 0,942477796 m

SOIL INFORMATION

DEPTH OF SOIL DATA : **30,45** m BOREHOLE BH3

SPT INTERVAL **1** m

note : *soil type clay, silty clay (CH/CL), clayey silt (MH) = 2*
sand (SP/SW), silty sand (SM), sandy silt (ML) = 1

depth m	**NSPT**	**Corrected NSPT N70 --> N55**	**soil type**	**Pf ton**	**Pb ton**	**ultimate capacity Pf+Pb ton**	**allowable capacity Pa SF=3 ton**	**remarks Pullout Sf=3**
0	0		**2**					0
1	5	4	**2**	2	4	6	2	0
2	2	2	**1**	2	7	9	3	1
3	2	2	**1**	3	5	8	3	1
4	3	2	**1**	3	6	9	3	1
5	3	2	**1**	3	5	9	3	1
6	1	1	**2**	5	2	7	2	1
7	1	1	**2**	6	1	7	2	1
8	1	1	**2**	6	1	8	3	2
9	1	1	**1**	7	4	10	3	2
10	3	2	**1**	7	5	12	4	2
11	3	2	**1**	7	7	14	5	2
12	3	2	**1**	8	7	15	5	2
13	4	3	**1**	8	8	16	5	2
14	4	3	**1**	9	9	18	6	2
15	4	3	**1**	9	24	33	11	2
16	24	19	**1**	12	41	53	18	3
17	28	22	**1**	15	61	76	25	4
18	30	24	**1**	20	47	67	22	5
19	6	5	**1**	22	32	54	18	5
20	7	6	**1**	23	13	36	12	5
21	4	3	**1**	24	12	36	12	6
22	5	4	**2**	27	6	33	11	6
23	6	5	**2**	32	12	44	15	7

PILE CAPACITY CALCULATION FOR DRIVEN PILE (MEYERHOFF'S FORMULA)

PILE INFORMATION

Length :	**15** m			
Pile type	**Precast**	Round	Area	0,0707 m2
Dimension	**0,30** m		Perimeter	0,942477796 m

SOIL INFORMATION

DEPTH OF SOIL DATA :	**30,45** m	BOREHOLE	BH3
SPT INTERVAL	**1** m		

note : *soil type* *clay, silty clay (CH/CL), clayey silt (MH) = 2*
sand (SP/SW), silty sand (SM), sandy silt (ML) = 1

depth m	**NSPT**	**Corrected NSPT N70 --> N55**	**soil type**	**Pf ton**	**Pb ton**	**ultimate capacity Pf+Pb ton**	**allowable capacity Pa SF=3 ton**	**remarks Pullout Sf=3**
24	22	17	**2**	42	19	61	20	10
25	24	19	**2**	59	28	87	29	14
26	29	23	**2**	79	32	110	37	18
27	33	26	**2**	102	36	138	46	24
28	36	28	**2**	127	41	169	56	30
29	43	34	**2**	156	47	203	68	36
30	47	37	**2**	190	50	240	80	44

PILE CAPACITY CALCULATION FOR DRIVEN PILE (MEYERHOFF'S FORMULA)

PILE INFORMATION

Length : **15** m

Pile type **Precast** Round Area 0,1257 m2

Dimension **0,40** m Perimeter 1,256637061 m

SOIL INFORMATION

DEPTH OF SOIL DATA : **30,45** m BOREHOLE BH3

SPT INTERVAL **1** m

note : *soil type* *clay, silty clay (CH/CL), clayey silt (MH) = 2*
sand (SP/SW), silty sand (SM), sandy silt (ML) = 1

depth m	NSPT	Corrected NSPT N70 --> N55	soil type	Pf ton	Pb ton	ultimate capacity Pf+Pb ton	allowable capacity Pa SF=3 ton	remarks Pullout Sf=3
0	0		**2**					0
1	5	4	**2**	2	7	9	3	1
2	2	2	**1**	3	12	15	5	1
3	2	2	**1**	4	9	13	4	1
4	3	2	**1**	4	11	15	5	1
5	3	2	**1**	5	9	14	5	1
6	1	1	**2**	7	3	10	3	2
7	1	1	**2**	8	2	10	3	2
8	1	1	**2**	9	2	11	4	2
9	1	1	**1**	9	7	15	5	2
10	3	2	**1**	9	9	18	6	2
11	3	2	**1**	10	12	22	7	2
12	3	2	**1**	10	13	24	8	2
13	4	3	**1**	11	14	26	9	3
14	4	3	**1**	12	16	28	9	3
15	4	3	**1**	13	42	55	18	3
16	24	19	**1**	15	74	89	30	4
17	28	22	**1**	21	108	128	43	5
18	30	24	**1**	26	84	111	37	6
19	6	5	**1**	30	57	86	29	7
20	7	6	**1**	31	22	53	18	7
21	4	3	**1**	32	21	53	18	8
22	5	4	**2**	37	10	47	16	9
23	6	5	**2**	42	22	64	21	10

PILE CAPACITY CALCULATION FOR DRIVEN PILE (MEYERHOFF'S FORMULA)

PILE INFORMATION

Length :	**15**	m			
Pile type	**Precast**	Round	Area	0,1257	m2
Dimension	**0,40**	m	Perimeter	1,256637061	m

SOIL INFORMATION

DEPTH OF SOIL DATA :	**30,45**	m	BOREHOLE	BH3
SPT INTERVAL	**1**	m		

note : *soil type* *clay, silty clay (CH/CL), clayey silt (MH) = 2*
sand (SP/SW), silty sand (SM), sandy silt (ML) = 1

depth m	**NSPT**	**Corrected NSPT N70 --> N55**	**soil type**	**Pf ton**	**Pb ton**	**ultimate capacity Pf+Pb ton**	**allowable capacity Pa SF=3 ton**	**remarks Pullout Sf=3**
24	22	17	**2**	56	34	90	30	13
25	24	19	**2**	79	49	128	43	18
26	29	23	**2**	105	57	161	54	24
27	33	26	**2**	135	65	200	67	32
28	36	28	**2**	169	74	243	81	40
29	43	34	**2**	208	83	291	97	49
30	47	37	**2**	253	89	342	114	59

PILE CAPACITY CALCULATION FOR DRIVEN PILE (MEYERHOFF'S FORMULA)

PILE INFORMATION

Length : **15** m

Pile type **Precast** Round

Area 0,1963 m2

Dimension **0,50** m

Perimeter 1,571 m

SOIL INFORMATION

DEPTH OF SOIL DATA : **30,45** m

BOREHOLE BH3

SPT INTERVAL **1** m

note : *soil type* *clay, silty clay (CH/CL), clayey silt (MH) = 2*
sand (SP/SW), silty sand (SM), sandy silt (ML) = 1

depth m	**NSPT**	**Corrected NSPT N70 --> N55**	**soil type**	**Pf ton**	**Pb ton**	**ultimate capacity Pf+Pb ton**	**allowable capacity Pa SF=3 ton**	**remarks Pullout Sf=3**
0	0		**2**					0
1	5	4	**2**	3	11	14	5	1
2	2	2	**1**	4	19	22	7	1
3	2	2	**1**	4	14	19	6	1
4	3	2	**1**	5	16	22	7	1
5	3	2	**1**	6	14	20	7	1
6	1	1	**2**	8	5	13	4	2
7	1	1	**2**	10	3	13	4	2
8	1	1	**2**	11	3	14	5	3
9	1	1	**1**	11	10	21	7	3
10	3	2	**1**	11	14	26	9	3
11	3	2	**1**	12	19	31	10	3
12	3	2	**1**	13	21	34	11	3
13	4	3	**1**	14	23	36	12	3
14	4	3	**1**	15	25	39	13	3
15	4	3	**1**	16	66	82	27	4
16	24	19	**1**	19	115	134	45	4
17	28	22	**1**	26	169	194	65	6
18	30	24	**1**	33	132	164	55	8
19	6	5	**1**	37	88	126	42	9
20	7	6	**1**	39	35	74	25	9
21	4	3	**1**	40	33	73	24	9
22	5	4	**2**	46	15	61	20	11
23	6	5	**2**	53	34	87	29	12

PILE CAPACITY CALCULATION FOR DRIVEN PILE (MEYERHOFF'S FORMULA)

PILE INFORMATION

Length :	**15** m			
Pile type	**Precast**	Round	Area	0,1963 m2
Dimension	**0,50** m		Perimeter	1,571 m

SOIL INFORMATION

DEPTH OF SOIL DATA :	**30,45** m	BOREHOLE	BH3
SPT INTERVAL	**1** m		

note : *soil type* *clay, silty clay (CH/CL), clayey silt (MH) = 2*
sand (SP/SW), silty sand (SM), sandy silt (ML) = 1

depth m	**NSPT**	**Corrected NSPT N70 --> N55**	**soil type**	**Pf ton**	**Pb ton**	**ultimate capacity Pf+Pb ton**	**allowable capacity Pa SF=3 ton**	**remarks Pullout Sf=3**
24	22	17	**2**	70	53	123	41	16
25	24	19	**2**	98	77	175	58	23
26	29	23	**2**	131	88	219	73	31
27	33	26	**2**	169	101	270	90	39
28	36	28	**2**	212	115	327	109	49
29	43	34	**2**	261	130	390	130	61
30	47	37	**2**	316	139	455	152	74

PILE CAPACITY CALCULATION FOR DRIVEN PILE (MEYERHOFF'S FORMULA)

PILE INFORMATION

Length : **15** m

Pile type **Precast** Round — Area 0,0707 m2

Dimension **0,30** m — Perimeter 0,942477796 m

SOIL INFORMATION

DEPTH OF SOIL DATA : **25,45** m — BOREHOLE BH4

SPT INTERVAL **1** m

note : *soil type clay, silty clay (CH/CL), clayey silt (MH) = 2*
sand (SP/SW), silty sand (SM), sandy silt (ML) = 1

depth m	NSPT	Corrected NSPT N70 --> N55	soil type	Pf ton	Pb ton	ultimate capacity Pf+Pb ton	allowable capacity Pa SF=3 ton	remarks Pullout Sf=3
0	0		**2**					0
1	2	2	**2**	1	2	3	1	0
2	2	2	**2**	2	2	4	1	1
3	1	1	**2**	3	1	5	2	1
4	1	1	**2**	4	1	5	2	1
5	1	1	**2**	5	2	7	2	1
6	3	2	**2**	6	2	8	3	1
7	1	1	**2**	8	2	10	3	2
8	1	1	**2**	9	1	10	3	2
9	2	2	**2**	10	2	11	4	2
10	2	2	**2**	11	2	13	4	3
11	2	2	**2**	13	2	15	5	3
12	2	2	**2**	14	2	16	5	3
13	2	2	**2**	16	2	18	6	4
14	2	2	**2**	17	2	19	6	4
15	2	2	**2**	19	2	21	7	4
16	2	2	**2**	20	2	22	7	5
17	2	2	**2**	21	2	24	8	5
18	2	2	**2**	23	3	26	9	5
19	3	2	**2**	25	13	38	13	6
20	31	24	**2**	37	21	59	20	9
21	24	19	**2**	58	27	84	28	13
22	17	13	**2**	73	21	94	31	17
23	15	12	**2**	85	17	102	34	20
24	14	11	**2**	96	17	113	38	22
25	18	14	**2**	107	18	125	42	25

PILE CAPACITY CALCULATION FOR DRIVEN PILE (MEYERHOFF'S FORMULA)

PILE INFORMATION

Length : **15** m
Pile type **Precast** Round
Dimension **0,40** m

Area 0,1257 m2
Perimeter 1,256637061 m

SOIL INFORMATION

DEPTH OF SOIL DATA : **25,45** m
SPT INTERVAL **1** m

BOREHOLE BH4

note : *soil type clay, silty clay (CH/CL), clayey silt (MH) = 2*
sand (SP/SW), silty sand (SM), sandy silt (ML) = 1

depth m	NSPT	Corrected NSPT N70 --> N55	soil type	Pf ton	Pb ton	ultimate capacity Pf+Pb ton	allowable capacity Pa SF=3 ton	remarks Pullout Sf=3
0	0		**2**					0
1	2	2	**2**	1	4	5	2	0
2	2	2	**2**	3	3	6	2	1
3	1	1	**2**	4	3	7	2	1
4	1	1	**2**	5	2	7	2	1
5	1	1	**2**	6	3	10	3	1
6	3	2	**2**	8	3	12	4	2
7	1	1	**2**	10	3	14	5	2
8	1	1	**2**	11	3	14	5	3
9	2	2	**2**	13	3	16	5	3
10	2	2	**2**	15	4	19	6	3
11	2	2	**2**	17	4	21	7	4
12	2	2	**2**	19	4	23	8	4
13	2	2	**2**	21	4	25	8	5
14	2	2	**2**	23	4	27	9	5
15	2	2	**2**	25	4	29	10	6
16	2	2	**2**	27	4	31	10	6
17	2	2	**2**	29	4	33	11	7
18	2	2	**2**	31	5	35	12	7
19	3	2	**2**	33	24	57	19	8
20	31	24	**2**	50	38	88	29	12
21	24	19	**2**	77	47	124	41	18
22	17	13	**2**	97	37	134	45	23
23	15	12	**2**	113	30	143	48	26
24	14	11	**2**	127	31	158	53	30
25	18	14	**2**	143	32	175	58	33

PILE CAPACITY CALCULATION FOR DRIVEN PILE (MEYERHOFF'S FORMULA)

PILE INFORMATION

Length : **15** m

Pile type **Precast** Round Area 0,1963 m2

Dimension **0,50** m Perimeter 1,571 m

SOIL INFORMATION

DEPTH OF SOIL DATA : **25,45** m BOREHOLE BH4

SPT INTERVAL **1** m

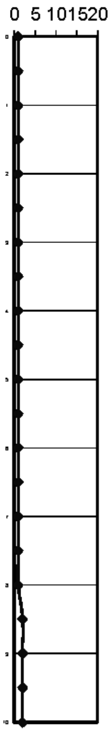
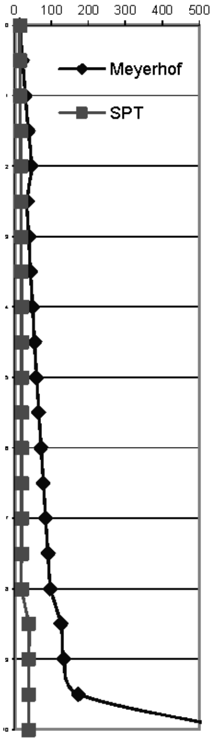
note : *soil type* *clay, silty clay (CH/CL), clayey silt (MH) = 2*
sand (SP/SW), silty sand (SM), sandy silt (ML) = 1

depth m	**NSPT**	**Corrected NSPT N70 --> N55**	**soil type**	**Pf ton**	**Pb ton**	**ultimate capacity Pf+Pb ton**	**allowable capacity Pa SF=3 ton**	**remarks Pullout Sf=3**
0	0		**2**					0
1	2	2	**2**	1	6	7	2	0
2	2	2	**2**	4	5	9	3	1
3	1	1	**2**	6	4	10	3	1
4	1	1	**2**	7	3	10	3	2
5	1	1	**2**	8	5	13	4	2
6	3	2	**2**	10	5	16	5	2
7	1	1	**2**	13	5	18	6	3
8	1	1	**2**	14	4	18	6	3
9	2	2	**2**	16	5	21	7	4
10	2	2	**2**	19	6	25	8	4
11	2	2	**2**	21	6	27	9	5
12	2	2	**2**	23	6	30	10	5
13	2	2	**2**	26	6	32	11	6
14	2	2	**2**	28	6	35	12	7
15	2	2	**2**	31	6	37	12	7
16	2	2	**2**	33	6	39	13	8
17	2	2	**2**	36	6	42	14	8
18	2	2	**2**	38	7	45	15	9
19	3	2	**2**	41	37	78	26	10
20	31	24	**2**	62	60	122	41	15
21	24	19	**2**	96	74	170	57	22
22	17	13	**2**	122	58	179	60	28
23	15	12	**2**	141	47	189	63	33
24	14	11	**2**	159	48	208	69	37
25	18	14	**2**	179	49	228	76	42

SHALLOW BEARING

CALCULATION OF SOIL BEARING CAPACITY SHALLOW FOUNDATION

Project	Southern Bali Water Supply System	**Made By**	Andrianto
Client	NIHON SUIDO CONSULTANT	Undrained shear strength and friction angle is obtained from lab tests. Unit weight value also taken from lab All values subject to engineer judgement	
Borehole Number	BH-1		
Method	Meyerhoff (1963, SPT 1974)		
Width of Foundation (B)	4 m		

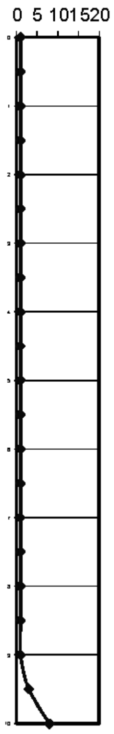
Depth	SPT Value (Weighed)	c_u	ϕ	Soil Symbol	γ'	q ultimate (Meyerhoff 1963)	q allowable (Meyerhoff 1963) (SF=3)	qa Value (kPa) -SPT (Meyerhoff 1974)	SPT N Value (N55)	Allowable Bearing Capacity (kPa)
(m)	(N55)	(kPa)			(kPa)	(kPa)	(kPa)	(kPa)		
0	1	5	6	SOFT CLAY	16	43	14	14.45		
0.5	1	5	6		16	64	21	15.04		
1	1	5	6		16	87	29	15.64		
1.5	1	5	6		16	112	37	16.23		
2	1	5	6		16	138	46	16.83		
2.5	1	5	6		6	103	34	17.42		
3	1	5	6		6	117	39	18.02		
3.5	1	5	6		6	132	44	18.62		
4	1	5	6		6	148	49	19.21		
4.5	1	5	6		6	164	55	19.21		
5	1	5	6		6	180	60	19.21		
5.5	1	5	6		6	197	66	19.21		
6	1	5	6		6	215	72	19.21		
6.5	1	5	6		6	234	78	19.21		
7	1	5	6		6	253	84	19.21		
7.5	1	5	6		6	273	91	19.21		
8	1	5	6		6	293	98	19.21		
8.5	2	5	8		6	377	126	38.42		
9	2	5	8		6	404	135	38.42		
9.5	2	8	8		6	522	174	38.42		
10	2	8	20		6	1792	597	38.42		

CALCULATION OF SOIL BEARING CAPACITY SHALLOW FOUNDATION

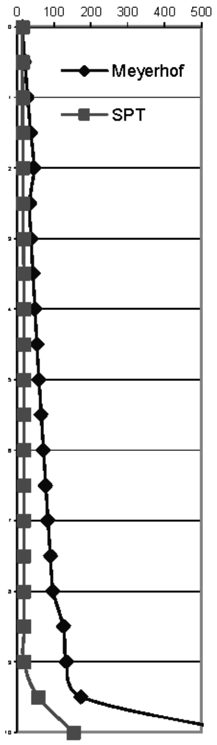
Project	Southern Bali Water Supply System	**Made By**	Andrianto
Client	NIHON SUIDO CONSULTANT	Undrained shear strength and friction	
Borehole Number	BH-2	angle is obtained from lab tests.	
Method	Meyerhoff (1963, SPT 1974)	Unit weight value also taken from lab	
Width of Foundation (B)	4 m	All values subject to engineer judgement	

Depth	SPT Value (Weighed)	c_u	ϕ	Soil Symbol	γ'	q ultimate (Meyerhoff 1963)	q allowable (Meyerhoff 1963) (SF=3)	qa Value (kPa) -SPT (Meyerhoff 1974)
(m)	(N55)	(kPa)			(kPa)	(kPa)	(kPa)	(kPa)
0	1	5	6	SOFT CLAY	16	43	14	14.45
0.5	1	5	6		16	64	21	15.04
1	1	5	6		16	87	29	15.64
1.5	1	5	6		16	112	37	16.23
2	1	5	6		16	138	46	16.83
2.5	1	5	6		6	103	34	17.42
3	1	5	6		6	117	39	18.02
3.5	1	5	6		6	132	44	18.62
4	1	5	6		6	148	49	19.21
4.5	1	5	6		6	164	55	19.21
5	1	5	6		6	180	60	19.21
5.5	1	5	6		6	197	66	19.21
6	1	5	6		6	215	72	19.21
6.5	1	5	6		6	234	78	19.21
7	1	5	6		6	253	84	19.21
7.5	1	5	6		6	273	91	19.21
8	1	5	6		6	293	98	19.21
8.5	1	5	8		6	377	126	19.21
9	1	5	8		6	404	135	19.21
9.5	3	8	8		6	522	174	57.64
10	8	8	20		6	1792	597	153.70

SPT N Value (N55)

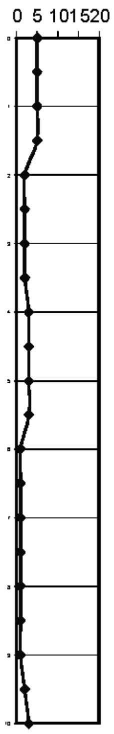
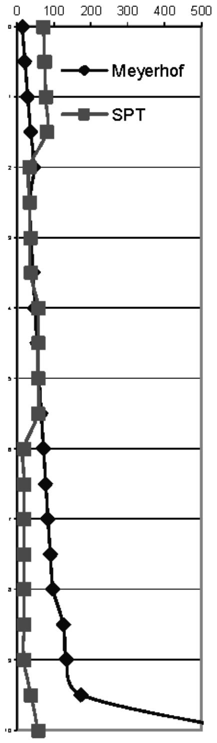


Allowable Bearing Capacity (kPa)



CALCULATION OF SOIL BEARING CAPACITY SHALLOW FOUNDATION

Project	Southern Bali Water Supply System	**Made By**	Andrianto
Client	NIHON SUIDO CONSULTANT	Undrained shear strength and friction	
Borehole Number	BH-3	angle is obtained from lab tests.	
Method	Meyerhoff (1963, SPT 1974)	Unit weight value also taken from lab	
Width of Foundation (B)	4 m	All values subject to engineer judgement	

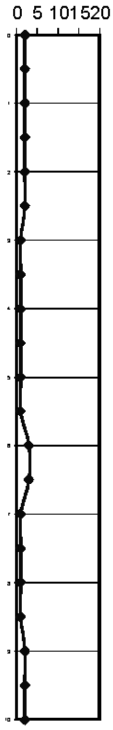
Depth	SPT Value (Weighed)	c_u	ϕ	Soil Symbol	γ'	q ultimate (Meyerhoff 1963)	q allowable (Meyerhoff 1963) (SF=3)	qa Value (kPa) -SPT (Meyerhoff 1974)	SPT N Value (N55)	Allowable Bearing Capacity (kPa)
(m)	(N55)	(kPa)			(kPa)	(kPa)	(kPa)	(kPa)		
0	5	5	6	FILL	16	43	14	72.23		
0.5	5	5	6		16	64	21	75.21		
1	5	5	6		16	87	29	78.19		
1.5	5	5	6		16	112	37	81.16		
2	2	5	6	SILTY CLAY WITH CORAL	16	138	46	33.66		
2.5	2	5	6		6	103	34	34.85		
3	2	5	6		6	117	39	36.04		
3.5	2	5	6		6	132	44	37.23		
4	3	5	6		6	148	49	57.64		
4.5	3	5	6		6	164	55	57.64		
5	3	5	6		6	180	60	57.64		
5.5	3	5	6		6	197	66	57.64		
6	1	5	6		6	215	72	19.21		
6.5	1	5	6		6	234	78	19.21		
7	1	5	6		6	253	84	19.21		
7.5	1	5	6		6	273	91	19.21		
8	1	5	6		6	293	98	19.21		
8.5	1	5	8		6	377	126	19.21		
9	1	5	8		6	404	135	19.21		
9.5	2	8	8		6	522	174	38.42		
10	3	8	20		6	1792	597	57.64		

CALCULATION OF SOIL BEARING CAPACITY SHALLOW FOUNDATION

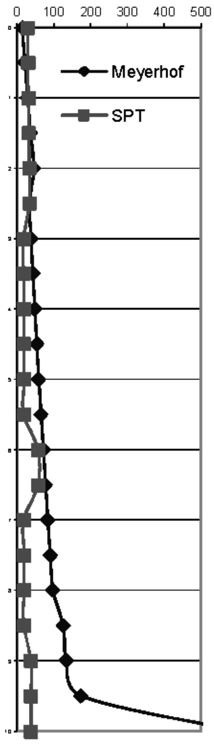
Project	Southern Bali Water Supply System	**Made By**	Andrianto
Client	NIHON SUIDO CONSULTANT	Undrained shear strength and friction angle is obtained from lab tests. Unit weight value also taken from lab All values subject to engineer judgement	
Borehole Number	BH-4		
Method	Meyerhoff (1963, SPT 1974)		
Width of Foundation (B)	4 m		

Depth	SPT Value (Weighed)	c_u	ϕ	Soil Symbol	γ'	q ultimate (Meyerhoff 1963)	q allowable (Meyerhoff 1963) (SF=3)	qa Value (kPa) -SPT (Meyerhoff 1974)
(m)	(N55)	(kPa)			(kPa)	(kPa)	(kPa)	(kPa)
0	2	5	6	FILL	16	43	14	28.89
0.5	2	5	6		16	64	21	30.08
1	2	5	6		16	87	29	31.27
1.5	2	5	6		16	112	37	32.47
2	2	5	6	SILTY CLAY WITH CORAL	16	138	46	33.66
2.5	2	5	6		6	103	34	34.85
3	1	5	6		6	117	39	18.02
3.5	1	5	6		6	132	44	18.62
4	1	5	6		6	148	49	19.21
4.5	1	5	6		6	164	55	19.21
5	1	5	6		6	180	60	19.21
5.5	1	5	6		6	197	66	19.21
6	3	5	6		6	215	72	57.64
6.5	3	5	6		6	234	78	57.64
7	1	5	6		6	253	84	19.21
7.5	1	5	6		6	273	91	19.21
8	1	5	6		6	293	98	19.21
8.5	1	5	8		6	377	126	19.21
9	2	5	8		6	404	135	38.42
9.5	2	8	8		6	522	174	38.42
10	2	8	20		6	1792	597	38.42

SPT N Value (N55)



Allowable Bearing Capacity (kPa)



APPENDIX 5

CONCEPT DESIGN OF RECLAIMED WATER TREATMENT FACILITY

APPENDIX 5 CONCEPT DESIGN OF RECLAIMED WATER TREATMENT FACILITY

5.a Calculation Sheets Water Reclaimed Water for BALI

Item	Case 1	Case 2
1.Design Parameter		
1-1 Outline of Reclaimed Water System		
(1) Area of Plant		
(2) Grand Level of Plant		
(3) Type of Reclaimed Water System		
(4) Water Treatment Process		
1-2 Design Flowrate Water Reuse		
Maximum Daily Flowrate	4500m^3/d	9000m^3/d
Reclaimed Water System Flowrate		
Raw Water Flowrate	5900m^3/d	11800m^3/d
Biological Filtration Flowrate	5900m^3/d	11800m^3/d
Ozone Cotactor Flowrate	4800m^3/d	9600m^3/d
Ceramic Membrane Filtration Flowrate	4800m^3/d	9600m^3/d
Reclaimed Water Flowrate	4800m^3/d	9600m^3/d
1-3 Number of Series	1 Series	2 Series
2.Raw Water		
2-1 Raw Water Tank		
Raw Water Flowrate	= 5900m^3/d	= 11800m^3/d
Retention Time	= 5.0 minutes	= 5.0 minutes
Req. Volume	= 5900m^3/d / 1440min/d x 5min ≒20.5m^3	= 11800m^3/d / 1440min/d x 5min ≒41m^3
Number of Series	= 1 Series	= 2 Series
Number of Basin	= 1 Basin	= 1 Basin
One Basin Volume	= 20.5 / 1 = 20.5m^3	= 41 / 2 / 1 = 20.5m^3
Length	= 3.3 m	= 3.3 m
Width	= 2.5 m	= 2.5 m
Water Depth	= 2.5 m	= 2.5 m
Total Volume	= 3.3 x 2.5 x 2.5 = 20.625 m^3/Series	= 3.3 x 2.5 x 2.5 = 20.625 m^3/Series
Total Number of Basins	= 2 Basins	= 2 Basins
Raw Water Feed Pump		
Total Pump Capacity	= 5900m^3/d / 1440min/d ≒ 4.1m3/min	= 11800m^3/d / 1440min/d ≒ 8.2m3/min
Number of Series	= 1 Series	= 2 Series
Pump Capacity	= 4.1 / 12 = 4.1m^3/min	= 8.2 / 2 = 4.1m^3/min
Total Number of Pumps	= 2 Pumps (Including Backup Pump)	= 3 Pumps (Including Backup Pump)

Item	Case 1	Case 2
3.Biological Filtration		
3-1 Biological Filtration Tank		
Design Flowrate		
Biological Filtration Flowrate	= 5900m^3/d	= 11800m^3/d
Biological Filtration Speed	= 40m/d	= 40m/d
Req. Area	= 5900m^3/d / 40m/d = 148m^2	= 11800m^3/d / 40m/d = 295m^2
Number of Series	= 1 Series	= 2 Series
Number of Basin	= 4 Basins	= 4 Basins
One Reactor Req. Area	= 148 / 1 / 4 = 37m^2	= 295 / 2 / 4 = 36.9m^2
Length	= 6.1 m	= 6.1 m
Width	= 6.1 m	= 6.1 m
Biological Filtration Area	= 6.1 x 6.1 = 37.21m^2	= 6.1 x 6.1 = 37.21m^2
Total Number of Basins	= 4 Basins	= 8 Basins
Biological Filtration Backwash Pump		
Biological Filtration Area	= 37.21m^2	= 37.21m^2
Backwash Speed	= 0.45$m^3/m^2 \cdot$min	= 0.45$m^3/m^2 \cdot$min
Pump Capacity	= 37.21 X 0.45 ≒ 16.8m^3/min	= 37.21 X 0.45 ≒ 16.8m^3/min
Number of Series	= 1 Series	= 2 Series
Req. Number of Pump / One Series	= 1 Pump	= 1 Pump
Total Number of Pumps	= 2 Pumps (Including Backup Pump)	= 3 Pumps (Including Backup Pump)

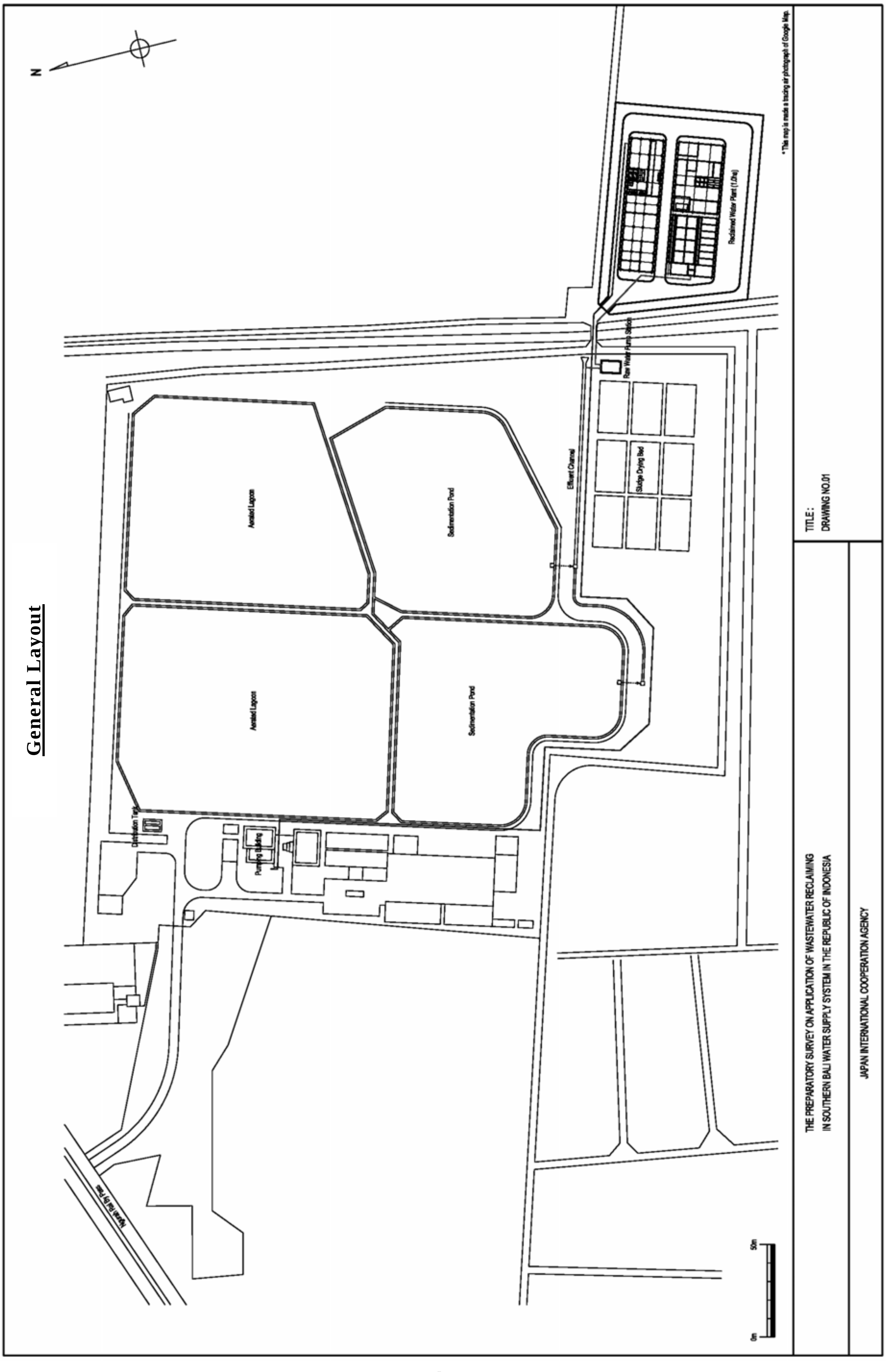
Item	Case 1	Case 2
3-2 Biological Filter Treated Water Tank		
Biological Filtration Flowrate	= 5900m^3/d	= 11800m^3/d
Ozone Cotactor Flowrate	= 4800m^3/d	= 9600m^3/d
Biological Filtration Backwash Water	= 5900m^3 - 4800m^3 = 1100m^3	= 11800m^3 - 9600m^3 = 2200m^3
Number of Series	= 1 Series	= 2 Series
Number of Basin	= 4 Basins	= 4 Basins
One Cotactor Req. Backwash Water	= 1100 / 1 / 4 = 275m^3	= 2200 / 2 / 4 = 275m^3
Retention Time of Biological Filter Backwash	= 30.0 minutes	= 30.0 minutes
Outflow of Biological Filter Treated Water Tank	= 3.4m^3/min	= 3.4m^3/min
Inflow of Biological Filter Treated Water Tank	= 4.1m^3/min	= 4.1m^3/min
One Cotactor Req. Volume	= 275 + 3.4 x 30 - 4.1 x 30 = 254m^3	= 275 + 3.4 x 30 - 4.1 x 30 = 254m^3
Length	= 15.0 m	= 15.0 m
Width	= 6.3 m	= 6.3 m
Water Depth	= 3.3 m	= 3.3 m
Total Volume	= 15.0 x 6.3 x 3.3 ≒ 311.8m^3	= 15.0 x 6.3 x 3.3 ≒ 311.8m^3
Total Number of Basin	= 1 Basin	= 1 Basin
Biological Filter Treated Water Feed Pump		
Ozone Cotactor Flowrate	= 4800m^3/d	= 9600m^3/d
Total Pump Capacity	= 4800m^3/d / 1440min/d ≒ 3.4m^3/min	= 9600m^3/d / 1440min/d ≒ 6.8m^3/min
Number of Series	= 1 Series	= 2 Series
Pump Capacity	= 3.4 / 1 = 3.4m^3/min	= 6.8 / 2 = 3.4m^3/min
Total Number of Pumps	= 2pumps (Including Backup Pump)	= 3pumps (Including Backup Pump)

Item	Case 1	Case 2
4.Ozone Cotactor 4-1 Ozone Cotactor Tank		
Ozone Cotactor Flowrate	= 4800m^3/d	= 9600m^3/d
Retention Time	= 5.0 minutes	= 5.0 minutes
Req. Volume	= 4800m^3/d / 1440min/d x 5min ≒16.7m^3	= 9600m^3/d / 1440min/d x 5min ≒33.4m^3
Number of Series	= 1 Series	= 2 Series
Number of Basin (2 Basins in Series)	= 1 Basin	= 1 Basin
One Reactor Volume	= 16.7 / 1 / 1 = 16.7m^3	= 33.4 / 2 / 1 = 16.7m^3
Length	= 2.9 m	= 2.9 m
Width	= 1.3 m	= 1.3 m
Water Depth	= 5.0 m	= 5.0 m
Total Volume	= 2.9 x 1.3 x 5.0 = 18.8m^3/Basin	= 2.9 x 1.3 x 5.0 = 18.8m^3/Basin
Total Number of Basins	= 1 Basin	= 2 Basins

Item	Case 1	Case 2
4-2 Coagulation / Flocculation Tank		
Coagulation Tank		
Ozone Cotactor Flowrate	= 4800m^3/d	= 9600m^3/d
Retention Time of Congulation Tank	= 1.0 minutes	= 1.0 minutes
Req. Volume of Congulation Tank	= 4800m^3/d / 1440min/d x 1min ≒ 3.4m^3	= 9600m^3/d / 1440min/d x 1min ≒ 6.8m^3
Number of Series	= 1 Series	= 2 Series
Number of Basin	= 1 Basin	= 1 Basin
One Reactor Volume	= 3.4 / 1 / 1 = 3.4m^3	= 6.8 / 2 / 1 = 3.4m^3
Length	= 1.5 m	= 1.5 m
Width	= 2.0 m	= 2.0 m
Water Depth	= 1.7 m	= 1.7 m
Total Volume	= 1.5 x 2.0 x 1.7 = 5.1m^3	= 1.5 x 2.0 x 1.7 = 5.1m^3
Flocculation Tank		
Retention Time of Flocculation Tank	= 2.0 minutes	= 2.0 minutes
Req. Volume of Congulation Tank	= 4800m^3/d / 1440min/d x 2min ≒ 6.7m^3	= 9600m^3/d / 1440min/d x 2min ≒ 13.4m^3
Number of Series	= 1 Series	= 2 Series
Number of Basin (2 Basins in Series)	= 1 Basin	= 1 Basin
One Reactor Volume	= 6.7 / 1 / 1 = 6.7m^3	= 13.4 / 2 / 1 = 6.7m^3
Length	= 2.0 m	= 2.0 m
Width	= 2.0 m	= 2.0 m
Water Depth	= 1.7 m	= 1.7 m
Total Volume	= 2.0 x 2.0 x 1.7 = 6.8m^3	= 2.0 x 2.0 x 1.7 = 6.8m^3
Total Number of Basins (Coagulation / Flocculation Tank)	= 1 Basin	= 2 Basins
Coagulated / Flocculated Water Feed Pump		
Total Pump Capacity	= 4800m^3/d ≒ 6.8m^3/min	= 9600m^3/d ≒ 6.8m^3/min
Number of Series	= 1 Series	= 2 Series
Pump Capacity	= 3.4 / 1 = 3.4m^3/min	= 6.8 / 2 = 3.4m^3/min
Pump Numbers	= 2pumps (Including Backup Pump)	= 3pumps (Including Backup Pump)

Item	Case 1	Case 2
5.Ceramic Membrane Filtration Unit		
Ceramic Membrane Filtration Flowrate	= $4800m^3/d$	= $9600m^3/d$
Design One Ceramic Membrane Filter Area	= $25m^2$	= $25m^2$
Design Velocity	= $4.0m^3/m^2/d$	= $4.0m^3/m^2/d$
Efficiency	= 0.9	= 0.9
Req. Number of Ceramic Membrane Filters	= $4800m^3/d$ / $25m^2$ / $4.0m^3/m^2/d$ / 0.9≒53.4	= $9600m^3/d$ / $25m^2$ / $4.0m^3/m^2/d$ / 0.9≒106.7
Design Module of Ceramic Membrane Filters	= 10 Filters	= 10 Filters
Design Series of Modules	= 6 Modules	= 6 Modules
Number of Series	= 1 Series	= 2 Series
Design Number of Ceramic Membrane Filters	= 10 x 6 x 1 = 60 Filters	= 10 x 6 x 2 = 120 Filters
6.Reclaimed Water Tank		
Reclaimed Water Flowrate	= $4800m^3/d$	= $9600m^3/d$
Retention Time of Congulation Tank	= 5.0 minutes	= 5.0 minutes
Req. Volume	= $4800m^3/d$ / 1440min/d x 5min ≒ $16.7m^3$	= $9600m^3/d$ / 1440min/d x 5min ≒ $33.3m^3$
Number of Basin	= 1 Basin	= 1 Basin
One Basin Volume	= 16.7 / 1 = $16.7m^3$	= 33.3 / 1 = $33.3m^3$
Length	= 8.1 m	= 8.1 m
Width	= 3.8 m	= 3.8 m
Water Depth	= 2.0 m	= 2.0 m
Total Volume	= 8.1 x 3.8 x 2.0 = 61.5 m^3/System	= 8.1 x 3.8 x 2.0 = 61.5 m^3/System
Total Number of Basin	= 1 Basin	= 1 Basin

5.b Design Drawing

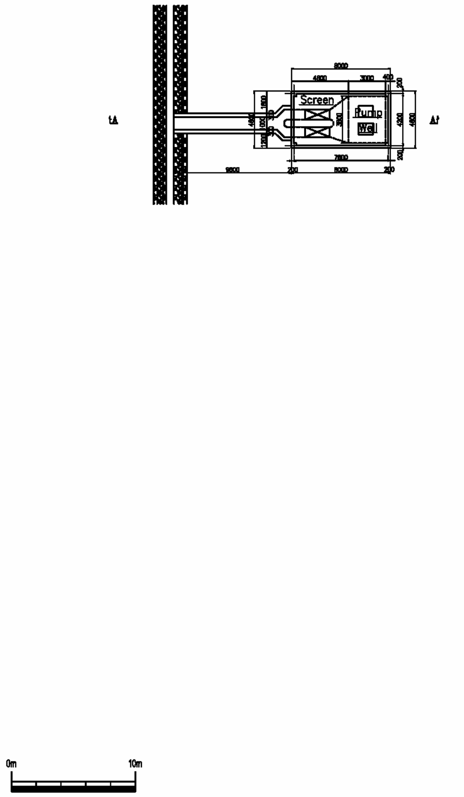


General Layout

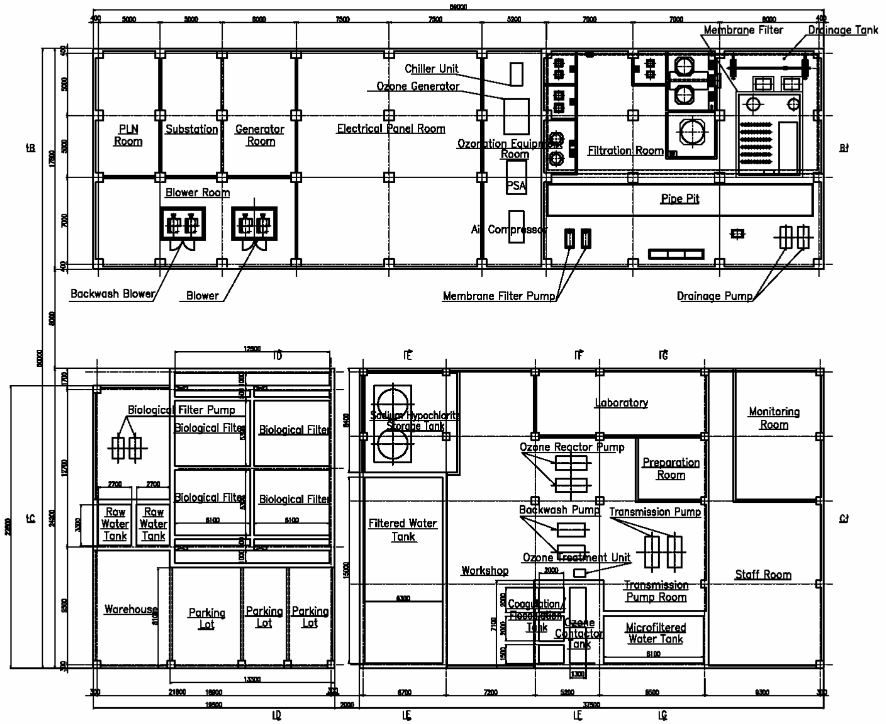
Plan of Reclaimed Water Treatment Facility for Case 1

S=1/400

Plan of Raw Water Pump Station



Plan of Reclaimed Water Treatment Facility



THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

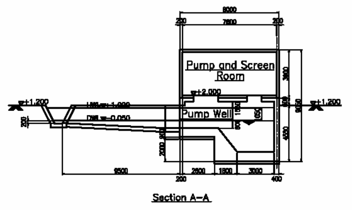
JAPAN INTERNATIONAL COOPERATION AGENCY

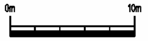
TITLE :
DRAWING NO.01

Section of Reclaimed Water Treatment Facility for Case 1

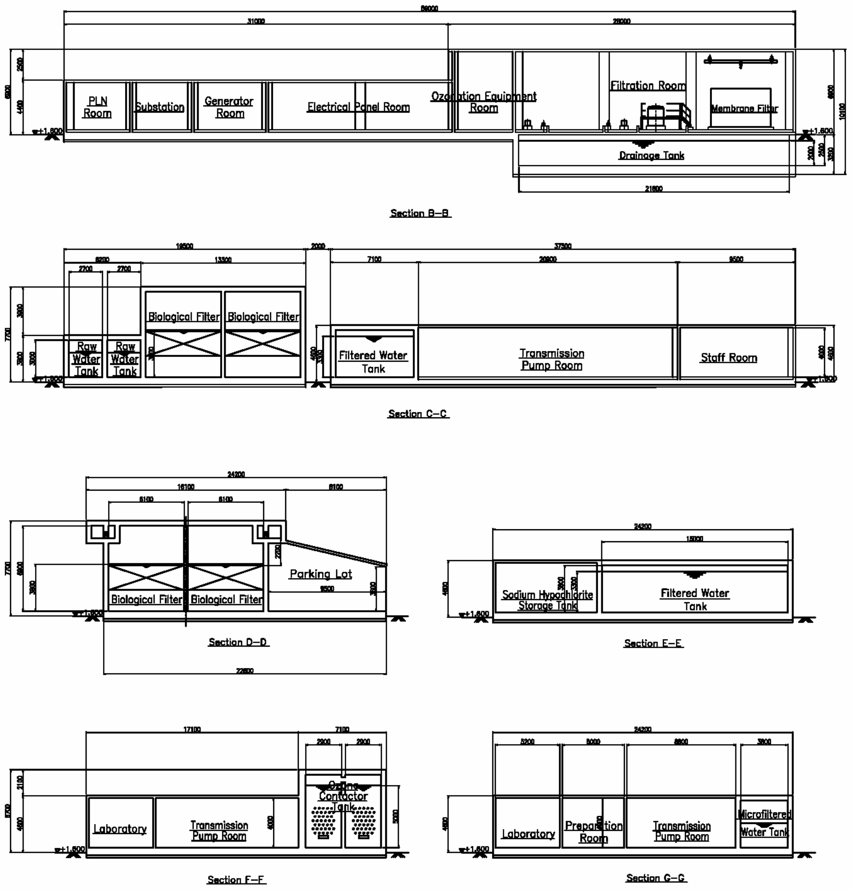
S=1/400

Section of Raw Water Pump Station





Section of Reclaimed Water Treatment Facility



THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

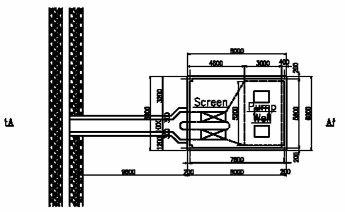
JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE :
DRAWING NO.01

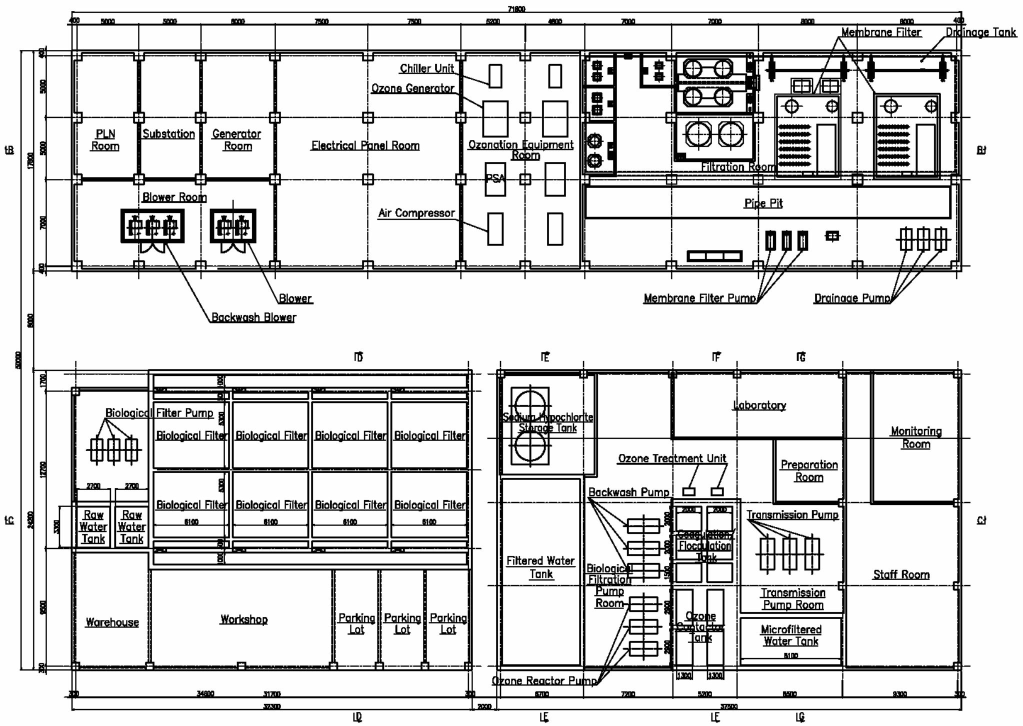
Plan of Reclaimed Water Treatment Facility for Case 2

S=1/400

Plan of Raw Water Pump Station



Plan of Reclaimed Water Treatment Facility



0m 10m

THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

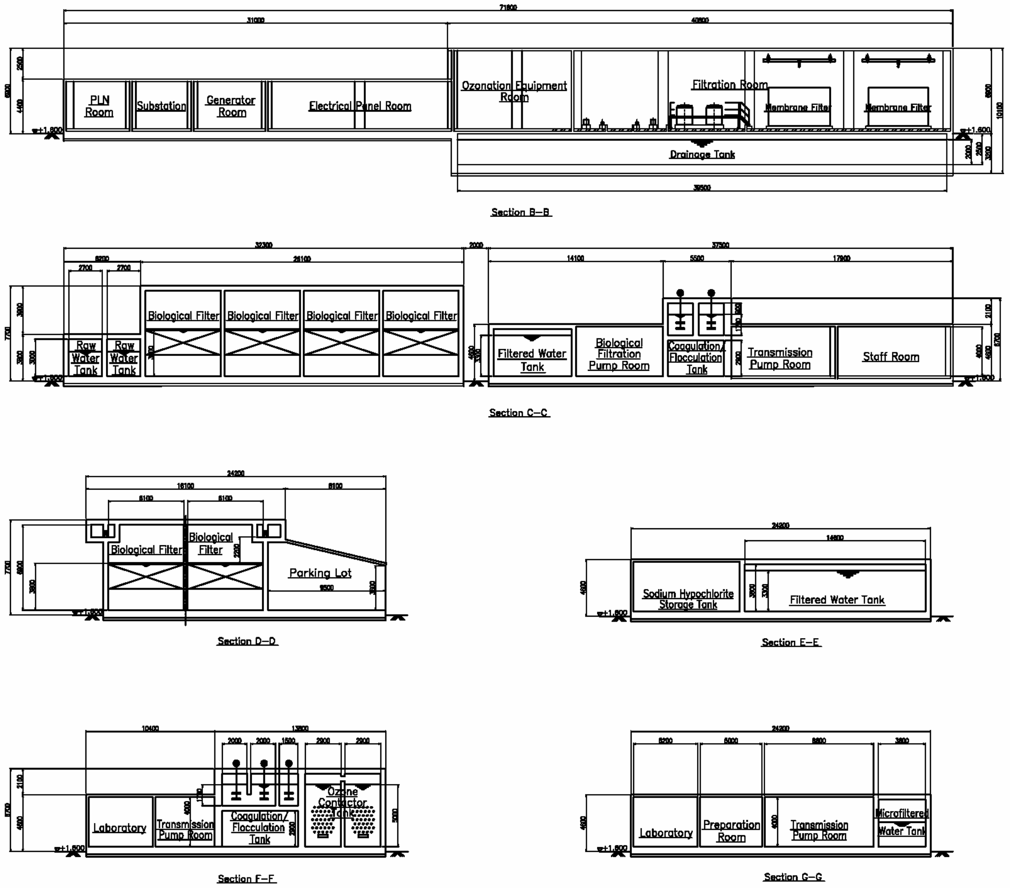
TITLE :
DRAWING NO.01

Section of Reclaimed Water Treatment Facility for Case 2

S=1/400

Section of Raw Water Pump Station

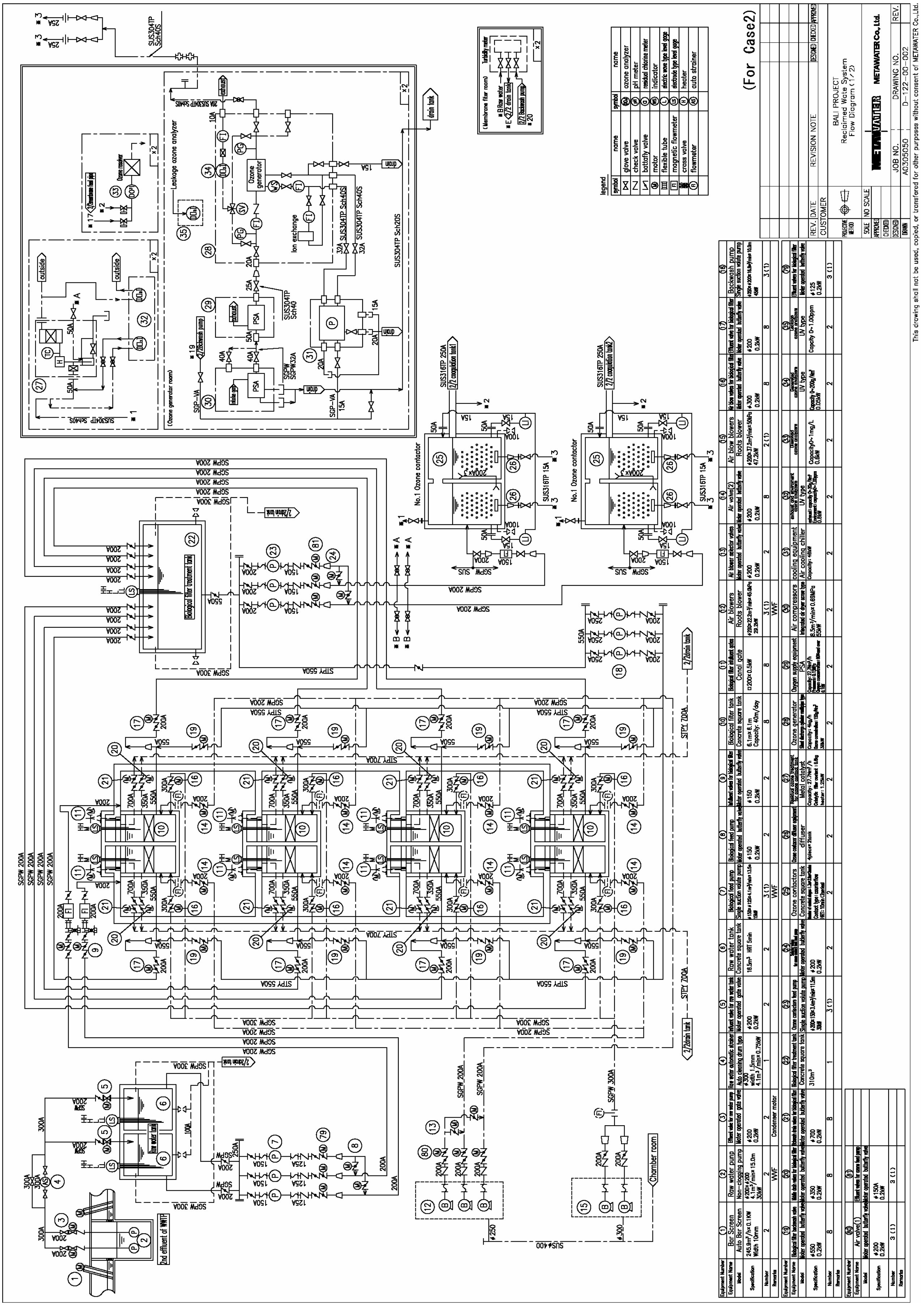
Section of Reclaimed Water Treatment Facility

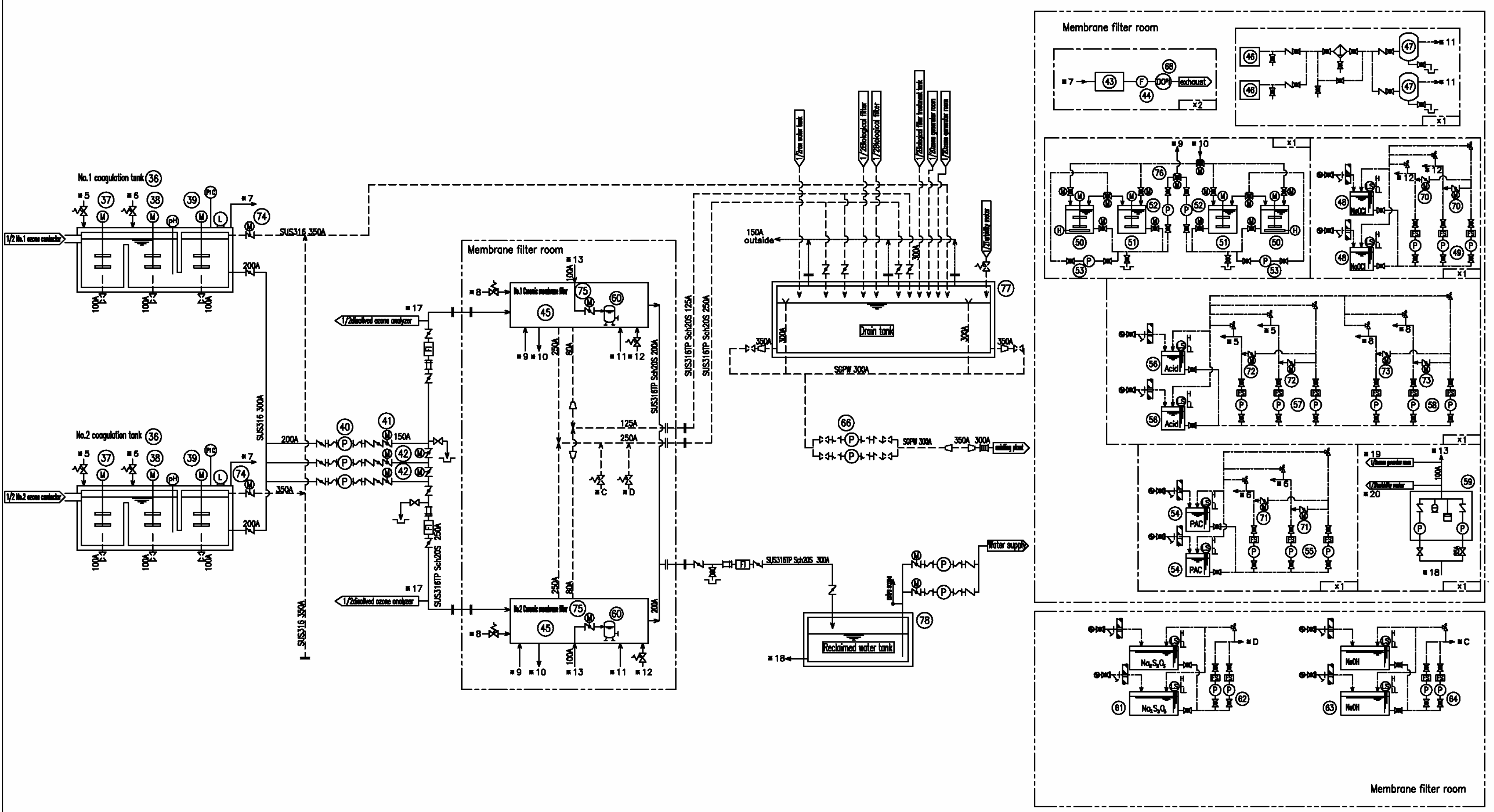


THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE :
DRAWING NO.01


(For Case2)
BALI PROJECT
Reclaimed Wate System
Flow Diagram (1/2)
METAWATER Co., Ltd.
JOB NO. A0305050
DRAWING NO. D-122-00-002
REV.
DATE
REVISION NOTE
CUSTOMER
PROJECTIVE METHOD
SCALE NO SCALE
APPROVED
CHECKED
DESIGNED
DRAWN
This drawing shall not be used, copied, or transfered for other purposes without consent of METAWATER Co.,Ltd.
legend
glove valve
check valve
buttefly valve
motor
flexible tube
magnetic flowmeter
cross valve
flowmeter
ozone analyzer
pH meter
residual chlorine meter
indicator
electric wave type level gage
electrode type level gage
heater
auto strainer
2nd effluent of WWTP
Raw water tank
Biological filter treatment tank
No.1 Ozone contactor
Ozone generator
Ion exchange
PSA
Leakage ozone analyzer
Ozone resolver
Chamber room
2/2 drain tank
2/2 coagulation tank1
2/2 Backwash pump
outside
drain
exhaust
SGPW 200A
SGPW 300A
STPY 550A
STPY 700A
SUS316TP 250A
SUS304TP Sch40S
SUS400



Equipment Number	(36)	(37)	(38)	(39)	(40)	(41)	(42)	(43)	(44)	(45)	(46)	(47)	(48)	(49)	(50)	(51)
Equipment Name	Coagulation tanks	pH adjustment tank mixer	1st mixing tank mixer	2nd mixing tank mixer	Membrane filter feed pump	[illegible]	[illegible]	[illegible]	Coagulation tank blower	Microfiltration equipment	Compressor for membrane	Air tank for membrane	NaOCl tank	NaOCl feed pump	Chemical cleaning tank	Rinsing tank
Model		Propeller type	Propeller type	Propeller type	Single suction volute pump	Motor operated butterfly valve	Motor operated butterfly valve	Metal catalyst	Ring blow	Ceramic membrane	Integrated air dryer screw type	Drum tank	PVC drum tank	Diaphragm pump	PE drum tank	PE drum tank
Specification	2.0m×6.1m×1.7mH Capacity: 3.6m³ 6.8m³×2tank	2.2kW	2.2kW	2.2kW	[illegible] 30kW	φ150 0.2kW	φ250 0.2kW	Capacity: 63.7Nm³/h [illegible] heater: 3.0kW	Capacity: 3Nm³/h Pressure: 6.4kPa 2.2kW	φ180×1.5mL,Atype 10element×6,module	1100L/min×0.88MPa 15kW	2000L×0.98MPa	Capacity: 50L	387mL/min×0.7MPa 0.03kW	Capacity: 1.5m³	Capacity: 1.5m³
Number	2	2	2	2	3 (1)	3	2	2	2	2	2 (1)	2	2	2 (1)	2	2
Remarks					WWF				WWF							

Equipment Number	(52)	(53)	(54)	(55)	(56)	(57)	(58)	(59)	(60)	(61)	(62)	(63)	(64)		(66)	
Equipment Name	Chemical cleaning pump	Chemical drain pump	Coagulant tank	Coagulant feed pump	pH adjustor tank	pH adjustor feed pump	Acid feed pump	Backwash pump	Backwash tank	$Na_2S_2O_3$ tank	$Na_2S_2O_3$ feed pump	NaOH tank	NaOH feed pump		Drain tank drain pump	
Model	Single suction volute pump	Magnet pump	PE drum tank	Diaphragm pump	PE drum tank	Diaphragm pump	Diaphragm pump	Constant pressure feed type	drum tank	PVC drum tank	Diaphragm pump	PE drum tank	Diaphragm pump		Single suction volute pump	
Specification	[illegible] 1.5kW	16L/min×0.05MPa 0.265kW	Capacity: 4m³	139mL/min×0.7MPa 20W	500L	31mL/min×0.7MPa 30W	1065mL/min×0.7MPa 0.2kW	642L/min×0.15MPa 3.7kW	750L×0.49MPa	Capacity: 50L	39mL/min×0.7MPa 20W	Capacity: 300L	1.7L/min×0.7MPa 200W		[illegible] 11kW	
Number	2	2	2	3 (1)	2	3 (1)	3 (1)	1	2	2	2 (1)	2	2 (1)		2 (1)	
Remarks																

Equipment Number	(69)		(70)	(71)	(72)	(73)	(74)	(75)	(76)	(77)	(78)					
Equipment Name	[illegible]		Selector valve for NaOCl feed pump	Selector valve for PAC feed pump	Selector valve(1) for acid feed pump	Selector valve(2) for acid feed pump	Overflow valve for coagulation tank	Influent valve for backwash tank	[illegible]	Drain tank	Reclaimed water tank					
Model	UV type		Motor operated butterfly valve	Motor operated butterfly valve	Motor operated butterfly valve	Motor operated butterfly valve	Motor operated butterfly valve	Motor operated butterfly valve	Motor operated ball valve	Concrete square tank	Concrete square tank					
Specification	Capacity 0~1000ppm 1.5kW		φ15 0.1kW	φ15 0.1kW	φ15 0.1kW	φ15 0.1kW	φ350 0.2kW	φ100 0.2kW	φ15 0.1kW	93m³	37.5m³					
Number	2		2	2	2	2	2	2	12	2	1					
Remarks																

(For Case2)

REV.	DATE	REVISION NOTE	DESIGNED	CHECKED	APPROVED

CUSTOMER

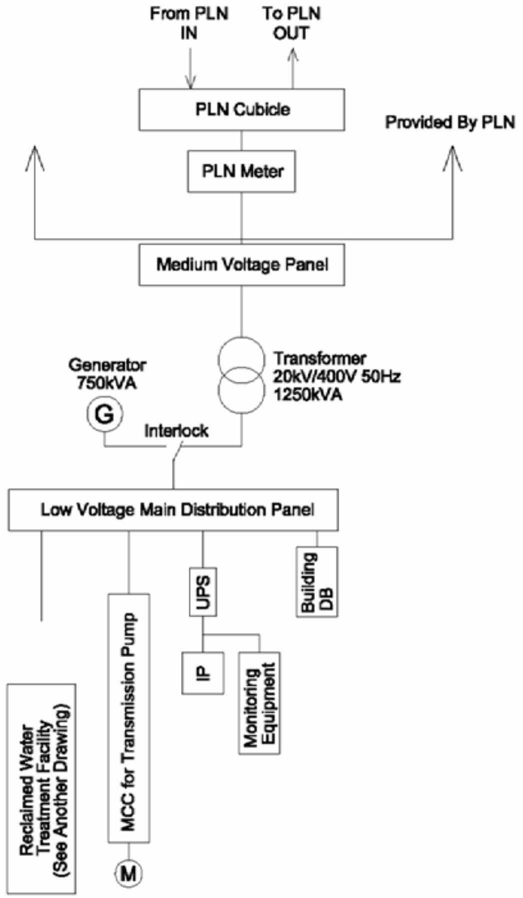
PROJECTING METHOD

BALI PROJECT
Reclaimed Wate System
Flow Diagram (2/2)

SCALE NO SCALE
APPROVED
CHECKED
DESIGNED
DRAWN

METAWATER Co., Ltd.

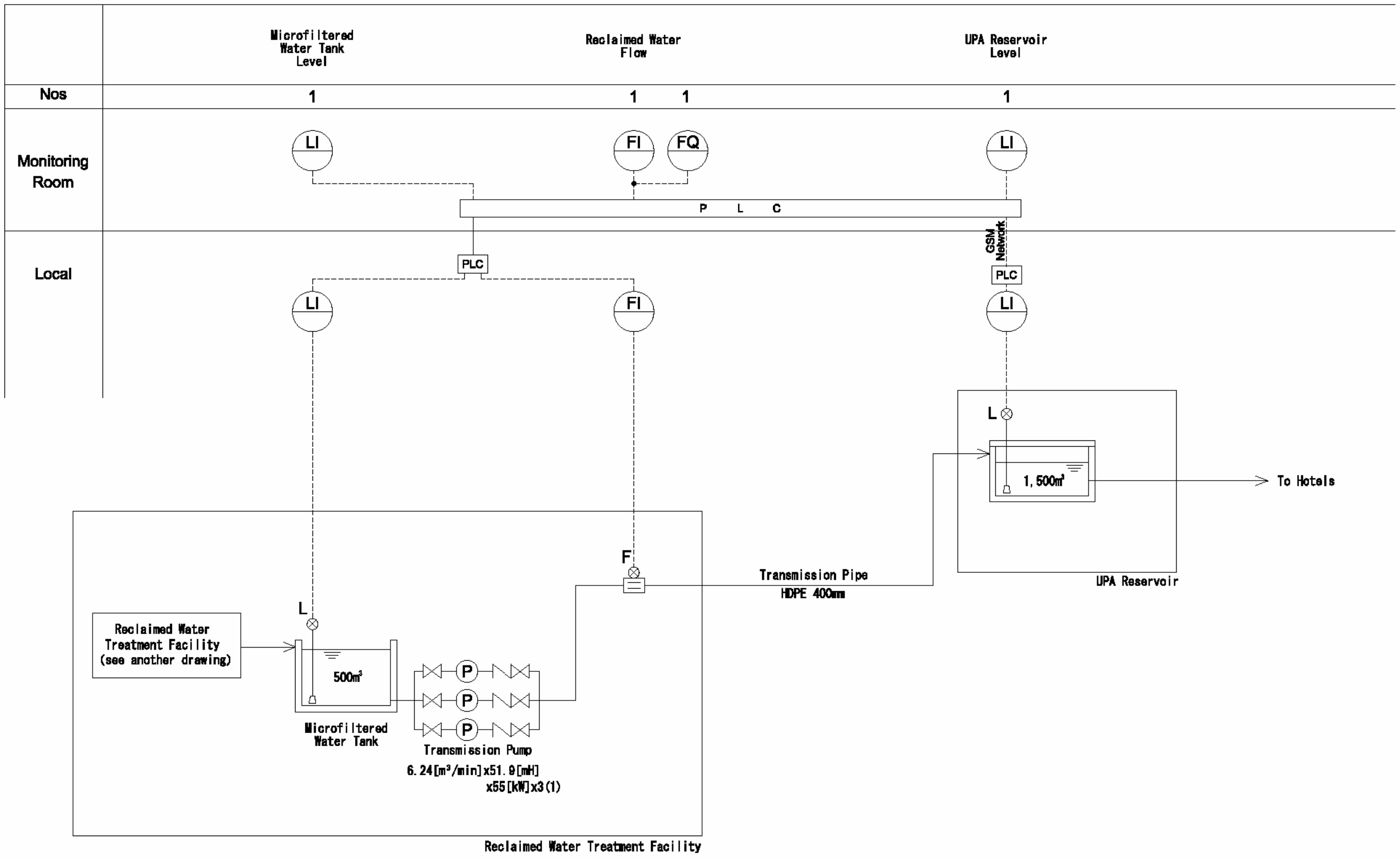
JOB NO.	DRAWING NO.	REV.
A0305050	D-122-00-003	



THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

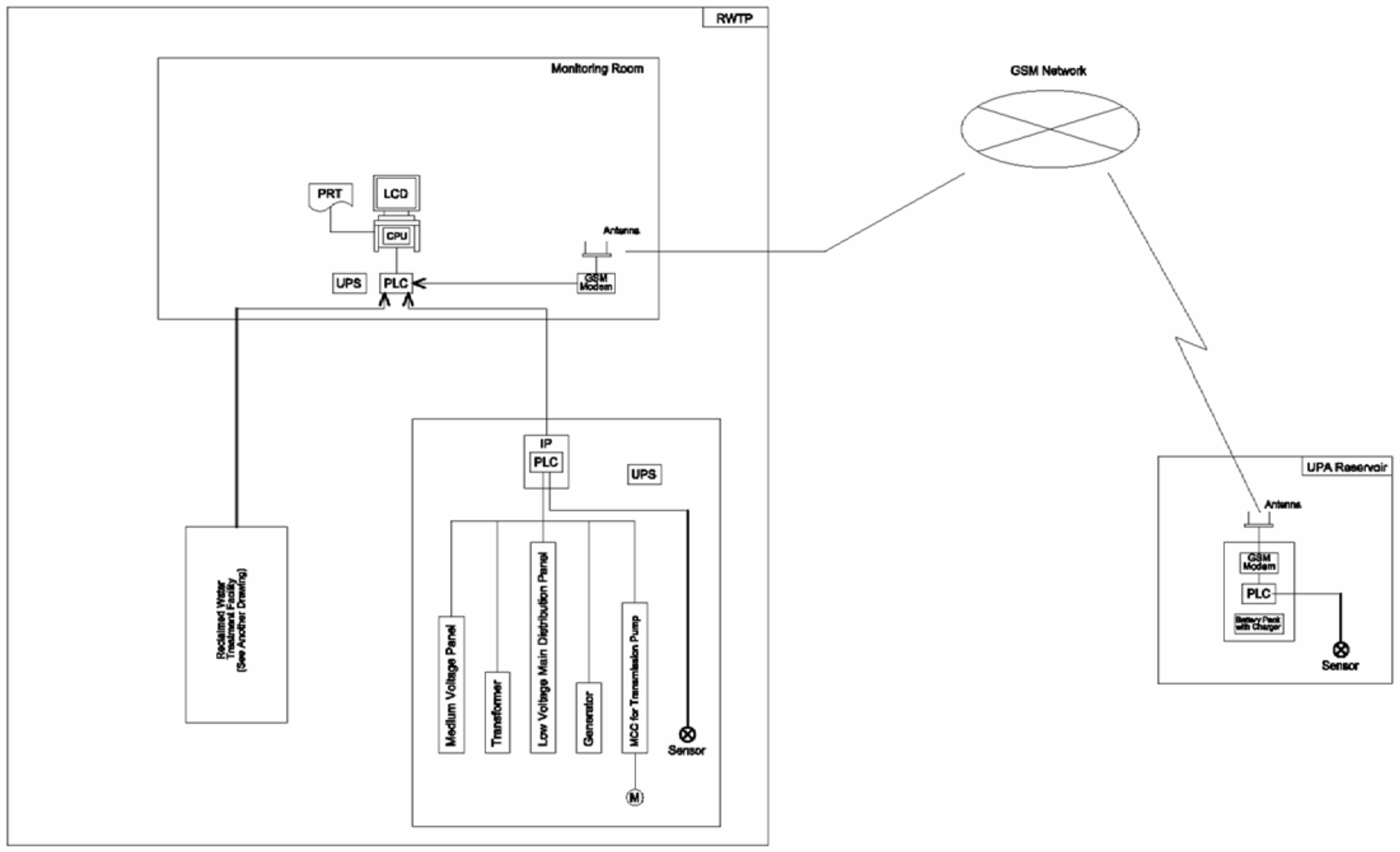
TITLE : Power Distribution Diagram
DRAWING NO.01



THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE: P&I Diagram
DRAWING NO.02



THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE : Schematic Draiagram of SCADA
DRAWING NO.03

APPENDIX 6

CONCEPT DESIGN OF TRANSMISSION FACILITY

APPENDIX 6 CONCEPT DESIGN OF TRANSMISSION FACILITY

6.a Design Criteria

The following descriptions are shown for the case of Case2.

6.a.1 Transmission pump facility

Design Transmission Flow: Maximum daily flow shall be considered for the transmission pump.

Design maximum daily flow 9,000 m^3/day (= 6.250 m^3/min = 104.2 L/s)

Transmission pump specification: Shall be determined considering the elevation difference between Denpasar WWTP and UPA reservoir, head loss of transmission pipe, head loss around the pipe, water hammer analysis and others.

Power receiving facility: Shall have the capacity enough for duty operation of the transmission pumps.

Generator equipment: Shall have the capacity enough for emergency operation of the transmission pumps.

Electrical and instrumentation equipment, and monitoring equipment:

Shall consider automatic operation

6.a.2 Transmission Pipe

Laying roulte: The laying route of transmission pipe is shown in Figure 6.a.1. The length is approximately 16km.

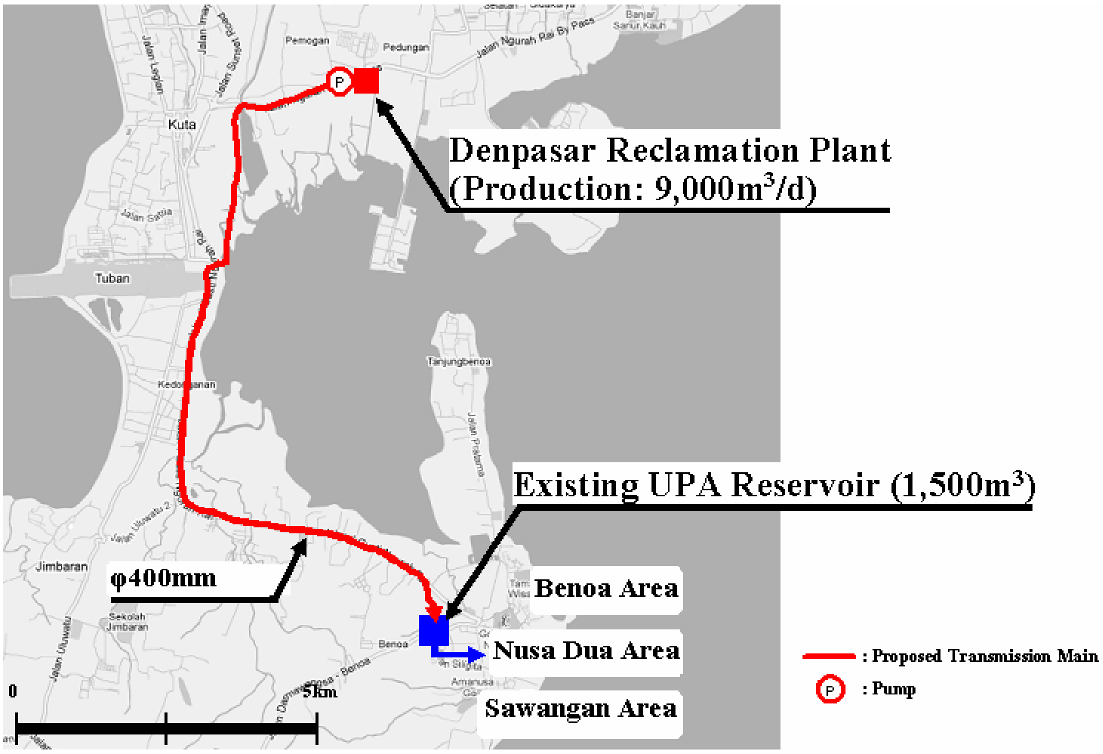


Figure 6.a.1 Transmission Pipe Route

Design Transmission Flow: Maximum daily flow shall be considered for the transmission pipe.

Design maximum daily flow 9,000 m^3/day (= 6.250 m^3/min = 104.2 L/s)

Pipe type, diameter: HDPE, φ400 (based on the result of water hammer analysis)

Construction method:

-General open cut method part: Standard section shown in Figure 6.a.2 shall be applied.

-Other special construction method part: Construction method shown in Figure 6.a.3 shall be applied as a result of field survey.

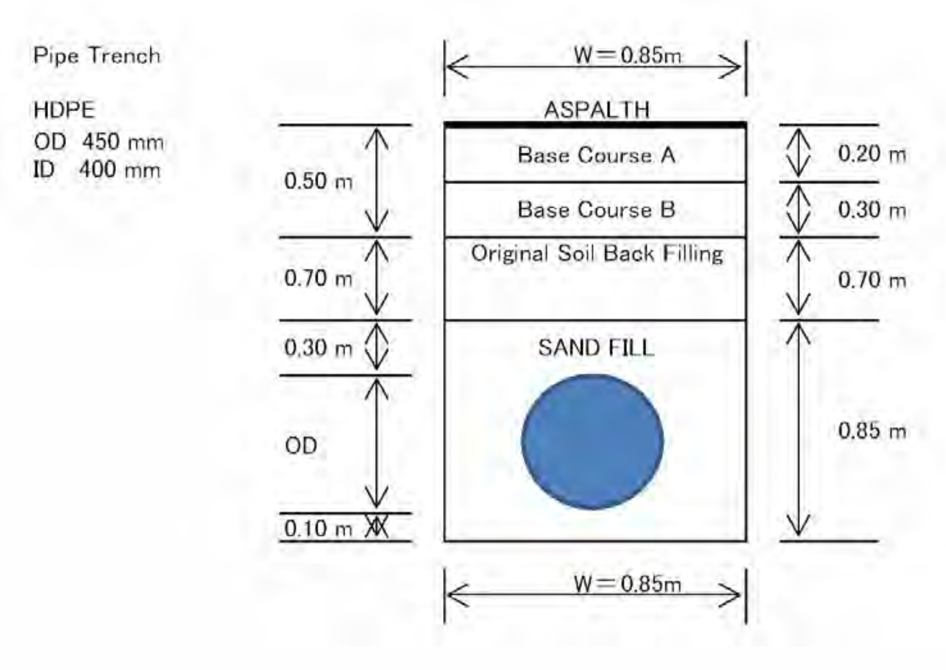


Figure 6.a.2 Standard Section of Pipe Earthwork for the General Open Cut Method Part

Figure 6.a.3 Location of Transmission Pipe for Special Construction Method Part

6.b Equipment Design

6.b.1 Reclaimed Water Transmission Equipment

(1) Design Criteria

Design Flow

Daily average transmission Flow: 6.250[m^3/min]

Water Level

Pump well LWL 1.6 [m]

UPA reservoir HWL 29.335 [m]

(2) Pump Specification

Discharge: 3.125 [m^3/min]

Motor output: 75 [kW]

Quantity: 3(1) [Nos]

(3) Water Hammer Analysis

The result of simplified calculation to judge whether a water hammer will occur has showed that there is no point where the minimum pressure gradient curve goes below the pipeline longitudinal section, and negative pressure is not generated. Therefore it is confirmed that a water column separation will not be caused.

6.b.2 Power Receiving Equipment and Substation

It is assumed that the maximum demand power of this facility amounts to approximately 780 kW. After power receiving at 20kV from the electric power company, 20kV is transformed into 400V by the transformer at site, and then 400V is supplied to each load. Power distribution diagram is shown in Figure 6.#.

In addition, indoor space with not less than 3m x 7 m is required for the space of switchboard installation of the electric power company. Based on the electric power supply regulation, it is necessary to pay the electric power company for a connection fee.

6.b.3 Generator Equipment

This equipment is to supply the power for producing reclaimed water at the time of a power failure, and supply the treated water to UPA reservoir.

(1) Reason to install

This facility needs to produce and supply the reclaimed water always and stably, even at a time of power failure, based on the PPP contract. According to the hearing to the electric power company, the frequency of power failure of 20kV power line is about ten times a year, and its duration is about two hours at maximum. Therefore, installation of emergency power generating facility to secure the power supply at least two hours needs to be considered.

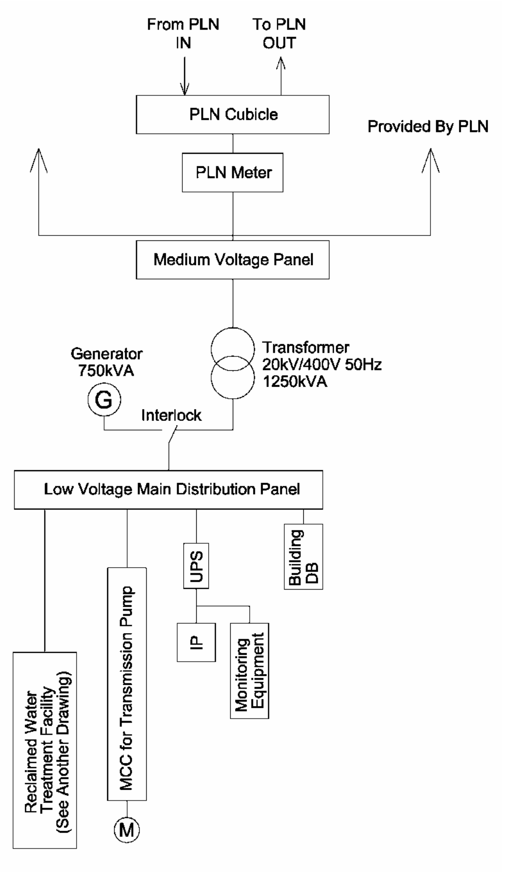


Figure 6.b.1 Power Distribution Diagram

All the facilities related to this project have emergency generators as the measure against power failure. The details of the generators are summarized as follows. Power failures are occurring frequently and they are operating frequently.

- Suwung WWTP (The facility to provide the reclaimed WTP with raw water)
  Engine Type: Diesel
  Quantity: 1 [set]
  Capacity: 500 [kVA]
  Fuel Type: Diesel Oil
  Capacity of Fuel Tank: 4 [m^3]

- Teluk Benoa Reservoir (The facility to transmit the clean water to UPA reservoir)
  Engine Type: Diesel
  Quantity: 1 [set]
  Capacity: 750 [kVA]
  Fuel Type: Diesel Oil
  Capacity of Fuel Tank: 1 [m^3]

- UPA reservoir (The facility to supply the clean water to Nusa Dua area)
  Engine Type: Diesel
  Quantity: 1 [set]
  Capacity: 106 [kVA]
  Fuel Type: Diesel Oil
  Capacity of Fuel Tank: 1.3 [m^3]

(2) Required load in case of emergency

Required load in case of emergency shall be the capacity enough to operate one train of reclaimed water treatment (4,500m^3/d), because if all the trains are considered for emergency power, required capacity will become excessive and the amount of investment will increase. If one train operation is considered at power failure, the reclaimed water would be supplied to the customer for at least four hours without interruption under the condition that there is certain amount of reclaimed water in UPA reservoir. Moreover, the load necessary for maintenance such as building power, building lighting shall be minimized in consideration of demand factor.

(3) Engine Type

Diesel engine or gas turbine engine is used for generator, and diesel engine is selected in consideration of maintenance, since the diesel engine is used in the related facilities. Reclaimed water shall also be used as the cooling water for the generator.

(4) Specification

The outline of generator equipment to be installed in this facility is as follows. Capacity calculation is attached.

Engine Type: Diesel
Quantity: 1 [set]
Capacity: 750 [kVA]
Fuel Type: Diesel Oil
Capacity of Fuel Tank: 2.5 [m^3]

6.b.4 Reclaimed water transmission pump instrumentation and control equipment

This equipment is to operate and control the transmission pump which transmits the reclaimed water to UPA reservoir. Normally, two transmission pumps shall be operated in duty. Operation of the pump shall be automatic according to water level of UPA reservoir. Level meters shall be installed at transmission pump well and UPA reservoir for automatic operation. Moreover, transmission flow meter shall be installed in order to understand the amount of reclaimed water supplied.

6.b.5 Supervision equipment

Supervisor equipment is the equipment to monitor and control the plant equipment dispersed broadly in a central monitoring room by the operator, and to perform the plant operation safely, efficiently, and stably. It is installed for the purpose of operation and maintenance cost reduction, laborsaving, labor environment improvement, and workability improvement. The basic function of supervisor equipment is as follows.

- Monitoring function (Status display, failure display, measured value display)
- Operation / setting function
- Recording function

Schematic diagram is shown in Figure 6.b.2.

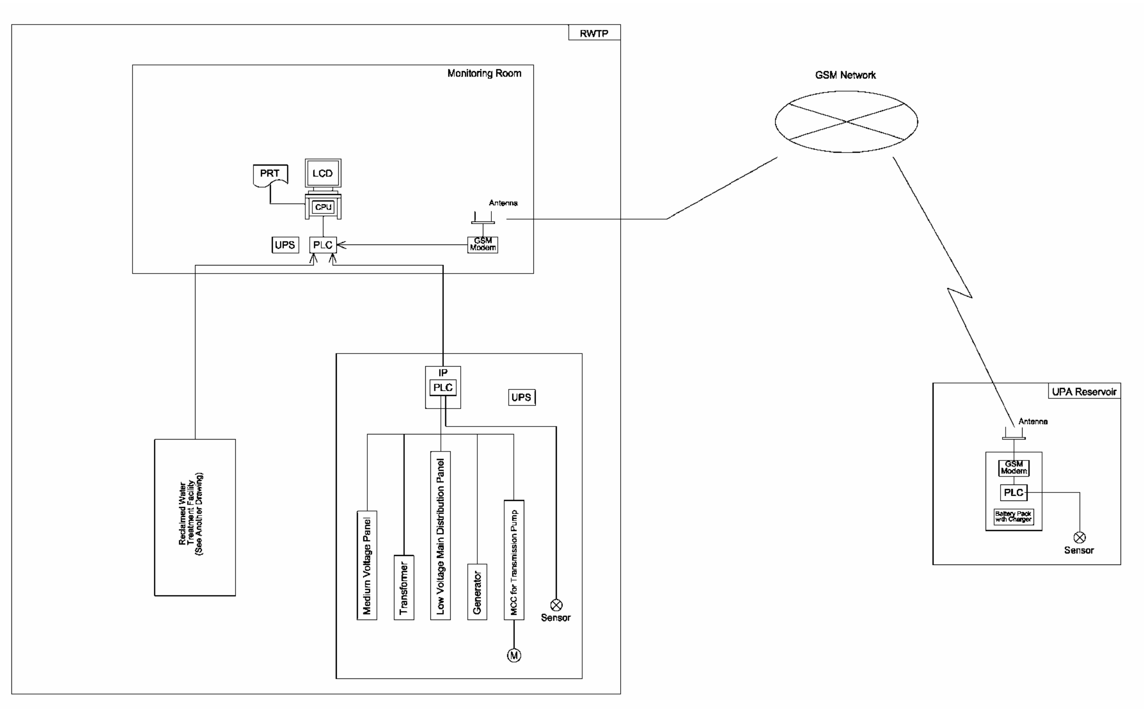


Figure 6.b.2　Schematic Diagram of Supervision System

【Calculations of Equipment for Concept Design】

1. Calculation of Reclaimed Water Transmission Pump
2. Water Hammer Analysis
3. Calculation of Transformer
4. Calculation of Emergency Generator
5. Calculation of Fuel Tank

1. Calculation of Reclaimed Water Transmission Pump

i) Head Loss in Transmission Pipe

a) Head loss around the pump H_{f1}

Estimated as 10 [m]

b) Head loss in transmission pipe

b-1) Hazen–Williams Equation

$$Hl = 10.666 \times C^{-1.85} \times D^{-4.87} \times Q^{1.85} \times L$$

C	Coefficient	HDPE
D	Diameter of Pipe	[m]
Q	Flow Rate	[m^3/s]
L	Length of Pipeline	[m]

$$= 10.666 \times 140^{-1.85} \times 0.4^{-4.87} \times 0.104^{1.85} \times 15{,}230$$

$$= 22.90 \text{ [m]}$$

b-2) Head loss around the corner

Estimated as 10% of head loss in transmission pipe

$$= 2.29 \text{ [m]}$$

ii) Driving power of a pump

$$P = \frac{0.163 \times \gamma \times Q \times H}{\eta} \times (1+a)$$

γ	Density of Liquid	
Q	Amount of Discharge	[m^3/min]
H	Total Head	[m]
η	Pump Efficiency	
a	Allowance Rate	

$$= \frac{0.163 \times 1 \times 6.24 \times (10+22.90+2.29+27.735)}{0.6} \times (1+0.1)$$

$$= 117 \quad \text{[kW]}$$

$$\rightarrow \ 75\text{[kW]} \times 3(1)$$

2. Water Hammer Analysis

1. Pump Details

	単位 Unit	記号 Symbol	数値 Value	備考 Remarks
Motor Output	[kW]		75	
Frequency	[Hz]		50	
Static Head	[m]	Ha	27.735	
Loss of Head	[m]	Hf	35.19	
Total Head	[m]	Ht	63	Ha+Hf
Pump Shaft Power	[kW]	Pw	53.4	0.163γQH/ηp
Efficiency	[%]	ηp	60	
Discharge Flow	$[m^3/min]$	Q_0	3.12	
Revolution Speed	$[min^{-1}]$	N	1,000	6P
Fly-wheel Effect	$[kg\text{-}m^2]$	GD^2	16.50	
Number of Pump		n	2	

2. Pipeline Details

	単位 Unit	記号 Symbol	数値 Value	備考 Remarks
Pipeline Length	[m]	L	15,230	
Diameter	[mm]	D	400	
Thickness	[mm]	t	23.7	
Material	HDPE			
k/E	-	k/E	2.07	
Pump Suction WL	[m]		1.6	
Pipeline Profile				Figure 4.b.2

3. Calculation

	単位 Unit	記号 Symbol	計算式 Formula	数値 Result
運転時トルク Pump Torque	[N･m]	M	$\frac{\Sigma(9,550*Pw)}{N} = \frac{9,550*53.4*2}{1,000} =$	1019.9
慣性係数 Inertial Coefficient	-	k	$\frac{38.2*\Sigma M}{\Sigma(GD^2_n*N_n)} = \frac{38.2*1019.9}{16.5*2*1000} =$	1.181
損失百分率 Pipeline loss of head [percentage]	[%]	R	$\frac{Hf}{Ht}*100 = \frac{35.19}{63}*100 =$	55.9
圧力伝播速度 Pressure Propagation Velocity	[m/s]	a	$\frac{1425}{\sqrt{1+K/E \cdot D/t}} = \frac{1425}{\sqrt{1+2.07 \cdot 400/23.7}} =$	237.7
管内流速 Average Flow Velocity	[m/s]	V	$\frac{Q_0}{60*\pi/4*D^2} = \frac{3.12}{60*\pi/4*0.4\text{^}2\ /2} =$	0.828
管路定数 Pipeline Constant	-	2ρ	$\frac{a*V}{g*Ht} = \frac{237.7*0.828}{9.8*63} =$	0.32
サージ係数 Surge Coefficient	-	S	$2*k*\frac{L}{a} = 2*1.181*\frac{15,230}{237.7} =$	151.339

4. Pressure

Location	最低圧力比 Lowest Pressure Ratio [%]	最低圧力 Lowest Pressure Estimated
At pump installation point	10.0	6.30
At 1/2L point	35.0	22.05
At 3/4L point	38.0	23.94

5. Result

Water column separation is considered not to occur. However, detail calculation will be required in detail design.

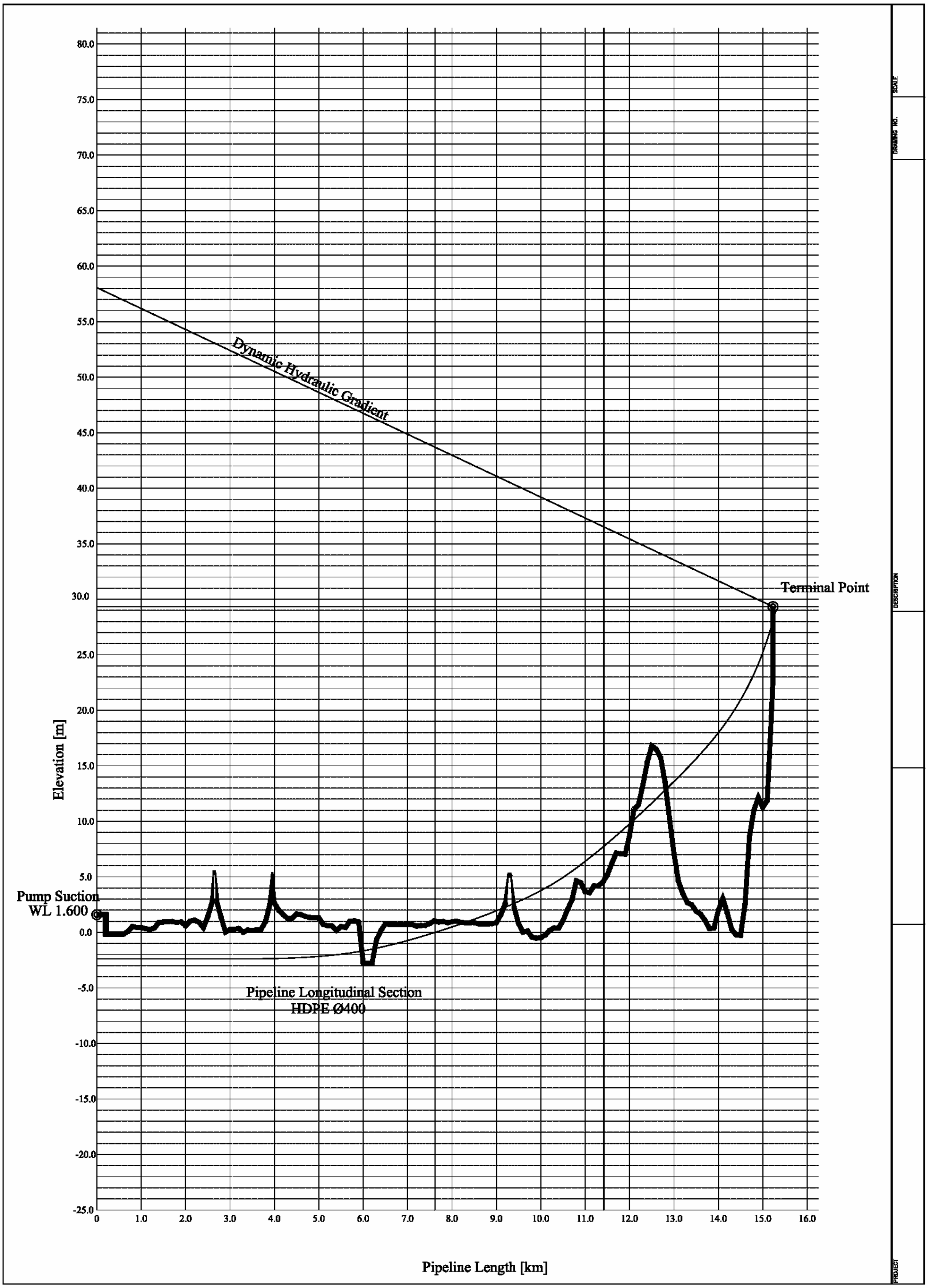


Figure 6.b.3 Pipeline Profile

3. Calculation of Transformer

Load List

	kW	Nos	Total [kW]
From raw water pump to reclamation process equipment	706.94	1 lot	706.94
Reclaimed Water Transmission Pump	75	3(1)	150
Building Service	60	1 lot	60
Others	10	1 lot	10
3-phase Total [kW]			**926.94**
Building Service	50	1 lot	50
Laboratory	30	1 lot	30
Others	10	1 lot	10
1-phase Total [kW]			**90**

1) Formula

$$\text{Required Capacity P[kVA]} = \text{Total Load [kW]} \times \frac{\beta\times\alpha}{\eta\times\varphi}$$

Here,			
	φ:	Total Power Factor	0.85
	η:	Total Efficiency	0.85
	β:	Demand Factor	0.8
	α:	Allowance Rate	1.1

2) Calculation

$$1016.94\times\frac{0.8\times1.1}{0.85\times0.85} = 1{,}239 \text{ [kVA]}$$

3) Result

1,250[kVA] shall be selected since the required capacity amounts to 1,239 [kVA].

4. Calculation of Emergency Generator

Load List for Emergency Generator

	kW	Nos	Total [kW]
From raw water pump to reclamation process equipment	455.755	1 lot	455.755
Reclaimed Water Transmission Pump	75	1	75
Building Service	18	1 lot	18
Others	10	1 lot	10
3-phase Total [kW]			**558.755**
Building Service	15	1 lot	15
Laboratory	9	1 lot	9
Others	3	1 lot	3
1-phase Total [kW]			**27**

(1) Formula

Capacity of generator shall exceed the largest among the required capacity calculated using the following formulas.

a. PG_1: Required capacity for steady operation of all the loads

$$PG_1=\frac{\Sigma P_0}{\eta_L \times \varphi_L} \times \alpha \times Sf \text{ [kVA]}$$

$$Sf=1+0.6\times\frac{\Delta P}{\Sigma P_0}$$

Here,

ΣP_0: Total Load for Emergency Generator [kW]

Calculation of ΣP_0

a) Equipment that the rating is displayed as output kW (such as general induction motor)

Pi= Rated Output [kW]

b) Equipment that the rating is displayed as output kVA (such as CVCF)

Pi= Rated Output [kVA] × Power Factor (0.9)

c) Rectification equipment

Pi= Rated DC Voltage [V] × DC side Rated Current [A]

d) Fluorescent Light and Incandescence Light

P_i= Rated Power Consumption or Lamp Power [kW]

Referred to as Pi= Rated Output [kVA] x0.8 when [kVA] is used as the unit for fluorescent light output.

η_L: Total Load Efficiency 0.85

φ_L: Total Load Power Factor 0.8

α: Demand Factor 0.8

ΔP: Total of unbalance part of single phase load

Starting kVA decided by starting method

Starting Method		β×C
Squirrel -Cage Type	DOL	7.2×1.0
	Star Delta	7.2×2/3
	Reactor Starting	50% 7.2×0.5 65% 7.2×0.65 80% 7.2×0.8
	Kondorfer Starting	50% 7.2×0.25 65% 7.2×0.42 80% 7.2×0.64
	VFD Starting	1.2
Wound-Rotor Type		1.2

(Note) In case of closed transition Star Delta starter, β×C shall be 7.2×1/3.

b. PG_2: Required capacity for allowable voltage drop

$$PG_2=P_m\times\beta\times C\times Xd'\times\frac{1-\Delta E}{\Delta E}\quad [kVA]$$

Here,

P_m:	The Maximum Motor Output	[kW]
β:	Starting kVA of the maximum capacity motor per kW	[kVA]
C:	The coefficient decided by starting method	
Xd':	Generator Constant	0.25
ΔE:	Allowable Voltage Drop Rate	0.25

c. PG_3: Required capacity for starting of the motor with maximum capacity at the end

$$PG_3=\frac{f_{v1}}{\gamma_G}\ \{(\Sigma P_0-P_m)\times\frac{\alpha}{\eta_L\times\varphi_L}\ +P_m\times\beta\times C\}\ [kVA]$$

Here,

ΣP_0:	Total Load for Emergency Generator (excludes standby load)	[kW]
η_L:	Total Load Efficiency	0.85
α:	Demand Factor	0.8
P_m:	The Maximum Motor Output	[kW]
φ_L:	Total Load Power Factor	0.8
β:	Starting kVA of the maximum capacity motor per kW	[kVA]
C:	The coefficient decided by starting method	
γ_G:	Instant overload capacity of generator	1.5
f_{v1}:	Loading Abatement Factor	1.0

(2) Calculation

a. PG_1: Required capacity for steady operation of all the loads

$$\Sigma P_0=558.755+0\times0.9+33.75\times0.8=585.8$$

$$Sf=1+0.6\times\frac{27}{585.8}\ =1.028$$

$$PG_1=\frac{585.8}{0.85\times0.8}\ \times0.8\times1.028\ ≒\ 708.4$$

b. PG_2: Required capacity for allowable voltage drop

$$PG_2=75\times7.2\times0.8\times0.25\times\frac{1-0.25}{0.25}$$

$$≒\ 324$$

c. PG_3: Required capacity for starting of the motor with maximum capacity at the end

$$PG_3=\frac{1.0}{1.5}\ \{(585.8-75)\times\frac{0.8}{0.85\times0.8}\ +75\times7.2\times0.8\}$$

$$≒\ 688.6$$

(3) Result

750[kVA] shall be selected since the required capacity is calculated as 708.4[kVA].

5. Calculation of Fuel Tank

1) Formula

Required capacity of fuel tank $Q[\mathrm{m}^3] = \frac{P \times be \times H \times \alpha}{d}$

Here,
P: Engine Output [kW]
be: Fuel consumption rate [kg/kW・h]
H: Operating time [h]
α: Allowance Rate 1.1
d: Fuel Density

2) Calculation

Engine Output $P[\mathrm{kW}] = \frac{P_G \times \varphi_G}{\eta_G} = \frac{750 \times 0.8}{0.923} = 650.1$

Here,
P_G: Generator Output
φ_G: Generator Power Factor
η_G: Generator Efficiency

$$Q = \frac{P \times be \times H \times \alpha}{d} = \frac{650.1 \times 0.231 \times 12 \times 1.1}{830} = 2.38[\mathrm{m}^3]$$

3) Result

2.5[m^3] of fuel tank shall be selected as required capacity is 2.38[m^3].

6.c Design Drawing

Transmission pipe plan, transmission pipe cross section, transmission pipe vertical section, water pipe bridge schematic drawing, and pipe-thrusting method outline drawing are shown in the attached drawings. Drawing list is shown in the following table.

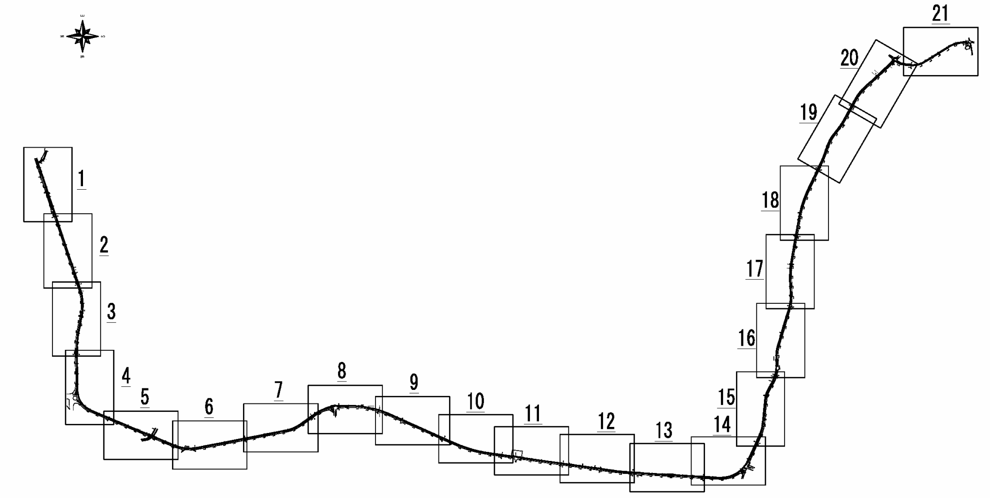
Table 6.c.1 Drawing List of Transmission Pipe Concept Design

NO.	Title	Scale	Remarks
1-1	Key Plan	None	
2-1	Transmission Pipe Plan (1)	1/2000	
2-2	Transmission Pipe Plan (2)	1/2000	
2-3	Transmission Pipe Plan (3)	1/2000	
2-4	Transmission Pipe Plan (4)	1/2000	
2-5	Transmission Pipe Plan (5)	1/2000	
2-6	Transmission Pipe Plan (6)	1/2000	
2-7	Transmission Pipe Plan (7)	1/2000	
2-8	Transmission Pipe Plan (8)	1/2000	
2-9	Transmission Pipe Plan (9)	1/2000	
2-10	Transmission Pipe Plan (10)	1/2000	
2-11	Transmission Pipe Plan (11)	1/2000	
2-12	Transmission Pipe Plan (12)	1/2000	
2-13	Transmission Pipe Plan (13)	1/2000	
2-14	Transmission Pipe Plan (14)	1/2000	
2-15	Transmission Pipe Plan (15)	1/2000	
2-16	Transmission Pipe Plan (16)	1/2000	
2-17	Transmission Pipe Plan (17)	1/2000	
2-18	Transmission Pipe Plan (18)	1/2000	
2-19	Transmission Pipe Plan (19)	1/2000	
2-20	Transmission Pipe Plan (20)	1/2000	
2-21	Transmission Pipe Plan (21)	1/2000	

NO.	Title	Scale	Remarks
3-1	Transmission Pipe Cross Section (1)	1/100	
3-2	Transmission Pipe Cross Section (2)	1/100	
3-3	Transmission Pipe Cross Section (3)	1/100	
3-4	Transmission Pipe Cross Section (4)	1/100	
3-5	Transmission Pipe Cross Section (5)	1/100	
3-6	Transmission Pipe Cross Section (6)	1/100	
3-7	Transmission Pipe Cross Section (7)	1/100	
3-8	Transmission Pipe Cross Section (8)	1/100	
3-9	Transmission Pipe Cross Section (9)	1/100	
3-10	Transmission Pipe Cross Section (10)	1/100	
3-11	Transmission Pipe Cross Section (11)	1/100	
3-12	Transmission Pipe Cross Section (12)	1/100	
3-13	Transmission Pipe Cross Section (13)	1/100	
3-14	Transmission Pipe Cross Section (14)	1/100	
3-15	Transmission Pipe Cross Section (15)	1/100	
3-16	Transmission Pipe Cross Section (16)	1/100	
3-17	Transmission Pipe Cross Section (17)	1/100	
3-18	Transmission Pipe Cross Section (18)	1/100	
3-19	Transmission Pipe Cross Section (19)	1/100	
3-20	Transmission Pipe Cross Section (20)	1/100	
3-21	Transmission Pipe Cross Section (21)	1/100	
3-22	Transmission Pipe Cross Section (22)	1/100	
3-23	Transmission Pipe Cross Section (23)	1/100	
3-24	Transmission Pipe Cross Section (24)	1/100	
3-25	Transmission Pipe Cross Section (25)	1/100	
3-26	Transmission Pipe Cross Section (26)	1/100	
3-27	Transmission Pipe Cross Section (27)	1/100	
3-28	Transmission Pipe Cross Section (28)	1/100	
3-29	Transmission Pipe Cross Section (29)	1/100	
3-30	Transmission Pipe Cross Section (30)	1/100	
3-31	Transmission Pipe Cross Section (31)	1/100	
3-32	Transmission Pipe Cross Section (32)	1/100	
3-33	Transmission Pipe Cross Section (33)	1/100	
3-34	Transmission Pipe Cross Section (34)	1/100	
3-35	Transmission Pipe Cross Section (35)	1/100	
3-36	Transmission Pipe Cross Section (36)	1/100	
3-37	Transmission Pipe Cross Section (37)	1/100	

NO.	Title	Scale	Remarks
4-1	Transmission Pipe Vertical Section (1)	H=1/2000,V=1/200	
4-2	Transmission Pipe Vertical Section (2)	H=1/2000,V=1/200	
4-3	Transmission Pipe Vertical Section (3)	H=1/2000,V=1/200	
4-4	Transmission Pipe Vertical Section (4)	H=1/2000,V=1/200	
4-5	Transmission Pipe Vertical Section (5)	H=1/2000,V=1/200	
4-6	Transmission Pipe Vertical Section (6)	H=1/2000,V=1/200	
4-7	Transmission Pipe Vertical Section (7)	H=1/2000,V=1/200	
4-8	Transmission Pipe Vertical Section (8)	H=1/2000,V=1/200	
4-9	Transmission Pipe Vertical Section (9)	H=1/2000,V=1/200	
4-10	Transmission Pipe Vertical Section (10)	H=1/2000,V=1/200	
4-11	Transmission Pipe Vertical Section (11)	H=1/2000,V=1/200	
4-12	Transmission Pipe Vertical Section (12)	H=1/2000,V=1/200	
4-13	Transmission Pipe Vertical Section (13)	H=1/2000,V=1/200	
4-14	Transmission Pipe Vertical Section (14)	H=1/2000,V=1/200	
4-15	Transmission Pipe Vertical Section (15)	H=1/2000,V=1/200	
4-16	Transmission Pipe Vertical Section (16)	H=1/2000,V=1/200	
4-17	Transmission Pipe Vertical Section (17)	H=1/2000,V=1/200	
4-18	Transmission Pipe Vertical Section (18)	H=1/2000,V=1/200	
4-19	Transmission Pipe Vertical Section (19)	H=1/2000,V=1/200	
4-20	Transmission Pipe Vertical Section (20)	H=1/2000,V=1/200	
4-21	Transmission Pipe Vertical Section (21)	H=1/2000,V=1/200	
4-22	Transmission Pipe Vertical Section (22)	H=1/2000,V=1/200	
4-23	Transmission Pipe Vertical Section (23)	H=1/2000,V=1/200	
4-24	Transmission Pipe Vertical Section (24)	H=1/2000,V=1/200	
4-25	Transmission Pipe Vertical Section (25)	H=1/2000,V=1/200	
5-1	Water Pipe Bridge Layout Plan (1)	1/200	
5-2	Water Pipe Bridge Layout Plan (2)	1/200	

Key Plan



THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

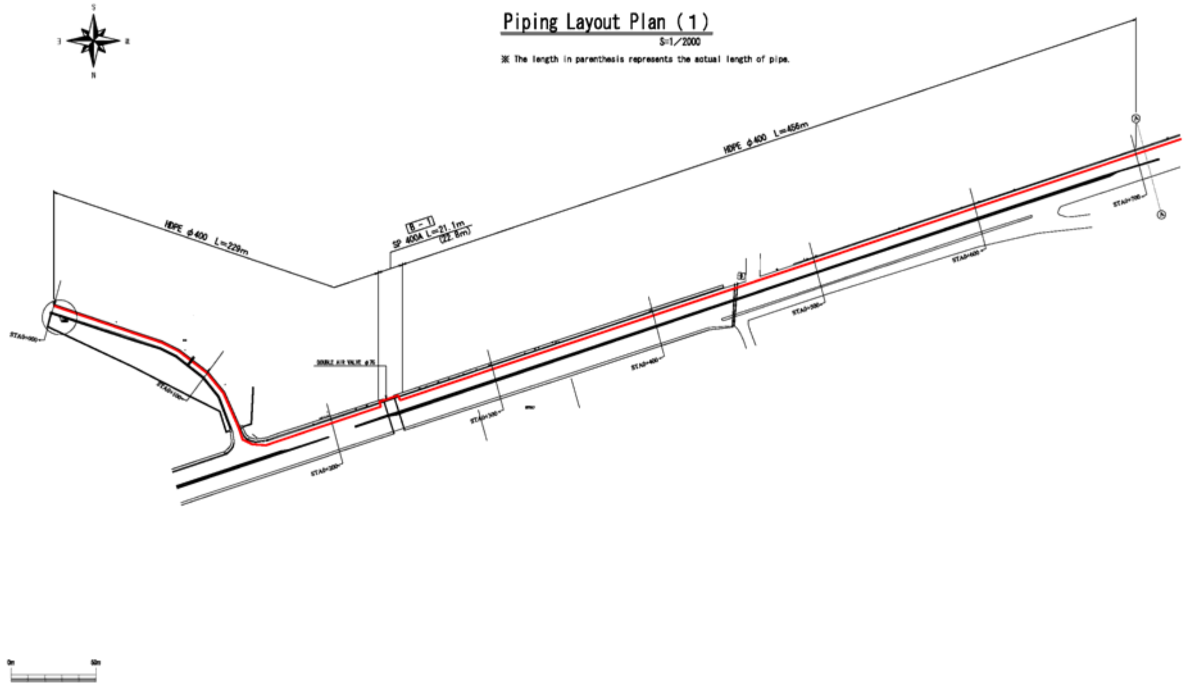
JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE :
Key Plan

Piping Layout Plan (1)

S=1/2000

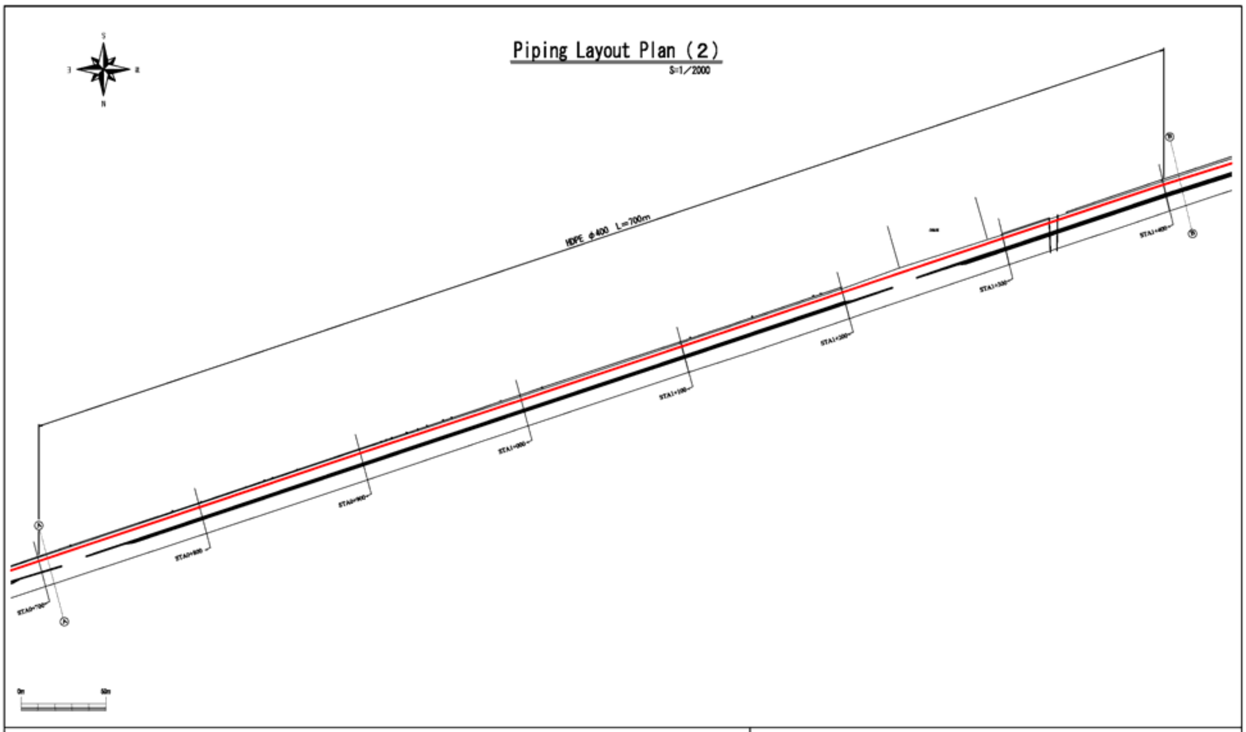
※ The length in parenthesis represents the actual length of pipe.



THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE :
Piping Layout Plan (1)



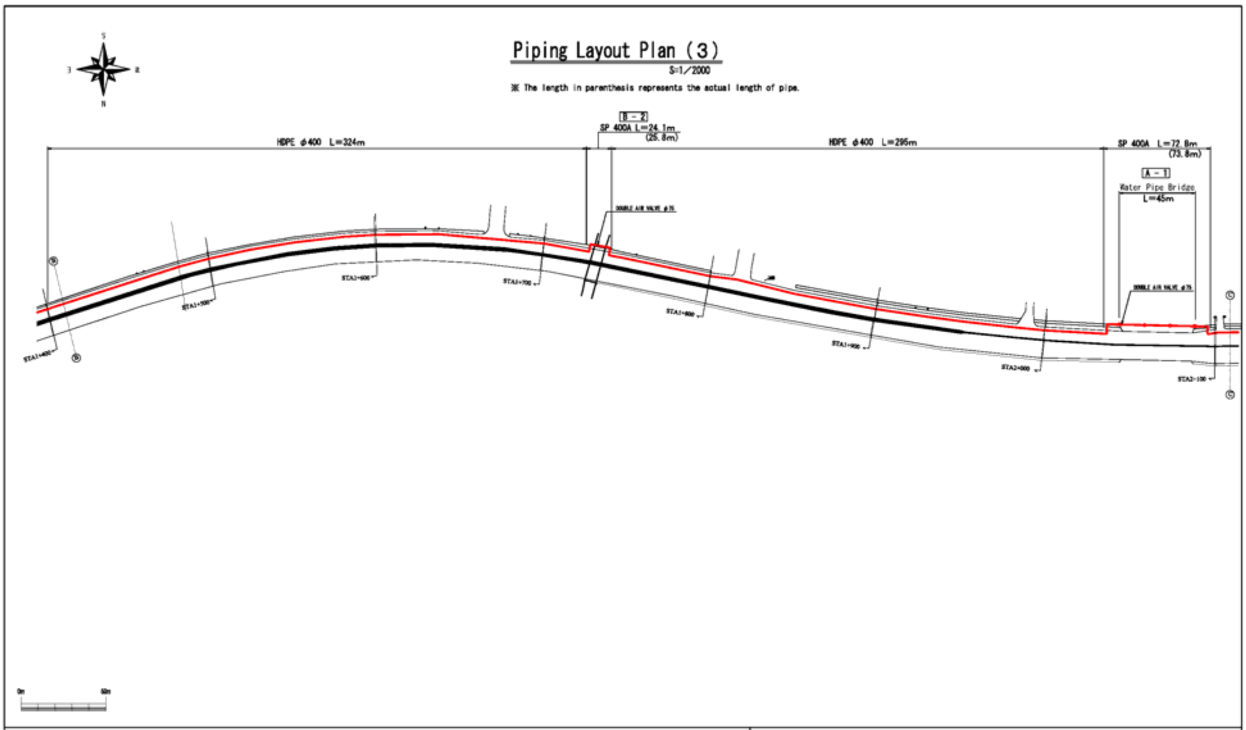
Piping Layout Plan (2)

S=1/2000

THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Piping Layout Plan (2)



Piping Layout Plan (3)

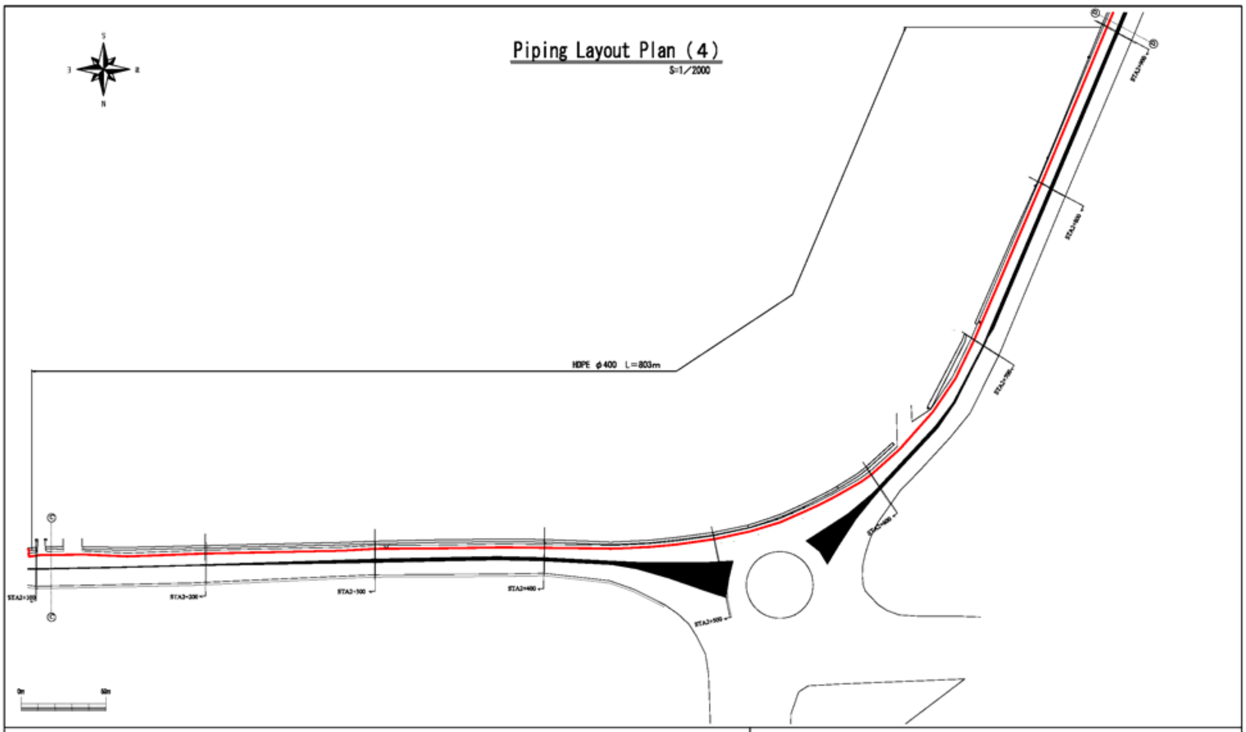
S=1/2000

※ The length in parenthesis represents the actual length of pipe.

THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

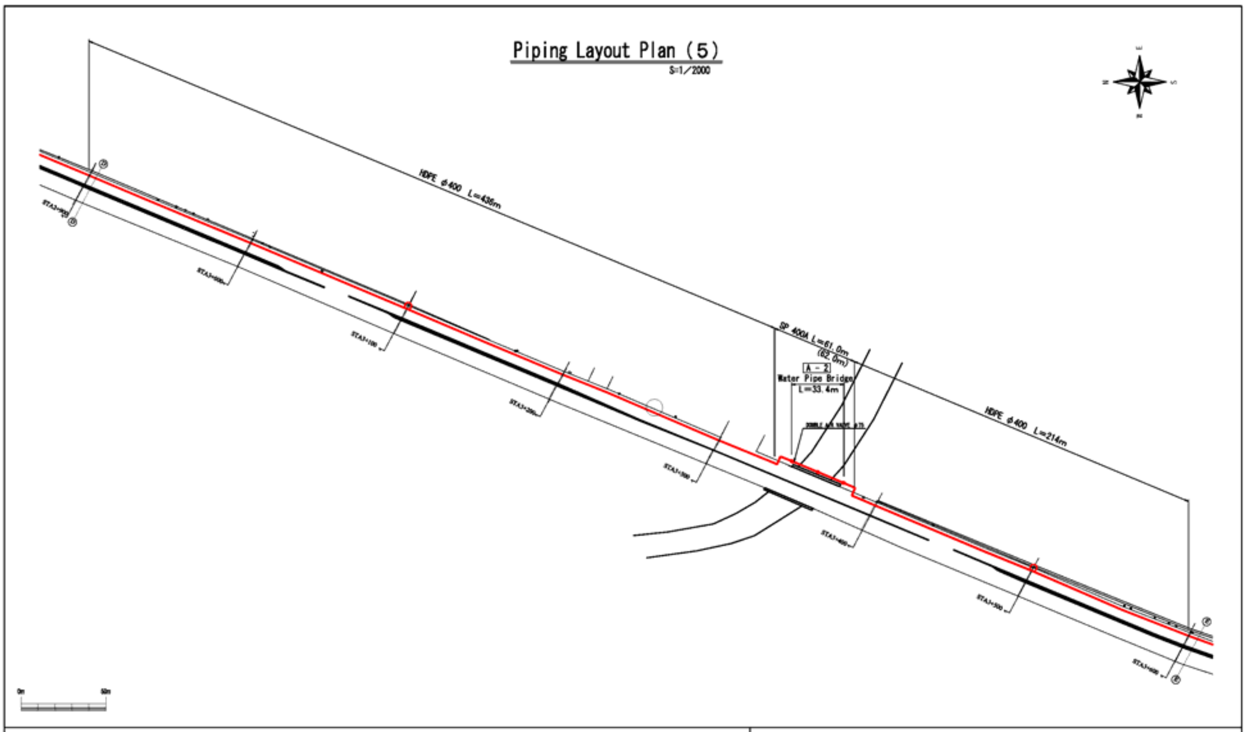
TITLE:
Piping Layout Plan (3)



Piping Layout Plan (4)

S=1/2000

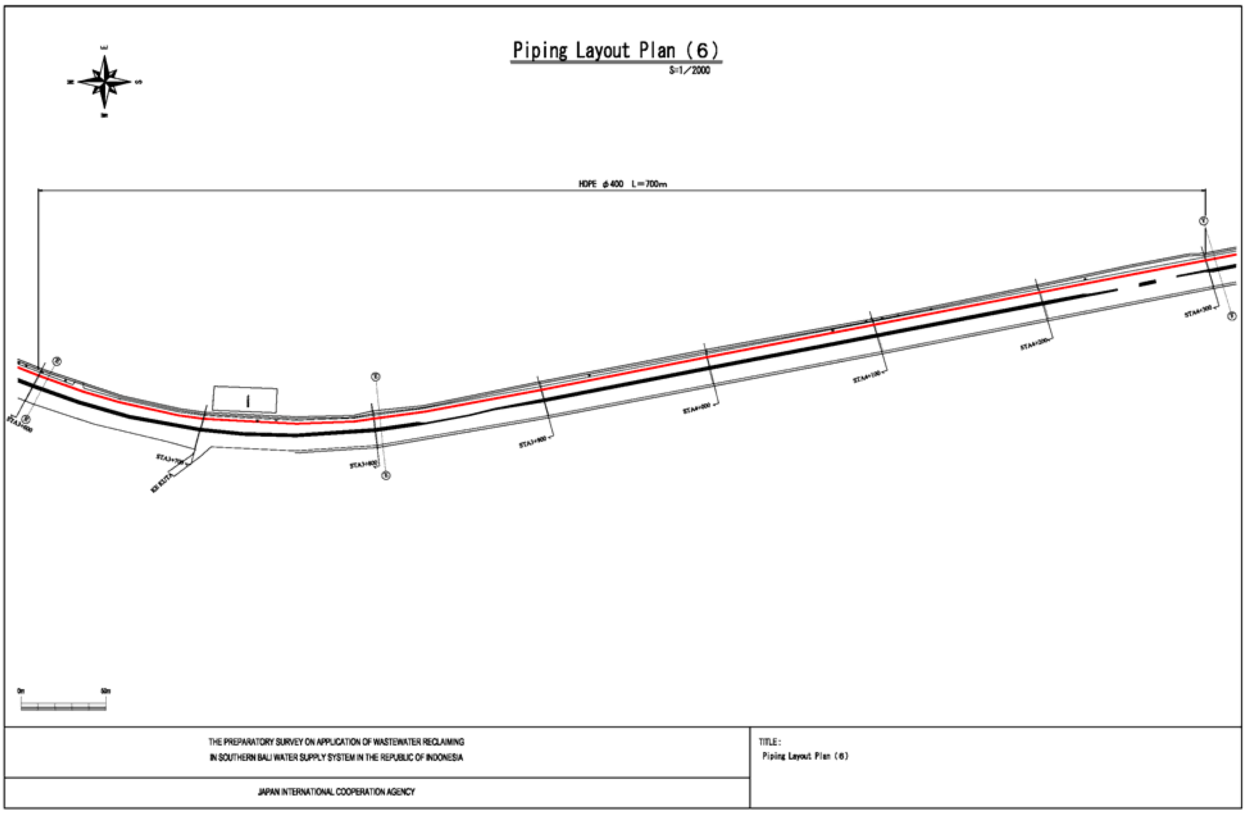
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA	TITLE : Piping Layout Plan (4)
JAPAN INTERNATIONAL COOPERATION AGENCY	

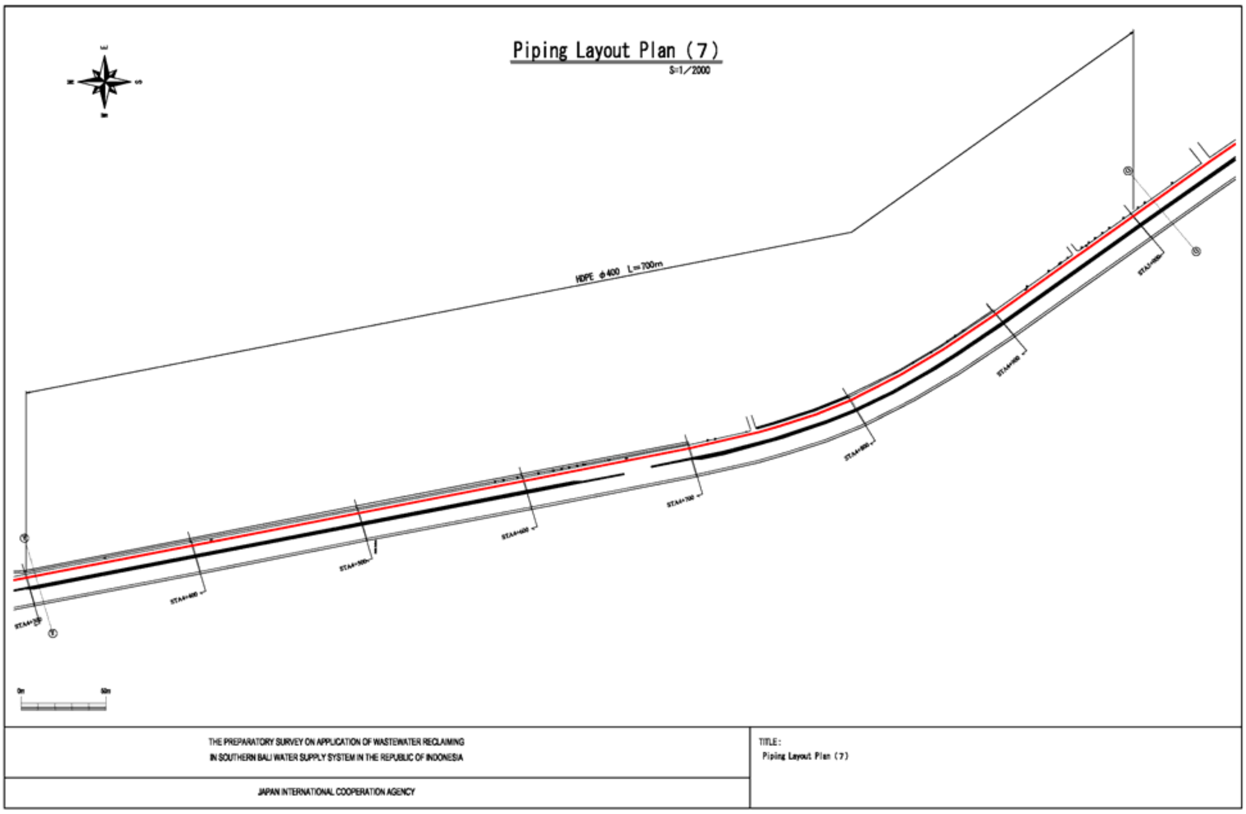


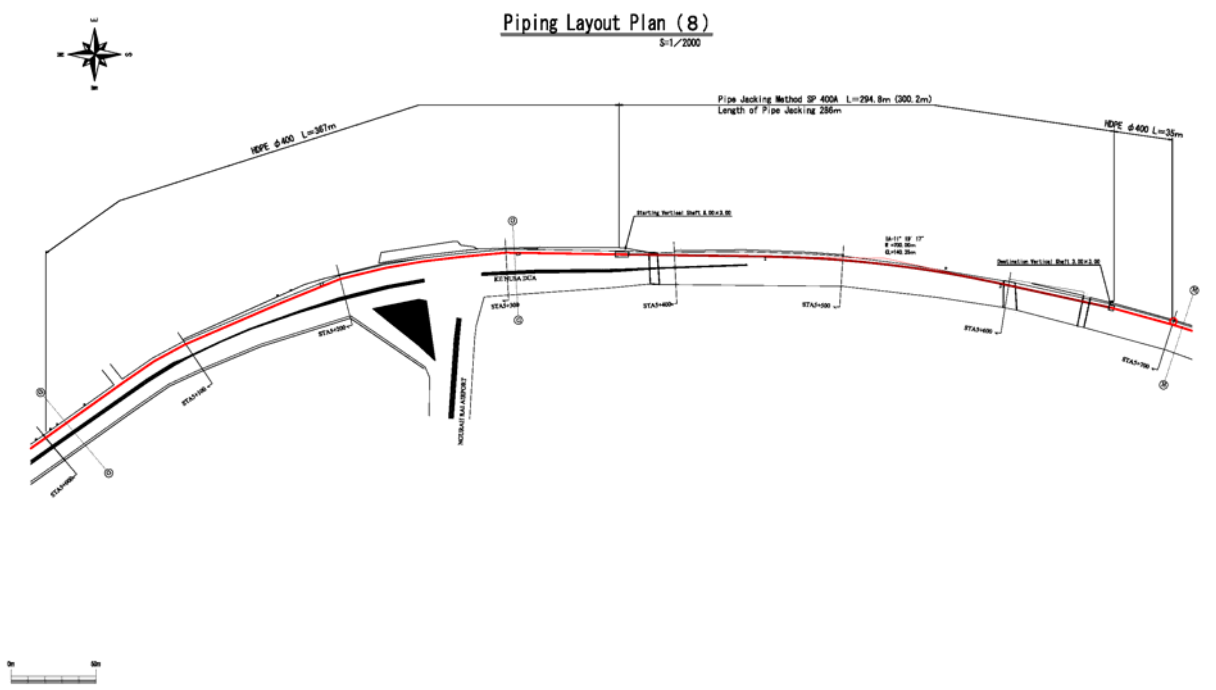
Piping Layout Plan (5)

S=1/2000

THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA	TITLE : Piping Layout Plan (5)
JAPAN INTERNATIONAL COOPERATION AGENCY	


Piping Layout Plan (6)
S=1/2000
HDPE φ400 L=700m
STA3+600
STA3+700
KE KUTA
STA3+800
STA3+900
STA4+000
STA4+100
STA4+200
STA4+300
0m
50m
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA
JAPAN INTERNATIONAL COOPERATION AGENCY
TITLE:
Piping Layout Plan (6)

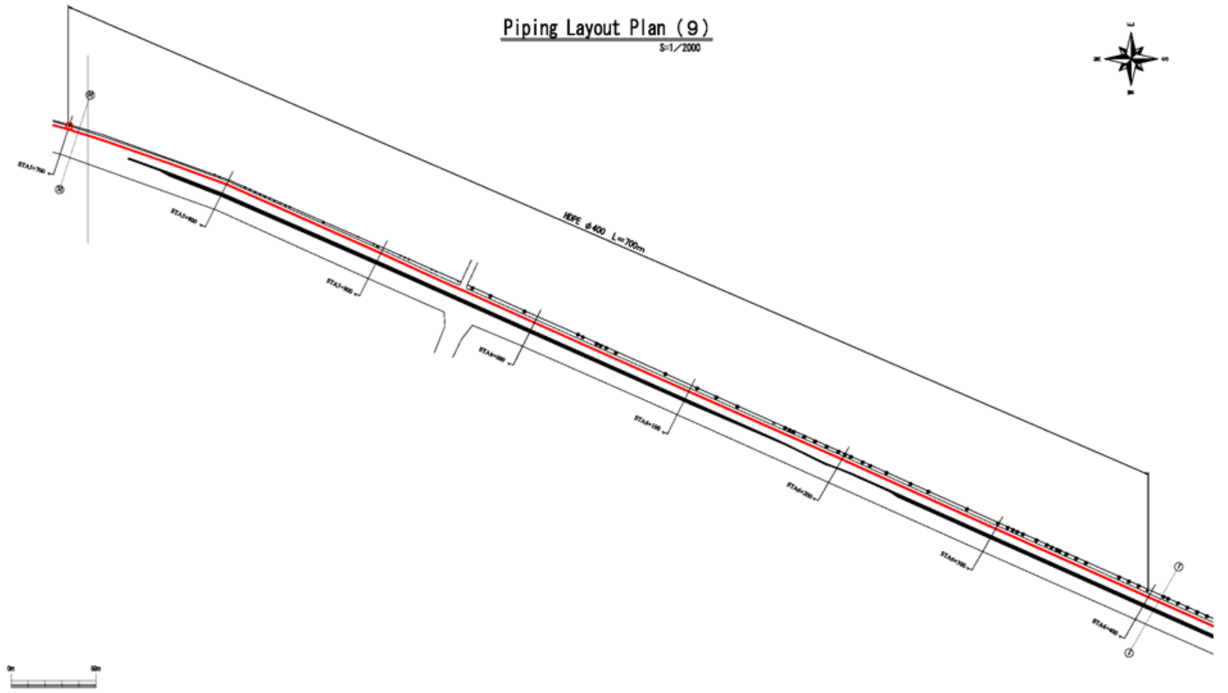

Piping Layout Plan (7)
S=1/2000
HDPE φ400 L=700m
STA4+300
STA4+400
STA4+500
STA4+600
STA4+700
STA4+800
STA4+900
STA5+000
0m
50m
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA
JAPAN INTERNATIONAL COOPERATION AGENCY
TITLE:
Piping Layout Plan (7)



THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

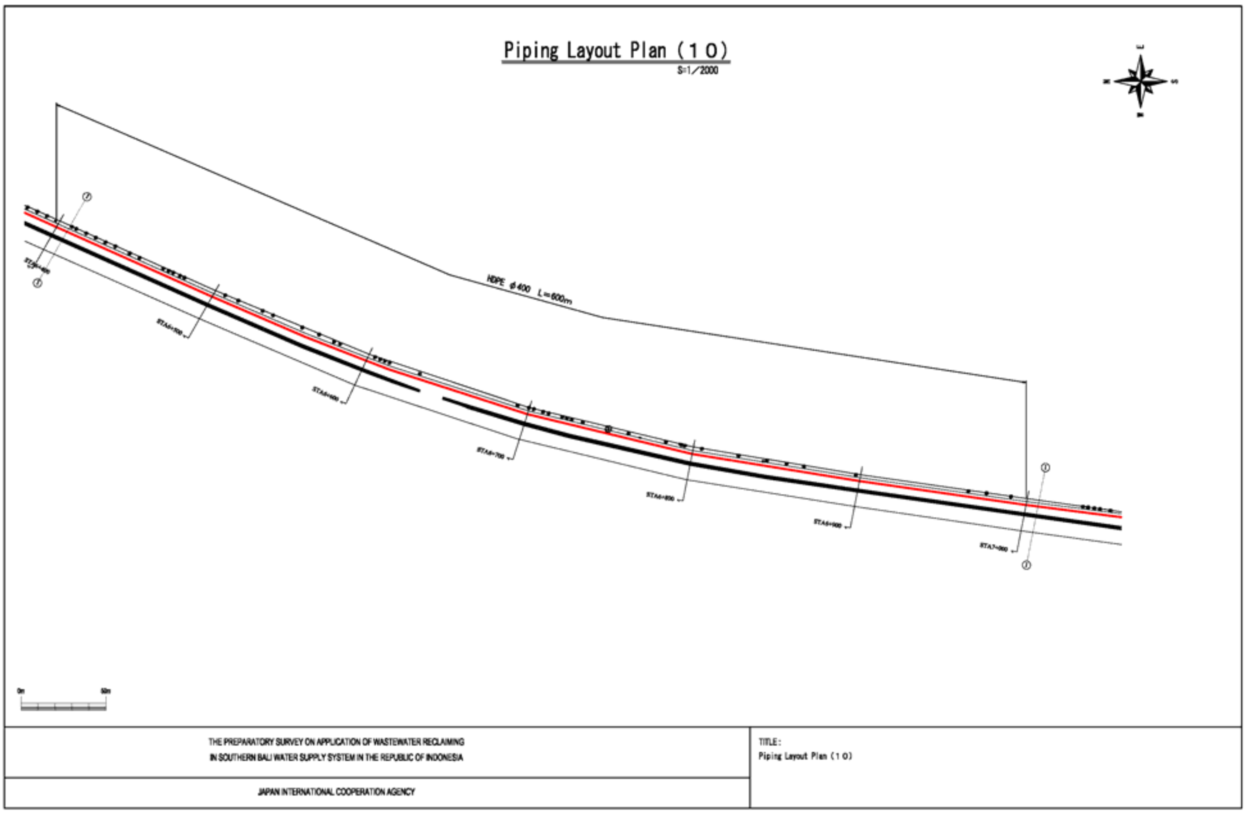
TITLE:
Piping Layout Plan (8)

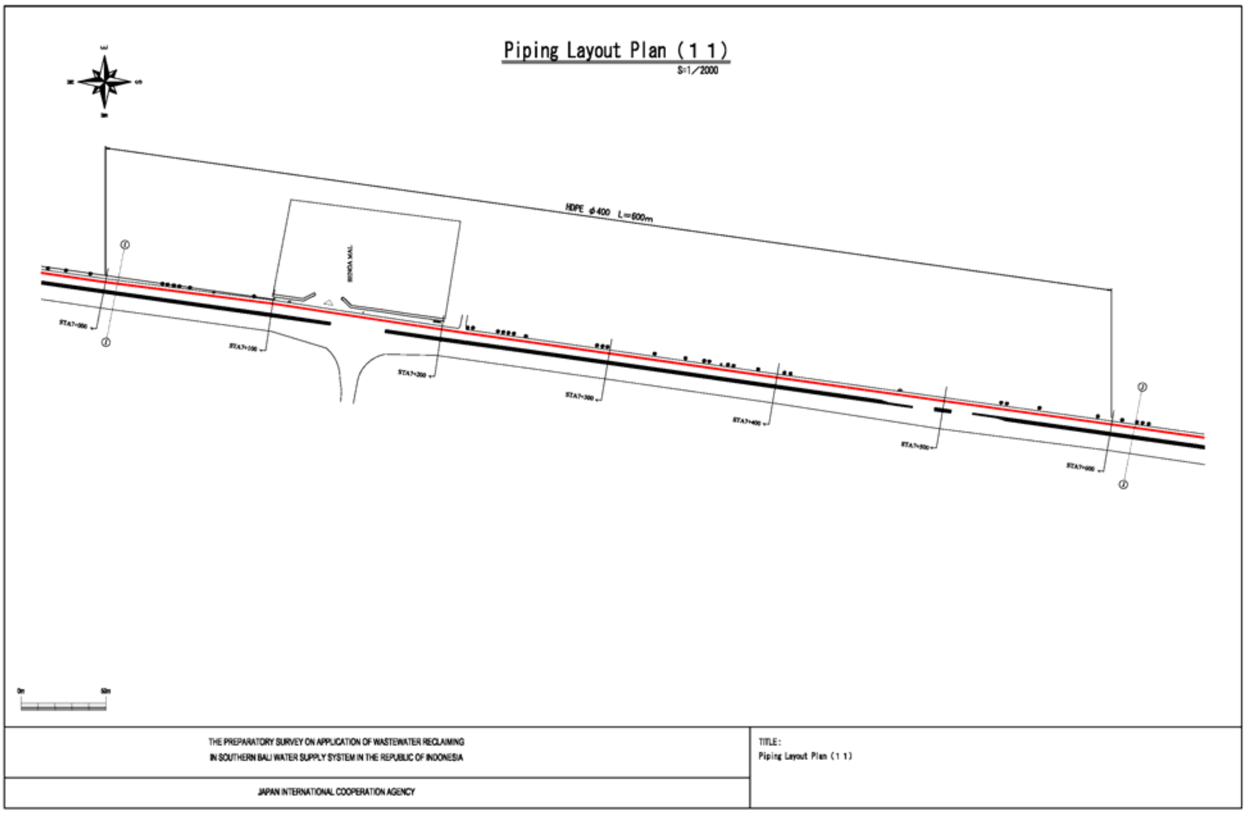


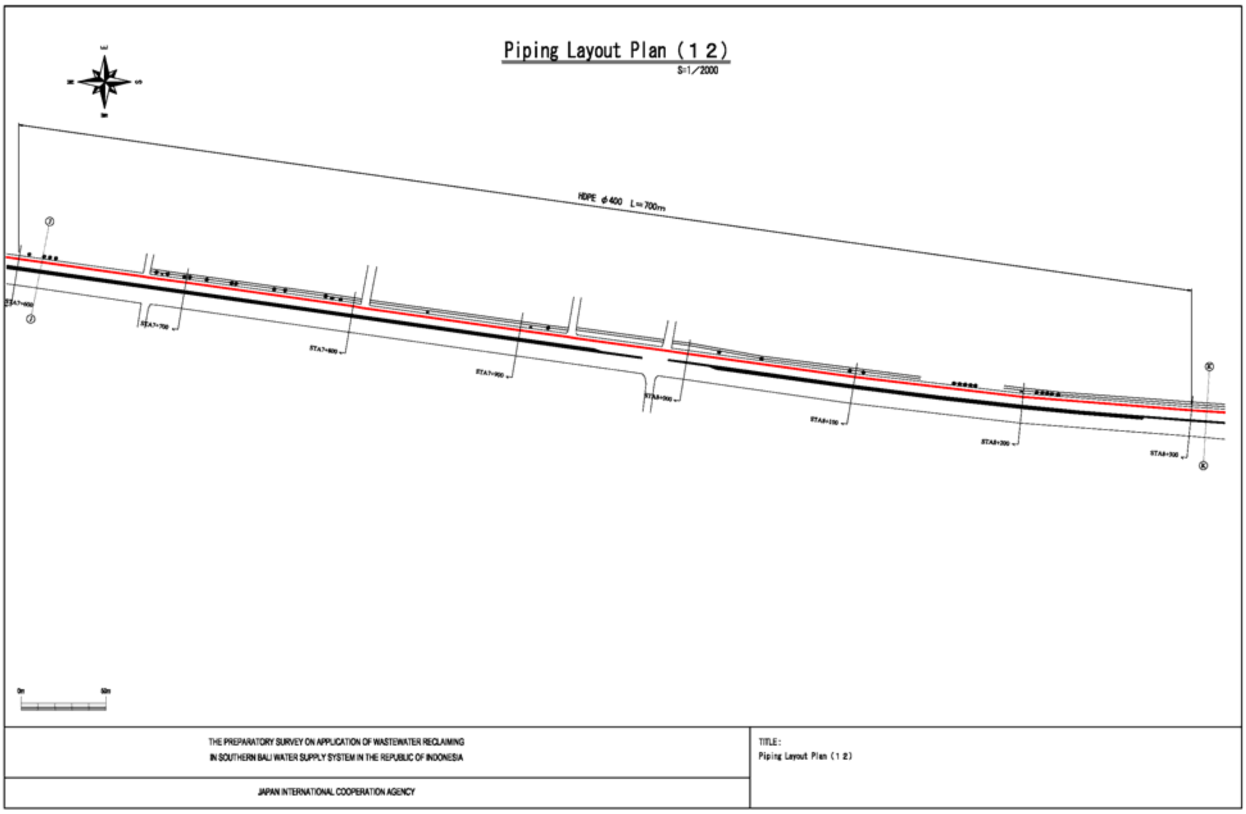
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

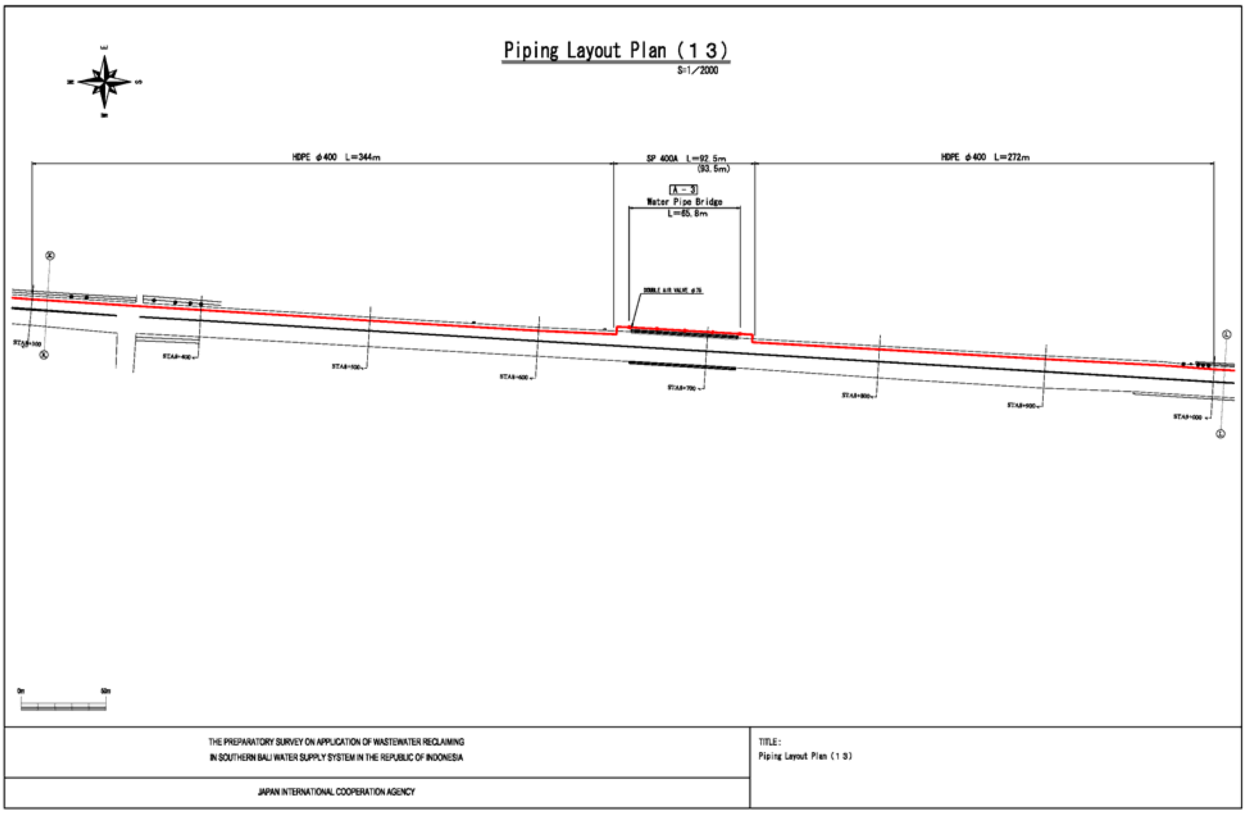
JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Piping Layout Plan (9)


Piping Layout Plan (10)
S=1/2000
HDPE φ400 L=600m
STA6+400
STA6+500
STA6+600
STA6+700
STA6+800
STA6+900
STA7+000
0m
50m
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA
JAPAN INTERNATIONAL COOPERATION AGENCY
TITLE:
Piping Layout Plan (10)

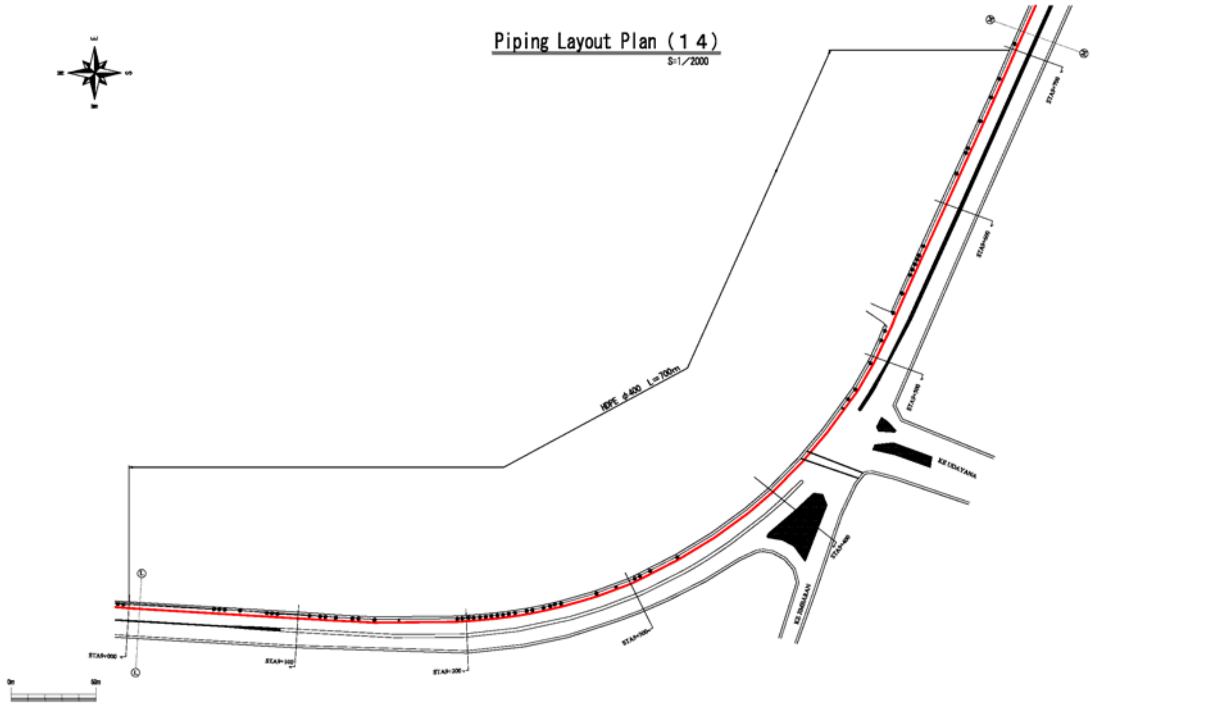

Piping Layout Plan (11)
S=1/2000
HDPE φ400 L=600m
BENOA MAL
STA7+000
STA7+100
STA7+200
STA7+300
STA7+400
STA7+500
STA7+600
0m
50m
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA
JAPAN INTERNATIONAL COOPERATION AGENCY
TITLE:
Piping Layout Plan (11)


Piping Layout Plan (1 2)
S=1／2000
HDPE φ400 L=700m
Ⓙ
Ⓚ
STA7+600
STA7+700
STA7+800
STA7+900
STA8+000
STA8+100
STA8+200
STA8+300
0m
50m
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA
JAPAN INTERNATIONAL COOPERATION AGENCY
TITLE:
Piping Layout Plan (1 2)


Piping Layout Plan (1 3)
S=1／2000
HDPE φ400 L=344m
SP 400A L=92.5m
(93.5m)
A－3
Water Pipe Bridge
L=65.8m
HDPE φ400 L=272m
DOUBLE AIR VALVE φ75
Ⓚ
Ⓛ
STA8+300
STA8+400
STA8+500
STA8+600
STA8+700
STA8+800
STA8+900
STA9+000
0m
50m
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA
JAPAN INTERNATIONAL COOPERATION AGENCY
TITLE:
Piping Layout Plan (1 3)

Piping Layout Plan (14)

S=1/2000



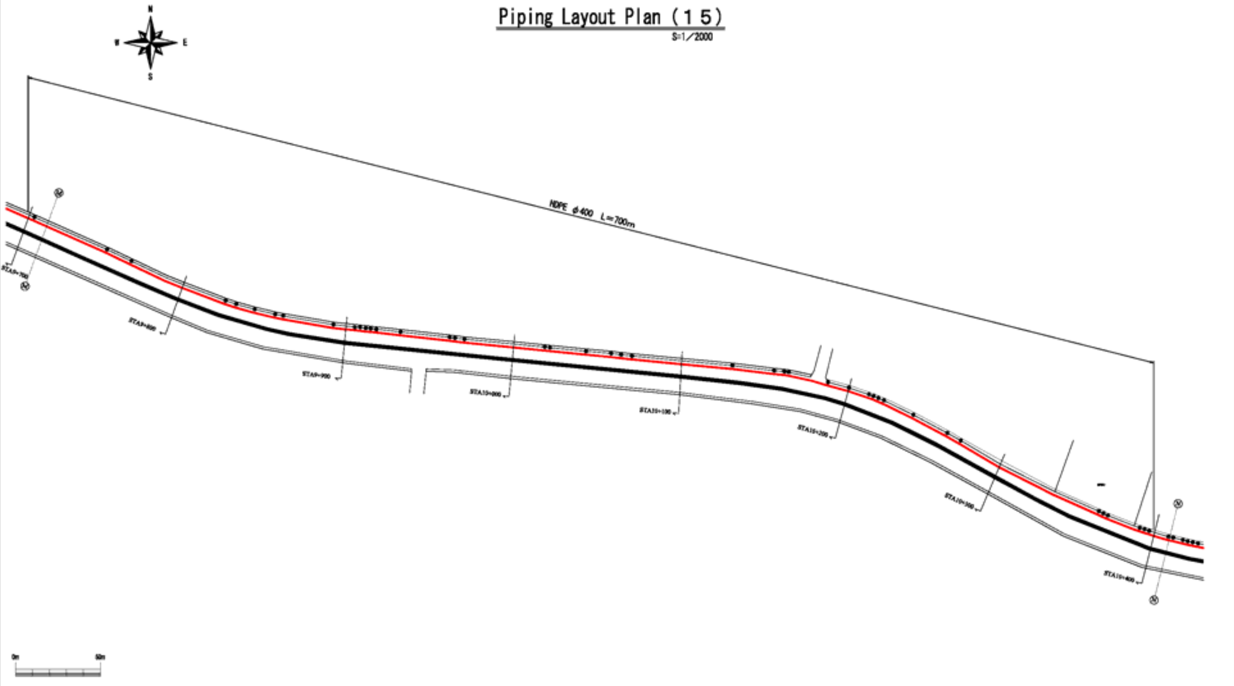
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Piping Layout Plan (1 4)

Piping Layout Plan (15)

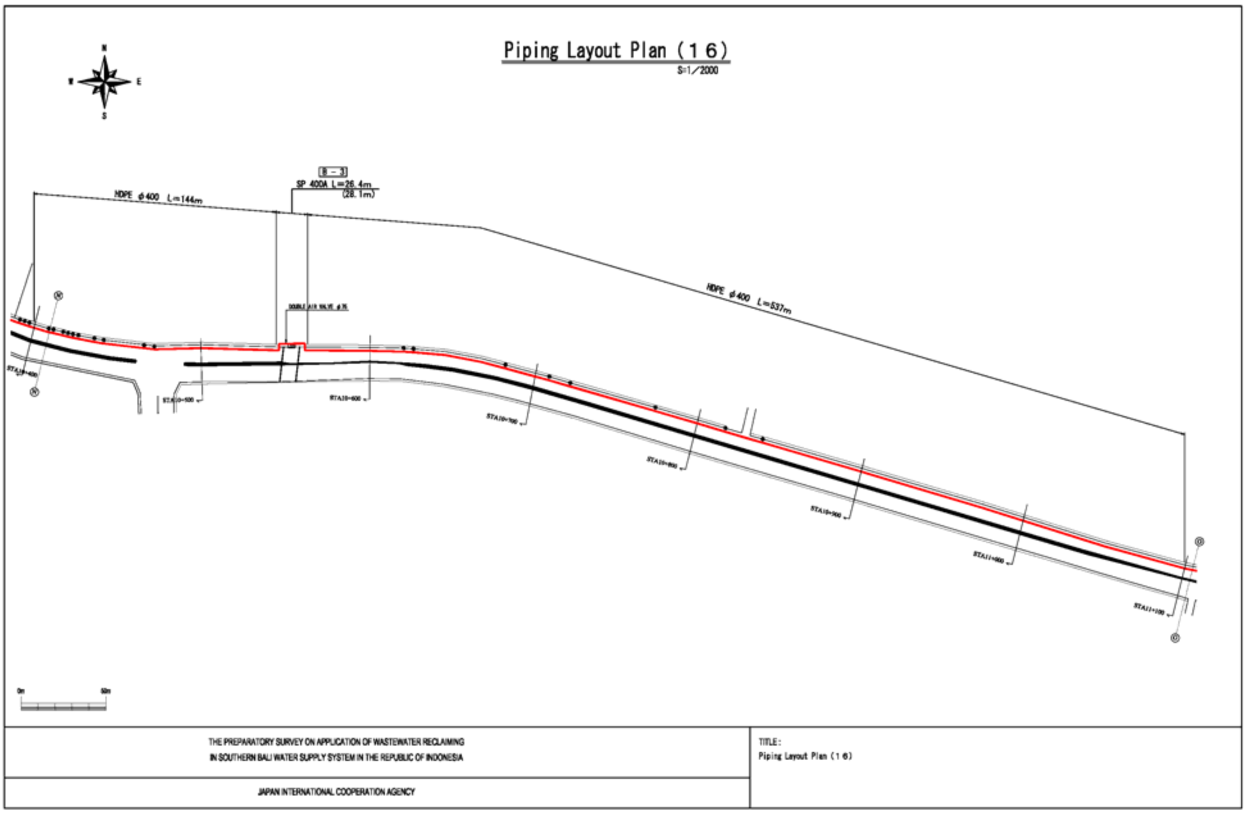
S=1/2000

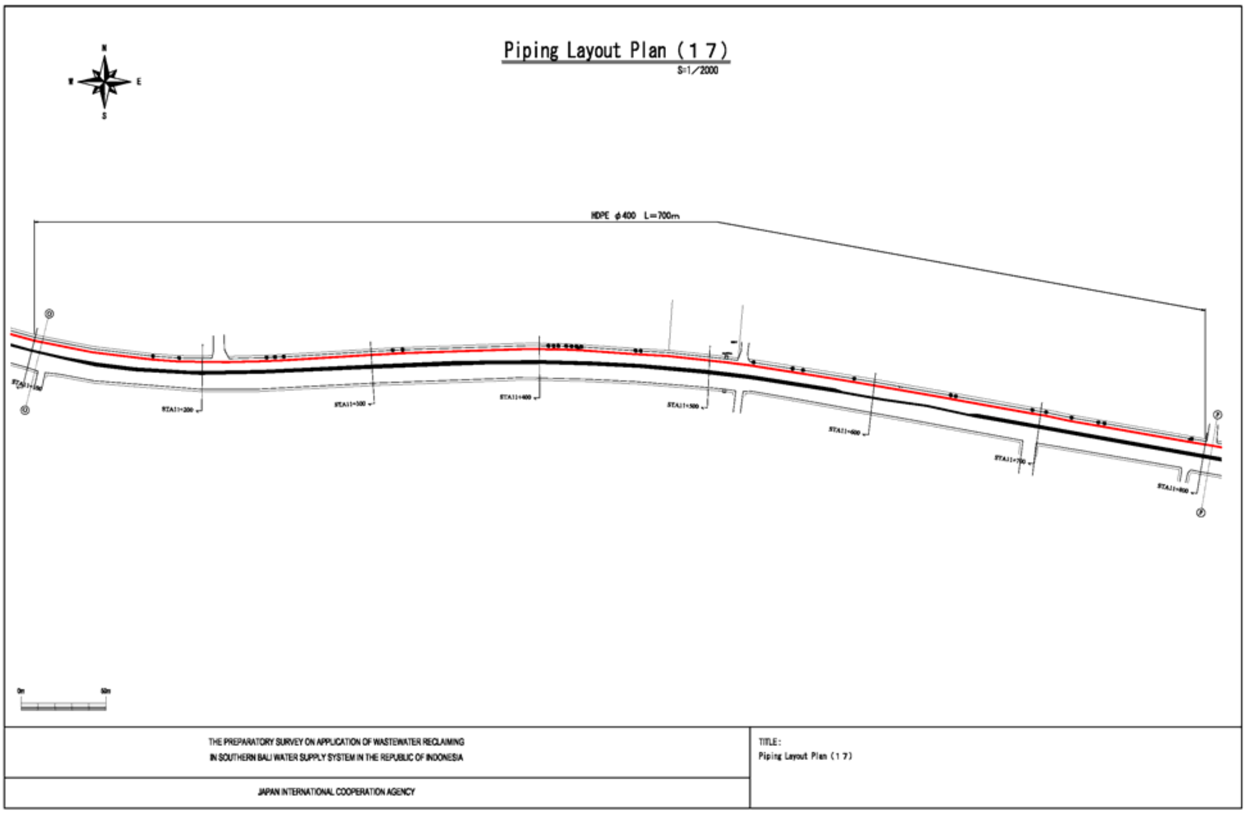


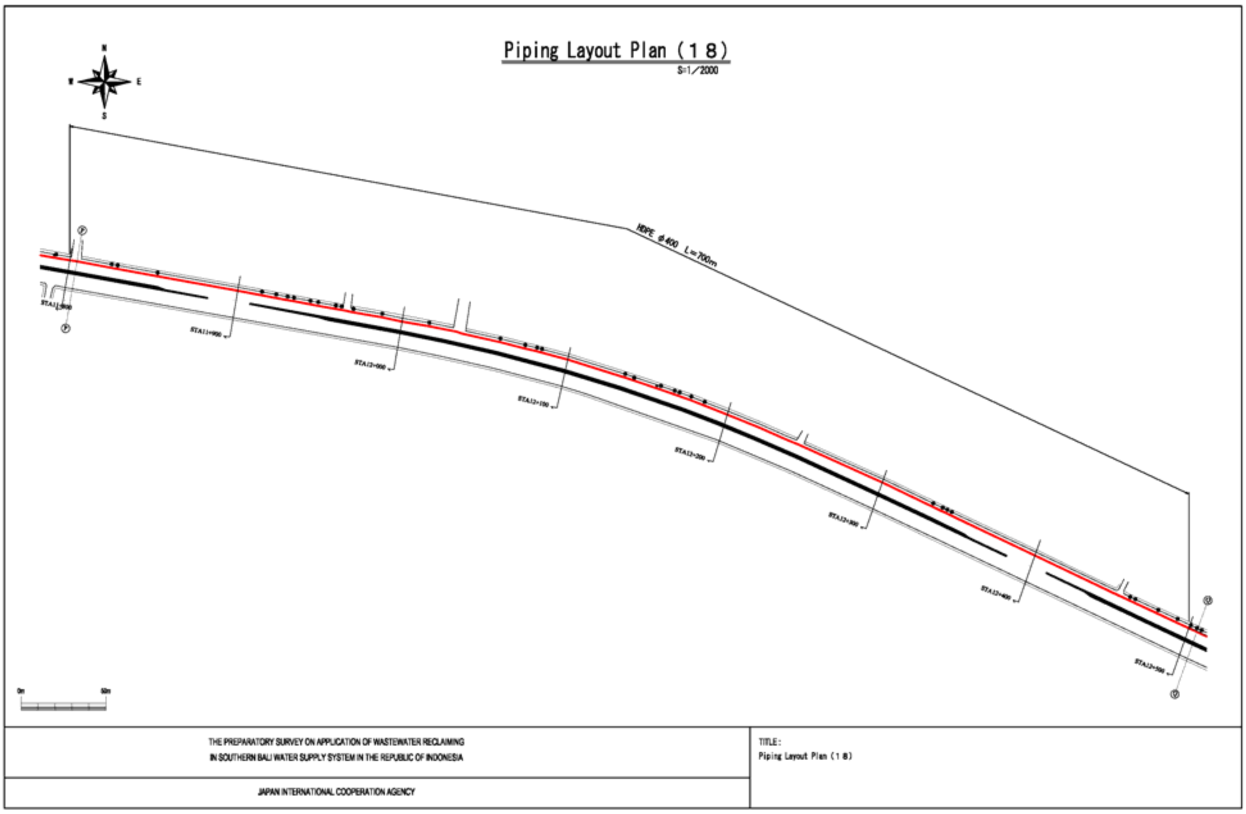
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

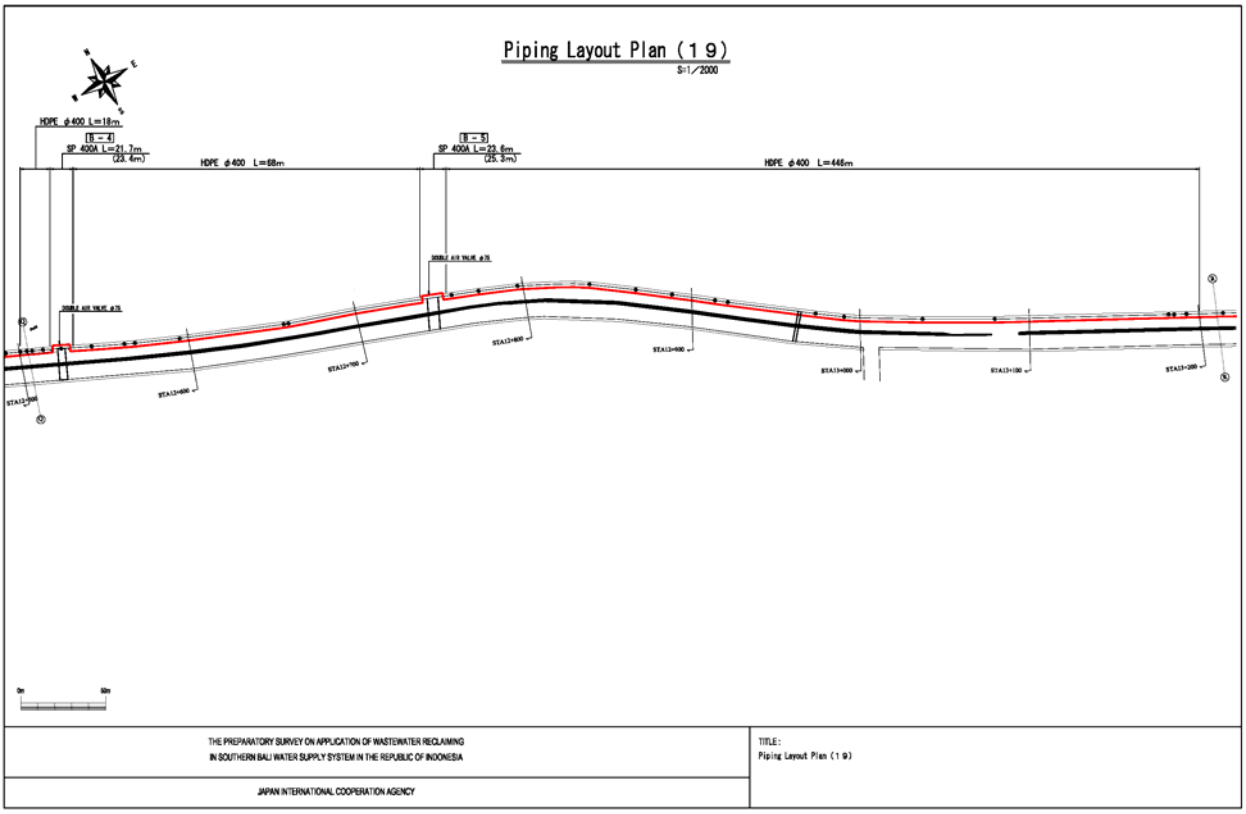
JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Piping Layout Plan (1 5)

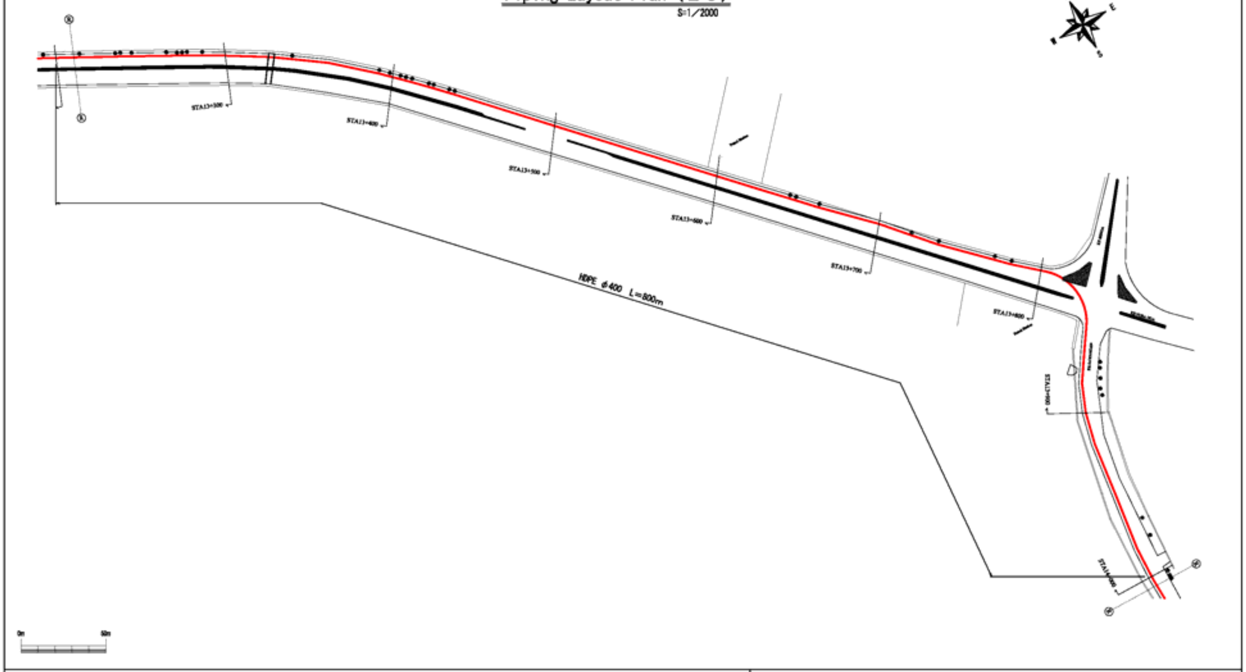

Piping Layout Plan (16)
S=1/2000
N
W
E
S
HDPE φ400 L=144m
B - 3
SP 400A L=26.4m
(28.1m)
DOUBLE AIR VALVE φ75
HDPE φ400 L=537m
N
STA10+400
STA10+500
STA10+600
STA10+700
STA10+800
STA10+900
STA11+000
STA11+100
O
0m
50m
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA
JAPAN INTERNATIONAL COOPERATION AGENCY
TITLE:
Piping Layout Plan (16)


Piping Layout Plan (17)
S=1/2000
N
W
E
S
HDPE φ400 L=700m
O
STA11+100
STA11+200
STA11+300
STA11+400
STA11+500
STA11+600
STA11+700
STA11+800
P
0m
50m
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA
JAPAN INTERNATIONAL COOPERATION AGENCY
TITLE:
Piping Layout Plan (17)


Piping Layout Plan (1 8)
S=1/2000
N
W
E
S
HDPE φ400 L=700m
STA11+900
STA12+000
STA12+100
STA12+200
STA12+300
STA12+400
STA12+500
0m
50m
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA
JAPAN INTERNATIONAL COOPERATION AGENCY
TITLE:
Piping Layout Plan (1 8)


Piping Layout Plan (1 9)
S=1/2000
N
E
W
S
HDPE φ400 L=18m
B - 4
SP 400A L=21.7m
(23.4m)
HDPE φ400 L=68m
B - 5
SP 400A L=23.6m
(25.3m)
HDPE φ400 L=446m
DOUBLE AIR VALVE φ75
DOUBLE AIR VALVE φ75
STA12+500
STA12+600
STA12+700
STA12+800
STA12+900
STA13+000
STA13+100
STA13+200
0m
50m
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA
JAPAN INTERNATIONAL COOPERATION AGENCY
TITLE:
Piping Layout Plan (1 9)

Piping Layout Plan (2 0)

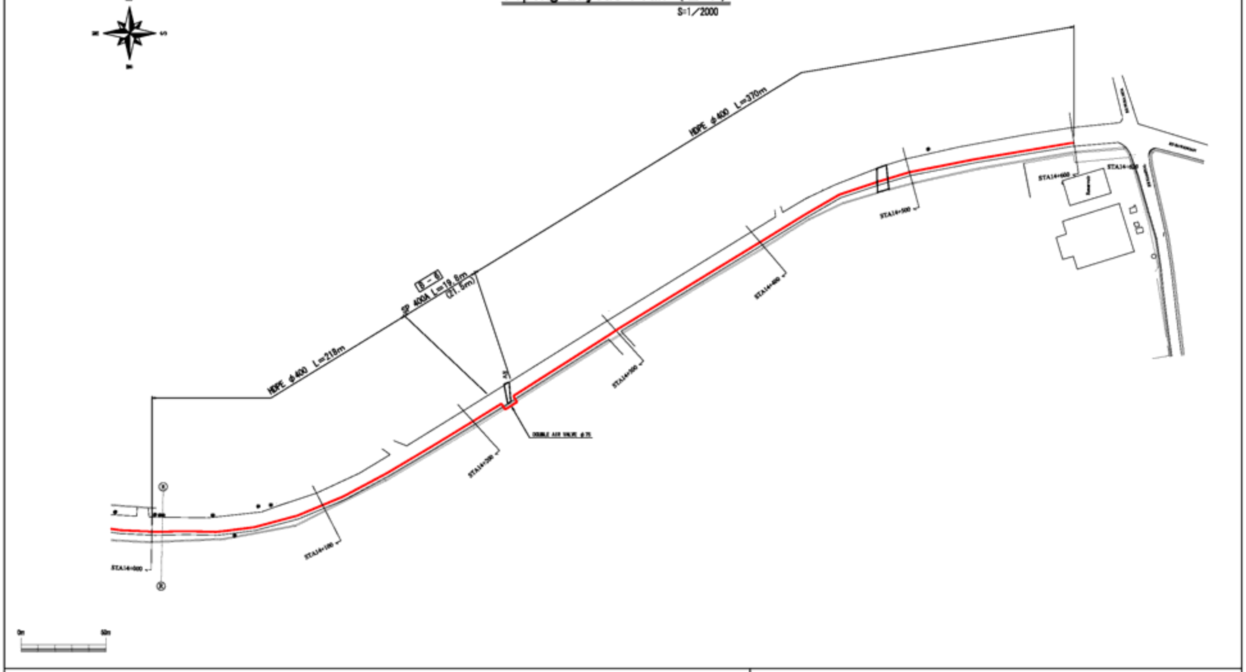


THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Piping Layout Plan (2 0)

Piping Layout Plan (2 1)



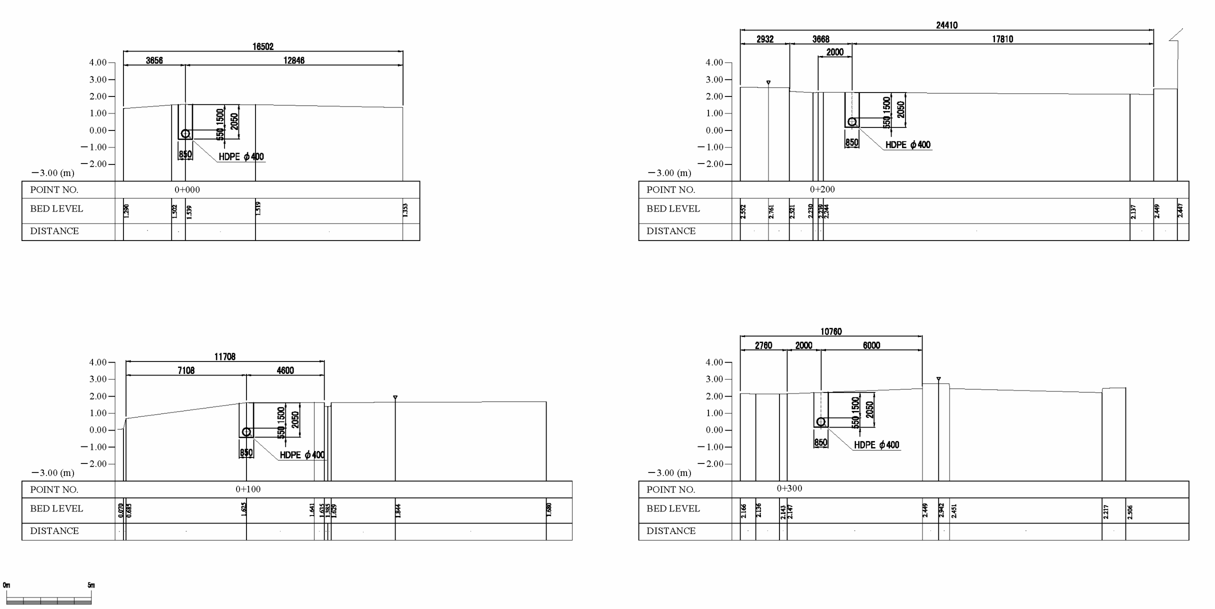
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Piping Layout Plan (2 1)

Cross-sectional View of Piping (1)

S=1/100



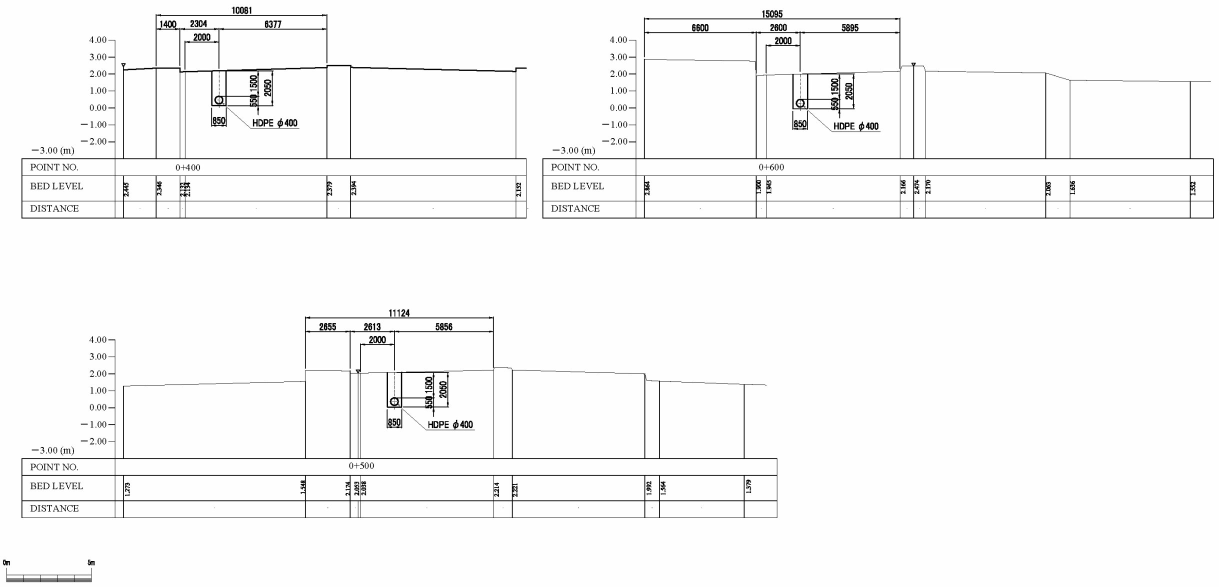
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Cross-sectional View of Piping (1)

Cross-sectional View of Piping (2)

S=1/100



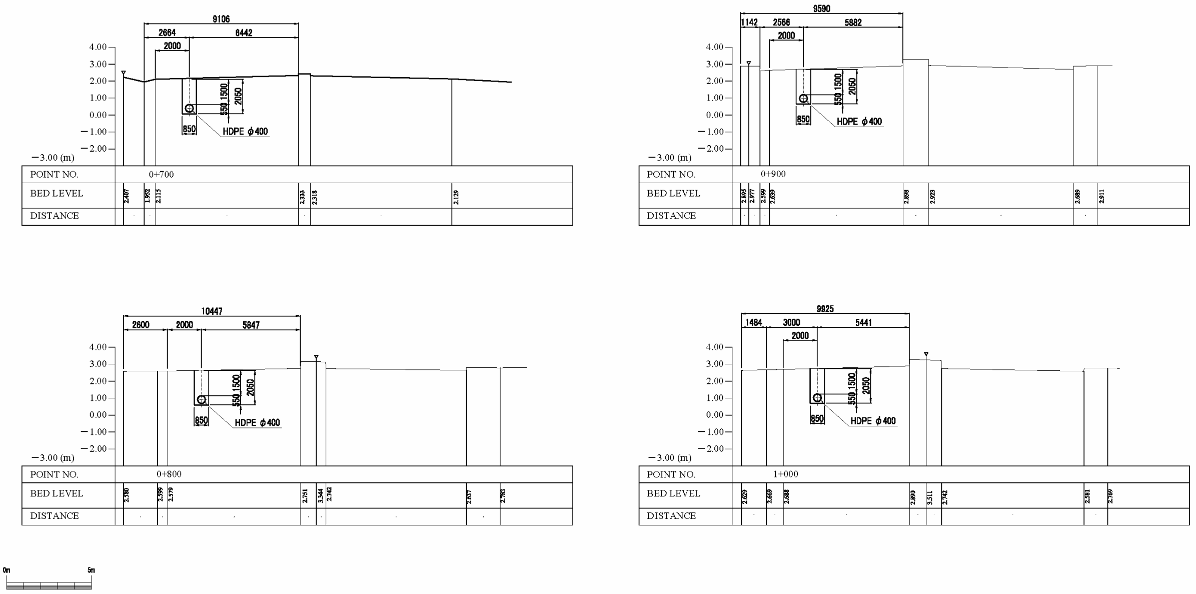
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Cross-sectional View of Piping (2)

Cross-sectional View of Piping (3)

S=1/100



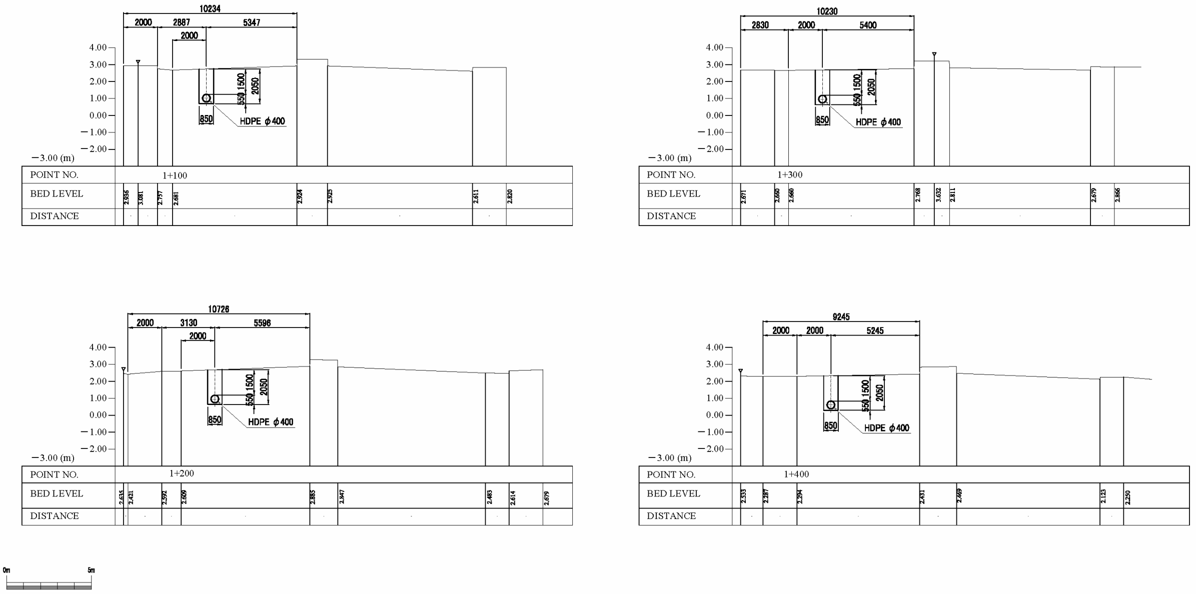
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

TITLE:
Cross-sectional View of Piping (3)

JAPAN INTERNATIONAL COOPERATION AGENCY

Cross-sectional View of Piping (4)

S=1/100

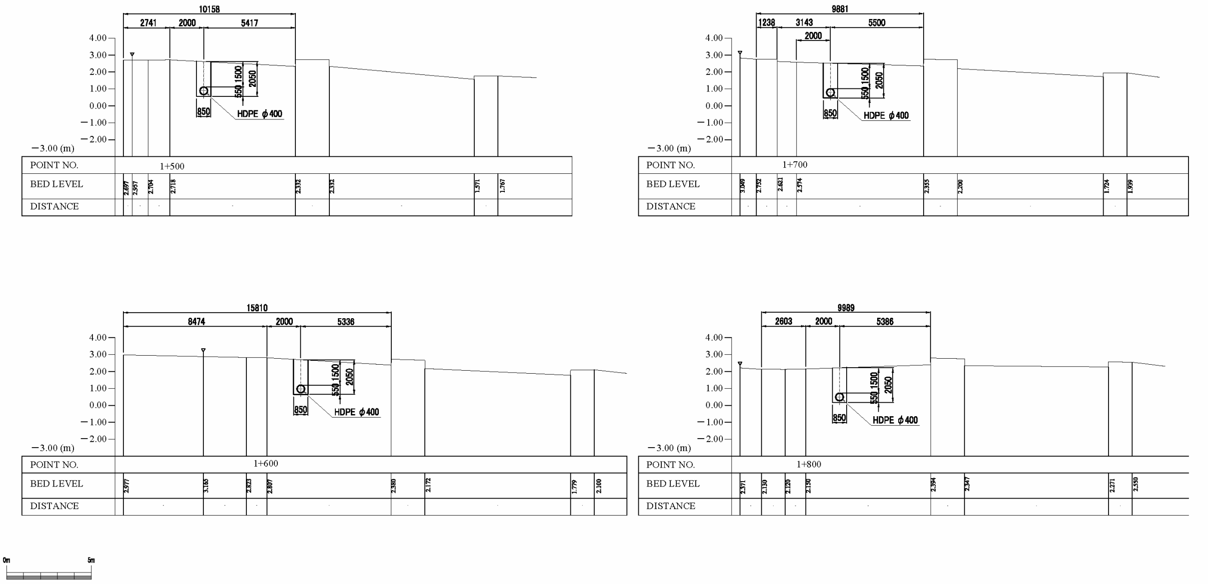


THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

TITLE:
Cross-sectional View of Piping (4)

JAPAN INTERNATIONAL COOPERATION AGENCY

Cross-sectional View of Piping (5)



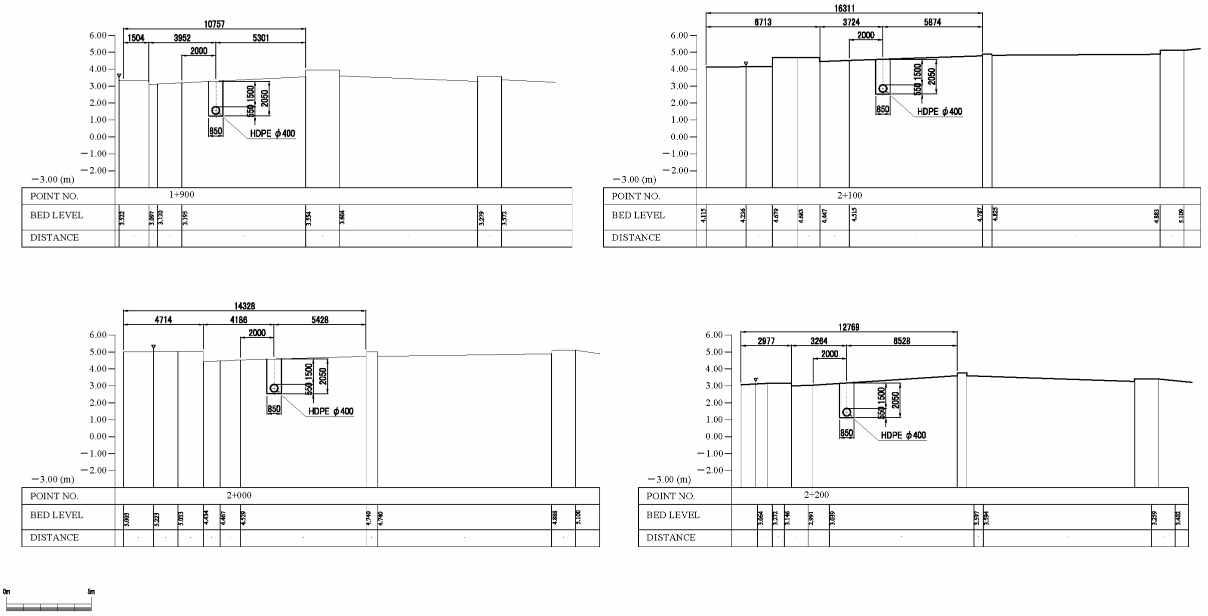
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Cross-sectional View of Piping (5)

Cross-sectional View of Piping (6)

S=1/100



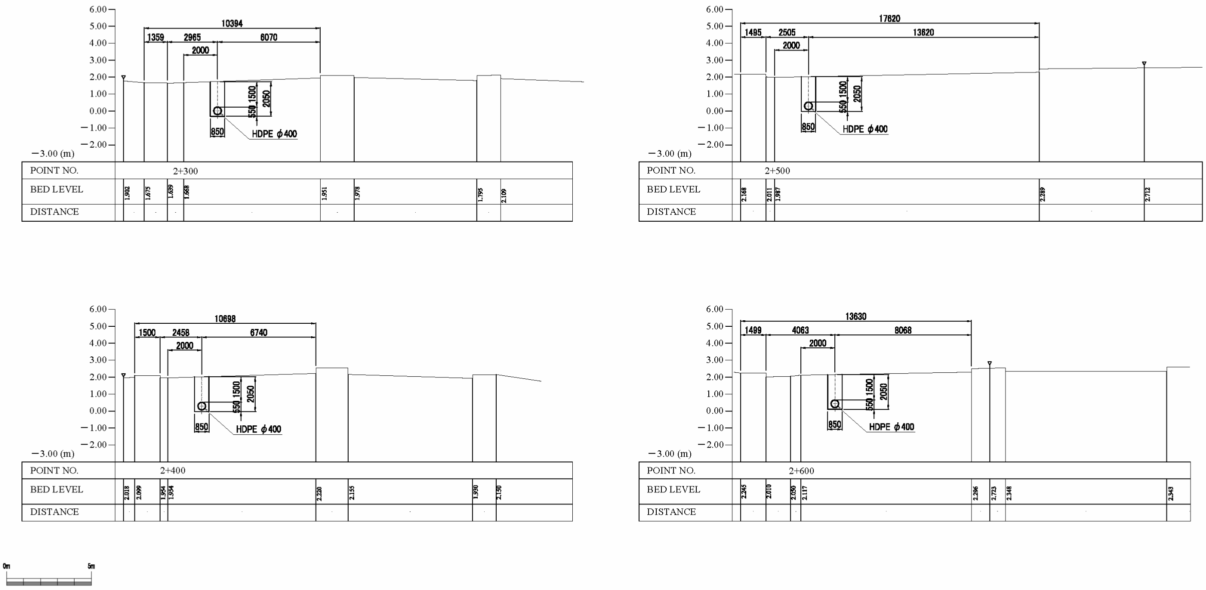
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Cross-sectional View of Piping (6)

Cross-sectional View of Piping (7)

S=1/100



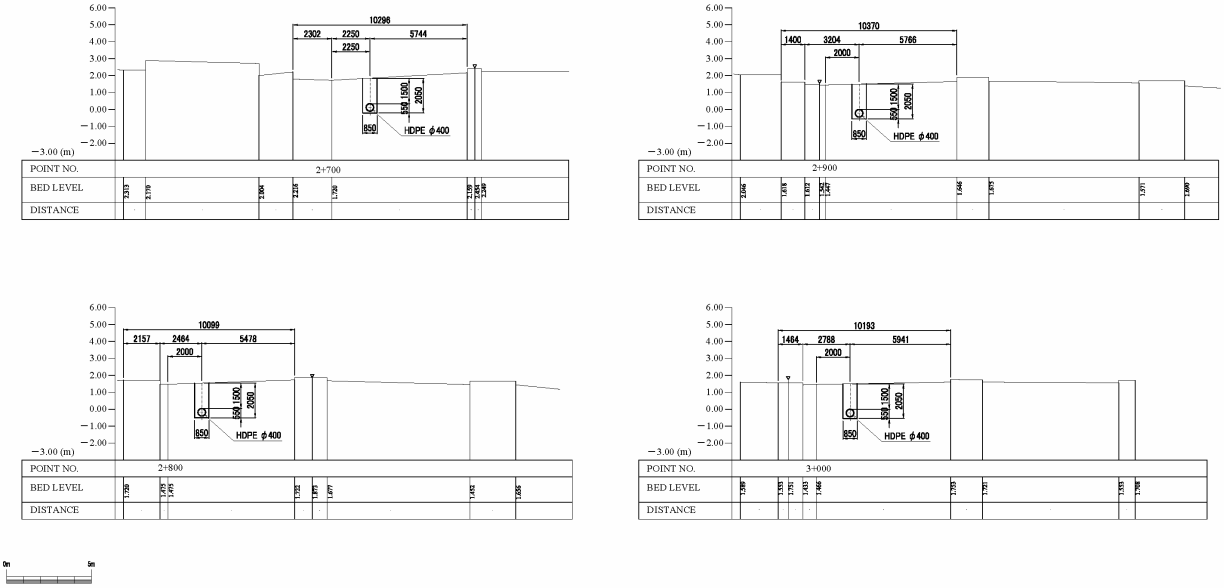
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Cross-sectional View of Piping (7)

Cross-sectional View of Piping (8)

S=1/100



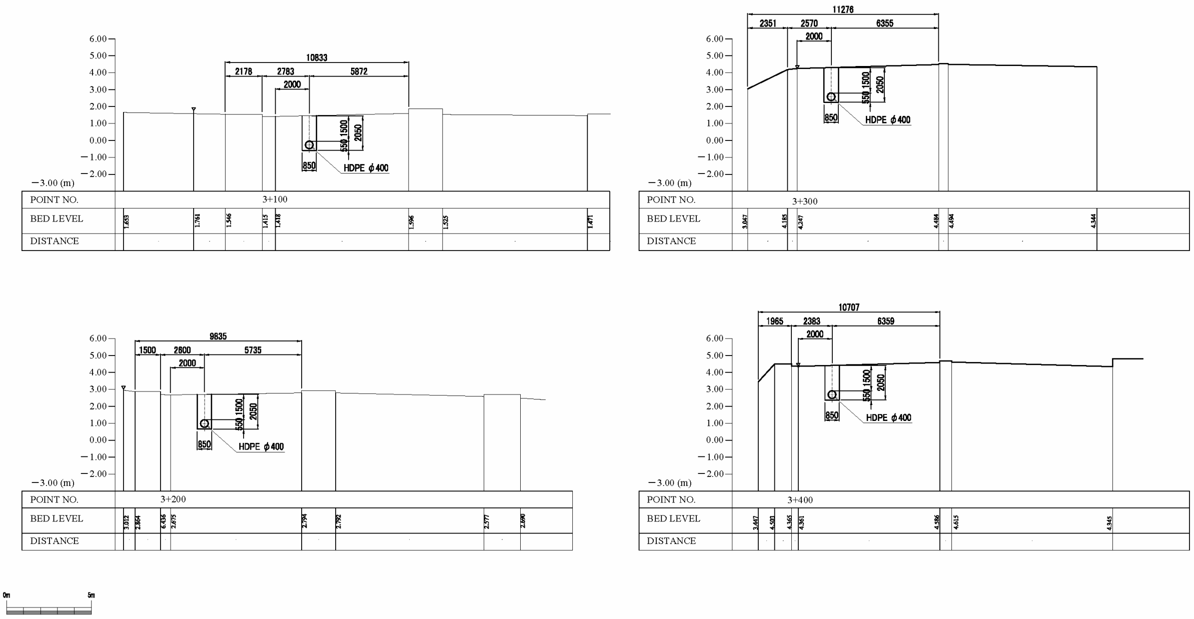
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Cross-sectional View of Piping (8)

Cross-sectional View of Piping (9)

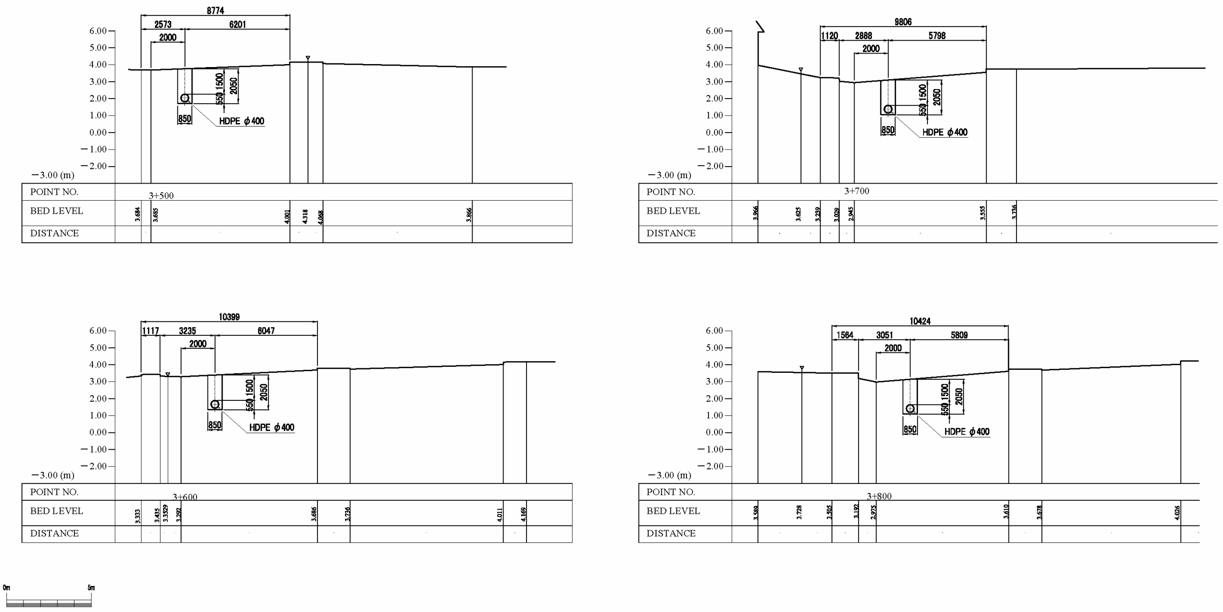
S=1/100



THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA	TITLE: Cross-sectional View of Piping (9)
JAPAN INTERNATIONAL COOPERATION AGENCY	

Cross-sectional View of Piping (10)

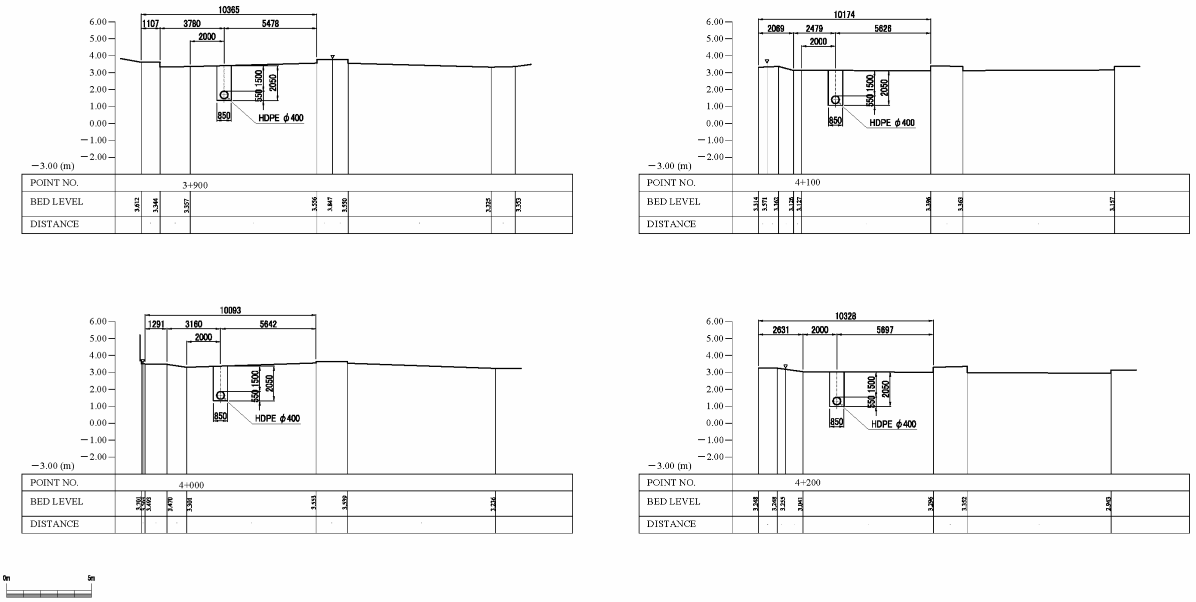
S=1/100



THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA	TITLE: Cross-sectional View of Piping (10)
JAPAN INTERNATIONAL COOPERATION AGENCY	

Cross-sectional View of Piping（１１）

S=1／100



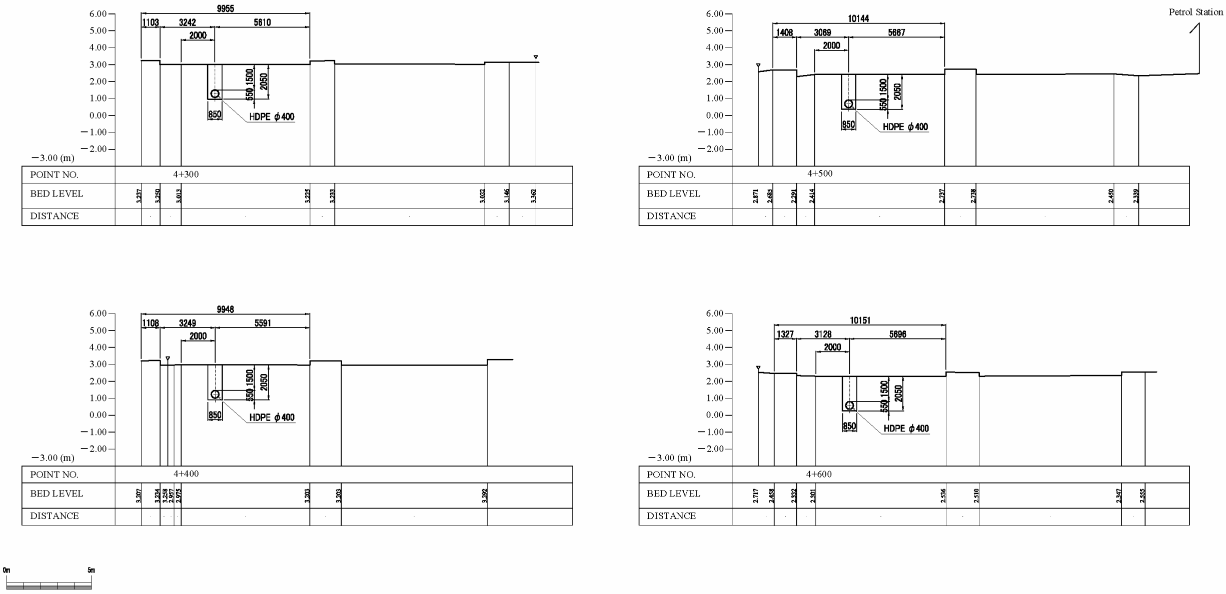
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Cross-sectional View of Piping（１１）

Cross-sectional View of Piping（１２）

S=1／100



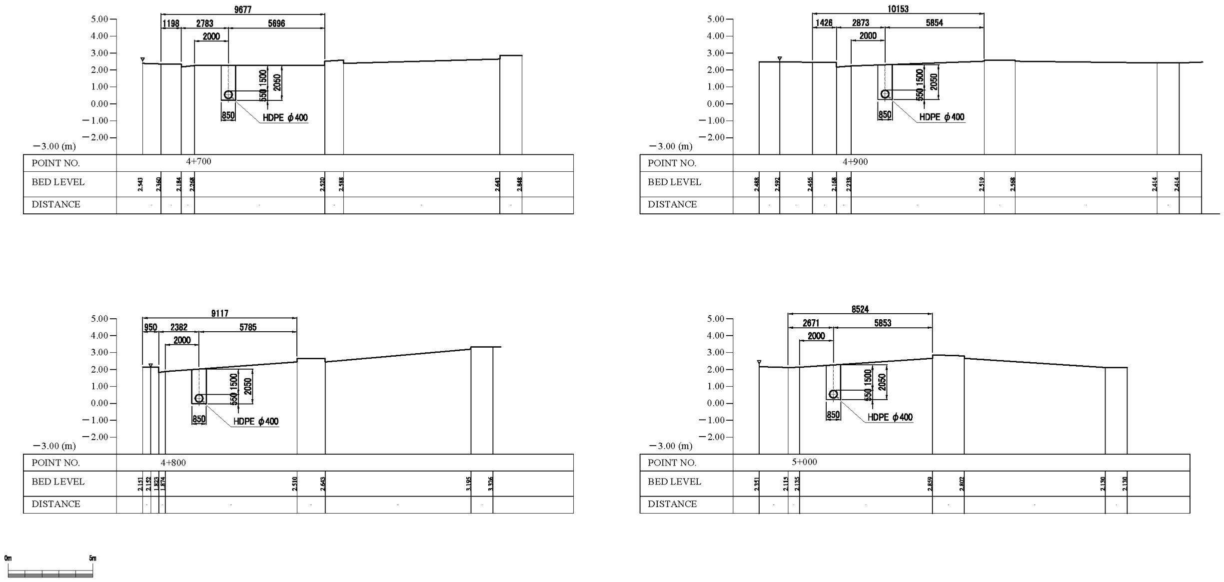
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Cross-sectional View of Piping（１２）

Cross-sectional View of Piping (１３)

S=1／100



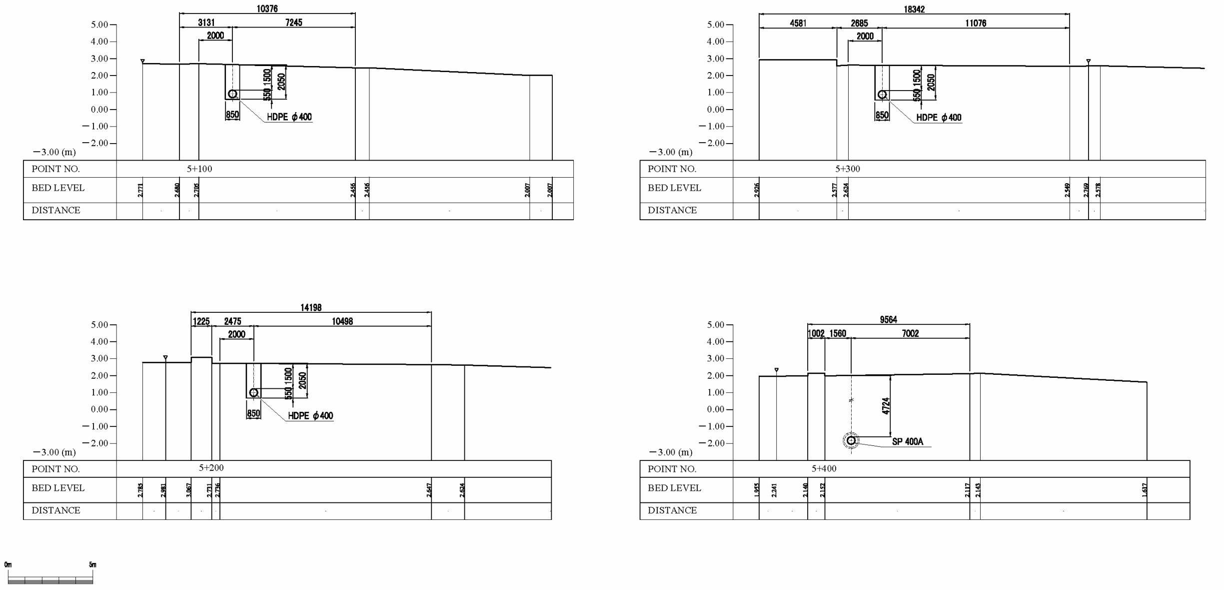
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Cross-sectional View of Piping (１３)

Cross-sectional View of Piping (１４)

S=1／100



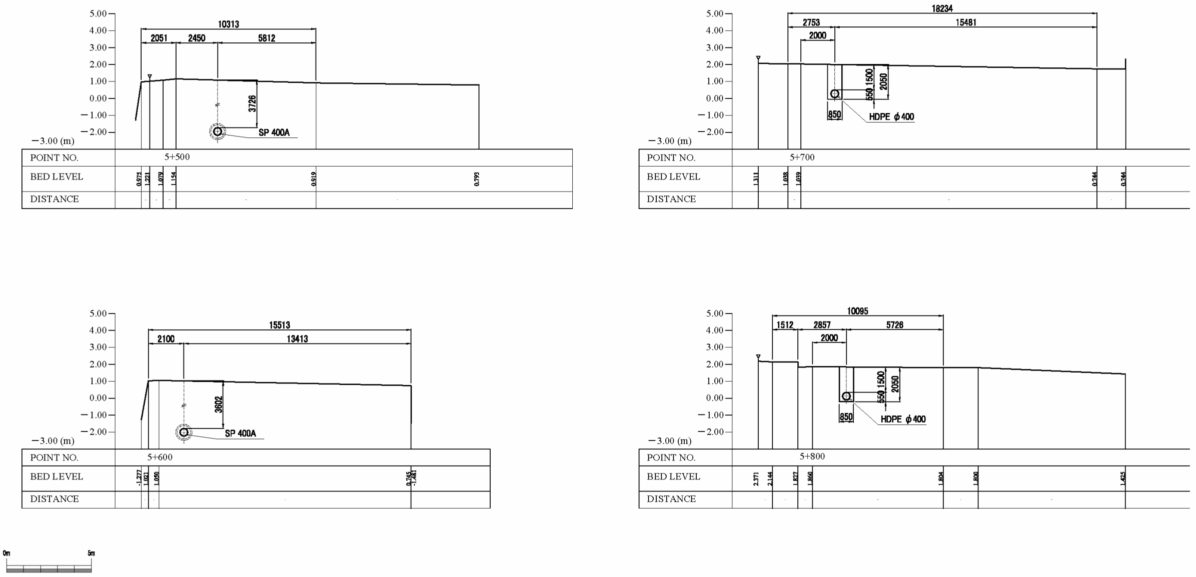
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Cross-sectional View of Piping (１４)

Cross-sectional View of Piping (１５)

S=1／100



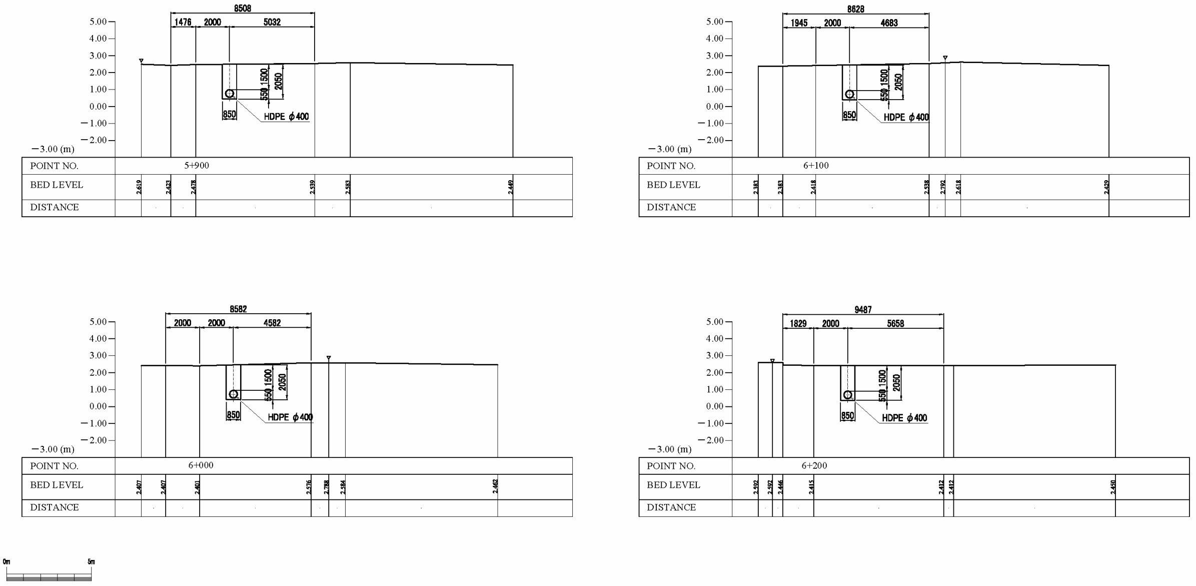
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Cross-sectional View of Piping (１５)

Cross-sectional View of Piping (１６)

S=1／100



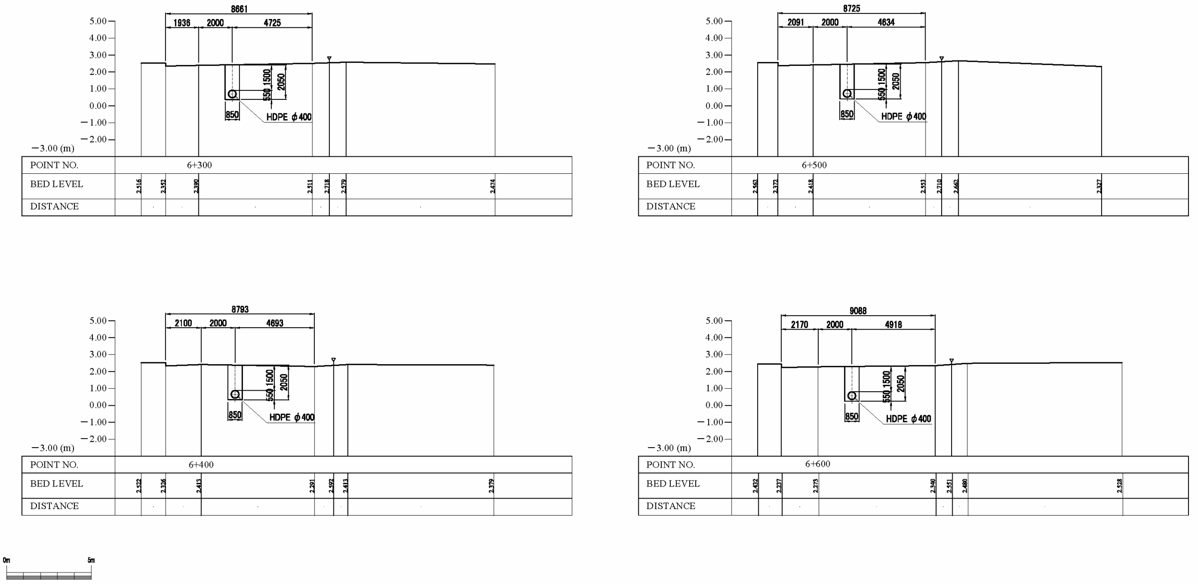
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Cross-sectional View of Piping (１６)

Cross-sectional View of Piping (１７)

S=1／100



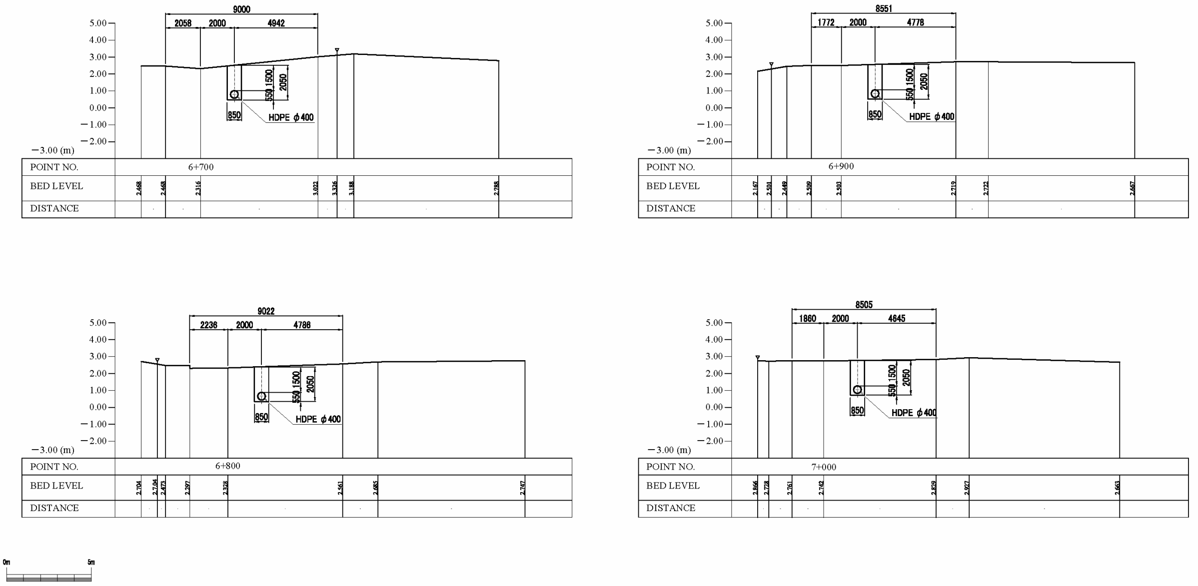
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Cross-sectional View of Piping (１７)

Cross-sectional View of Piping (１８)

S=1／100



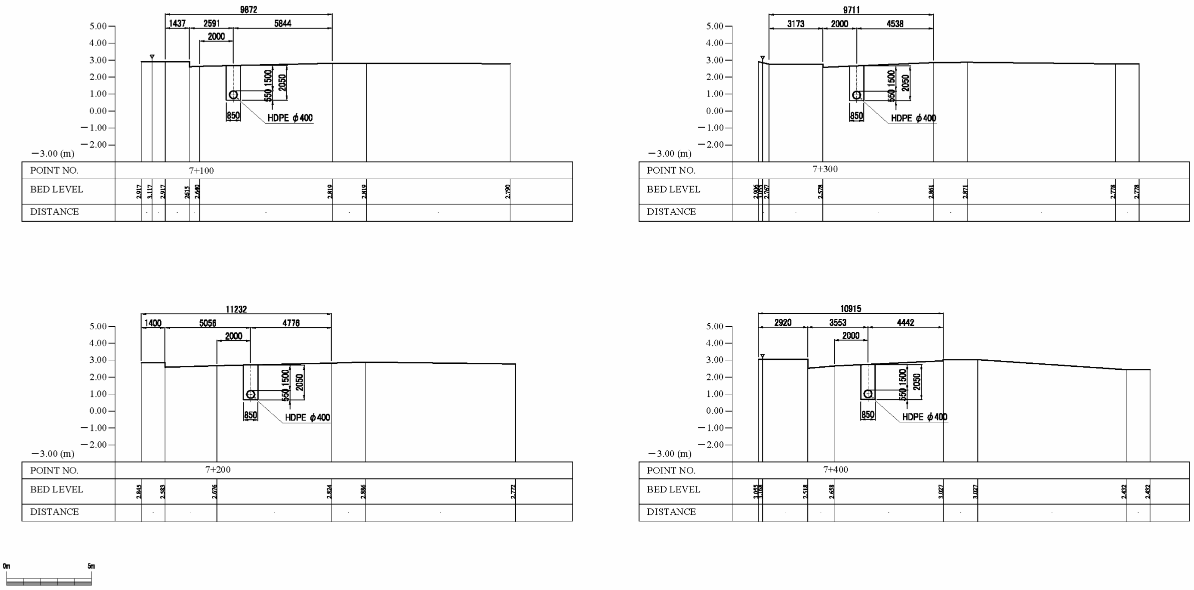
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Cross-sectional View of Piping (１８)

Cross-sectional View of Piping（１９）

S=1／100



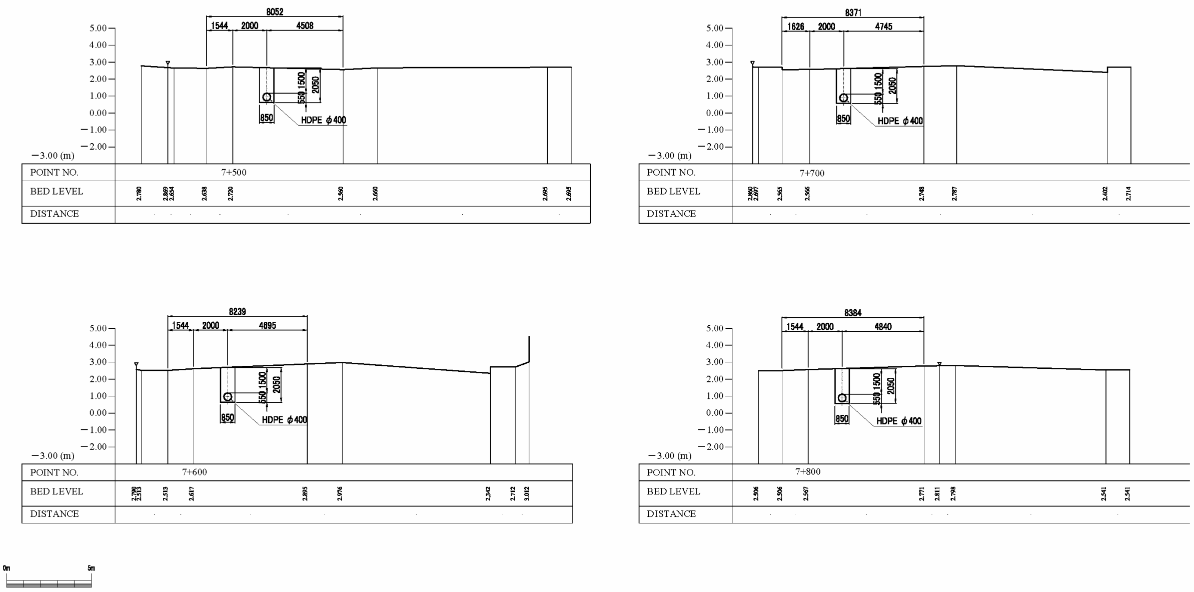
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Cross-sectional View of Piping（１９）

Cross-sectional View of Piping（２０）

S=1／100



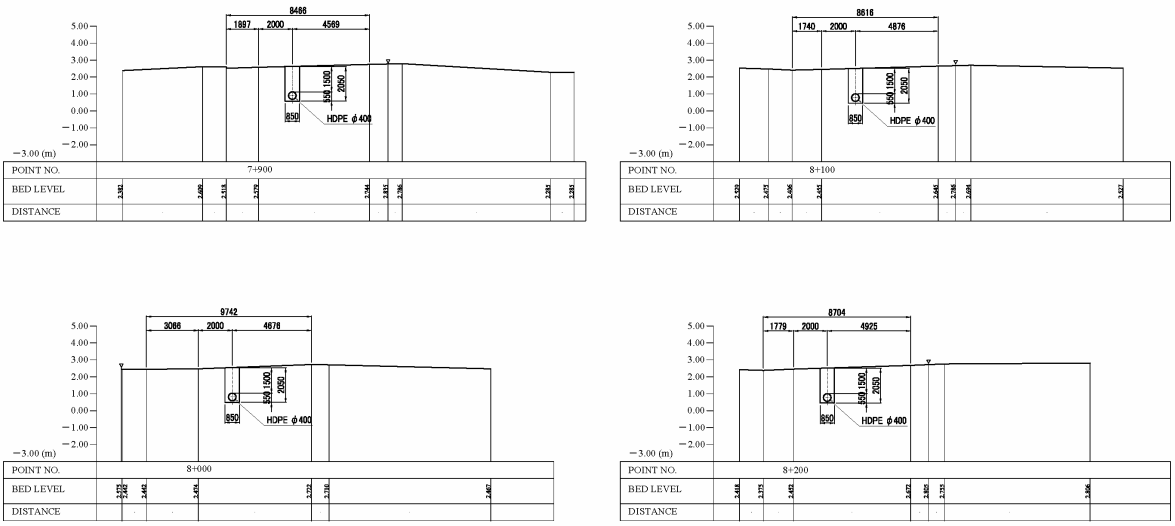
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Cross-sectional View of Piping（２０）

Cross-sectional View of Piping (2 1)

S=1／100



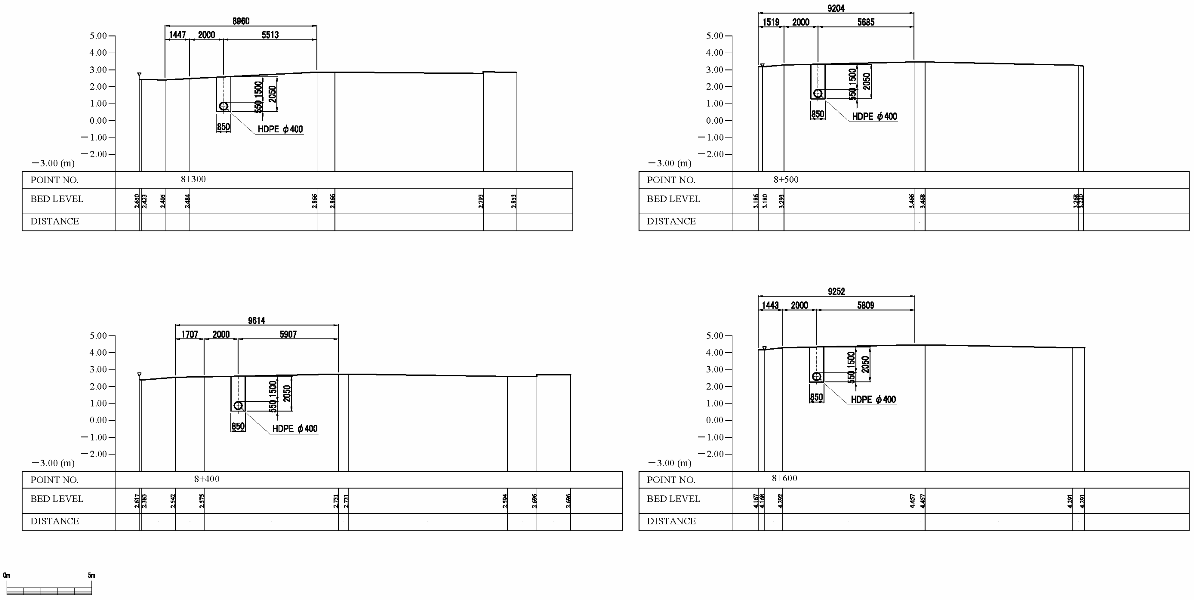
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Cross-sectional View of Piping (2 1)

Cross-sectional View of Piping (2 2)

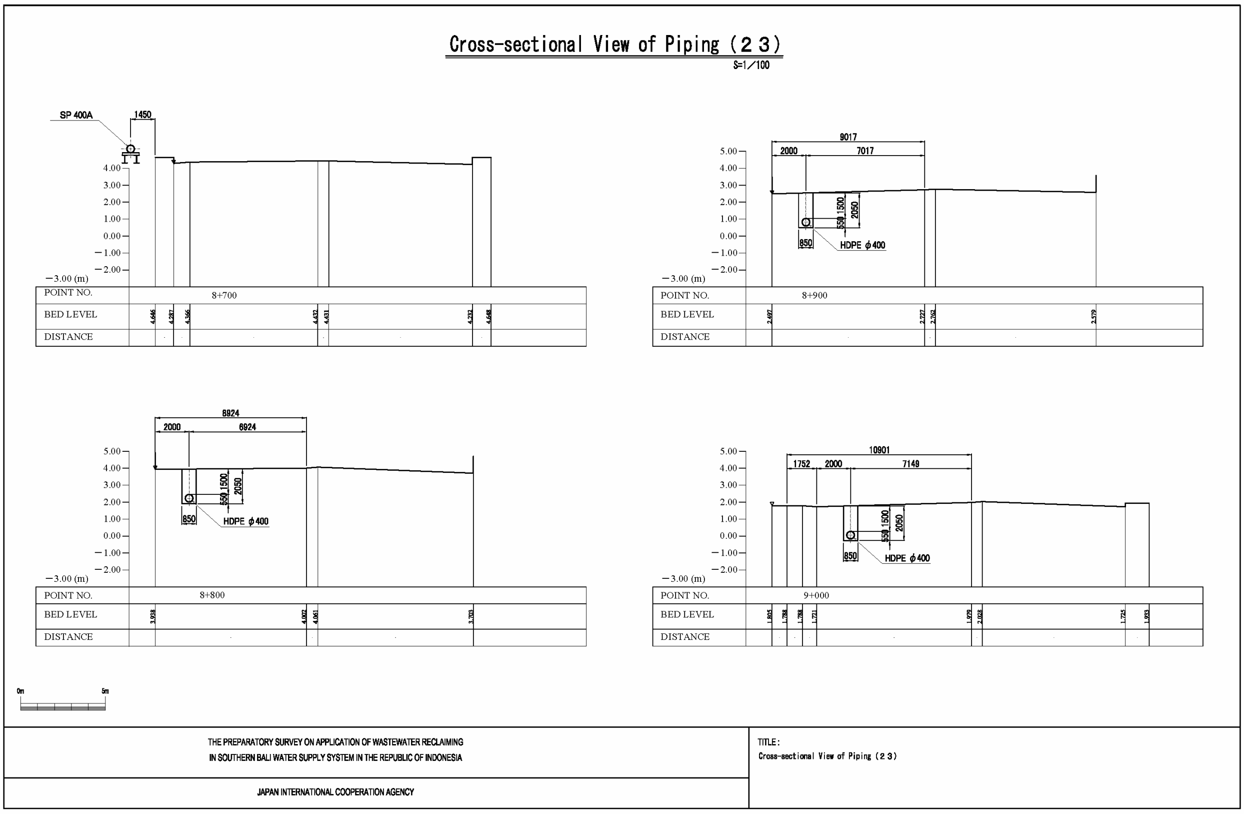
S=1／100

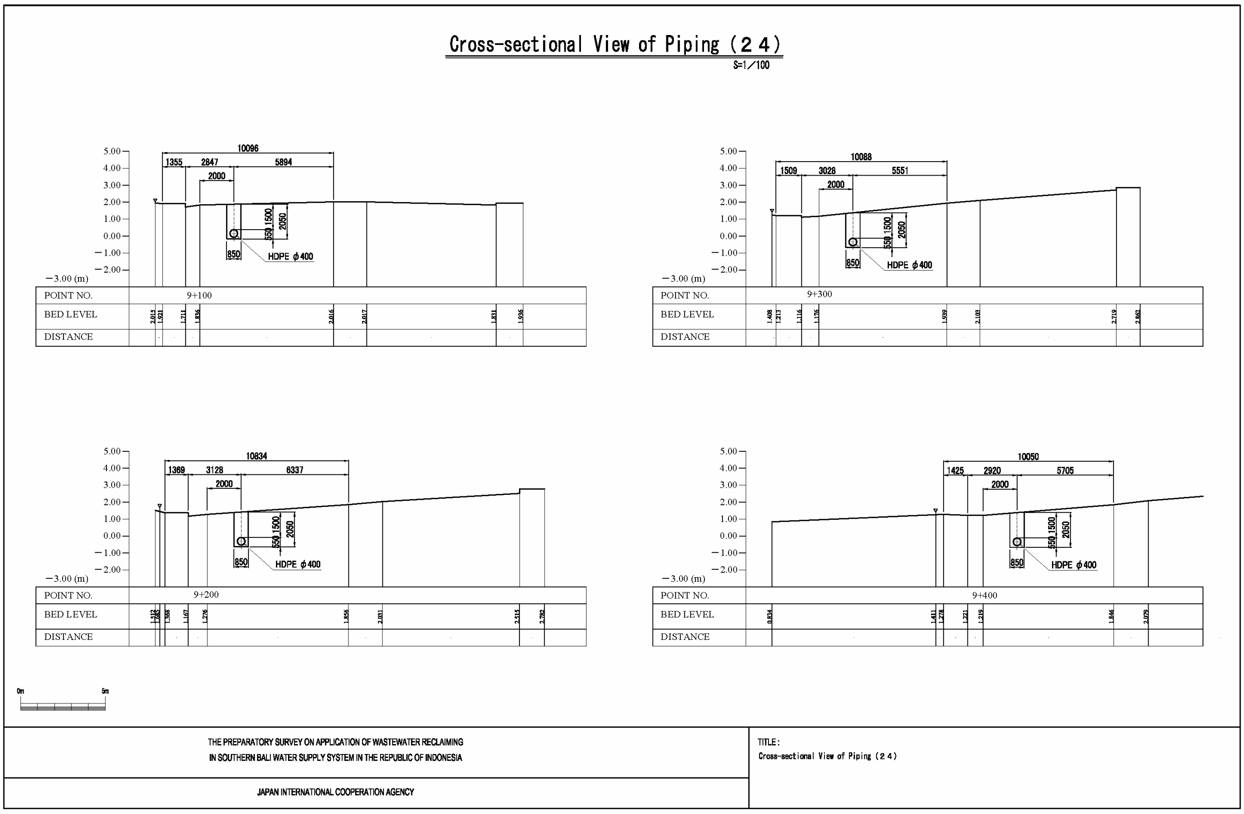


THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

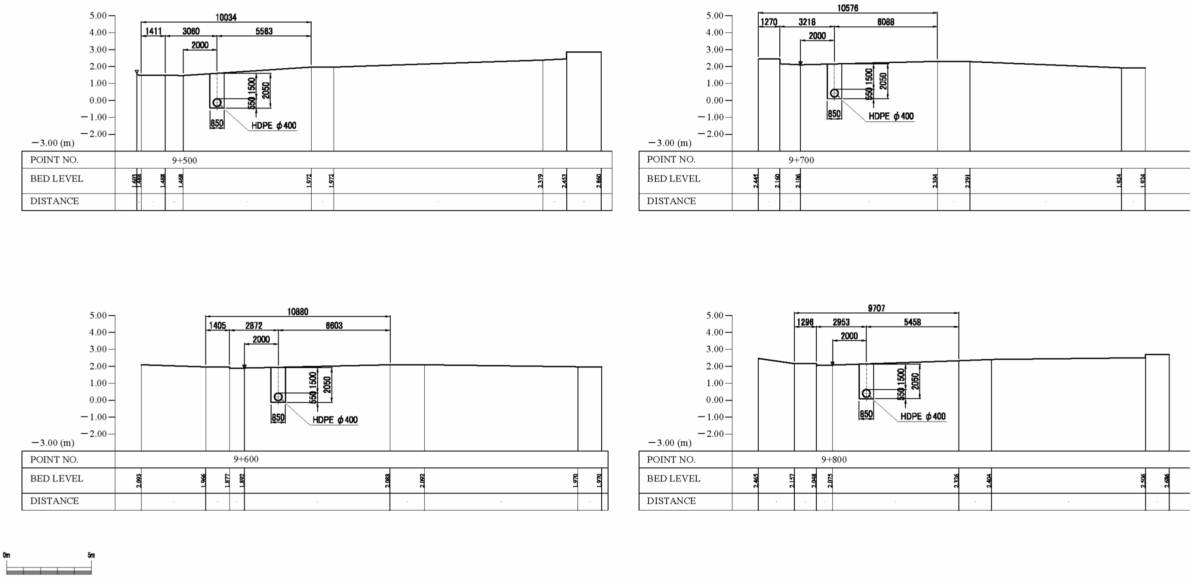
TITLE:
Cross-sectional View of Piping (2 2)


Cross-sectional View of Piping (２３)
S=1／100
SP 400A
1450
8+700
8+900
9017
2000
7017
550 1500
2050
850
HDPE φ400
8824
2000
6924
8+800
10901
1752
2000
7149
9+000
5.00
4.00
3.00
2.00
1.00
0.00
−1.00
−2.00
−3.00 (m)
POINT NO.
BED LEVEL
DISTANCE
0m
5m
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA
JAPAN INTERNATIONAL COOPERATION AGENCY
TITLE:
Cross-sectional View of Piping (２３)


Cross-sectional View of Piping (２４)
S=1／100
10096
1355
2847
5894
2000
550 1500
2050
850
HDPE φ400
9+100
10088
1509
3028
5551
9+300
10834
1369
3128
6337
9+200
10050
1425
2920
5705
9+400
5.00
4.00
3.00
2.00
1.00
0.00
−1.00
−2.00
−3.00 (m)
POINT NO.
BED LEVEL
DISTANCE
0m
5m
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA
JAPAN INTERNATIONAL COOPERATION AGENCY
TITLE:
Cross-sectional View of Piping (２４)

Cross-sectional View of Piping (２５)

S=1／100



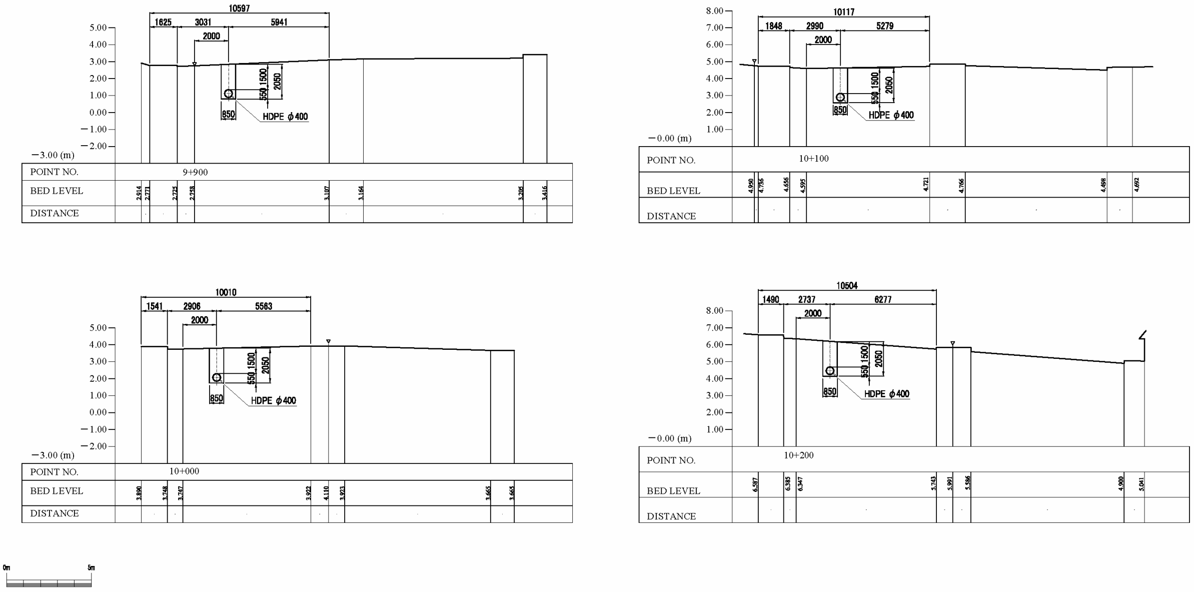
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Cross-sectional View of Piping (２５)

Cross-sectional View of Piping (２６)

S=1／100



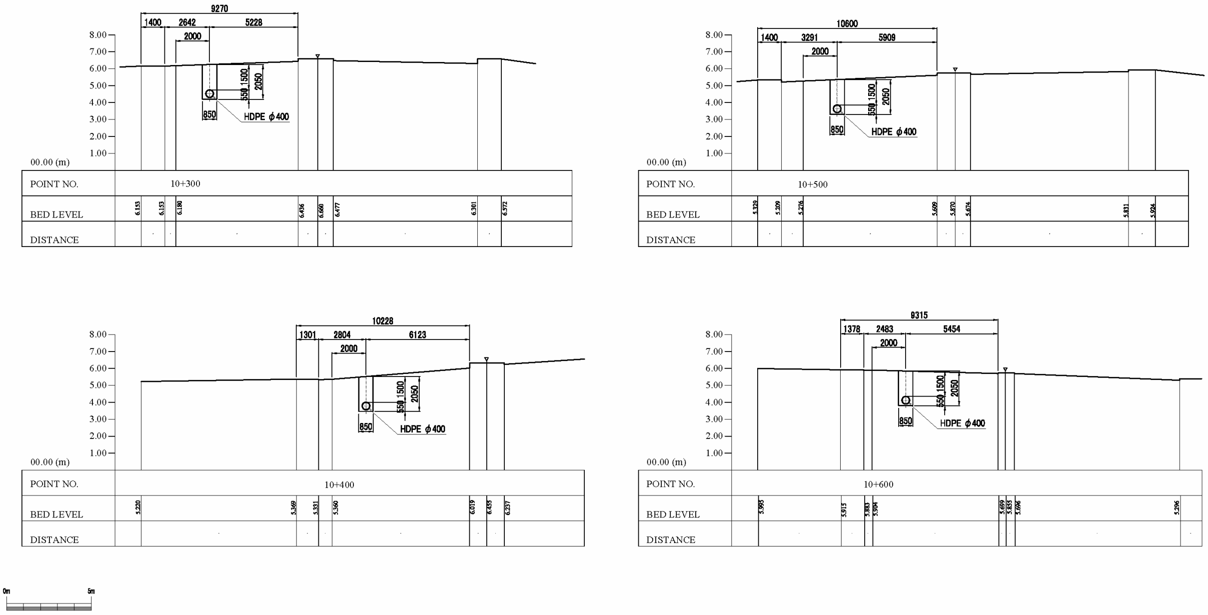
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Cross-sectional View of Piping (２６)

Cross-sectional View of Piping (２７)

S=1／100



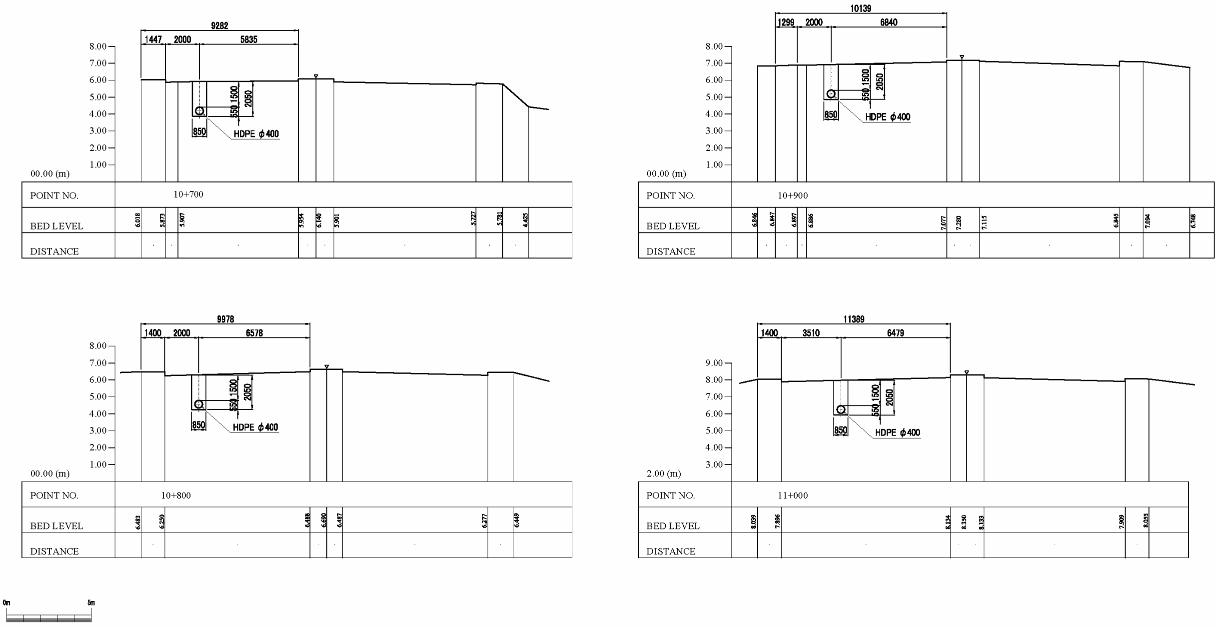
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Cross-sectional View of Piping (２７)

Cross-sectional View of Piping (２８)

S=1／100



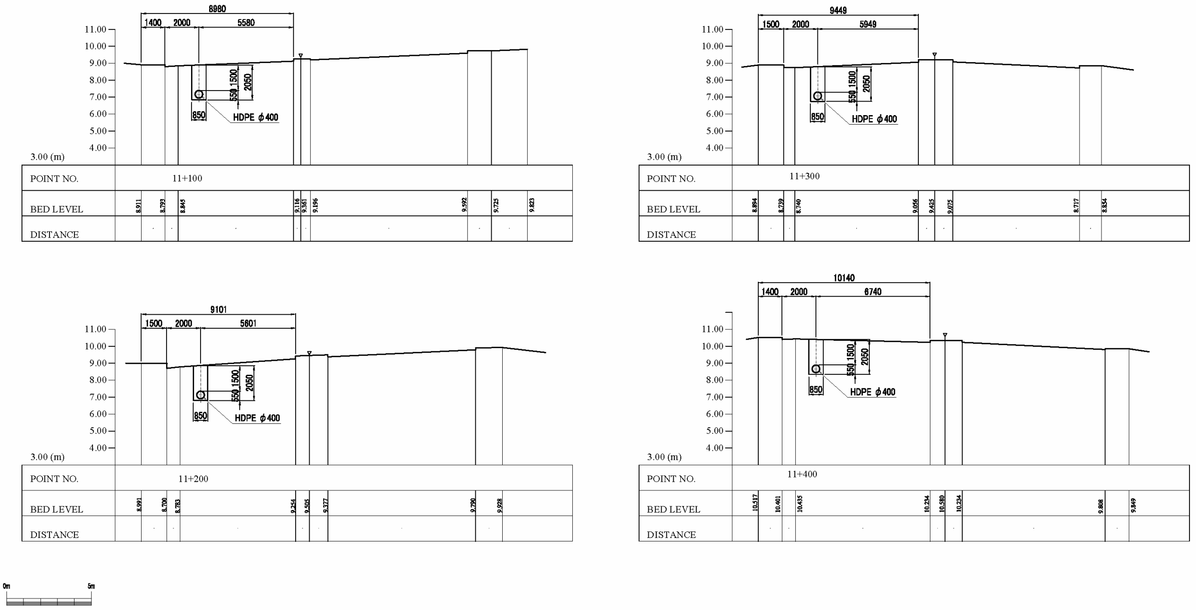
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Cross-sectional View of Piping (２８)

Cross-sectional View of Piping (２９)

S=1／100



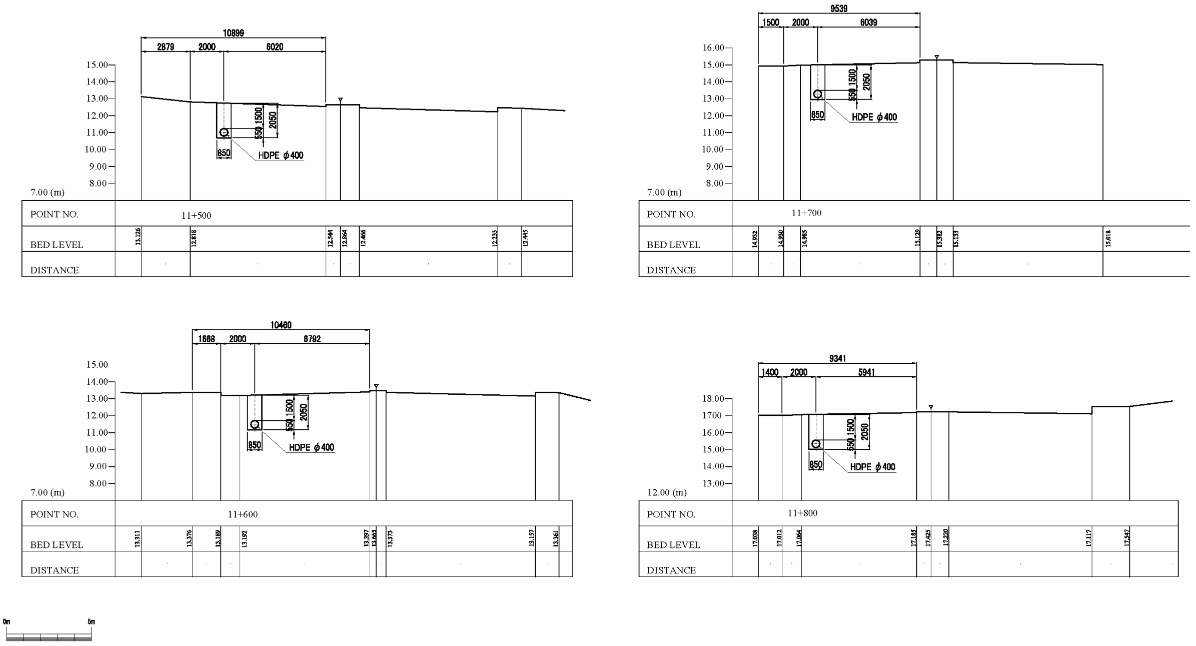
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Cross-sectional View of Piping (２９)

Cross-sectional View of Piping (３０)

S=1／100



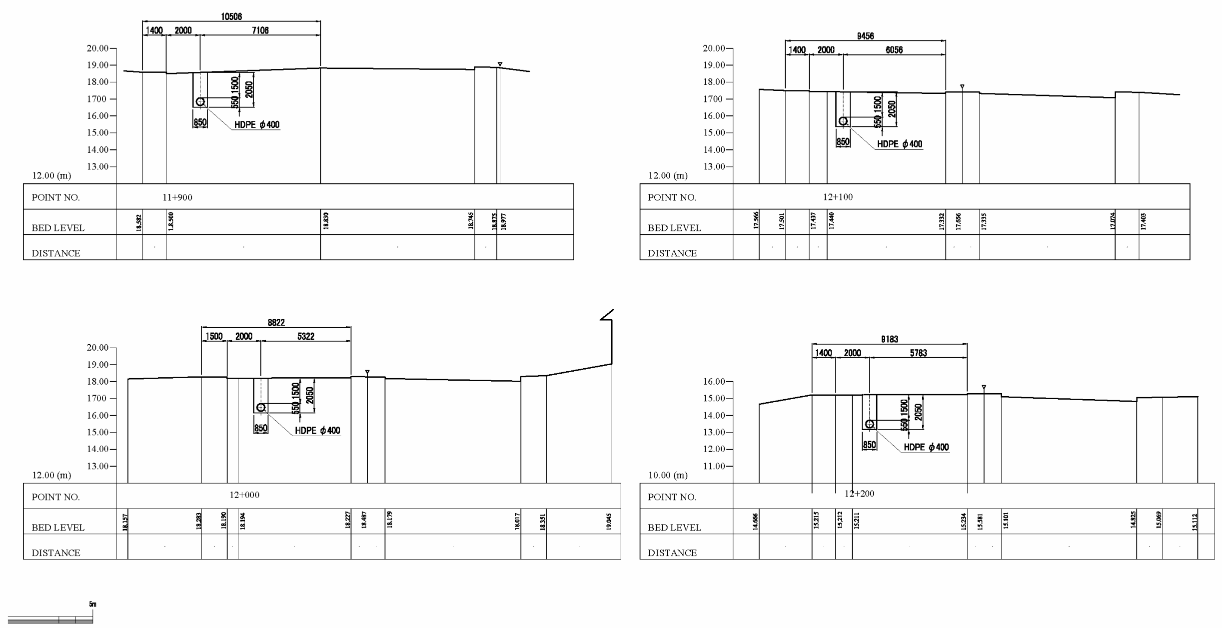
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Cross-sectional View of Piping (３０)

Cross-sectional View of Piping (3 1)

S=1／100



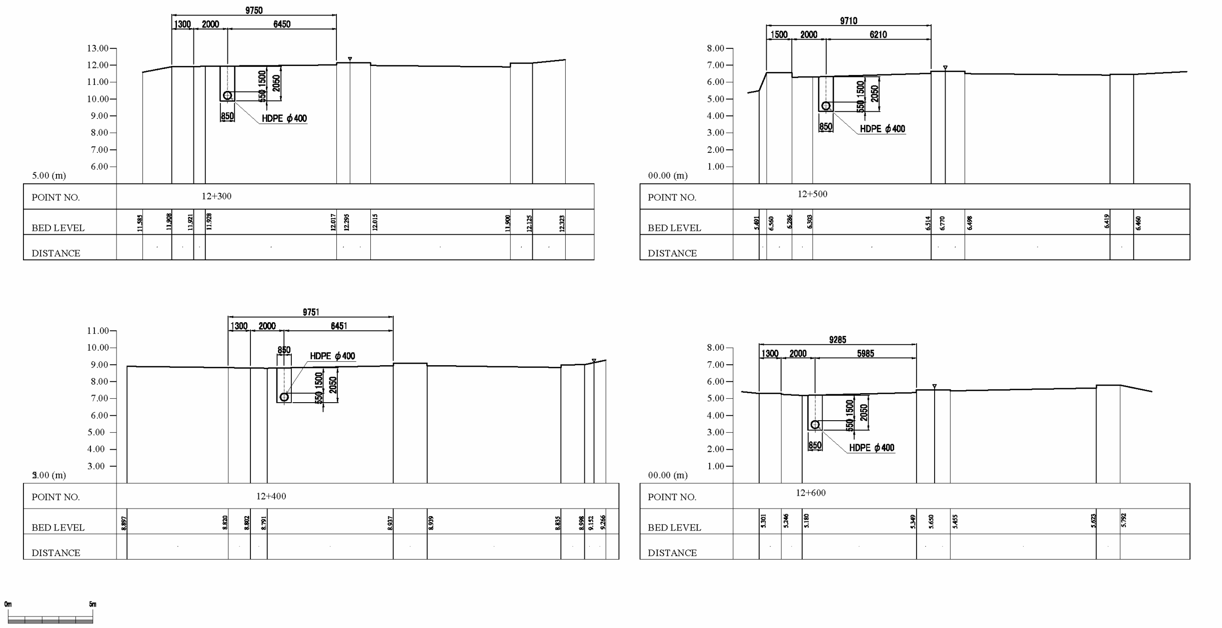
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Cross-sectional View of Piping (3 1)

Cross-sectional View of Piping (3 2)

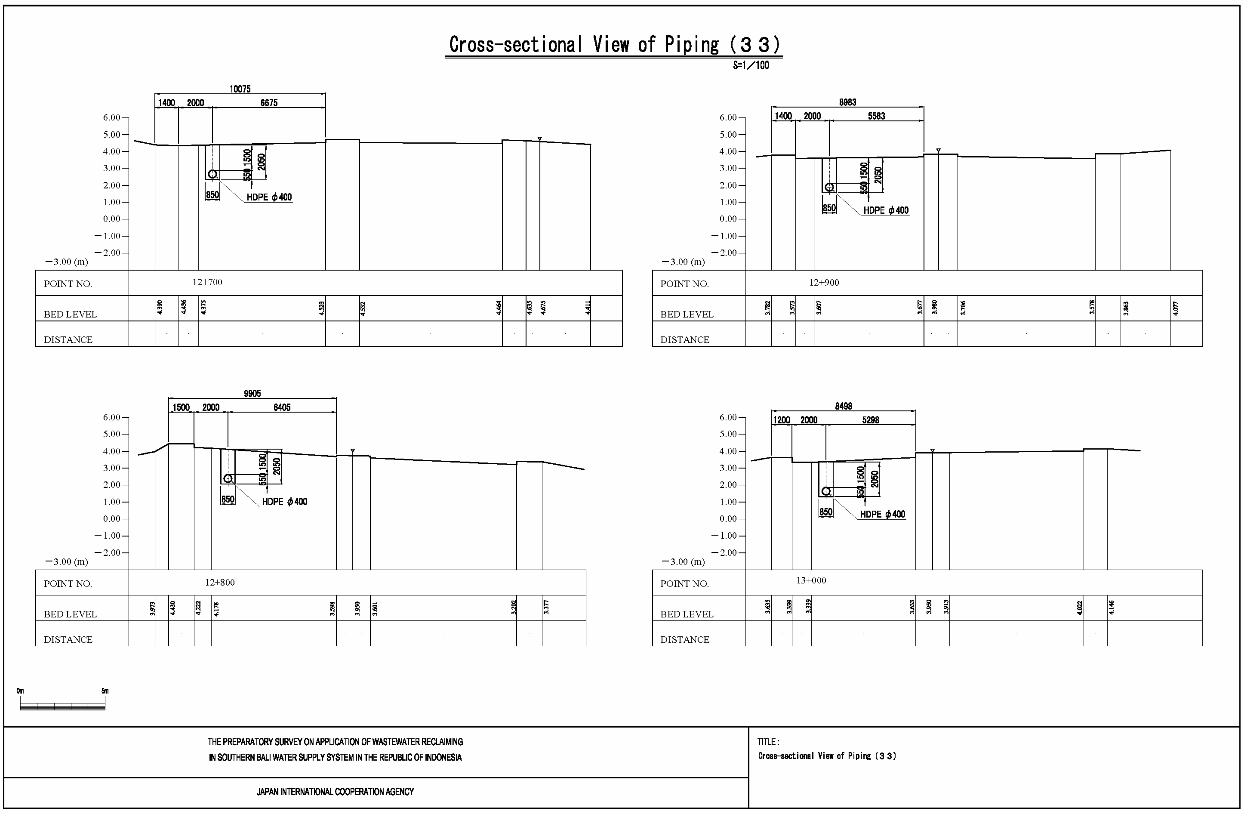
S=1／100

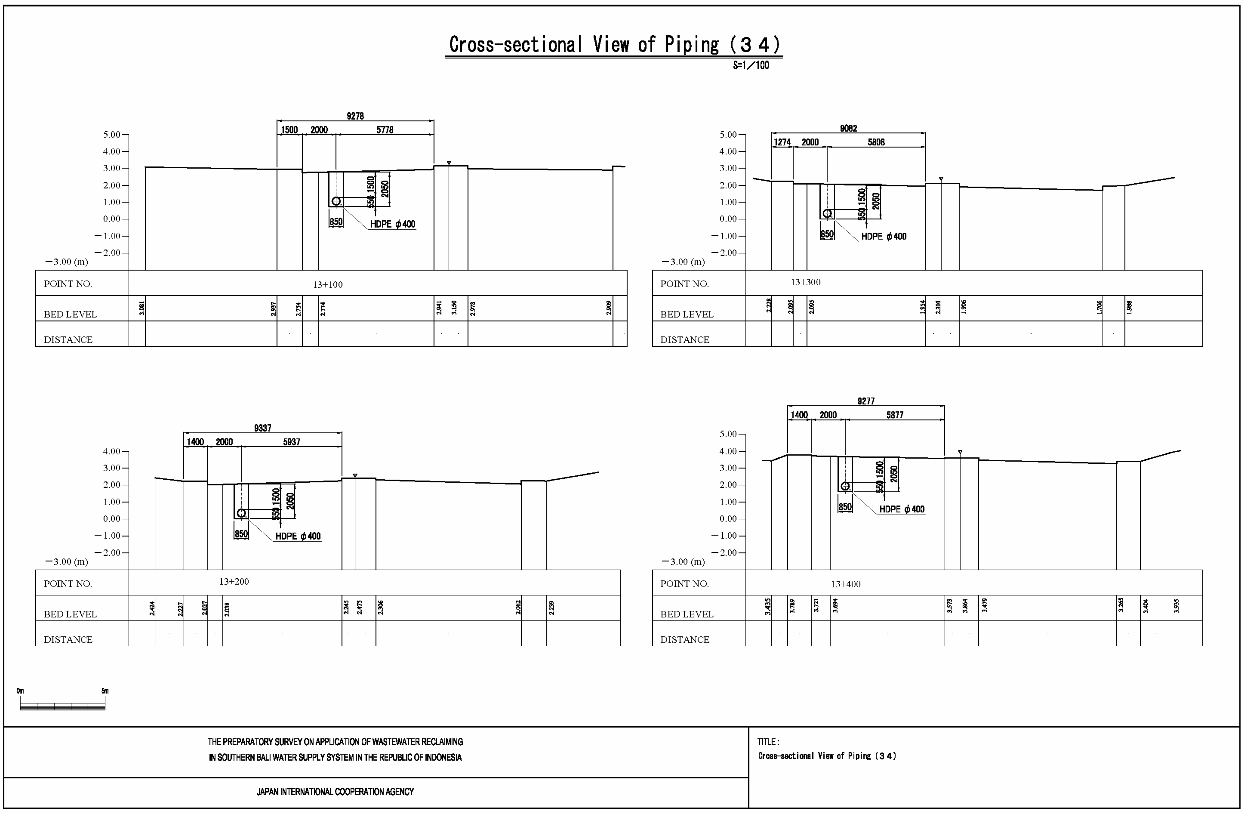


THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

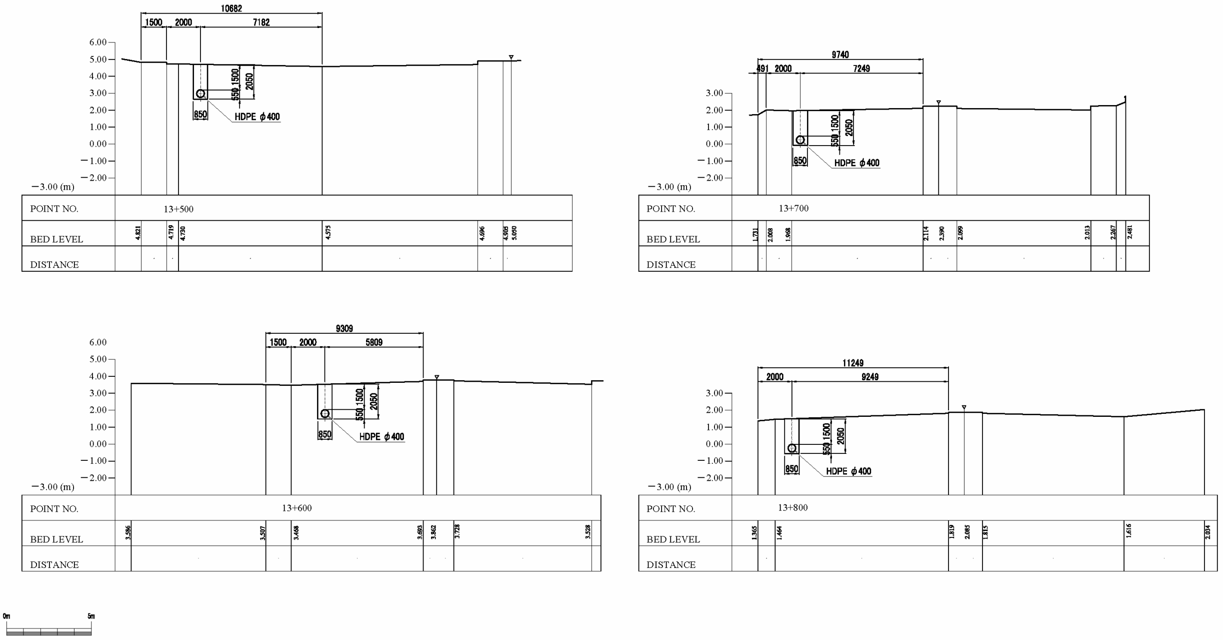
TITLE:
Cross-sectional View of Piping (3 2)


Cross-sectional View of Piping（３３）
S=1／100
10075
1400 2000 6675
8983
1400 2000 5583
9905
1500 2000 6405
8498
1200 2000 5298
550 1500
2050
850
HDPE φ400
6.00
5.00
4.00
3.00
2.00
1.00
0.00
−1.00
−2.00
−3.00 (m)
POINT NO.
BED LEVEL
DISTANCE
12+700
12+900
12+800
13+000
0m
5m
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA
JAPAN INTERNATIONAL COOPERATION AGENCY
TITLE:
Cross-sectional View of Piping (３３)


Cross-sectional View of Piping（３４）
S=1／100
9278
1500 2000 5778
9082
1274 2000 5806
9337
1400 2000 5937
9277
1400 2000 5877
550 1500
2050
850
HDPE φ400
5.00
4.00
3.00
2.00
1.00
0.00
−1.00
−2.00
−3.00 (m)
POINT NO.
BED LEVEL
DISTANCE
13+100
13+300
13+200
13+400
0m
5m
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA
JAPAN INTERNATIONAL COOPERATION AGENCY
TITLE:
Cross-sectional View of Piping (３４)

Cross-sectional View of Piping (３５)

S=1／100



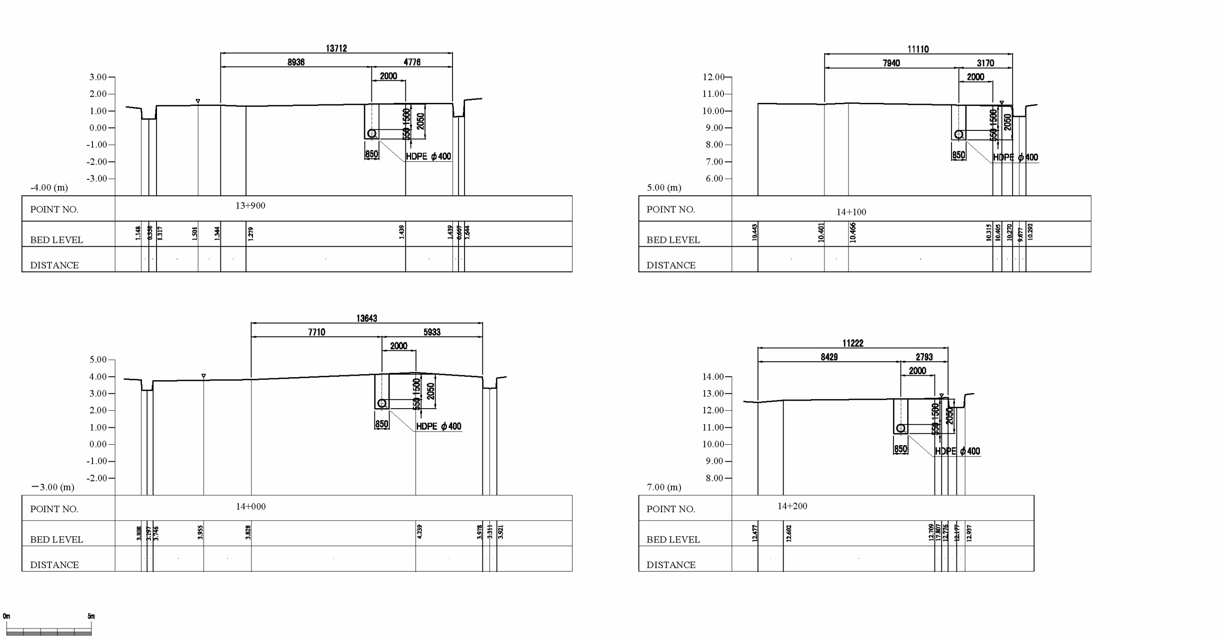
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Cross-sectional View of Piping (３５)

Cross-sectional View of Piping (３６)

S=1／100



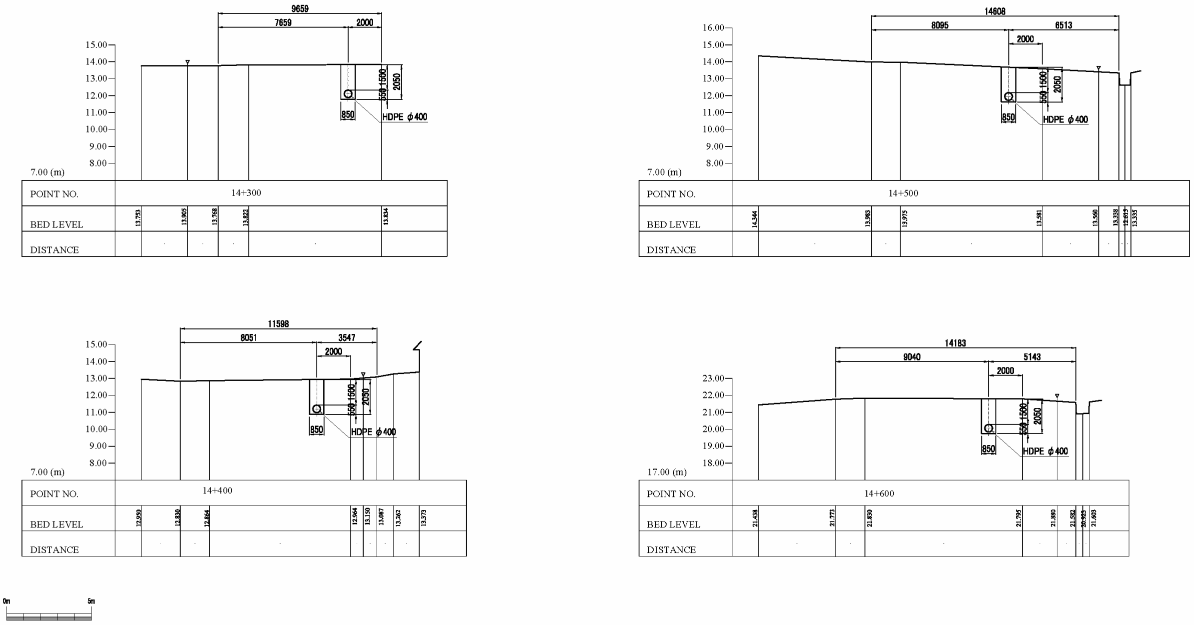
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Cross-sectional View of Piping (３６)

Cross-sectional View of Piping (３７)

S=1／100



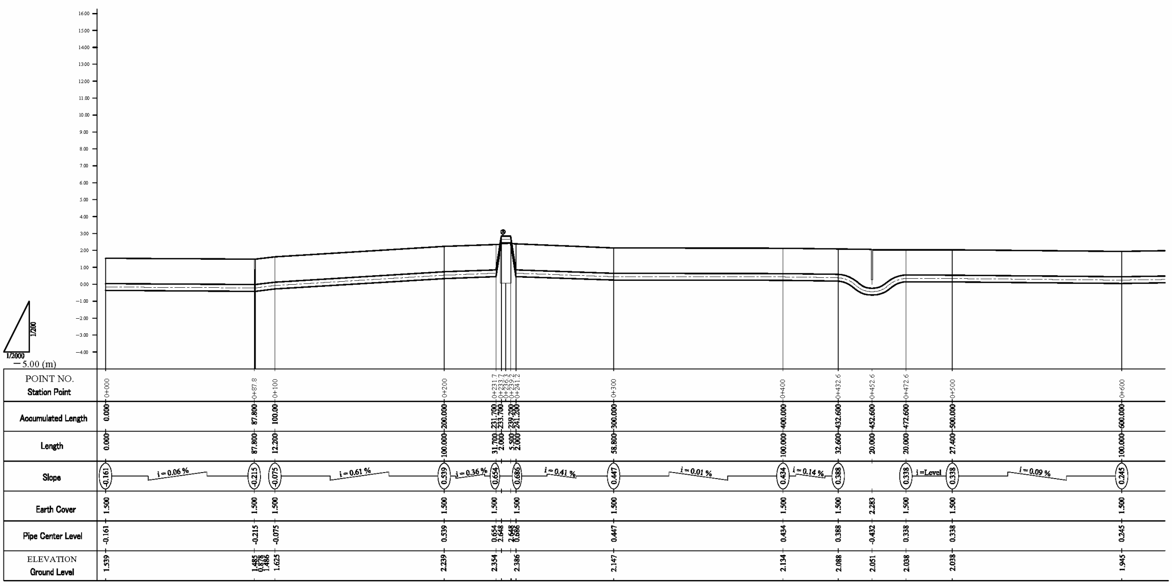
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE :
Cross-sectional View of Piping (３７)

Longitudinal Sectional View of Piping (１)

S=1／2000



POINT NO. Station Point	Accumulated Length	Length	Slope	Earth Cover	Pipe Center Level	ELEVATION Ground Level
0+000	0.000	0.000	-0.161	1.500	-0.161	1.539
0+87.8	87.800	87.800	-0.215	1.500	-0.215	1.485 0.878 1.486
0+100	100.00	12.200	-0.075	1.500	-0.075	1.625
0+200	200.000	100.000	0.539	1.500	0.539	2.239
0+231.7	231.700	31.700	0.654	1.500	0.654	2.354
0+233.7	233.700	2.000			2.648	
0+236.3						
0+239.2	239.200	5.500			2.648	
0+241.2	241.200	2.000	0.686	1.500	0.686	2.386
0+300	300.000	58.800	0.447	1.500	0.447	2.147
0+400	400.000	100.000	0.434	1.500	0.434	2.134
0+432.6	432.600	32.600	0.388	1.500	0.388	2.088
0+452.6	452.600	20.000		2.283	-0.432	2.051
0+472.6	472.600	20.000	0.338	1.500	0.338	2.038
0+500	500.000	27.400	0.338	1.500	0.338	2.038
0+600	600.000	100.000	0.245	1.500	0.245	1.945

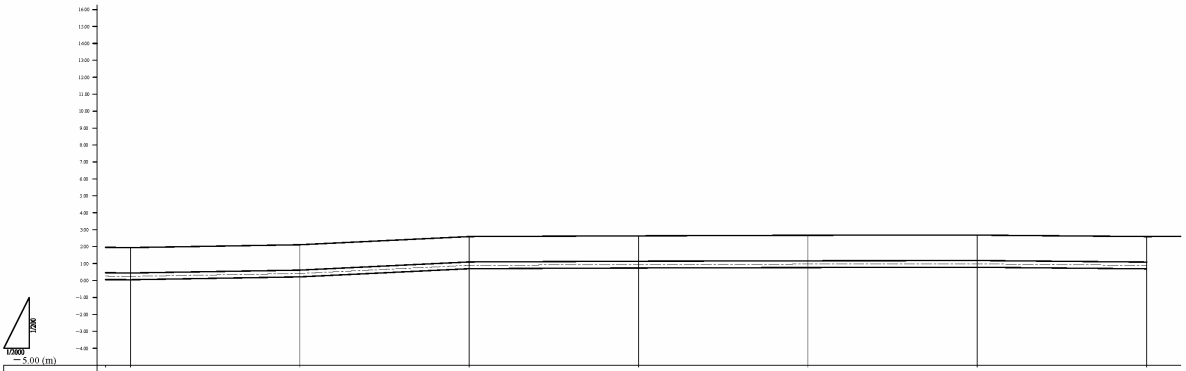
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE :
Longitudinal Sectional View of Piping (１)

Longitudinal Sectional View of Piping (2)

S=1/2000



POINT NO. Station Point	0+600		0+700		0+800		0+900		1+000		1+100		1+200
Accumulated Length	600.000		700.000		800.000		900.000		1000.000		1100.000		1200.000
Length	100.000		100.000		100.000		100.000		100.000		100.000		100.000
Slope	0.245	i = 0.17 %	0.415	i = 0.48 %	0.899	i = 0.04 %	0.939	i = 0.03 %	0.969	i = 0.01 %	0.981	i = 0.09 %	0.892
Earth Cover	1.500		1.500		1.500		1.500		1.500		1.500		1.500
Pipe Center Level	0.245		0.415		0.899		0.939		0.969		0.981		0.892
ELEVATION Ground Level	1.945		2.115		2.599		2.639		2.669		2.681		2.592

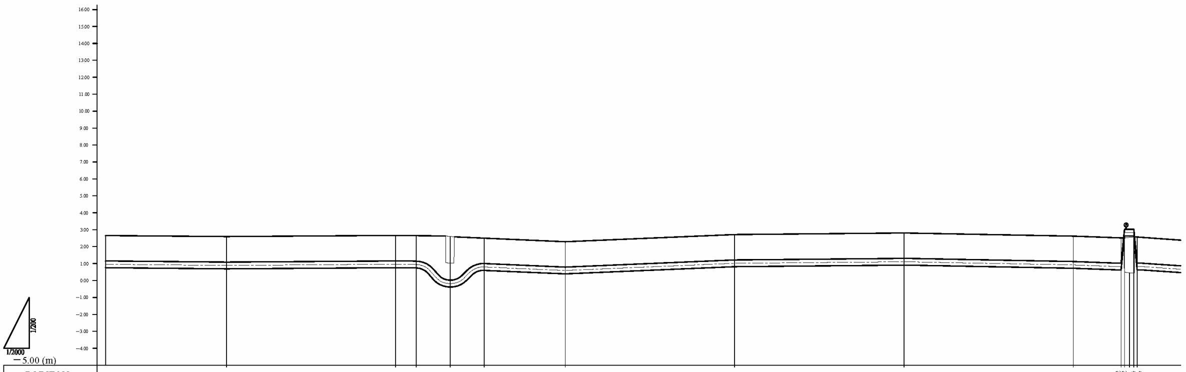
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Longitudinal Sectional View of Piping (2)

Longitudinal Sectional View of Piping (3)

S=1/2000



POINT NO. Station Point		1+200		1+300	1+312.1	1+332.1	1+352.1		1+400		1+500		1+600		1+700		1+728.2	1+730.2	1+733.1	1+735.7	1+737.7
Accumulated Length		1200.000		1300.000	1312.100	1332.100	1352.100		1400.000		1500.000		1600.000		1700.000		1728.200	1730.200		1735.700	1737.700
Length		100.000		100.000	12.100	20.000	20.000		47.900		100.000		100.000		100.000		28.200	2.000		5.500	2.000
Slope	i = 0.07 %	0.892	i = 0.07 %	0.960	0.947		0.801	i = 0.43 %	0.594	i = 0.42 %	1.018	i = 0.09 %	1.107	i = 0.19 %	0.921	i=0.37 %	0.816				0.873
Earth Cover		1.500		1.500	1.500	2.583	1.500		1.500		1.500		1.500		1.500		1.500				1.500
Pipe Center Level		0.892		0.960	0.947	-0.181	0.801		0.594		1.018		1.107		0.921		0.816	2.827		2.827	0.873
ELEVATION Ground Level		2.592		2.660	2.647	2.602	2.501		2.294		2.718		2.807		2.621		2.516	2.510		2.583	2.573

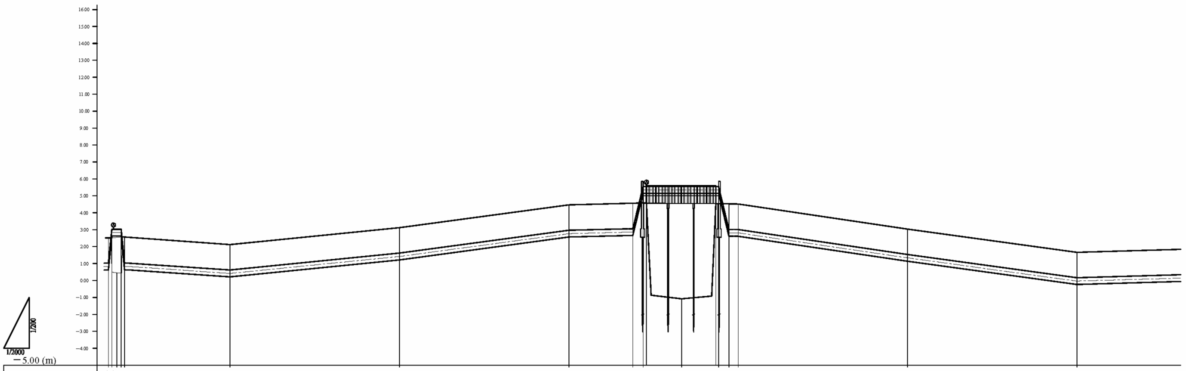
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Longitudinal Sectional View of Piping (3)

Longitudinal Sectional View of Piping (4)

S=1／2000



POINT NO. Station Point	1+728.2	1+730.2	1+733.1	1+735.7	1+737.7	1+800	1+900	2+000	2+ 37.8	2+ 43.8	2+ 67	2+ 88.5	2+ 94.5	2+100	2+200	2+300
Accumulated Length	1728.200	1730.200		1735.700	1737.700	1800.000	1900.000	2000.000	2037.800	2043.800	2067.000	2088.500	2094.500	2100.000	2200.000	2300.000
Length	28.200	2.000		5.500	2.000	62.300	100.000	100.000	37.800	6.000	23.200	21.500	6.000	5.500	100.000	100.000
Slope	0.816				0.873 i = 0.73 %	0.420 i = 1.00 %	1.420 i = 1.35 %	2.767 i = 0.25 %	2.862	5.355 i =Level		5.355	2.826	2.815 i = 1.48 %	1.339 i = 1.37 %	-0.032 i = 0.29 %
Earth Cover	1.500				1.500	1.500	1.500	1.500	1.500				1.500	1.500	1.500	1.500
Pipe Center Level	0.816	2.827		2.827	0.873	0.420	1.420	2.767	2.862	5.355	5.355	5.355	2.826	2.815	1.339	-0.032
ELEVATION Ground Level	2.516	2.510		2.583	2.573	2.120	3.120	4.467	4.562	4.577	-1.076	4.526	4.526	4.515	3.039	1.668

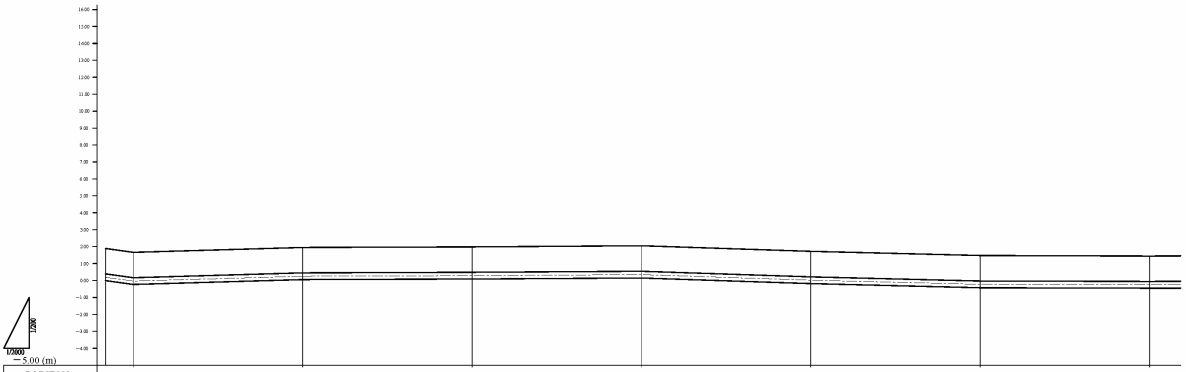
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Longitudinal Sectional View of Piping (4)

Longitudinal Sectional View of Piping (5)

S=1／2000



POINT NO. Station Point	2+300	2+400	2+500	2+600	2+700	2+800	2+900
Accumulated Length	2300.000	2400.000	2500.000	2600.000	2700.000	2800.000	2900.000
Length	100.000	100.000	100.000	100.000	100.000	100.000	100.000
Slope	-0.032 i = 0.29 %	0.254 i = 0.03 %	0.287 i = 0.06 %	0.350 i = 0.33 %	0.020 i = 0.25 %	-0.225 i = 0.03 %	-0.181
Earth Cover	1.500	1.500	1.500	1.500	1.500	1.500	1.500
Pipe Center Level	-0.032	0.254	0.287	0.350	0.020	-0.225	-0.253
ELEVATION Ground Level	1.668	1.954	1.987	2.050	1.720	1.475	1.447

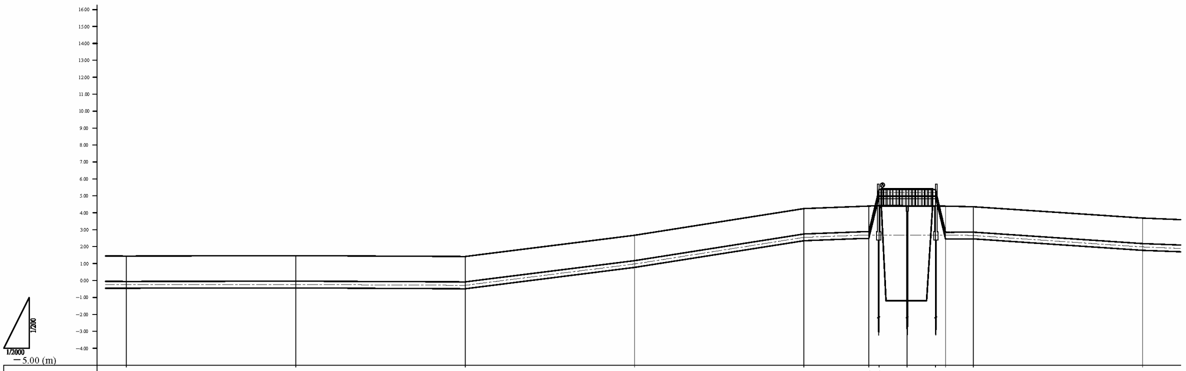
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Longitudinal Sectional View of Piping (5)

Longitudinal Sectional View of Piping (6)

S=1／2000



POINT NO. Station Point	2+900		3+000		3+100		3+200		3+300		3+338.4	3+344.4	3+361	3+377.7	3+383.7	3+400		3+500
Accumulated Length	2900.000		3000.000		3100.000		3200.000		3300.000		3338.400	3344.400	3361.000	3377.700	3383.700	3400.000		3500.000
Length	100.000		100.000		100.000		100.000		100.000		38.400	6.000	16.600	16.700	6.000	16.300		100.000
Slope	-0.181	i = 0.02 %	-0.234	i = 0.05 %	-0.282	i = 1.26 %	0.975	i = 1.57 %	2.547	i = 0.39 %	2.695	5.195	i =Level	5.195	2.692	2.661	i = 0.68 %	1.985
Earth Cover	1.500		1.500		1.500		1.500		1.500		1.500				1.500	1.500		1.500
Pipe Center Level	-0.253		-0.234		-0.282		0.975		2.547		2.695	5.195	5.195	5.195	2.692	2.661		1.985
ELEVATION Ground Level	1.447		1.466		1.418		2.675		4.247		4.395	4.418	2.378	4.403	4.392	4.361		3.685

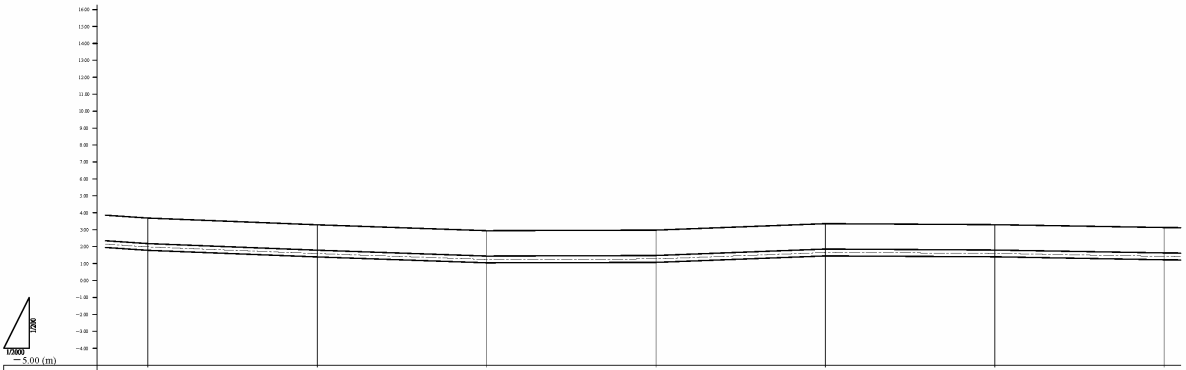
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Longitudinal Sectional View of Piping (6)

Longitudinal Sectional View of Piping (7)

S=1／2000



POINT NO. Station Point	3+500		3+600		3+700		3+800		3+900		4+000		4+100
Accumulated Length	3500.000		3600.000		3700.000		3800.000		3900.000		4000.000		4100.000
Length	100.000		100.000		100.000		100.000		100.000		100.000		100.000
Slope	1.985	i = 0.39 %	1.592	i = 0.35 %	1.245	i = 0.03 %	1.275	i = 0.38 %	1.657	i = 0.06 %	1.601	i = 0.17 %	1.427
Earth Cover	1.500		1.500		1.500		1.500		1.500		1.500		1.500
Pipe Center Level	1.985		1.592		1.245		1.275		1.657		1.601		1.427
ELEVATION Ground Level	3.685		3.292		2.945		2.975		3.357		3.301		3.127

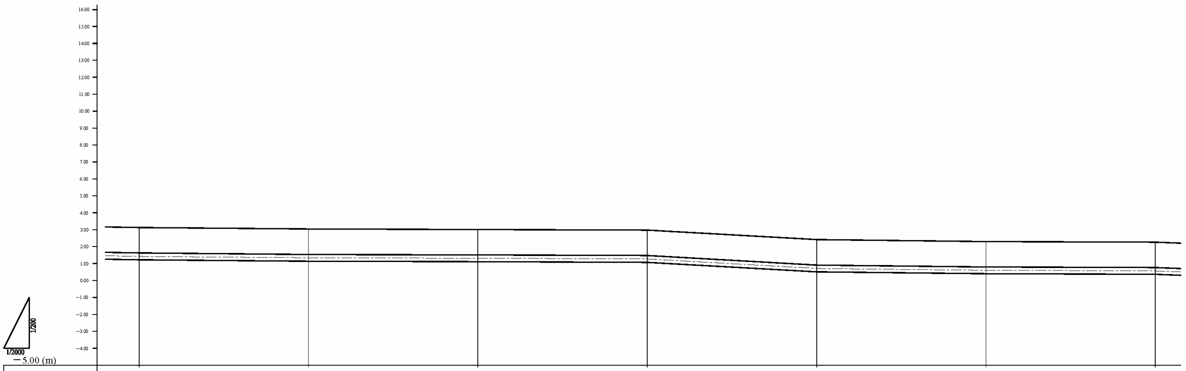
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Longitudinal Sectional View of Piping (7)

Longitudinal Sectional View of Piping (8)

S=1／2000



POINT NO. Station Point	4+100		4+200		4+300		4+400		4+500		4+600		4+700
Accumulated Length	4100.000		4200.000		4300.000		4400.000		4500.000		4600.000		4700.000
Length	100.000		100.000		100.000		100.000		100.000		100.000		100.000
Slope	1.427	i＝0.09 %	1.341	i＝0.03 %	1.313	i＝0.04 %	1.275	i＝0.56 %	0.714	i＝0.11 %	0.601	i＝0.03 %	0.568
Earth Cover	1.500		1.500		1.500		1.500		1.500		1.500		1.500
Pipe Center Level	1.427		1.341		1.313		1.275		0.714		0.601		0.568
ELEVATION Ground Level	3.127		3.041		3.013		2.975		2.414		2.301		2.268

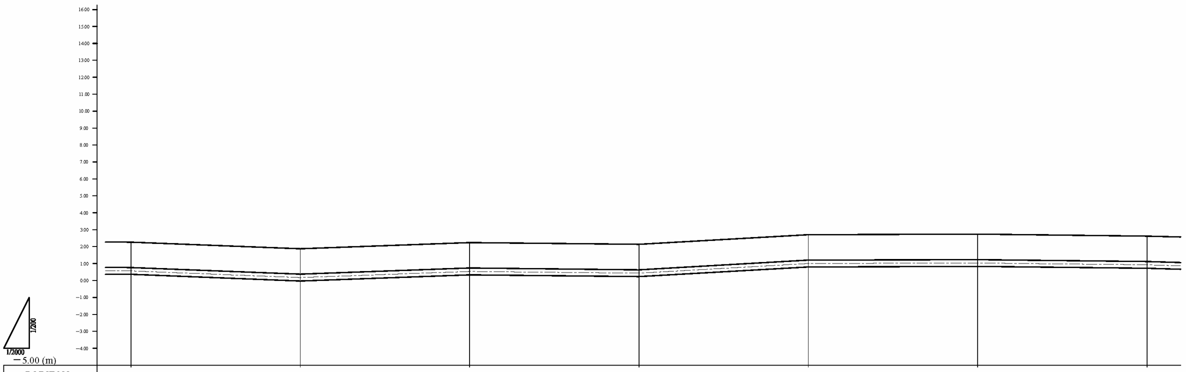
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Longitudinal Sectional View of Piping (8)

Longitudinal Sectional View of Piping (9)

S=1／2000



POINT NO. Station Point	4+700		4+800		4+900		5+000		5+100		5+200		5+300
Accumulated Length	4700.000		4800.000		4900.000		5000.000		5100.000		5200.000		5300.000
Length	100.000		100.000		100.000		100.000		100.000		100.000		100.000
Slope	0.568	i＝0.39 %	0.174	i＝0.36 %	0.538	i＝0.10 %	0.435	i＝0.52 %	0.955	i＝0.08 %	1.036	i＝0.11 %	0.924
Earth Cover	1.500		1.500		1.500		1.500		1.500		1.500		1.500
Pipe Center Level	0.568		0.174		0.538		0.435		0.955		1.036		0.924
ELEVATION Ground Level	2.268		1.874		2.238		2.135		2.655		2.736		2.624

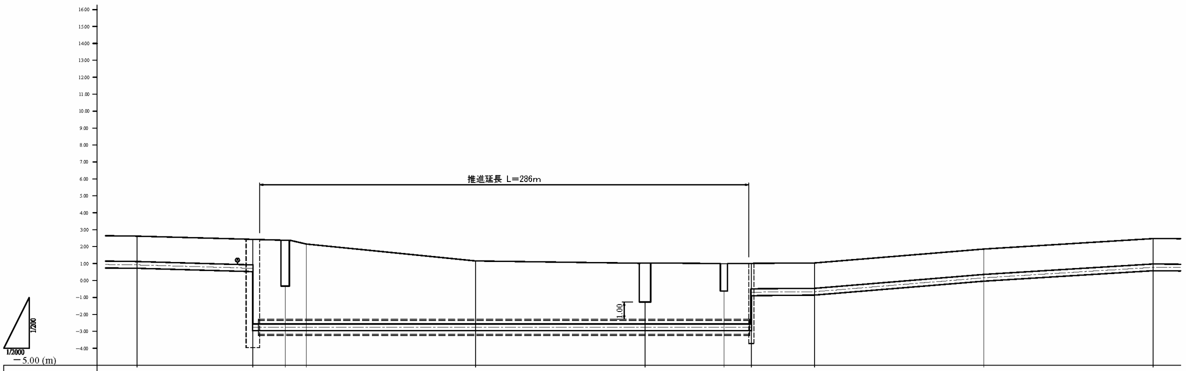
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Longitudinal Sectional View of Piping (9)

Longitudinal Sectional View of Piping（１０）

S=1／2000



POINT NO. Station Point	5+300	5+368.4	5+387.5	5+400	5+500	5+600	5+647	5+662.7	5+700	5+800	5+900
Accumulated Length	5300.000	5368.400	5387.500	5400.000	5500.000	5600.000	5647.000	5662.700	5700.000	5800.000	5900.000
Length	100.000	68.400	19.100	12.500	100.000	100.000	47.000	15.700	37.300	100.000	100.000
Slope	0.924 i＝0.29 %	0.728 -2.772			i =Level			-2.772 -0.689 i＝0.08 %	-0.661 i＝0.82 %	0.160 i＝0.62 %	0.778
Earth Cover	1.500	1.500 5.000		4.724	3.726	3.602		3.583 1.500	1.500	1.500	1.500
Pipe Center Level	0.924	0.728 -2.772	-2.772	-2.772	-2.772	-2.772	-2.772	-2.772 -0.689	-0.661	0.160	0.778
ELEVATION Ground Level	2.624	2.428		2.152	1.154	1.030		1.011	1.039	1.860	2.478

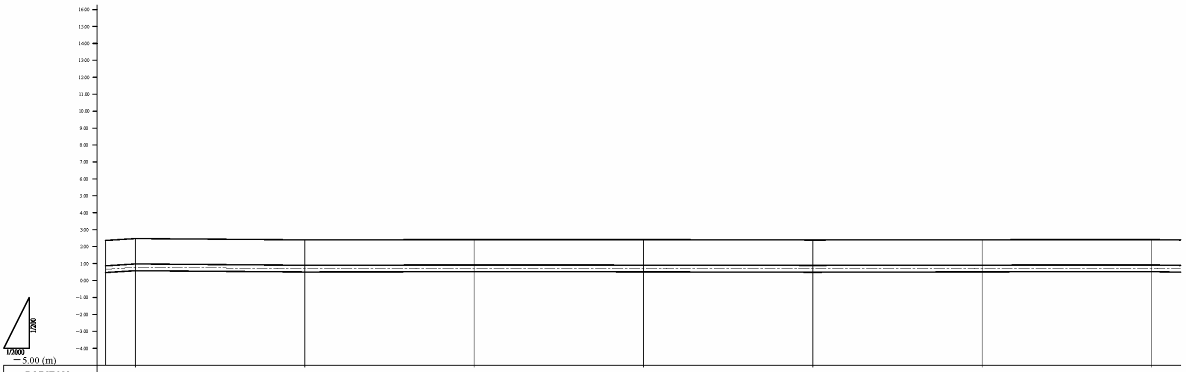
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Longitudinal Sectional View of Piping（１０）

Longitudinal Sectional View of Piping（１１）

S=1／2000



POINT NO. Station Point	5+900	6+000	6+100	6+200	6+300	6+400	6+500
Accumulated Length	5900.000	6000.000	6100.000	6200.000	6300.000	6400.000	6500.000
Length	100.000	100.000	100.000	100.000	100.000	100.000	100.000
Slope	0.778 i＝0.08 %	0.701 i＝0.02 %	0.718 i＝0.003 %	0.715 i＝0.03 %	0.690 i＝0.02 %	0.713 i＝0.01 %	0.718
Earth Cover	1.500	1.500	1.500	1.500	1.500	1.500	1.500
Pipe Center Level	0.778	0.701	0.718	0.715	0.690	0.713	0.718
ELEVATION Ground Level	2.478	2.401	2.418	2.415	2.390	2.413	2.418

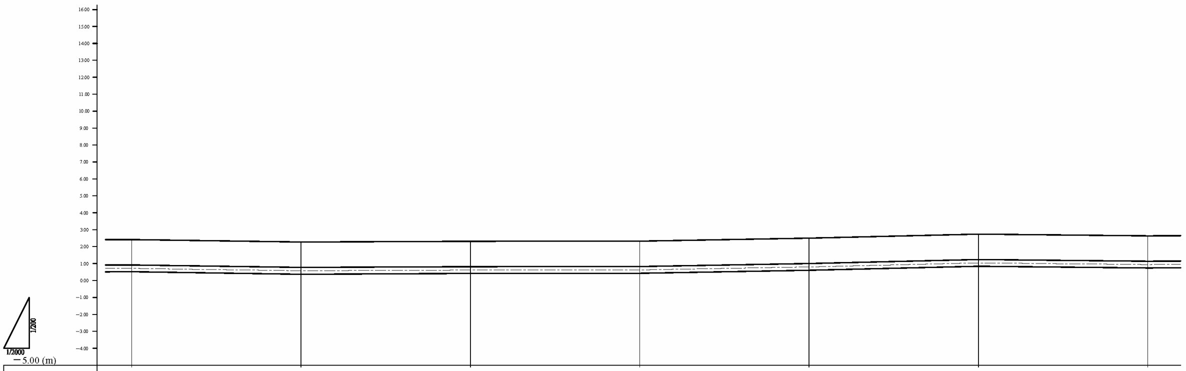
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Longitudinal Sectional View of Piping（１１）

Longitudinal Sectional View of Piping（１２）

S=1／2000



POINT NO. Station Point	6+500		6+600		6+700		6+800		6+900		7+000		7+100
Accumulated Length	6500.000		6600.000		6700.000		6800.000		6900.000		7000.000		7100.000
Length	100.000		100.000		100.000		100.000		100.000		100.000		100.000
Slope	0.718	i＝0.15 %	0.573	i＝0.04 %	0.616	i＝0.01 %	0.628	i＝0.18 %	0.803	i＝0.22 %	1.024	i＝0.08 %	0.940
Earth Cover	1.500		1.500		1.500		1.500		1.500		1.500		1.500
Pipe Center Level	0.718		0.573		0.616		0.628		0.803		1.024		0.940
ELEVATION Ground Level	2.418		2.273		2.316		2.328		2.503		2.724		2.640

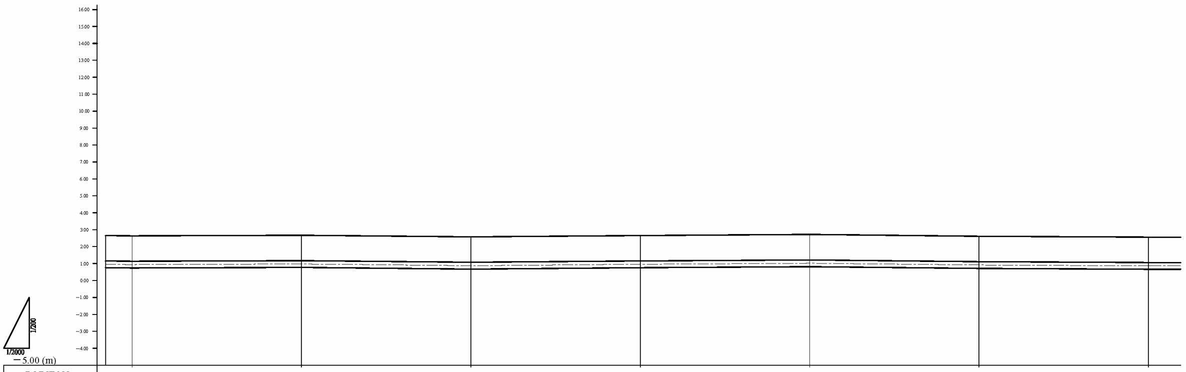
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE：
Longitudinal Sectional View of Piping（１２）

Longitudinal Sectional View of Piping（１３）

S=1／2000



POINT NO. Station Point	7+100		7+200		7+300		7+400		7+500		7+600		7+700
Accumulated Length	7100.000		7200.000		7300.000		7400.000		7500.000		7600.000		7700.000
Length	100.000		100.000		100.000		100.000		100.000		100.000		100.000
Slope	4.512	i＝0.04 %	0.976	i＝0.10 %	0.878	i＝0.08 %	0.958	i＝0.06 %	1.020	i＝0.10 %	0.917	i＝0.05 %	0.866
Earth Cover	1.500		1.500		1.500		1.500		1.500		1.500		1.500
Pipe Center Level	0.940		0.976		0.878		0.958		1.020		0.917		0.866
ELEVATION Ground Level	2.640		2.676		2.578		2.658		2.720		2.617		2.566

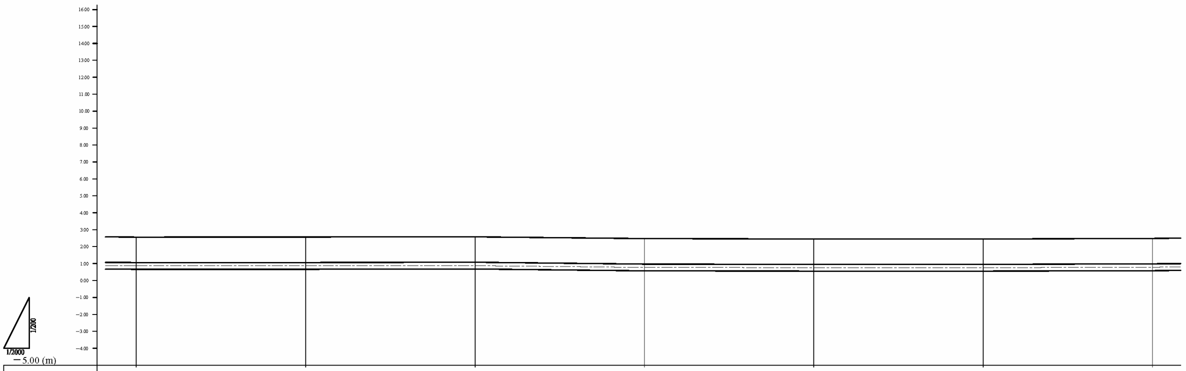
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE：
Longitudinal Sectional View of Piping（１３）

Longitudinal Sectional View of Piping（１４）

S=1／2000



POINT NO. Station Point	7+700		7+800		7+900		8+000		8+100		8+200		8+300
Accumulated Length	7700.000		7800.000		7900.000		8000.000		8100.000		8200.000		8300.000
Length	100.000		100.000		100.000		100.000		100.000		100.000		100.000
Slope	0.866	i = 0.001 %	0.867	i = 0.01 %	0.879	i = 0.11 %	0.774	i = 0.02 %	0.755	i = 0.003 %	0.752	i = 0.03 %	0.784
Earth Cover	1.500		1.500		1.500		1.500		1.500		1.500		1.500
Pipe Center Level	0.866		0.867		0.879		0.774		0.755		0.752		0.784
ELEVATION Ground Level	2.566		2.567		2.579		2.474		2.455		2.452		2.484

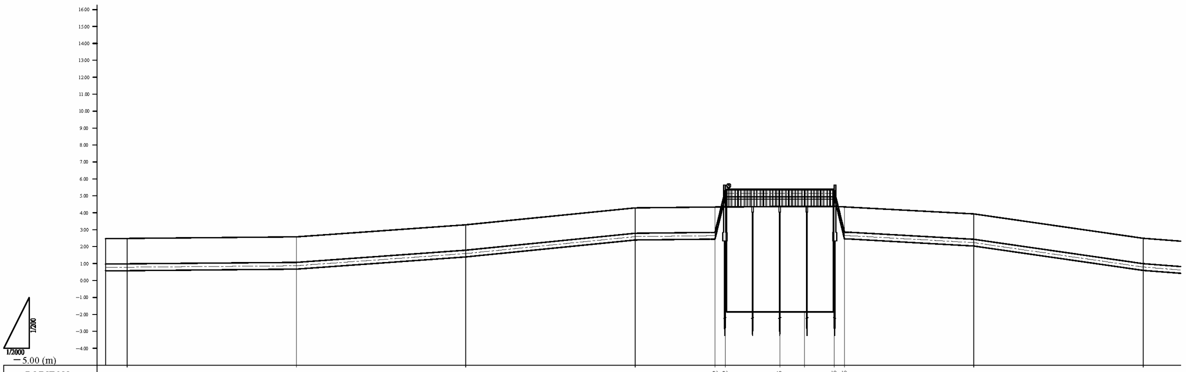
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Longitudinal Sectional View of Piping（１４）

Longitudinal Sectional View of Piping（１５）

S=1／2000



POINT NO. Station Point	8+300		8+400		8+500		8+600		8+647.2	8+653.2		8+685.5	8+700	8+717.6	8+723.6		8+800		8+900
Accumulated Length	8300.000		8400.000		8500.000		8600.000		8647.200	8653.200		8685.500	8700.000	8717.600	8723.600		8800.000		8900.000
Length	100.000		100.000		100.000		100.000		47.200	6.000		32.300	14.500	17.600	6.000		76.400		100.000
Slope	0.784	i = 0.09 %	0.875	i = 072 %	1.593	i = 1.00 %	2.592	i = 0.11 %	2.645	5.142	i =Level			5.142	2.650	i = 0.54 %	2.238	i = 1.44 %	0.797
Earth Cover	1.500		1.500		1.500		1.500		1.500						1.500		1.500		1.500
Pipe Center Level	0.784		0.875		1.593		2.592		2.645	5.142		5.142	5.142	5.142	2.650		2.238		0.797
ELEVATION Ground Level	2.484		2.575		3.293		4.292		4.345	4.352				4.383	4.350		3.938		2.497

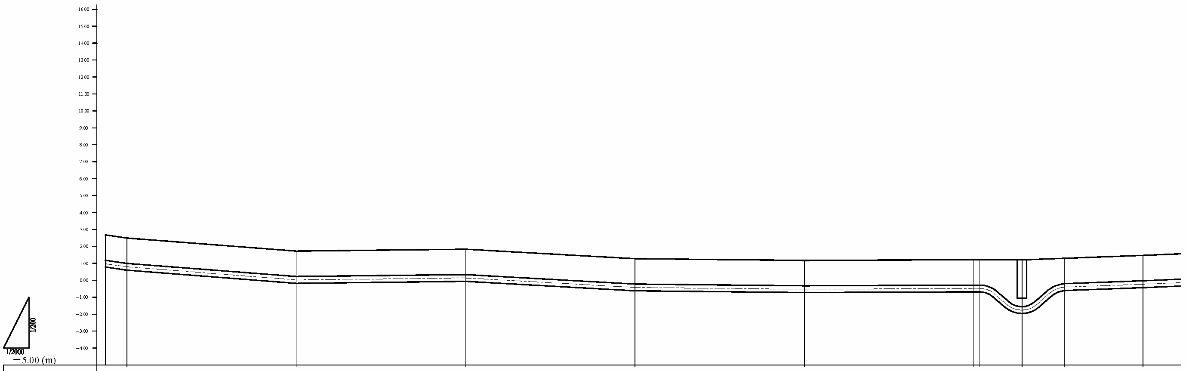
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Longitudinal Sectional View of Piping（１５）

Longitudinal Sectional View of Piping（１６）

S=1／2000



POINT NO. Station Point	8+900		9+000		9+100		9+200		9+300		9+400	9+404	9+429	9+454		9+500
Accumulated Length	8900.000		9000.000		9100.000		9200.000		9300.000		9400.000	9404.000	9429.000	9454.000		9500.000
Length	100.000		100.000		100.000		100.000		100.000		100.000	4.000	25.000	25.000		46.000
Slope	0.797	i＝0.78 %	0.021	i＝0.12 %	0.136	i＝0.56 %	-0.424	i＝0.10 %	-0.524	i＝0.04 %	-0.481			-0.400	i＝0.37 %	-0.232
Earth Cover	1.500		1.500		1.500		1.500		1.500		1.500	1.500	2.780	1.500		1.500
Pipe Center Level	0.797		0.021		0.136		-0.424		-0.524		-0.481	-0.481	-1.761	-0.400		-0.232
ELEVATION Ground Level	2.497		1.721		1.836		1.276		1.176		1.219	1.219	1.219	1.300		1.468

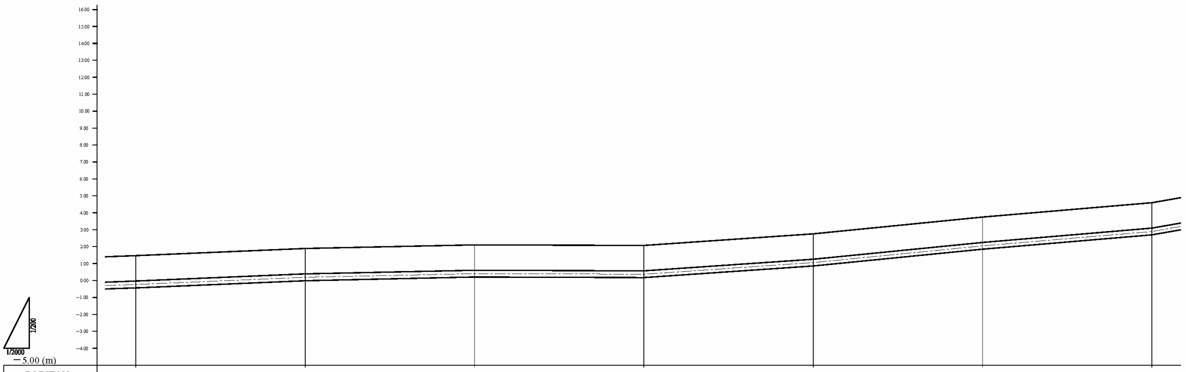
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Longitudinal Sectional View of Piping（１６）

Longitudinal Sectional View of Piping（１７）

S=1／2000



POINT NO. Station Point	9+500		9+600		9+700		9+800		9+900		10+000		10+100
Accumulated Length	9500.000		9600.000		9700.000		9800.000		9900.000		10000.00		10100.00
Length	46.000		100.000		100.000		100.000		100.000		100.000		100.000
Slope	-0.232	i＝0.42 %	0.192	i＝0.21 %	0.406	i＝0.03 %	0.375	i＝0.68 %	1.058	i＝0.99 %	2.047	i＝0.85 %	2.895
Earth Cover	1.500		1.500		1.500		1.500		1.500		1.500		1.500
Pipe Center Level	-0.232		0.192		0.406		0.375		1.058		2.047		2.895
ELEVATION Ground Level	1.468		1.892		2.106		2.075		2.758		3.747		4.595

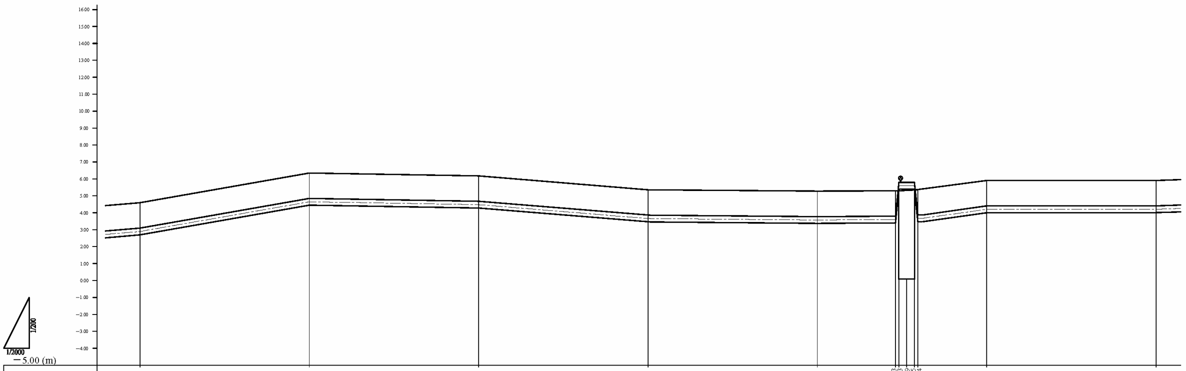
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Longitudinal Sectional View of Piping（１７）

Longitudinal Sectional View of Piping（１８）

S=1／2000



POINT NO. Station Point	10+100	10+200	10+300	10+400	10+500	10+547.3	10+549.3	10+553.9	10+558.5	10+560.4	10+600	10+700
Accumulated Length	10100.00	10200.00	10300.00	10400.00	10500.00	10547.30	10549.30		10558.50	10560.40	10600.00	10700.00
Length	100.000	100.000	100.000	100.000	100.000	47.300	2.000		9.200	1.900	39.600	100.000
Slope	2.895 i = 1.75 %	4.647 i = 0.17 %	4.480 i = 0.82%	3.660 i = 0.08%	3.576 i=0.04%	3.597				3.673 i=1.34%	4.204 i = 0.003 %	4.207
Earth Cover	1.500	1.500	1.500	1.500	1.500	1.500				1.500	1.500	1.500
Pipe Center Level	2.895	4.647	4.480	3.660	3.576	3.597	5.597		5.597	3.673	4.204	4.207
ELEVATION Ground Level	4.595	6.347	6.180	5.360	5.276	5.297				5.373	5.904	5.907

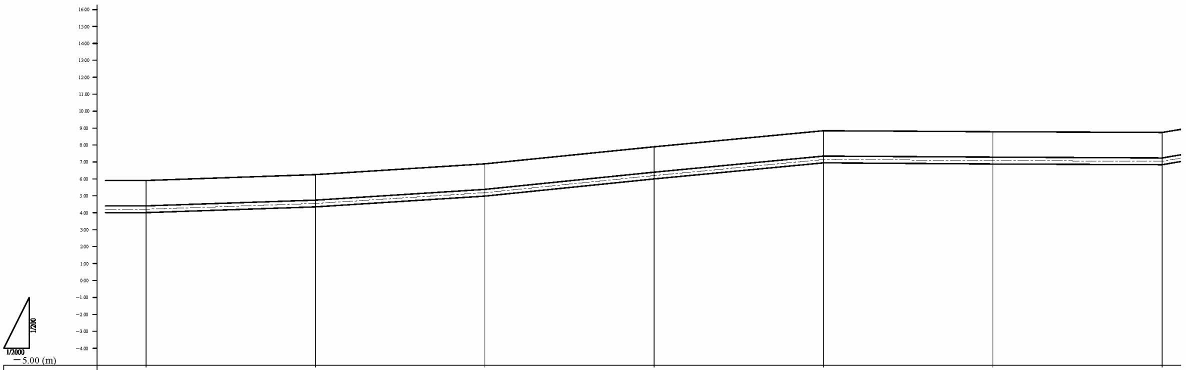
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

TITLE:
Longitudinal Sectional View of Piping（１８）

JAPAN INTERNATIONAL COOPERATION AGENCY

Longitudinal Sectional View of Piping（１９）

S=1／2000



POINT NO. Station Point	10+700	10+800	10+900	11+000	11+100	11+200	11+300
Accumulated Length	10700.00	10800.00	10900.00	11000.00	11100.00	11200.00	11300.00
Length	100.000	100.000	100.000	100.000	100.000	100.000	100.000
Slope	4.207 i = 0.34 %	4.550 i = 0.64 %	5.186 i = 1.01 %	6.196 i = 0.95 %	7.145 i = 0.06 %	7.083 i = 0.04 %	7.040
Earth Cover	1.500	1.500	1.500	1.500	1.500	1.500	1.500
Pipe Center Level	4.207	4.550	5.186	6.196	7.145	7.083	7.040
ELEVATION Ground Level	5.907	6.250	6.886	7.896	8.845	8.783	8.740

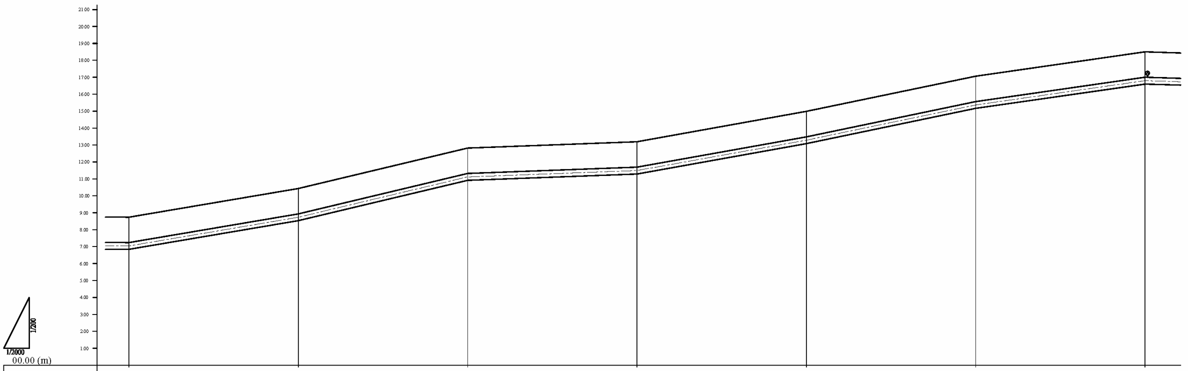
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

TITLE:
Longitudinal Sectional View of Piping（１９）

JAPAN INTERNATIONAL COOPERATION AGENCY

Longitudinal Sectional View of Piping（２０）

S=1／2000



POINT NO. Station Point	11+300		11+400		11+500		11+600		11+700		11+800		11+900
Accumulated Length	11300.00		11400.00		11500.00		11600.00		11700.00		11800.00		11900.00
Length	100.000		100.000		100.000		100.000		100.000		100.000		100.000
Slope	7.040	i = 1.71 %	8.753	i = 2.37 %	11.118	i = 0.37 %	11.492	i = 1.79 %	13.285	i = 2.08 %	15.364	i = 1.44 %	16.800
Earth Cover	1.500		1.500		1.500		1.500		1.500		1.500		1.500
Pipe Center Level	7.040		8.753		11.118		11.492		13.285		15.364		16.800
ELEVATION Ground Level	8.740		10.453		12.818		13.192		14.985		17.064		18.500

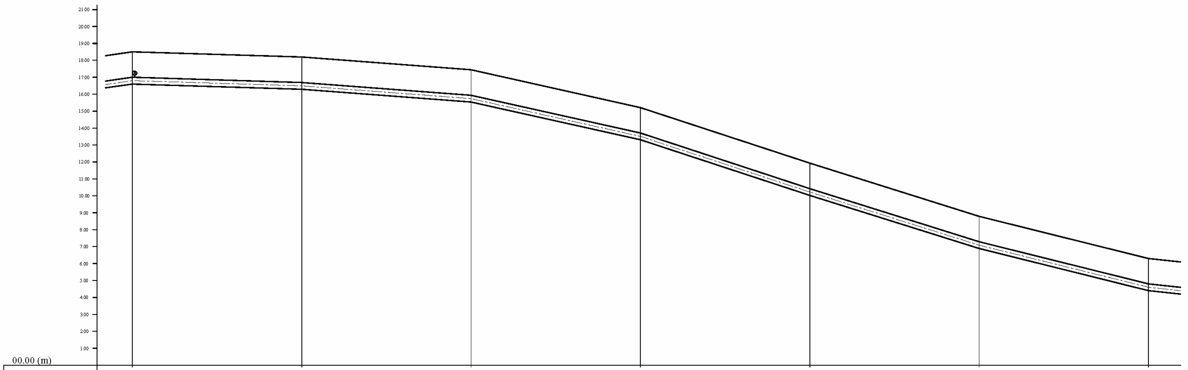
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Longitudinal Sectional View of Piping（２０）

Longitudinal Sectional View of Piping（２１）

S=1／2000



POINT NO. Station Point	11+900		12+000		12+100		12+200		12+300		12+400		12+500
Accumulated Length	11900.00		12000.00		12100.00		12200.00		12300.00		12400.00		12500.00
Length	100.000		100.000		100.000		100.000		100.000		100.000		100.000
Slope	16.800	i = 0.31 %	16.494	i = 0.75 %	15.740	i = 2.23 %	13.511	i = 3.28 %	10.228	i = 3.14 %	7.091	i = 2.49 %	4.603
Earth Cover	1.500		1.500		1.500		1.500		1.500		1.500		1.500
Pipe Center Level	16.800		16.494		15.740		13.511		10.228		7.091		4.603
ELEVATION Ground Level	18.500		18.194		17.440		15.211		11.928		8.791		6.303

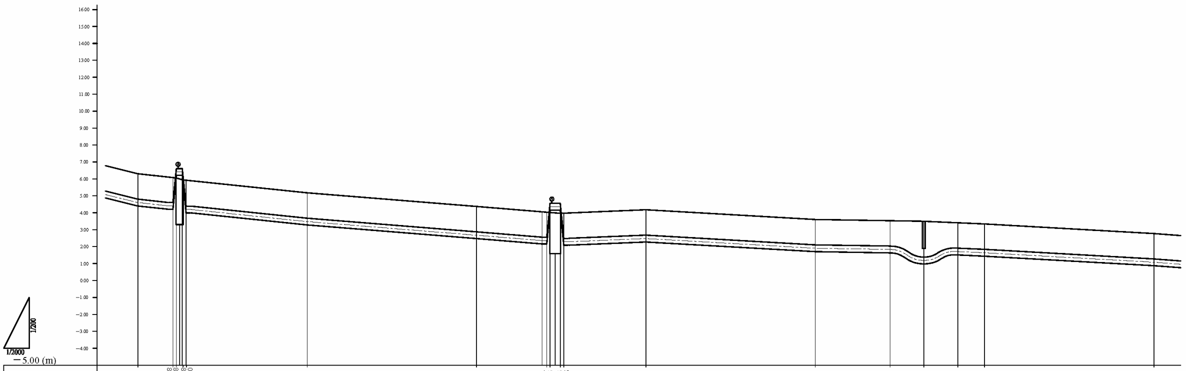
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE:
Longitudinal Sectional View of Piping（２１）

Longitudinal Sectional View of Piping（２２）

S=1／2000

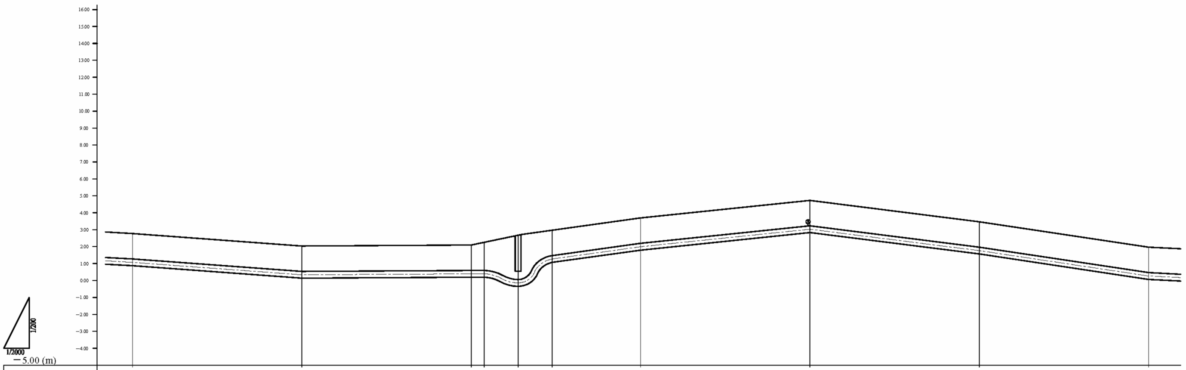


POINT NO. Station Point	12+500	12+520.8	12+522.8	12+526.8	12+529.0	12+600	12+700	12+741.4	12+743.5	12+749.5	12+751.6	12+800	12+900	12+944	12+964	12+984	13+000	13+100
Accumulated Length	12500.00	12520.80	12522.80	12526.80	12529.00	12600.00	12700.00	12741.40	12743.50	12749.50	12751.60	12800.00	12900.00	12944.00	12964.00	12984.00	13000.00	13100.00
Length	100.000	20.800	2.000	4.000	2.200	71.000	100.000	41.400	2.100	6.000	2.100	48.400	100.000	44.000	20.000	20.000	16.000	100.000
Slope	4.603 i=1.09%	4.377			4.218 i = 1.04 %	3.480 i = 0.81 %	2.675 i=0.82%	2.336			2.278 i=0.41%	2.478 i = 0.57%	1.907 i = 0.16 %	1.836		1.713 i=0.46%	1.639 i = 0.57 %	1.074
Earth Cover	1.500	1.500			1.500	1.500	1.500	1.500			1.500	1.500	1.500	1.500	2.110	1.500	1.500	1.500
Pipe Center Level	4.603	4.377	6.377	6.377	4.218	3.480	2.675	2.336	4.436	4.436	2.278	2.478	1.907	1.836	1.192	1.713	1.639	1.074
ELEVATION Ground Level	6.303	6.077			5.918	5.180	4.375	4.036			3.978	4.178	3.607	3.536	3.502	3.413	3.339	2.774

THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA	TITLE : Longitudinal Sectional View of Piping (２２)
JAPAN INTERNATIONAL COOPERATION AGENCY	

Longitudinal Sectional View of Piping（２３）

S=1／2000

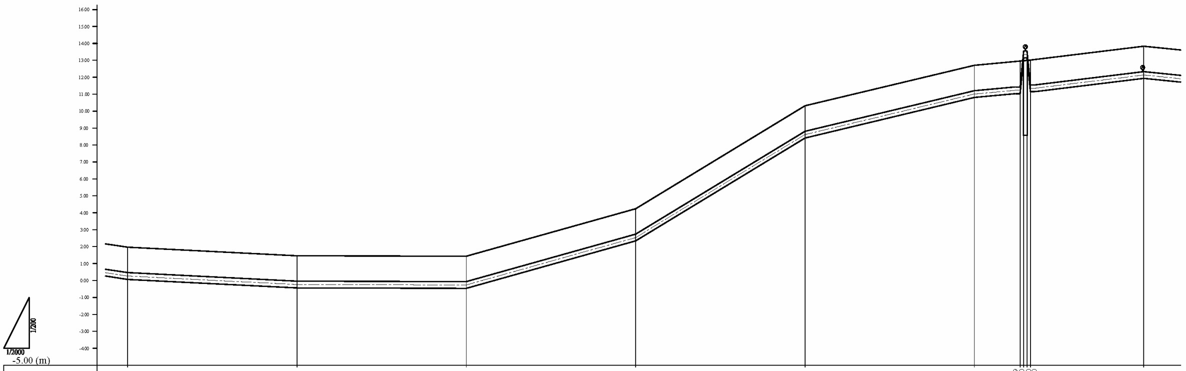


POINT NO. Station Point	13+100	13+200	13+300	13+308	13+328	13+348	13+400	13+500	13+600	13+700
Accumulated Length	13100.00	13200.00	13300.00	13308.00	13328.00	13348.00	13400.00	13500.00	13600.00	13700.00
Length	100.000	100.000	100.000	8.000	20.000	40.000	52.000	100.000	100.000	100.000
Slope	1.074 i = 0.74 %	0.338 i = 0.06 %	0.395	0.395		1.268 i = 1.40 %	1.994 i = 1.04 %	3.030 i = 1.26 %	1.768 i = 1.50 %	0.268
Earth Cover	1.500	1.500	1.500	1.662	2.620	1.500	1.500	1.500	1.500	1.500
Pipe Center Level	1.074	0.338	0.395	0.395	-0.143	1.268	1.994	3.030	1.768	0.268
ELEVATION Ground Level	2.774	2.038	2.095	2.257	2.677	2.968	3.694	4.730	3.468	1.968

THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA	TITLE : Longitudinal Sectional View of Piping (２３)
JAPAN INTERNATIONAL COOPERATION AGENCY	

Longitudinal Sectional View of Piping（２４）

S=1／2000



POINT NO. Station Point	13+700	13+800	13+900	14+000	14+100	14+200	14+226.9	14+229.0	14+231.0	14+233.0	14+300
Accumulated Length	13700.00	13800.00	13900.00	14000.00	14100.00	14200.00	14226.90	14229.00	14231.00	14233.00	14300.00
Length	100.000	100.000	100.000	100.000	100.000	100.000	26.900	2.100	2.000	2.000	67.000
Slope	0.268 i = 0.50 %	-0.236 i = 0.03 %	-0.261 i = 2.80 %	2.539 i = 6.08 %	8.615 i = 2.39 %	11.009 i=0.91%	11.255			11.320 i=1.21 %	12.134
Earth Cover	1.500	1.500	1.500	1.500	1.500	1.500	1.500			1.500	1.500
Pipe Center Level	0.268	-0.236	-0.261	2.539	8.615	11.009	11.255	13.320	13.320	11.320	12.134
ELEVATION Ground Level	1.968	1.464	1.439	4.239	10.315	12.709	12.955	12.983		13.020	13.834

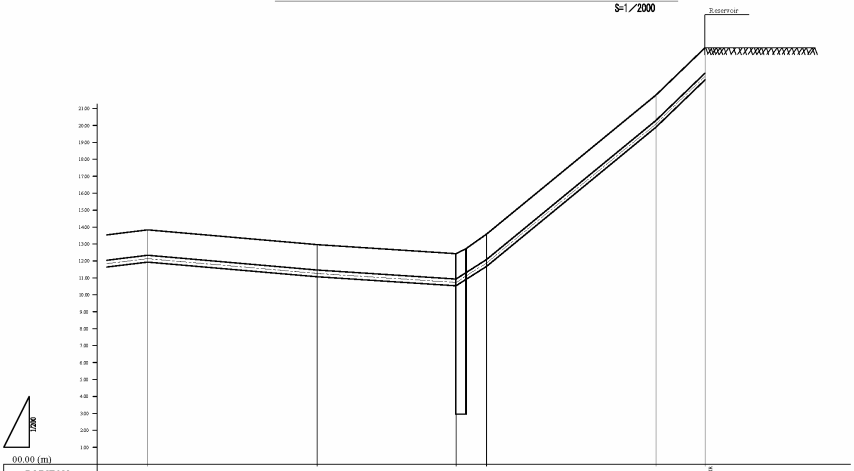
THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE：
Longitudinal Sectional View of Piping（２４）

Longitudinal Sectional View of Piping（２５）

S=1／2000



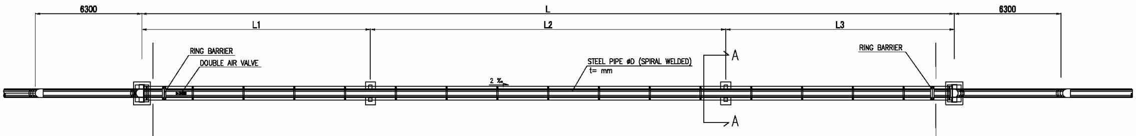
POINT NO. Station Point	14+300	14+400	14+482	14+500	14+600	14+629 RESERVOIR
Accumulated Length	14300.00	14400.00	14482.00	14500.00	14600.00	14629.00
Length	100.000	100.000	82.000	18.000	100.000	29.000
Slope	12.134 i = 0.87 %	11.264 i = 0.65 %	10.732 i=6.38%	11.881 i = 8.21 %	20.095 i=9.64%	22.890
Earth Cover	1.500	1.500	1.500	1.500	1.500	1.500
Pipe Center Level	12.134	11.264	10.732	11.881	20.095	22.890
ELEVATION Ground Level	13.834	12.964	12.432	13.581	21.795	24.590 22.335

THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

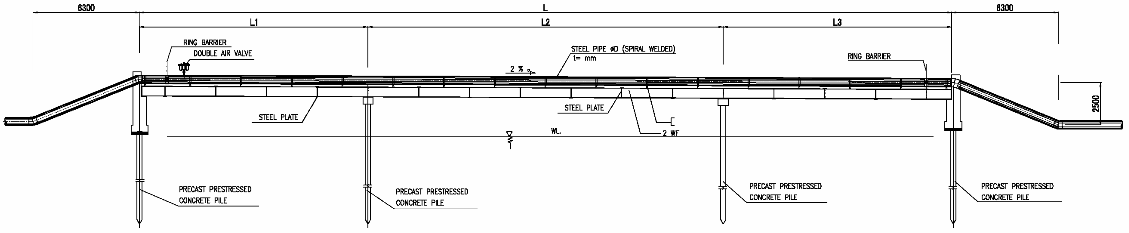
JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE：
Longitudinal Sectional View of Piping（２５）

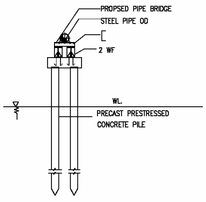
PLAN



SECTION



SECTION A - A



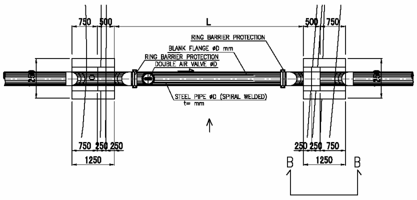
TYPE	D	t	L	L1	L2	L3
A-1	406.4	6.0	45 000	15 000	15 000	15 000
A-2	406.4	6.0	33 400	9 500	14 400	9 500
A-3	406.4	6.0	65 800	20 000	25 800	20 000

THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

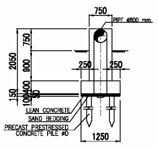
JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE :
Water Pipe Bridge Layout Plan (1)

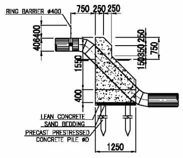
PLAN



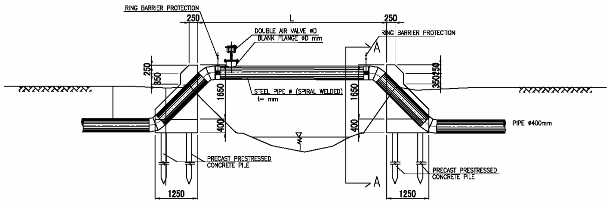
SECTION A-A



SECTION B-B



LONG SECTION



TYPE	D	t	L
B-1	406.4	6.0	21 100
B-2	406.4	6.0	24 100
B-3	406.4	6.0	26 400
B-4	406.4	6.0	21 700
B-5	406.4	6.0	23 600
B-6	406.4	6.0	19 800

THE PREPARATORY SURVEY ON APPLICATION OF WASTEWATER RECLAIMING
IN SOUTHERN BALI WATER SUPPLY SYSTEM IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE :
Water Pipe Bridge Layout Plan (2)

APPENDIX 7

INVESTIGATION DATA OF WATER DISTRIBUTION AND SUPPLY FACILITIES

APPENDIX 7 INVESTIGATION DATA OF WATER DISTRIBUTION AND SUPPLY FACILITIES

7.a Examination and Repair Strategy of Existing Distribution Pipe

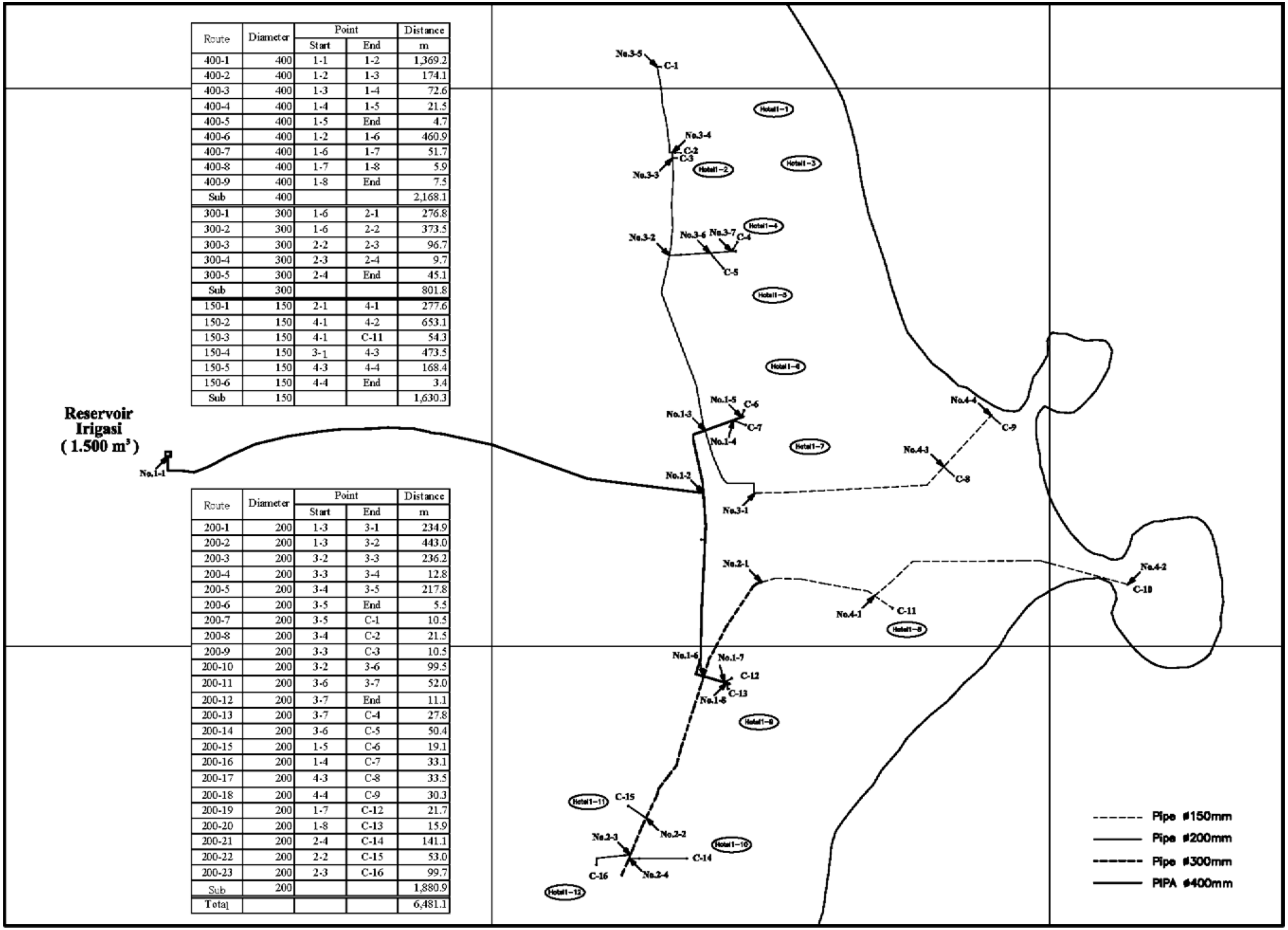
The route of existing main distribution pipe is shown as Table 7.a.1. The material of existing distribution pipes is DCIP, the length of each pipe diameter is shown as follows.

φ150mm : 1,630m
φ200mm : 1,880m
φ300mm : 800m
φ400mm : 2,170m
Total : 6,480m

The existing distribution pipe could not be confirmed by appearance inspection or etc because it is underground pipe. In detailed design stage, further investigations as follows are necessary for reconstruction.

- Water Leakage Investigation and Intratubular Washing of Existing Pipe
- Replacement of Water Shutoff Valve
- Reconstruction for water leakage part

The pipe reconstruction cost was calculated from reconstruction pipe length as 10% of total pipe length because confirmation of water leakage point of existing pipe is difficult.



Route	Diameter	Point		Distance
		Start	End	m
400-1	400	1-1	1-2	1,369.2
400-2	400	1-2	1-3	174.1
400-3	400	1-3	1-4	72.6
400-4	400	1-4	1-5	21.5
400-5	400	1-5	End	4.7
400-6	400	1-2	1-6	460.9
400-7	400	1-6	1-7	51.7
400-8	400	1-7	1-8	5.9
400-9	400	1-8	End	7.5
Sub	400			2,168.1
300-1	300	1-6	2-1	276.8
300-2	300	1-6	2-2	373.5
300-3	300	2-2	2-3	96.7
300-4	300	2-3	2-4	9.7
300-5	300	2-4	End	45.1
Sub	300			801.8
150-1	150	2-1	4-1	277.6
150-2	150	4-1	4-2	653.1
150-3	150	4-1	C-11	54.3
150-4	150	3-1	4-3	473.5
150-5	150	4-3	4-4	168.4
150-6	150	4-4	End	3.4
Sub	150			1,630.3

Route	Diameter	Point		Distance
		Start	End	m
200-1	200	1-3	3-1	234.9
200-2	200	1-3	3-2	443.0
200-3	200	3-2	3-3	236.2
200-4	200	3-3	3-4	12.8
200-5	200	3-4	3-5	217.8
200-6	200	3-5	End	5.5
200-7	200	3-5	C-1	10.5
200-8	200	3-4	C-2	21.5
200-9	200	3-3	C-3	10.5
200-10	200	3-2	3-6	99.5
200-11	200	3-6	3-7	52.0
200-12	200	3-7	End	11.1
200-13	200	3-7	C-4	27.8
200-14	200	3-6	C-5	50.4
200-15	200	1-5	C-6	19.1
200-16	200	1-4	C-7	33.1
200-17	200	4-3	C-8	33.5
200-18	200	4-4	C-9	30.3
200-19	200	1-7	C-12	21.7
200-20	200	1-8	C-13	15.9
200-21	200	2-4	C-14	141.1
200-22	200	2-2	C-15	53.0
200-23	200	2-3	C-16	99.7
Sub	200			1,880.9
Total				6,481.1

Figure 7.a.1 Route of Existing Distribution Pipe

7.b Study of Conversion for Water Service System in Hotels

In this section, the cost and renovation method of water service systems in hotels is studied in the case of reclaimed water use.

Building layout and structure of the hotel is different for every hotels, a case study is conducted because studies for all hotels of water supply target is difficult.

Hotel N was selected as a model of case study for the reason of below.

- Water service system is relatively complex system of plane and cross-section arrangement.
- Hotel N is the typical size hotel (Rooms 300-400) for water supply target hotels.
- Hotel N provided detailed floor plans, cross-section and plumbing.

Table 7.b.1 Distribution of Room Number in Hotels for Water Supply Target

Number of Rooms	Number of Hotel	Total Room Number
401～(750)	4	2,311
301～400	**7**	**2,512**
201～300	2	526
101～200	9	1,407
Under 100	19	832
Total	41	7588

The conditions of the cost study for renovation of water service pipes in Hotel N is as follows.

・Number of Rooms	: about 400 rooms
・Building Layout	: Main Building (3 floors), Northern Building (6 floors), Southern Building (5 floors), Coast Building (14 floors)
・Number of Restaurant	: 6 praces
・Total Volume of Water Consumption	: about 1,000 m^3/day
- Water Volume for Toilet	: about 200 m^3/day (20%) (Capacity of new pump for Case1)
- Water Volume for Drinking	: about 200 m^3/day (20%) (Capacity of new pump for Case2)
- Water Volume for Non-drinking	: about 800 m^3/day (40%) (including 400 m^3/day of reclaimed water volume for Case2)

Layout plan of Hotel N is shown as Figure 7.b.1, its profile is shown Figure 7.b.2.

Figure 7.b.1 Layout Plan of Hotel N (sources: G2011 Google-Map Data)

Figure 7.b.2 Profile of Hotel N (source: http://www.nikkobali.com/jp/)

2 case of renovation design as follows are studied

Case 1: Typical Reclaimed Water Service System
Case 2: New Clean Water Service System

(1) Case 1 Renovation Design

According to Case 1, the renovation design model is shown as Figure 7.b.3.

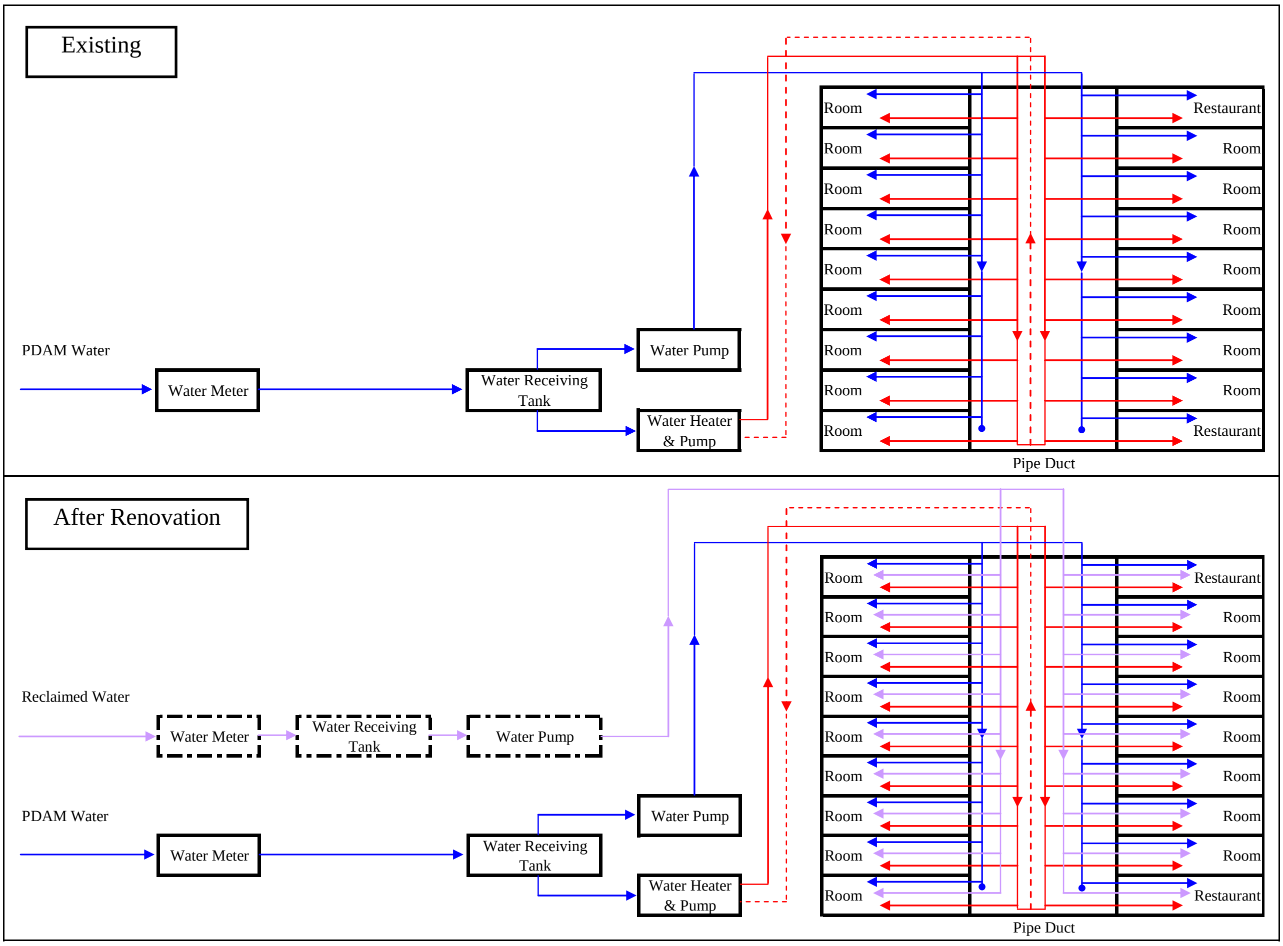


Figure 7.b.3 Model for Renovation of Water Service Pipes (Case 1)

Therefore the renovation work as following items is necessary.

- Installation work of reclaimed water service pipes
  (Water Meter – Receiving Tank – Water Pump – Rooms)
- Construction work of water receiving tank for reclaimed water
- Installation work of water meter for reclaimed water
- Installation work of water pump for reclaimed water

The image for route of new water service pipe is shown as Figure 7.b.4.

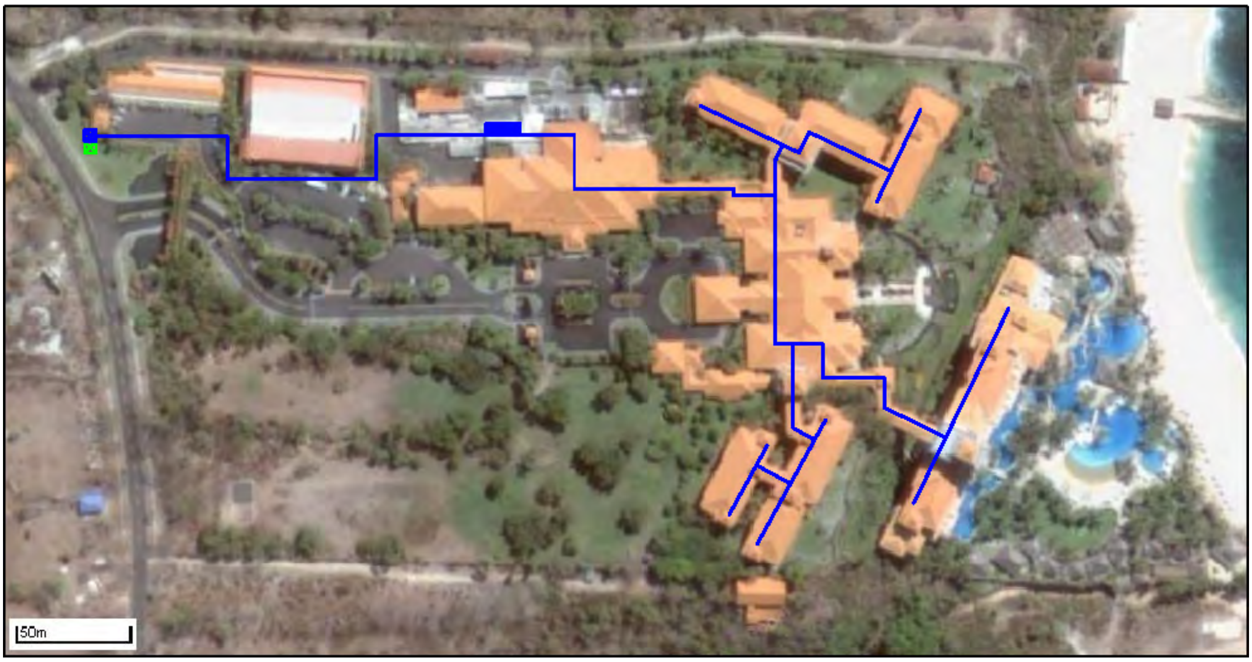


Figure 7.b.4 Image for Route of New Water Service Pipe (Case 1)

The existing water meter is located with green mark and the route of new water service is located with blue line on Figure 7.b.4.

The conversion cost based on above route is calculated as Table 7.b.2.

Table 7.b.2 Conversion Cost in Hotel for Typical Water Service System (Case1)

Item	Quantity	Unit	Unit Price (IDR)	Cost (IDR)
Installation work of reclaimed water service pipes	2,420	m	370,000	895,400,000
Construction work of water receiving tank for reclaimed water	1	Set	488,870,000	488,870,000
Installation work of water meter for reclaimed water	1	Set	8,000,000	8,000,000
Installation work of water meter for reclaimed water	1	Set	100,000,000	100,000,000
Total Cost				1,492,270,000

(2) Case 2 Renovation Design

According to Case 2, the renovation design model is shown as Figure 7.b.5.

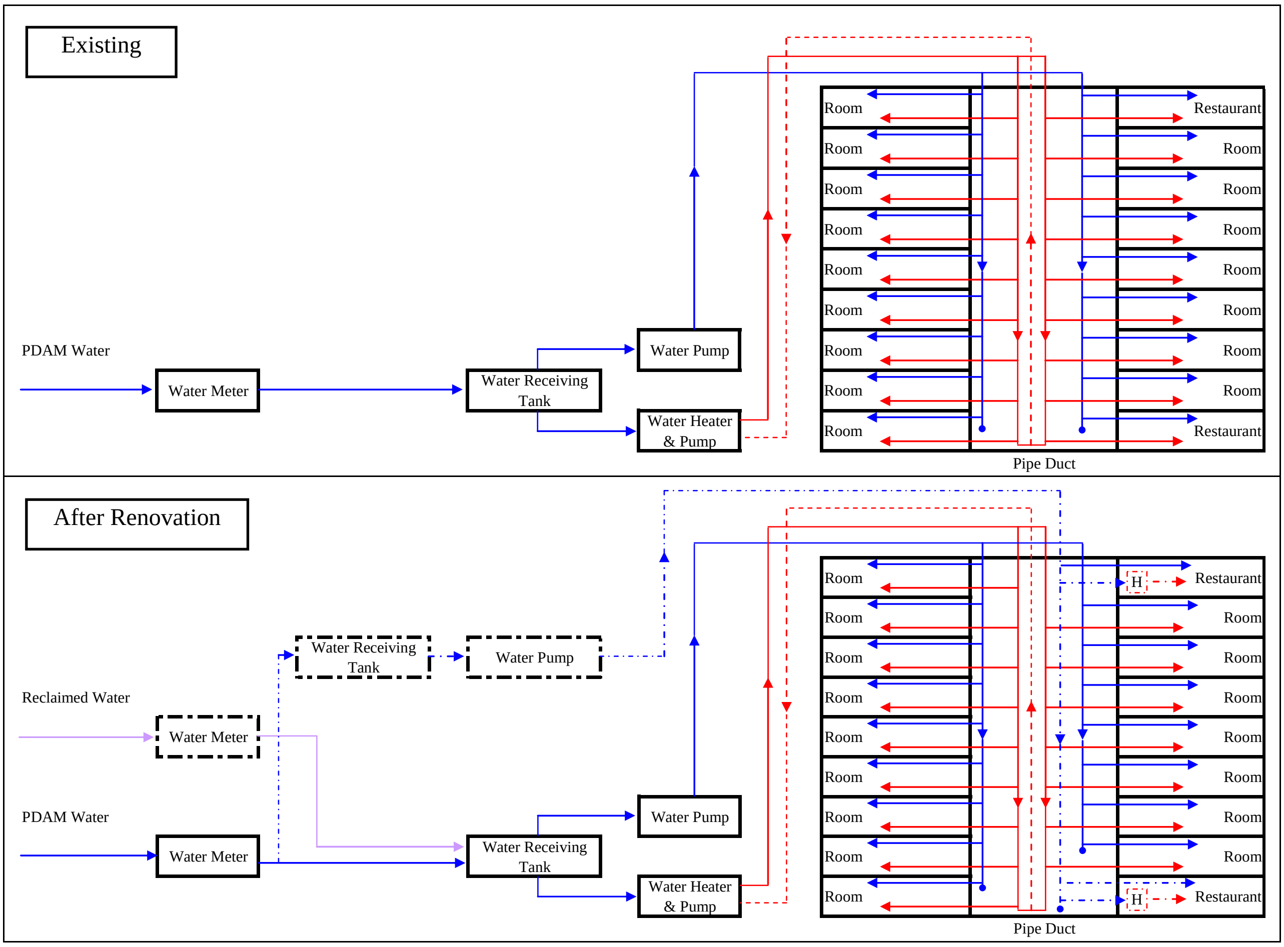


Figure 7.b.5 Model for Renovation of Water Service Pipes (Case 2)

Therefore the renovation work as following items is necessary.

- Installation work of reclaimed water service pipes
  (For reclaimed water: Water Meter – Receiving Tank)
  (For PDAM water: Water Meter – Receiving Tank – Water Pump – Restaurants)
- Construction work of water receiving tank for reclaimed water
- Installation work of water meter for reclaimed water
- Installation work of water pump for reclaimed water
- Installation work of water heater for reclaimed water

The image for route of new water service pipe is shown as Figure 7.b.6.

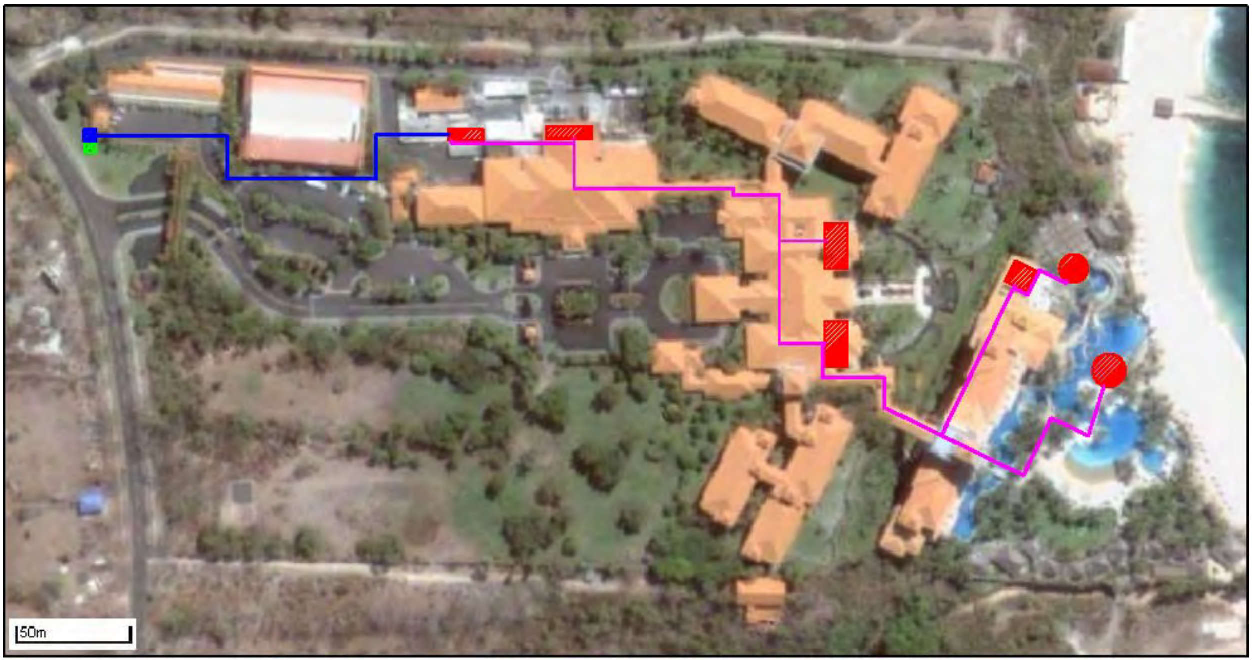


Figure 7.b.6 Image for Route of New Water Service Pipe (Case 2)

The existing water meter is located with green mark, restaurants are located with red marks and the route of new water service is located with blue line on Figure 7.b.6.

The conversion cost based on above route is calculated as Table 7.b.3.

Table 7.b.3 Conversion Cost in Hotel for Typical Water Service System (Case2)

Item	Quantity	Unit	Unit Price (IDR)	Cost (IDR)
Installation work of reclaimed water service pipes	920	m	363,000	333,960,000
Construction work of water receiving tank for reclaimed water	1	Set	488,870,000	488,870,000
Installation work of water meter for reclaimed water	1	Set	20,000,000	20,000,000
Installation work of water meter for reclaimed water	1	Set	100,000,000	100,000,000
Installation work of water heater for reclaimed water	6	Set	8,000,000	48,000,000
Total Cost				990,830,000

APPENDIX 8

DATA OF PROJECT COST ESTIMATE

APPENDIX 8　DATA OF PROJECT COST ESTIMATE

8.a　Component of Project Cost

The four main cost components of the reclaimed water supply project cost are construction, engineering services, taxes, operation and maintenance (O&M). These are further categorized as shown in the following table.

Table 8.a.1　Components of the Project Cost

Main Item	Detail Item
【1】Construction	(A) Site Preparation
	(B) Reclamation Plant Construction
	(C) Transmission Pipe Installation
	(D) Distribution Reservoir Reconstruction
	(E) Distribution Pipe Rehabilitation and Installation
	(F) Renovating the Service Pipe Facilities in Each Hotel
【2】Engineering Services	(A) Detailed Design, Construction Supervision, Other Surveys, etc.
	(B) Capacity Building
	(C) Publication and Education-related
【3】Tax Charges	(A) Value-added Tax (VAT)
	(B) Import Tax
	(C) Surface Water Use Tax
【4】Operation and Maintenance (O&M)	(A) Personnel
	(B) Electricity
	(C) Chemical
	(D) Fuel
	(E) Water Quality Testing
	(F) Repair and Replacement of parts and equipment
	(G) Office expenditures
	(H) Treated Water Use Rate

8.b　Construction Cost

Construction costs are calculated for all the facilities required for the project, from the reclamation plant to the renovation of service pipe facilities in each hotel. As explained in Chapter 7, the responsibility for constructing and renovating these facilities is divided between SPC, PDAM Badung and the hotels; and the associated costs are calculated separately for these parties. Construction costs under SPC's responsibility consist of site preparation, reclamation plant construction and transmission pipeline construction. Construction costs under PDAM's responsibility consist of distribution reservoir reconstruction, rehabilitation of the existing distribution network and installation of new distribution pipes. The construction costs under the responsibility of each hotel consist of renovation of their service pipe facilities. The detail of each construction cost item is explained in the following.

Table 8.b.1　Responsible Organization of the Each Component

Items	SPC	PDAM	Hotels
(A) Site Preparation	○		
(B) Reclamation Plant Construction	○		
(C) Transmission Pipe Installation	○		
(D) Distribution Reservoir Reconstruction		○	
(E) Distribution Pipe Installation		○	
(F) Renovating the Service Pipe Facilities in Each Hotel			○

(1) Site Preparation

Site preparation consists of the following:

- Improvement of the access road to the reclamation plant site
- Cutting down of mangrove trees, digging up of soft soil and removal of concrete debris
- Land reclamation and leveling using purchased soil

The land for the reclaimed water supply plant will be provided by the Bali Provincial Government as a precondition of this PPP project (the Bali Provincial Government needs to apply to to the Ministry of Forestry for the license to use the land.

(2) Reclamation Plant Construction

This cost category covers the construction of the pump facility to convey the secondary effluent from Denpasar WWTP, biological filtration facility, ozonation facility, membrane filtration facility and transmission pump facility. The breakdown by facility type is shown as follows.

1) Main plant construction (civil engineering and architectural works)
- Raw water pumping station
- Biological filtration process building
- Ozonation process building
- Membrane filtration process building
- Site work
- Vehicle purchase
- Connection charge for electrical service

2) Mechanical and Electrical Facility

- Mechanical equipment (including installation)
- Electrical equipment (including installation)

(3) Transmission Pipe Installation

The transmission pipe from Denpasar WWTP to the existing UPA distribution reservoir would be constructed in four sections, using different pipe installation methods, according to the level of traffic congestion and the ease of pipe installation at the location. The total cost for the transmission pipe installation the sum of the pipe installation costs for each section. The length of each road section is shown below.

- Open cut method (daytime work : about 7.5 km)
- Open cut method (nighttime work : about 7 km from Badung River to Sama River)
- Water pipe bridge method (crossing of river and drainage canal)
- Pipe jacking method (around the airport about 400 m)

(4) Distribution Reservoir Reconstruction

The existing reservoir does not have a roof and has many cracks and evidence of water leakage. The cost for reconstruction would cover the following:

- Crack repair
- Waterproofing
- Roof construction

(5) Distribution Pipe Installation

The distribution pipe installation cost would cover the following:

- Rehabilitation of the existing distribution pipes in Nusa Dua
- Installation of new distribution pipes in Benoa
- Installation of new distribution pipe in Sawangan

(6) Renovation of Service Pipe Facilities in the Hotels

The renovation cost is required to use reclaimed water in the hotels. The unit cost of renovation is calculated in Chapter 6.

<Summary of Case 1>
The renovation cost would establish a system to supply the reclaimed water to the toilet in each room or floor.

<Summary of Case 2>
The renovation cost would establish a system to supply the reclaimed water which is mixed with PDAM water and a separate system to supply drinking and cooking water to the restaurants inside the hotels.

(7) Total Construction Cost

The total construction costs calculated on the conditions by each facility and responsible agency explained above is shown in Table 8.b.2 (Case 1) or Table 8.b.3 (Case 2). The breakdown for each item of construction cost is shown as Table 8.b.4 (Case 1) and Table 8.b.5 (Case 2), the unit price is shown as Table 8.b.6.

Table 8.b.2 Construction Cost of Case 1

(1) Construction Cost by Each Facility

Item	IDR (×1,000)			JPY (×1,000)
	LC	FC	Total	Total
【A Site Preparation】				
Site Preparation	5,968,887	0	5,968,887	54,257
【B Reclamation Plant Facility】				
Structure Construction				
Raw Water Pump Building	976,400	0	976,400	8,875
Biological Treatment Building	5,455,191	0	5,455,191	49,588
Ozonation Building	7,942,297	0	7,942,297	72,195
Membrane Filtration Building	12,454,956	0	12,454,956	113,216
Site Work	3,598,539	0	3,598,539	32,711
Vehicles	2,070,000	0	2,070,000	18,816
Connection Charge for Electricity	631,250	0	631,250	5,738
Sub Total (1)	33,128,632	0	33,128,632	301,139
Mechanical and Electrical Facility				
Mechanical Equipment	28,027,620	24,004,951	52,032,571	472,976
Electrical Equipment	35,613,810	0	35,613,810	323,730
Sub Total (2)	63,641,430	24,004,951	87,646,381	796,706
Total	96,770,062	24,004,951	120,775,013	1,097,845
【C Water Transmission Pipe】				
Water Transmission Pipe	44,144,600	0	44,144,600	401,274
【D Distribution Reservoir】				
Distribution Reservoir	3,449,933	0	3,449,933	31,360
【E Distribution Pipe】				
Distribution Pipe for Nusa Dua	3,342,380	0	3,342,380	30,382
Distribution Pipe for Benoa	10,285,000	0	10,285,000	93,491
Distribution Pipe for Sawangan	8,465,200	0	8,465,200	76,949
Total	22,092,580	0	22,092,580	200,822
【F Renovation of Service Pipe Facilities in the Hotel 】				
Renovation Cost	29,230,000	0	29,230,000	265,701
Total	29,230,000	0	29,230,000	265,701

(2) Construction Cost by Responsible Agency

Item	IDR (×1,000)			JPY (×1,000)
	LC	FC	Total	Total
SPC Total Construction Cost	146,883,549	24,004,951	170,888,500	1,553,376
PDAM Total Construction Cost	25,542,513	0	25,542,513	232,181
Hotel Total Renovation Cost	29,230,000	0	29,230,000	265,701
Grand Total Construction Cost	201,656,062	24,004,951	225,661,013	2,051,259

Table 8.b.3 Construction Cost of Case 2

(1) Construction Cost by Each Facility

Item	IDR (×1,000)			JPY (×1,000)
	LC	FC	Total	Total
【A Site Preparation】				
Site Preparation	6,507,139	0	6,507,139	59,150
【B Reclamation Plant Facility】				
Structure Construction				
Raw Water Pump Building	1,224,468	0	1,224,468	11,130
Biological Treatment Building	9,387,773	0	9,387,773	85,335
Ozonation Building	8,823,814	0	8,823,814	80,208
Membrane Filtration Building	14,261,371	0	14,261,371	129,636
Site Work	4,357,294	0	4,357,294	39,608
Vehicles	2,070,000	0	2,070,000	18,816
Connection Charge for Electricity	631,250	0	631,250	5,738
Sub Total (1)	40,755,971	0	40,755,971	370,472
Mechanical and Electrical Facility				
Mechanical Equipment	33,402,949	34,308,417	67,711,366	615,496
Electrical Equipment	35,613,810	0	35,613,810	323,730
Sub Total (2)	69,016,759	34,308,417	103,325,176	939,226
Total	109,772,730	34,308,417	144,081,147	1,309,698
【C Water Transmission Pipe】				
Water Transmission Pipe	56,218,200	0	56,218,200	511,023
【D Distribution Reservoir】				
Distribution Reservoir	3,449,933	0	3,449,933	31,360
【E Distribution Pipe】				
Distribution Pipe for Nusa Dua	3,342,380	0	3,342,380	30,382
Distribution Pipe for Benoa	13,326,700	0	13,326,700	121,140
Distribution Pipe for Sawangan	10,757,200	0	10,757,200	97,783
Total	27,426,280	0	27,426,280	249,305
【F Renovation of Service Pipe Facilities in the Hotel 】				
Renovation Cost	19,750,000	0	19,750,000	179,528
Total	19,750,000	0	19,750,000	179,528

(2) Construction Cost by Responsible Agency

Item	IDR (×1,000)			JPY (×1,000)
	LC	FC	Total	Total
SPC Total Construction Cost	172,498,069	34,308,417	206,806,486	1,879,871
PDAM Total Construction Cost	30,876,213	0	30,876,213	280,665
Hotel Total Renovation Cost	19,750,000	0	19,750,000	179,528
Grand Total Construction Cost	223,124,281	34,308,417	257,432,698	2,340,063

Table 8.b.4 Breakdown for Each Item of Case 1 Construction Cost

A1 Site Preparation for Treatment Plant

Items	Specification	Unit	Quantity	Unit Cost (IDR)		Total Cost (1,000IDR)			Reference
				LC	FC	LC	FC	Total	
Excavation (Root of Mangrove, Existing Structure		m^3	7,590	102,000	0	774,180	0	774,180	
Waste Disposal (Root of Mangrove, Existing Struc		m^3	7,590	56,600	0	429,594	0	429,594	
Landfill	(Compacted use buy soil)	m^3	19,800	144,800	0	2,867,040	0	2,867,040	
Existing Bridge Removal		m^2	30	1,980,000	0	59,400	0	59,400	
Administrative Road	Pavement Work	m^2	2,910	260,300	0	757,473	0	757,473	
Administrative Road	Sub-base (aggregate A)	m^3	600	330,000	0	198,000	0	198,000	
Administrative Road	Sub-base (aggregate B)	m^3	900	330,000	0	297,000	0	297,000	
New Bridge Construction	Width=5m, Length=3m	m^2	15	5,720,000	0	85,800	0	85,800	
New Bridge Construction	Width=5m, Length=14m	m^2	70	5,720,000	0	400,400	0	400,400	
Gate and Guard Post		set	1	100,000,000	0	100,000	0	100,000	
Total						5,968,887	0	5,968,887	

B1 Raw Water Pump Tank

Items	Specification	Unit	Quantity	Unit Cost (IDR)		Total Cost (1,000IDR)			Reference
				LC	FC	LC	FC	Total	
Excavation	Sand, Cray	m^3	756	46,000	0	34,776	0	34,776	
Back Filling	BH	m^3	580	43,300	0	25,114	0	25,114	
Surplus Soil Disposal		m^3	176	56,600	0	9,962	0	9,962	
Foundation Pile	L=20m	pcs	23	12,940,000	0	297,620	0	297,620	
Sand Layer		m^3	7	202,300	0	1,416	0	1,416	
Leveling Concrete		m^3	4	1,294,000	0	5,176	0	5,176	
Reinforced Concrete		m^3	136	2,534,000	0	344,624	0	344,624	
Reinforcement		t	13.6	16,120,000	0	219,232	0	219,232	
Roofing		m^2	37	1,040,000	0	38,480	0	38,480	
Total						976,400	0	976,400	

B2 Biological Treatment Building

Items	Specification	Unit	Quantity	Unit Cost (IDR)		Total Cost (1,000IDR)			Reference
				LC	FC	LC	FC	Total	
Excavation	Sand, Cray	m^3	185	46,000	0	8,510	0	8,510	
Back Filling	BH	m^3	7	43,300	0	303	0	303	
Surplus Soil Disposal		m^3	178	56,600	0	10,075	0	10,075	
Foundation Pile	L=20m	pcs	150	12,940,000	0	1,941,000	0	1,941,000	
Sand Layer		m^3	89	202,300	0	18,005	0	18,005	
Leveling Concrete		m^3	45	1,294,000	0	58,230	0	58,230	
Reinforced Concrete		m^3	749	2,534,000	0	1,897,966	0	1,897,966	
Reinforcement		t	74.9	16,120,000	0	1,207,388	0	1,207,388	
Roofing		m^2	224	1,040,000	0	232,960	0	232,960	
Waterproofing		m^2	1,252	64,500	0	80,754	0	80,754	
Total						5,455,191	0	5,455,191	

B3 Ozonation Building

Items	Specification	Unit	Quantity	Unit Cost (IDR)		Total Cost (1,000IDR)			Reference
				LC	FC	LC	FC	Total	
Excavation	Sand, Cray	m^3	373	46,000	0	17,158	0	17,158	
Back Filling	BH	m^3	10	43,300	0	433	0	433	
Surplus Soil Disposal		m^3	363	56,600	0	20,546	0	20,546	
Foundation Pile	L=20m	pcs	172	12,940,000	0	2,225,680	0	2,225,680	
Sand Layer		m^3	182	202,300	0	36,819	0	36,819	
Leveling Concrete		m^3	91	1,294,000	0	117,754	0	117,754	
Reinforced Concrete		m^3	1,106	2,534,000	0	2,802,604	0	2,802,604	
Reinforcement		t	110.6	16,120,000	0	1,782,872	0	1,782,872	
Roofing		m^2	765	1,040,000	0	795,600	0	795,600	
Waterproofing		m^2	447	64,500	0	28,832	0	28,832	
Corrosion Protection Coating		m^2	114	1,000,000	0	114,000	0	114,000	
Total						7,942,297	0	7,942,297	

B4 Membrane Filtration Building

Items	Specification	Unit	Quantity	Unit Cost (IDR)		Total Cost (1,000IDR)			Reference
				LC	FC	LC	FC	Total	
Excavation	Sand, Cray	m^3	1,924	46,000	0	88,504	0	88,504	
Back Filling	BH	m^3	649	43,300	0	28,102	0	28,102	
Surplus Soil Disposal		m^3	1,275	56,600	0	72,165	0	72,165	
Foundation Pile	L=20m	pcs	245	12,940,000	0	3,170,300	0	3,170,300	
Sand Layer		m^3	210	202,300	0	42,483	0	42,483	
Leveling Concrete		m^3	105	1,294,000	0	135,870	0	135,870	
Reinforced Concrete		m^3	1,580	2,534,000	0	4,003,720	0	4,003,720	
Reinforcement		t	158.0	16,120,000	0	2,546,960	0	2,546,960	
Roofing		m^2	1,278	1,040,000	0	1,329,120	0	1,329,120	
Waterproofing		m^2	585	64,500	0	37,733	0	37,733	
Laboratory Equipment		set	1	1,000,000,000	0	1,000,000	0	1,000,000	
Total						12,454,956	0	12,454,956	

B5 Site Work

Items	Specification	Unit	Quantity	Unit Cost (IDR)		Total Cost (1,000IDR)			Reference
				LC	FC	LC	FC	Total	
Fence		m	350	500,000	0	175,000	0	175,000	
Road	Pavement Work	m^2	2,900	260,300	0	754,870	0	754,870	
Road	Sub-base (aggregate A)	m^3	580	330,000	0	191,400	0	191,400	
Road	Sub-base (aggregate B)	m^3	870	330,000	0	287,100	0	287,100	
Lawn Grass		m^2	2,290	50,800	0	116,332	0	116,332	
Drainage		m	332	1,431,000	0	475,092	0	475,092	
Electric Lamp		set	10	3,000,000	0	30,000	0	30,000	
Gate and Guard Post		set	1	100,000,000	0	100,000	0	100,000	
Pipe Laying Work	For Transmission pipe (300mm	m	560	1,631,000	0	913,360	0	913,360	
Pipe Laying Work	For Raw water pipe (300mm)	m	100	1,631,000	0	163,100	0	163,100	
Pipe Laying Work	For Discharge pipe (200mm)	m	335	1,171,000	0	392,285	0	392,285	
Total						3,598,539	0	3,598,539	

B6 Maintenance Equipment

Items	Specification	Unit	Quantity	Unit Cost (IDR)		Total Cost (1,000IDR)			Reference
				LC	FC	LC	FC	Total	
Patrol Car	Sedan Type	units	1	270,000,000		270,000	0	270,000	
Tanker Truck	4t	units	2	900,000,000		1,800,000	0	1,800,000	
Total						2,070,000	0	2,070,000	

B7 Machinery Construction

(1IDR = 0.00909)

Items	Specification	Unit	Quantity	Unit Cost (IDR)		Total Cost (1,000IDR)			Reference (JPY)
				LC	FC	LC	FC	Total	
Machinery Equipment		units	1	6,077,331,000	17,569,307,000	6,077,331	17,569,307	23,646,638	159,705,000
Transmission Pump		units	2	225,000,000	0	450,000	0	450,000	
Crane		units	1	216,000,000	0	216,000	0	216,000	
Equipment and Pipe Instration		units	1	21,284,289,000	6,435,644,000	21,284,289	6,435,644	27,719,933	58,500,000
Total						28,027,620	24,004,951	52,032,571	

B8 Electricity Construction

(1IDR = 0.00909)

Items	Specification	Unit	Quantity	Unit Cost (IDR)		Total Cost (1,000IDR)			Reference (JPY)
				LC	FC	LC	FC	Total	
Electricity Equipment for Main Facilities		units	1	10,290,267,000	0	10,290,267	0	10,290,267	
Monitoring Device		units	1	2,457,000,000	0	2,457,000	0	2,457,000	
Receiving Electricity Equipment	20kV	units	1	1,602,000,000	0	1,602,000	0	1,602,000	
Electric Generator		units	1	7,605,000,000	0	7,605,000	0	7,605,000	
Electricity Equipment for Transmission Pump		units	1	522,000,000	0	522,000	0	522,000	
Instrumentation Equipment for UPA Reservoir		units	1	90,000,000	0	90,000	0	90,000	
Monitoring Device for UPA Reservoir		units	1	99,000,000	0	99,000	0	99,000	
Equipment and Cable Installation for Main		units	1	7,730,541,000	0	7,730,541	0	7,730,541	
Equipment and Cable Installation for Others		units	1	5,218,002,000	0	5,218,002	0	5,218,002	
Total						35,613,810	0	35,613,810	

C1 Water Transmission Pipe Line

Items	Specification	Unit	Quantity	Unit Cost (IDR)		Total Cost (1,000IDR)			Reference
				LC	FC	LC	FC	Total	
Open Cut Methods	φ 300 (Daytime work)	m	7,500	2,125,000	0	15,937,500	0	15,937,500	
Open Cut Methods	φ 300 (Nighttime work)	m	7,000	2,762,500	0	19,337,500	0	19,337,500	
Pipe Bridge Methods	φ 300, L=120m	set	1	1,440,000,000	0	1,440,000	0	1,440,000	
Pipe Bridge Methods	φ 300, L=50m	set	1	884,000,000	0	884,000	0	884,000	
Pipe Bridge Methods	φ 300, L=70m	set	1	645,600,000	0	645,600	0	645,600	
Pipe Bridge Methods	φ 300, L=10m	set	5	180,000,000	0	900,000	0	900,000	
Pipe Jacking Methods	φ 300	m	400	12,500,000	0	5,000,000	0	5,000,000	
Total						44,144,600	0	44,144,600	

D1 Distribution Reservoir

Items	Specification	Unit	Quantity	Unit Cost (IDR)		Total Cost (1,000IDR)			Reference
				LC	FC	LC	FC	Total	
Mortar Removal		m^2	500	26,000		13,000	0	13,000	
Chemical Anchor		pcs	2,000	1,000,000		2,000,000	0	2,000,000	
Reinforced Concrete		m^3	100	2,534,000		253,400	0	253,400	
Reinforcement		t	10	16,120,000		161,200	0	161,200	
Waterproofing		m^2	900	64,500		58,050	0	58,050	
Roof		m^2	400	2,000,000		800,000	0	800,000	
Fixtures and Fittings		set	1	164,282,500		164,283	0	164,283	Total cost 5%
Total						3,449,933	0	3,449,933	

E1 Distribution Pipe Line for Nusa Dua

Items	Specification	Unit	Quantity	Unit Cost (IDR)		Total Cost (1,000IDR)			Reference
				LC	FC	LC	FC	Total	
Water Leakage Investigation		set	1	250,000,000		250,000	0	250,000	
Pipe Replacement DCIP	φ 400	m	220	5,442,000		1,197,240	0	1,197,240	
Pipe Replacement DCIP	φ 300	m	80	3,652,000		292,160	0	292,160	
Pipe Replacement DCIP	φ 200	m	190	2,302,000		437,380	0	437,380	
Pipe Replacement DCIP	φ 150	m	160	1,905,000		304,800	0	304,800	
Water Stop Valve Replacement	φ 400	set	2	72,000,000		144,000	0	144,000	
Water Stop Valve Replacement	φ 200	set	16	36,800,000		588,800	0	588,800	
Water Stop Valve Replacement	φ 150	set	4	32,000,000		128,000	0	128,000	
Total						3,342,380	0	3,342,380	

E2 Distribution Pipe Line for Benoa

Items	Specification	Unit	Quantity	Unit Cost (IDR)		Total Cost (1,000IDR)			Reference
				LC	FC	LC	FC	Total	
Pipe Laying	φ 200	m	5,800	1,606,000		9,314,800	0	9,314,800	
Pipe Laying	φ 100	m	700	1,386,000		970,200	0	970,200	
Total						10,285,000	0	10,285,000	

E3 Distribution Pipe Line for Sawangan

Items	Specification	Unit	Quantity	Unit Cost (IDR)		Total Cost (1,000IDR)			Reference
				LC	FC	LC	FC	Total	
Pipe Laying	ϕ 200	m	4,000	1,606,000		6,424,000	0	6,424,000	
Pipe Laying	ϕ 100	m	1,200	1,386,000		1,663,200	0	1,663,200	
Booster Pump	0.8m3/min 18.5kW	set	2	77,000,000		154,000	0	154,000	
Electric Panel	Soft Starter	set	1	224,000,000		224,000	0	224,000	
Total						8,465,200	0	8,465,200	

F1 Hotel Conversion

Items	Specification	Unit	Quantity	Unit Cost (IDR)		Total Cost (1,000IDR)			Reference
				LC	FC	LC	FC	Total	
Hotel Converting Cost		Room	7,900	3,700,000		29,230,000	0	29,230,000	
Total						29,230,000	0	29,230,000	

Table 8.b.5 Breakdown for Each Item of Case 2 Construction Cost

A1 Site Preparation for Treatment Plant

Items	Specification	Unit	Quantity	Unit Cost (IDR)		Total Cost (1,000IDR)			Reference
				LC	FC	LC	FC	Total	
Excavation (Root of Mangrove, Existing Structure		m^3	8,610	102,000	0	878,220	0	878,220	
Waste Disposal (Root of Mangrove, Existing Struc		m^3	8,610	56,600	0	487,326	0	487,326	
Landfill	(Compacted use buy soil)	m^3	22,400	144,800	0	3,243,520	0	3,243,520	
Existing Bridge Removal		m^2	30	1,980,000	0	59,400	0	59,400	
Administrative Road	Pavement Work	m^2	2,910	260,300	0	757,473	0	757,473	
Administrative Road	Sub-base (aggregate A)	m^3	600	330,000	0	198,000	0	198,000	
Administrative Road	Sub-base (aggregate B)	m^3	900	330,000	0	297,000	0	297,000	
New Bridge Construction	Width=5m, Length=3m	m^2	15	5,720,000	0	85,800	0	85,800	
New Bridge Construction	Width=5m, Length=14m	m^2	70	5,720,000	0	400,400	0	400,400	
Gate and Guard Post		set	1	100,000,000	0	100,000	0	100,000	
Total						6,507,139	0	6,507,139	

B1 Raw Water Pump Tank

Items	Specification	Unit	Quantity	Unit Cost (IDR)		Total Cost (1,000IDR)			Reference
				LC	FC	LC	FC	Total	
Excavation	Sand, Cray	m^3	837	46,000	0	38,502	0	38,502	
Back Filling	BH	m^3	616	43,300	0	26,673	0	26,673	
Surplus Soil Disposal		m^3	221	56,600	0	12,509	0	12,509	
Foundation Pile	L=20m	pcs	29	12,940,000	0	375,260	0	375,260	
Sand Layer		m^3	10	202,300	0	2,023	0	2,023	
Leveling Concrete		m^3	5	1,294,000	0	6,470	0	6,470	
Reinforced Concrete		m^3	172	2,534,000	0	435,848	0	435,848	
Reinforcement		t	17.2	16,120,000	0	277,264	0	277,264	
Roofing		m^2	48	1,040,000	0	49,920	0	49,920	
Total						1,224,468	0	1,224,468	

B2 Biological Treatment Building

Items	Specification	Unit	Quantity	Unit Cost (IDR)		Total Cost (1,000IDR)			Reference
				LC	FC	LC	FC	Total	
Excavation	Sand, Cray	m^3	303	46,000	0	13,938	0	13,938	
Back Filling	BH	m^3	8	43,300	0	346	0	346	
Surplus Soil Disposal		m^3	295	56,600	0	16,697	0	16,697	
Foundation Pile	L=20m	pcs	266	12,940,000	0	3,442,040	0	3,442,040	
Sand Layer		m^3	147	202,300	0	29,738	0	29,738	
Leveling Concrete		m^3	74	1,294,000	0	95,756	0	95,756	
Reinforced Concrete		m^3	1,277	2,534,000	0	3,235,918	0	3,235,918	
Reinforcement		t	127.7	16,120,000	0	2,058,524	0	2,058,524	
Roofing		m^2	327	1,040,000	0	340,080	0	340,080	
Waterproofing		m^2	2,399	64,500	0	154,736	0	154,736	
Total						9,387,773	0	9,387,773	

B3 Ozonation Building

Items	Specification	Unit	Quantity	Unit Cost (IDR)		Total Cost (1,000IDR)			Reference
				LC	FC	LC	FC	Total	
Excavation	Sand, Cray	m^3	373	46,000	0	17,158	0	17,158	
Back Filling	BH	m^3	10	43,300	0	433	0	433	
Surplus Soil Disposal		m^3	363	56,600	0	20,546	0	20,546	
Foundation Pile	L=20m	pcs	197	12,940,000	0	2,549,180	0	2,549,180	
Sand Layer		m^3	182	202,300	0	36,819	0	36,819	
Leveling Concrete		m^3	91	1,294,000	0	117,754	0	117,754	
Reinforced Concrete		m^3	1,234	2,534,000	0	3,126,956	0	3,126,956	
Reinforcement		t	123.4	16,120,000	0	1,989,208	0	1,989,208	
Roofing		m^2	683	1,040,000	0	710,320	0	710,320	
Waterproofing		m^2	658	64,500	0	42,441	0	42,441	
Corrosion Protection Coating		m^2	213	1,000,000	0	213,000	0	213,000	
Total						8,823,814	0	8,823,814	

B4 Membrane Filtration Building

Items	Specification	Unit	Quantity	Unit Cost (IDR)		Total Cost (1,000IDR)			Reference
				LC	FC	LC	FC	Total	
Excavation	Sand, Cray	m^3	2,422	46,000	0	111,412	0	111,412	
Back Filling	BH	m^3	706	43,300	0	30,570	0	30,570	
Surplus Soil Disposal		m^3	1,716	56,600	0	97,126	0	97,126	
Foundation Pile	L=20m	pcs	291	12,940,000	0	3,765,540	0	3,765,540	
Sand Layer		m^3	256	202,300	0	51,789	0	51,789	
Leveling Concrete		m^3	128	1,294,000	0	165,632	0	165,632	
Reinforced Concrete		m^3	1,848	2,534,000	0	4,682,832	0	4,682,832	
Reinforcement		t	184.8	16,120,000	0	2,978,976	0	2,978,976	
Roofing		m^2	1,278	1,040,000	0	1,329,120	0	1,329,120	
Waterproofing		m^2	750	64,500	0	48,375	0	48,375	
Laboratory Equipment		set	1	1,000,000,000	0	1,000,000	0	1,000,000	
Total						14,261,371	0	14,261,371	

B5 Site Work

Items	Specification	Unit	Quantity	Unit Cost (IDR)		Total Cost (1,000IDR)			Reference
				LC	FC	LC	FC	Total	
Fence		m	400	500,000	0	200,000	0	200,000	
Road	Pavement Work	m^2	3,200	260,300	0	832,960	0	832,960	
Road	Sub-base (aggregate A)	m^3	640	330,000	0	211,200	0	211,200	
Road	Sub-base (aggregate B)	m^3	960	330,000	0	316,800	0	316,800	
Lawn Grass		m^2	2,500	50,800	0	127,000	0	127,000	
Drainage		m	370	1,431,000	0	529,470	0	529,470	
Electric Lamp		set	10	3,000,000	0	30,000	0	30,000	
Gate and Guard Post		set	1	100,000,000	0	100,000	0	100,000	
Pipe Laying Work	For Transmission pipe (400mm	m	558	2,230,000	0	1,244,340	0	1,244,340	
Pipe Laying Work	For Raw water pipe (400mm)	m	99	2,230,000	0	220,770	0	220,770	
Pipe Laying Work	For Discharge pipe (300mm)	m	334	1,631,000	0	544,754	0	544,754	
Total						4,357,294	0	4,357,294	

B6 Maintenance Equipment

Items	Specification	Unit	Quantity	Unit Cost (IDR)		Total Cost (1,000IDR)			Reference
				LC	FC	LC	FC	Total	
Patrol Car	Sedan Type	units	1	270,000,000		270,000	0	270,000	
Tanker Truck	4t	units	2	900,000,000		1,800,000	0	1,800,000	
Total						2,070,000	0	2,070,000	

B7 Machinery Construction (1IDR = 0.00909)

Items	Specification	Unit	Quantity	Unit Cost (IDR)		Total Cost (1,000IDR)			Reference (JPY)
				LC	FC	LC	FC	Total	
Machinery Equipment		units	1	7,780,617,000	25,504,456,000	7,780,617	25,504,456	33,285,073	231,835,500
Transmission Pump		units	3	168,750,000	0	506,250	0	506,250	
Crane		units	1	162,000,000	0	162,000	0	162,000	
Equipment and Pipe Instration		units	1	24,954,081,750	8,803,961,000	24,954,082	8,803,961	33,758,043	80,028,000
Total						33,402,949	34,308,417	67,711,366	

B8 Electricity Construction (1IDR = 0.00909)

Items	Specification	Unit	Quantity	Unit Cost (IDR)		Total Cost (1,000IDR)			Reference (JPY)
				LC	FC	LC	FC	Total	
Electricity Equipment for Main Facilities		units	1	12,129,507,000	0	12,129,507	0	12,129,507	
Monitoring Device		units	1	2,457,000,000	0	2,457,000	0	2,457,000	
Receiving Electricity Equipment	20kV	units	1	1,201,500,000	0	1,201,500	0	1,201,500	
Electric Generator		units	1	5,703,750,000	0	5,703,750	0	5,703,750	
Electricity Equipment for Transmission Pump		units	1	445,500,000	0	445,500	0	445,500	
Instrumentation Equipment for UPA Reservoir		units	1	67,500,000	0	67,500	0	67,500	
Monitoring Device for UPA Reservoir		units	1	74,250,000	0	74,250	0	74,250	
Equipment and Cable Installation for Main		units	1	9,039,303,000	0	9,039,303	0	9,039,303	
Equipment and Cable Installation for Others		units	1	4,495,500,000	0	4,495,500	0	4,495,500	
Total						35,613,810	0	35,613,810	

C1 Water Transmission Pipe Line

Items	Specification	Unit	Quantity	Unit Cost (IDR)		Total Cost (1,000IDR)			Reference
				LC	FC	LC	FC	Total	
Open Cut Methods	φ 400 (Daytime work)	m	7,500	2,782,000	0	20,865,000	0	20,865,000	
Open Cut Methods	φ 400 (Nighttime work)	m	7,000	3,616,600	0	25,316,200	0	25,316,200	
Pipe Bridge Methods	φ 400, L=120m	set	1	1,800,000,000	0	1,800,000	0	1,800,000	
Pipe Bridge Methods	φ 400, L=50m	set	1	1,105,000,000	0	1,105,000	0	1,105,000	
Pipe Bridge Methods	φ 400, L=70m	set	1	807,000,000	0	807,000	0	807,000	
Pipe Bridge Methods	φ 400, L=10m	set	5	225,000,000	0	1,125,000	0	1,125,000	
Pipe Jacking Methods	φ 400	m	400	13,000,000	0	5,200,000	0	5,200,000	
Total						56,218,200	0	56,218,200	

D1 Distribution Reservoir

Items	Specification	Unit	Quantity	Unit Cost (IDR)		Total Cost (1,000IDR)			Reference
				LC	FC	LC	FC	Total	
Mortar Removal		m^2	500	26,000		13,000	0	13,000	
Chemical Anchor		pcs	2,000	1,000,000		2,000,000	0	2,000,000	
Reinforced Concrete		m^3	100	2,534,000		253,400	0	253,400	
Reinforcement		t	10	16,120,000		161,200	0	161,200	
Waterproofing		m^2	900	64,500		58,050	0	58,050	
Roof		m^2	400	2,000,000		800,000	0	800,000	
Fixtures and Fittings		set	1	164,282,500		164,283	0	164,283	Total cost 5%
Total						3,449,933	0	3,449,933	

E1 Distribution Pipe Line for Nusa Dua

Items	Specification	Unit	Quantity	Unit Cost (IDR)		Total Cost (1,000IDR)			Reference
				LC	FC	LC	FC	Total	
Water Leakage Investigation		set	1	250,000,000		250,000	0	250,000	
Pipe Replacement DCIP	ϕ 400	m	220	5,442,000		1,197,240	0	1,197,240	
Pipe Replacement DCIP	ϕ 300	m	80	3,652,000		292,160	0	292,160	
Pipe Replacement DCIP	ϕ 200	m	190	2,302,000		437,380	0	437,380	
Pipe Replacement DCIP	ϕ 150	m	160	1,905,000		304,800	0	304,800	
Water Stop Valve Replacement	ϕ 400	set	2	72,000,000		144,000	0	144,000	
Water Stop Valve Replacement	ϕ 200	set	16	36,800,000		588,800	0	588,800	
Water Stop Valve Replacement	ϕ 150	set	4	32,000,000		128,000	0	128,000	
Total						3,342,380	0	3,342,380	

E2 Distribution Pipe Line for Benoa

Items	Specification	Unit	Quantity	Unit Cost (IDR)		Total Cost (1,000IDR)			Reference
				LC	FC	LC	FC	Total	
Pipe Laying	ϕ 300	m	5,800	2,125,000		12,325,000	0	12,325,000	
Pipe Laying	ϕ 150	m	700	1,431,000		1,001,700	0	1,001,700	
Total						13,326,700	0	13,326,700	

E3 Distribution Pipe Line for Sawangan

Items	Specification	Unit	Quantity	Unit Cost (IDR)		Total Cost (1,000IDR)			Reference
				LC	FC	LC	FC	Total	
Pipe Laying	φ 300	m	4,000	2,125,000		8,500,000	0	8,500,000	
Pipe Laying	φ 150	m	1,200	1,431,000		1,717,200	0	1,717,200	
Booster Pump	1.5m3/min 18.5kW	set	2	110,000,000		220,000	0	220,000	
Electric Panel	Soft Starter	set	1	320,000,000		320,000	0	320,000	
Total						10,757,200	0	10,757,200	

F1 Hotel Conversion

Items	Specification	Unit	Quantity	Unit Cost (IDR)		Total Cost (1,000IDR)			Reference
				LC	FC	LC	FC	Total	
Hotel Converting Cost		Room	7,900	2,500,000		19,750,000	0	19,750,000	
Total						19,750,000	0	19,750,000	

Table 8.b.6 Unit Price for Construction Cost

Items	Specification	Unit	Unit Price		Remarks
			IDR	YEN	
Excavation	Root of Mangrove, Existing Structure	m^3	102,000		
Excavation	BH, Sand, Clay, Gravel	m^3	46,000		
Excavation	BH, Rock	m^3	102,000		
Backfilling by purchase Soil		m^3	145,000		
Backfilling	BH	m^3	43,300		
Backfilling	Bulldozer	m^3	20,000		
Backfilling	(Compacted use buy soil)	m^3	144,800		
Surplus Soil Disposal		m^3	56,600		
Waste Disposal		m^3	56,600		
Sand Layer		m^3	202,300		
Leveling Concrete		m^3	1,294,000		
Reinforced Concrete	Including formwork	m^3	2,534,000		
Reinforcement Bar	With rebar fabrication and assembly	t	16,120,000		
Roof	Without slab and beam	m^2	1,040,000		
Roof		m^2	2,000,000		
Pile	φ300	m	647,000		
Pile	φ300, L=20m	pcs	12,940,000		
Pavement work	block	m^2	260,300		
Cube Stone		m	148,300		
Sub-base (aggregate A)		m^3	330,000		
Sub-base (aggregate B)		m^3	330,000		
PVC Pipe	φ=150mm without Pavement	m	1,025,000		
PVC Pipe	φ=200mm without Pavement	m	1,171,000		
PVC Pipe	φ=300mm without Pavement	m	1,631,000		
HDPE Pipe	φ=400mm without Pavement	m	2,230,000		
PVC Pipe	φ=150mm with Pavement	m	1,431,000		
PVC Pipe	φ=200mm with Pavement	m	1,606,000		
PVC Pipe	φ=300mm with Pavement	m	2,125,000		
HDPE Pipe	φ=400mm with Pavement	m	2,782,000		
DCIP Pipe	φ=150mm with Pavement	m	1,905,000		
DCIP Pipe	φ=200mm with Pavement	m	2,302,000		
DCIP Pipe	φ=300mm with Pavement	m	3,652,000		
DCIP Pipe	φ=400mm with Pavement	m	5,442,000		
Water Stop Valve Replacement	φ=400mm	set	72,000,000		
Water Stop Valve Replacement	φ=200mm	set	36,800,000		
Water Stop Valve Replacement	φ=150mm	set	32,000,000		
Pipe Bridge	ϕ=400mm, L=120m	set	1,800,000,000		
Pipe Bridge	ϕ=400mm, L=70m	set	1,105,000,000		
Pipe Bridge	ϕ=400mm, L=50m	set	807,000,000		
Pipe Bridge	ϕ=400mm, L=10m	set	225,000,000		
Pipe Bridge	ϕ=300mm, L=120m	set	1,440,000,000		
Pipe Bridge	ϕ=300mm, L=70m	set	884,000,000		
Pipe Bridge	ϕ=300mm, L=50m	set	645,600,000		
Pipe Bridge	ϕ=300mm, L=10m	set	180,000,000		
Pipe Jacking	ϕ=400mm	m	13,000,000		
Pipe Jacking	ϕ=300mm	m	12,500,000		
Laboratory Equipment		set	1,000,000,000		
Mortar Removal		m^2	26,000		
Chemical Anchor		set	100,000		
Waterproofing		m^2	64,500		
Protecting Coating	for corrosion protection coating	m^2	1,000,000		
Electric Lamp		set	3,000,000		
Lawn Grass		m^2	50,800		
Fence	H=1.2m	m	500,000		
Gate and Guard Post		set	100,000,000		
Bridge Removal		m^2	1,980,000		
Bridge Construction		m^2	5,720,000		
Demolish		m^3	100,000		
Water Leakage Investigation		set	250,000,000		
Booster Pump	1.5m3/min 18.5kw	set	110,000,000		
Electric Panel	Soft Starter	set	320,000,000		
Converting Cost	for Case1 (for Room Toilet)	room	3,700,000		
Converting Cost	for Case2 (for Restaurant)	room	2,500,000		

8.c Engineering Service

8.c.1 Cost of Detailed Design, Construction Supervision and Surveys

This cost is calculated as the sum of the following cost items.

- Detailed design
- Construction supervision
- Project management during construction
- EIA implementation
- Additional ground and geological surveys
- Inspection of the existing distribution reservoir and distribution pipes (originally used for irrigation)

The detailed design and construction supervision costs are calculated based on the estimated required man-months (MM) of foreign and local engineers as shown below, including office expenses, etc.

- Foreign Engineer : 86 MM
- Local Engineer : 275 MM

8.c.2 Capacity Building and Promotion

The capacity building and promotion activities are being conducted at the pilot reclamation plant in Denpasar WWTP. The cost of capacity building and promotion is excluded from the total project cost because it is a precondition of the project that the major part of the promotion should be finished before the confirmation of the reclaimed water demand at the target hotels.

Table 8.c.1 Spreadsheet for Engineering Services Cost

Description			Unit	Unit Price	Total Quantity	Total Amount
1. Foreign Cost						
1. Remuneration for Professional A				**yen**		**Japanese Yen**
		Foreign Staff				
		1-1 Foreign Staff				
A-	1	Consulting Services - Team Leader	M/M	3,200,000	22	70,400,000
A-	2	Sub-Team Leader - Pipe Line Engineer	M/M	3,000,000	9	27,000,000
A-	3	Civil Engineer for Transmission Pipe	M/M	2,800,000	3	8,400,000
A-	4	Sub-Team Leader - Treatment Plant/Pump Station	M/M	3,000,000	9	27,000,000
A-	5	Civil / Structural Engineer	M/M	2,800,000	4	11,200,000
A-	6	Mechanical Engineer	M/M	2,800,000	12	33,600,000
A-	7	Electrical Engineer	M/M	2,800,000	12	33,600,000
A-	8	Architect	M/M	2,800,000	3	8,400,000
A-	9	Document Specialist	M/M	2,800,000	5	14,000,000
A-	10	Cost Estimator	M/M	2,800,000	3	8,400,000
A-	11	Environmental Specialist	M/M	2,800,000	4	11,200,000
					86	
2. Direct Cost						
	1	International Air Fare	nos	200,000	45	9,000,000
Total						**262,200,000**
Description			**Unit**	**Unit Price**	**Total Quantity**	**Total Amount**
II. Local Cost						
1. Remuneration for Professional B				**IDR**		**IDR**
B-	1	Deputy Team Leader	M/M	33,003,000	45	1,485,135,000
B-	2	Geotechnical Engineer	M/M	27,503,000	4	110,012,000
B-	3	Topographic Surveyor	M/M	27,503,000	6	165,018,000
B-	4	Pipe Line Engineer	M/M	27,503,000	16	440,048,000
B-	5	Civil Engineer	M/M	27,503,000	16	440,048,000
B-	6	Structural Engineer	M/M	27,503,000	6	165,018,000
B-	7	Mechanical Engineer	M/M	27,503,000	17	467,551,000
B-	8	Electrical Engineer	M/M	27,503,000	17	467,551,000
B-	9	Architect	M/M	27,503,000	7	192,521,000
B-	10	Document Specialist	M/M	27,503,000	6	165,018,000
B-	11	Environmental Expert	M/M	27,503,000	7	192,521,000
B-	12	Quantity Surveyor	M/M	27,503,000	46	1,265,138,000
B-	13	Chief Inspector	M/M	16,502,000	41	676,582,000
B-	14	Inspector	M/M	11,001,000	41	451,041,000
					275	
2. Remuneration for Supporting Staffs						
		1-7 Project Office				
C-	1	Office Manager	M/M	10,000,000	45	450,000,000
C-	2	Accountant	M/M	10,000,000	45	450,000,000
C-	3	CAD Support for Pipe Line	M/M	10,000,000	20	200,000,000
C-	4	CAD Support for Civil Works and Structural	M/M	10,000,000	5	50,000,000
C-	5	CAD Support for M & E	M/M	10,000,000	20	200,000,000
C-	6	Translator / Interpreter	M/M	10,000,000	34	340,000,000
C-	7	Secretary	M/M	5,000,000	45	225,000,000
C-	8	Security Guard	M/M	1,000,000	135	135,000,000
C-	9	Office Boy	M/M	1,000,000	54	54,000,000
					403	
3. Direct Cost						
	1	Accommodation for Professional A	Month	33,003,000	86	2,838,258,000
	2	Accommodation for Professional B	Month	3,300,000	275	907,500,000
	3	Vehicle Rental	Month/Car	11,001,000	120	1,320,120,000
	4	Office Rental	Month	22,002,000	45	990,090,000
	5	International Communications	Month	2,200,000	45	99,000,000
	6	Domestic Communications	Month	2,200,000	45	99,000,000
	7	Office Maintenance	Month	5,501,000	45	247,545,000
	8	Office Furniture and Equipment	Ls	220,022,000	1	220,022,000
	9	Report Preparation	nos	550,000	45	24,750,000
	10	Software (CAD etc)	Ls	110,011,000	1	110,011,000
	11	Topographic Survey	Ls	110,011,000	1	110,011,000
	12	Geological Investigation	Ls	165,017,000	1	165,017,000
	13	EIA	Ls	1,650,165,017	1	1,650,165,017
Total						**17,568,691,017**

Grand Total for Detail Design and Supervision	**Yen**	**421,899,401**

8.d Tax Charges

The following taxes are estimated as part of the project cost.

(1) Value-added Tax (VAT)

VAT is estimated at 10% of the local currency portions of the project cost.

(2) Import Duty

The import tax depends on the items to be imported but the import tax is about 10% of the total price of the equipment to be imported, based on the experience with the construction of the pilot reclamation plant. According to the investigate and examine the results with the support of the tax consultant office in Indonesia, there is a possibility that the reclaimed water project will be exempted from import tax if import duty exemption as stipulated in the Ministry of Finance Regulation No. 101/PMK.04/2007 is applicable to this Project. Contents of the tax consultant office are shown below.

1) Minister of Finance defines in the provision, exempt from import duties pertaining to the import of raw materials and equipment to be used to prevent environmental pollution. Exemption shall be applied to the waste disposal or industry companies. These equipments can be used for other purposes or be transferred to others with the permission of the Directorate General of Customs, if the equipments were used as intended for two years from the import.

2) Definition of "waste" is the relevant provision has not been specified. In addition, the SPC to the management of the reclaimed water project is unclear whether the applicable to “waste disposal company” under such provision, but this project is considered to be business in line with the spirit of the law. Therefore the local tax office in Indonesia recommended that the SPC submits an application for the approval of the import tax exemption to the Ministry of Directorate General of Taxation with the following documents after the project approval.
    - Investment Coordinating Board approval
    - Tax ID card issued by the Revenue Department
    - Registered businesses VAT (PKP)
    - Details of materials and equipments (amount, type and specifications)
    - Letter of recommendation by the Ministry of the Environment and Environmental Committee (It describes that these equipments entail no adverse consequence to the environment during the waste treatment and these are recommended the materials and equipments for using to waste treatment.)

Application for approval of import tax exemption is after the establishment of SPC, but the project costs in this survey are exempt from import tax as a prerequisite for the calculations.

(3) Surface Water Use Tax

The surface water use tax will be imposed on the Indonesian law (28/2009), if the water is use as a water source of tap water. The operation and tax rate are defined by the local government regulations. The taxable water is only surface water and groundwater on these regulations, but there is no provision for the treated wastewater from secondary treatment.

Table 8.d.1 Laws, Regulation and Tax Rate for Water Source

	Water source	Laws and regulations	Tax rates
1	Surface water	Regulation of Bali (16/2009, Revision 1/2011)	10% of water price
2	Ground water	(In case of Badung Regency) Regulation of Badung Regency (1/2011)	20% of water price

The definition of surface water in Indonesian law (7/2004, GR42/2008) has been defined as "all the water on the ground", but the definition in Bali regulations (1/2011) has been defined as excluding the seawater on the land and sea. Therefore the use of seawater in the state of Bali is not subject to taxation.

According to the results of request to investigate and examine the law firm and tax consultant offices in Indonesia about whether the surface water should be regarded as treated wastewater, it is necessary to confirmation and agreement of the relevant agencies of Bali government but they think that there is unreasonable to tax the treated wastewater as surface water from the following two reasons.

1) The treated wastewater has been discharged to the sea so that this water isn't used in fact. The treated wastewater is the seawater rather than the surface water if it is dared to classify.
2) The treated wastewater does not have a valuation from the viewpoint of taxation.

Based on the above-mentioned expert opinion, the treated wastewater is considered as a tax-free advance in this survey.

8.e Operation and Maintenance Cost

The annual operation and maintenance costs include costs for personnel, electricity, chemicals, fuel, water quality tests, repairs and replacements, and office expenditures, as explained below. The details are presented in Table 8.e.3 to 8.e.10.

(1) Personnel

The cost of Case 1 covers to employ 22 staffs for the management, administration, finance and technical departments. The cost of Case 2 covers to employ 24 staffs. The details are presented in Section 9.4.

(2) Electricity

The electricity cost is calculated by multiplying the unit price from electricity by the expected annual average electrical consumption of SPC. The unit price for electricity is set according to the electricity price list (2010) of PT PLN (PERSERO: Indonesian Electric Power Public Corporation).

(3) Chemicals

The annual chemicals cost for the reclamation plant consists of the costs for the following chemicals.
- Flocculant
- pH Adjuster (Acid, Alkali)
- Hypochlorous Acid
- Thiosulfuric Acid

(4) Fuel

The annual fuel cost consists of the fuel costs for the following machinery and vehicles.

- Standby generator (for monthly test operation)
- Patrol car
- Tanker truck

(5) Water Quality Test Cost

This is the outsourcing costs for the monthly and semiannually water quality tests excluding the cost of routine water quality tests in the laboratory of the reclamation plant.

(6) Repairs and Replacements

This is estimated as follows:

・Annual repair cost for civil & architectural structures: 0.1% of their total construction cost.
・Annual repair cost for mechanical & electrical equipment:1.5% of their total purchase/installation cost.
・Annual repair cost for vehicles and other machineries: 3.0% of their total purchase cost.

The replacement cost of the filtration membrane during the operation is also estimated and converted into an annual cost.

(7) Office expenditures

This cost category covers the rental cost of SPC’s office in BLUPAL and the rental fee of copy machine and other office equipment.

(8) Treated Water Use Rate

Currently, the treated wastewater is expected to have worthless and no utility rate because it has been discharged directly into the sea.

(9) Indirect Cost

The indirect cost covers miscellaneous expenses, which is calculated as 10% of the total cost of (1) to (8).

(10) Tax

The tax covers value-added tax (VAT), which is calculated as 10% of the total cost of (1) to (9).

(11) Total Operation and Maintenance Costs

The total operation and maintenance costs during the first and the second stages are shown in Tables 8.e.1 and 8.e.2, respectively.

Table 8.e.1 Operation and Maintenance Cost for Case 1

Items	Cost (IDR/year)	Tax (IDR/year)	Total (IDR/year)
〔A〕Direct O&M Cost			
1. Personnel Cost	2,061,600,000	206,160,000	2,267,760,000
2. Electricity Cost	1,746,794,076	174,679,408	1,921,473,483
3. Chemicals and Materials	618,379,040	61,837,904	680,216,944
4. Fuel Cost	187,401,600	18,740,160	206,141,760
5. Water Quality Test	17,800,000	1,780,000	19,580,000
6. Repair and Replace Cost	1,631,336,584	163,133,658	1,794,470,243
7. Office Cost	600,000,000	60,000,000	660,000,000
8. Treated Water Use Rate	0	0	0
Sub Total A	6,863,311,300	686,331,130	7,549,642,430
〔B〕 Indirect O&M Cost (10% of Direct O&M Cost)			
Sub Total B	686,331,130	68,633,113	754,964,243
Total Cost	7,549,642,430	754,964,243	8,304,606,673

Table 8.e.2 Operation and Maintenance Cost for Case 2

Items	Cost (IDR/year)	Tax (IDR/year)	Total (IDR/year)
〔A〕Direct O&M Cost			
1. Personnel Cost	2,259,600,000	225,960,000	2,485,560,000
2. Electricity Cost	3,471,874,301	347,187,430	3,819,061,732
3. Chemicals and Materials	1,236,758,080	123,675,808	1,360,433,887
4. Fuel Cost	187,401,600	18,740,160	206,141,760
5. Water Quality Test	17,800,000	1,780,000	19,580,000
6. Repair and Replace Cost	2,060,757,696	206,075,770	2,266,833,466
7. Office Cost	600,000,000	60,000,000	660,000,000
8. Treated Water Use Rate	0	0	0
Sub Total A	9,834,191,677	983,419,168	10,817,610,845
〔B〕 Indirect O&M Cost (10% of Direct O&M Cost)			
Sub Total B	983,419,168	98,341,917	1,081,761,085
Total Cost	10,817,610,845	1,081,761,085	11,899,371,930

Table 8.e.3 Personnel Cost

(1) Case 1

		Numbers Total	Unit Price (IDR/Staff/month)	Annual Total (IDR)
Management	Director	1	33,000,000	396,000,000
	Deputy Director	1	22,000,000	264,000,000
	Secretary	1	5,500,000	66,000,000
	Sub Total	3		726,000,000
Admini & Finance	Manager	1	15,000,000	180,000,000
	Administration Secretary	1	5,500,000	66,000,000
	Administration Staff	2	5,500,000	132,000,000
	Security Staff	3	1,500,000	54,000,000
	Office Boy	1	1,000,000	12,000,000
	Sub Total	8		444,000,000
Treatment Plant and Pipe Facility Technical Staff	Manager	1	16,300,000	195,600,000
	Engineer/Operator	9	5,500,000	594,000,000
	Chemist	1	8,500,000	102,000,000
	Sub Total	11		891,600,000
Total		22		2,061,600,000

(2) Case 2

		Numbers Total	Unit Price (IDR/Staff/month)	Annual Total (IDR)
Management	Director	1	33,000,000	396,000,000
	Deputy Director	1	22,000,000	264,000,000
	Secretary	1	5,500,000	66,000,000
	Sub Total	3		726,000,000
Admini & Finance	Manager	1	15,000,000	180,000,000
	Administration Secretary	1	5,500,000	66,000,000
	Administration Staff	2	5,500,000	132,000,000
	Security Staff	3	1,500,000	54,000,000
	Office Boy	1	1,000,000	12,000,000
	Sub Total	8		444,000,000
Treatment Plant and Pipe Facility Technical Staff	Manager	1	16,300,000	195,600,000
	Engineer/Operator	12	5,500,000	792,000,000
	Chemist	1	8,500,000	102,000,000
	Sub Total	14		1,089,600,000
Total		25		2,259,600,000

Table 8.e.4 Electricity Cost (Case 1)

	power ［kW］	unit ［unit］	total power ［kW］	running unit ［unit］	total power ［kW］	running hour ［h/day］	load (%)	Daily Electricity use (kWh)	Annual Electricity use (kWh)	Annual Electricity cost (IDR.)
BAR SCREEN	0.1	1	0.1	1	0.1	24.0	80	1.92	701	525,600
RAW WATER PUMP	30	2	60	1	30	24.0	80	576	210,240	157,680,000
STRAINER	0.75	1	0.75	1	0.75	24.0	80	14.4	5,256	3,942,000
BIOLOGICAL FILTER PUMP	15	2	30	1	15	24.0	80	288	105,120	78,840,000
BLOWER	29.2	2	58.4	1	29.2	24.0	80	560.64	204,634	153,475,200
BACKWASH BLOWER	47.2	2	94.4	1	47.2	0.1	80	4.5312	1,654	1,240,416
BACKWASH PUMP	45	3	135	2	90	0.1	80	8.64	3,154	2,365,200
OZONE REACTOR PUMP	30	2	60	1	30	24.0	80	576	210,240	157,680,000
OZONE GENERATOR	38	1	38	1	38	24.0	68	620.16	226,358	169,768,800
O2 PSA	0.1	1	0.1	1	0.1	24.0	90	2.16	788	591,300
AIR COMPRESSOR	55	1	55	1	55	24.0	65	858	313,170	234,877,500
CHILLER UNIT	48	1	48	1	48	24.0	76	875.52	319,565	239,673,600
OZONE TREATMENT UNIT（FOR OZONE UNIT)	1.25	1	1.25	1	1.25	24.0	80	24	8,760	6,570,000
AGITATOR (PH ADJUST)	2.2	1	2.2	1	2.2	24.0	80	42.24	15,418	11,563,200
AGITATOR (RAPID)	2.2	1	2.2	1	2.2	24.0	80	42.24	15,418	11,563,200
AGITATOR (SLOW)	2.2	1	2.2	1	2.2	24.0	80	42.24	15,418	11,563,200
COAGULANT FEED PUMP	0.02	2	0.04	1	0.02	24.0	65	0.312	114	85,410
PH MODIFIER PUMP (ACID INJECTION)	0.03	2	0.06	1	0.03	24.0	65	0.468	171	128,115
MEMBRANE FILTER PUMP	30	2	60	1	30	24.0	80	576	210,240	157,680,000
OZONE TREATMENT UNIT	3	1	3	1	3	24.0	80	57.6	21,024	15,768,000
COAGULANT TANK BLOWER	2.2	1	2.2	1	2.2	24.0	80	42.24	15,418	11,563,200
AIR COMPRESSOR	15	2	30	1	15	0.9	80	11.28	4,117	3,087,900
WATER SUPPLY PUMP UNIT	3.7	1	3.7	1	3.7	16.0	80	47.36	17,286	12,964,800
HYPOCHLORITE FEED PUMP	0.03	2	0.06	1	0.03	0.2	65	0.002925	1	801
ACID FEED PUMP	0.2	2	0.4	1	0.2	0.5	80	0.08	29	21,900
CHEMICAL CLEANING PUMP	1.2	2	2.4	2	2.4	-	80	0	≒0	≒0
CHEMICAL PULLING PUMP	1.5	2	3	2	3	-	80	0	≒0	≒0
THIOSULFURIC ACID PUMP	0.02	2	1	1	0.02	2.3	80	0.0368	13	10,074
SODIUM HYDROXIDE PUMP	0.02	2	0.04	1	0.02	7.0	80	0.112	41	30,660
DRAINAGE PUMP	11	2	22	1	11	6.0	80	52.8	19,272	14,454,000
TRANSMISSION PUMP	55	2	110	1	55	24.0	80	1056	385,440	289,080,000
Total								6,381	2,329,059	1,746,794,076

※Connection fee to Electric Power Company (631,250,000 IDR) is added on fist year.

750 IDR/kWh = Unit rate of electricity

Total Electricity Cost = 1,746,794,076 (IDR/ year)

Table 8.e.5 Chemicals Cost (Case 1)

	Used Amount (kg/day)	Chemical usage rate	Cost/Kg (IDR)	Annual cost (IDR)
Coagulant (PACL)	540.0	0.5	4,348	428,495,400
Acid (pH)	92.7	0.5	2,717	45,965,527
Acid (Backwash)	47.0	0.5	2,717	23,305,068
Sodium Hydroxide	115.0	0.5	3,261	68,440,238
Hypochlorite	12.0	0.5	7,609	16,663,710
Thiosulfuric Acid	2.6	0.5	16,304	7,736,248
Hypochlorite (for Disinfection)	20.0	0.5	7,609	27,772,850
Total				618,379,040

Table 8.e.6 Electricity Cost (Case 2)

	power ［kW］	unit ［unit］	total power ［kW］	running unit ［unit］	total power ［kW］	running hour ［h/day］	load （%）	Daily Electricity use (kWh)	Annual Electricity use (kWh)	Annual Electricity cost (IDR.)
BAR SCREEN	0.1	2	0.2	1	0.1	24.0	80	1.92	701	525,600
RAW WATER PUMP	30	3	90	2	60	24.0	80	1152	420,480	315,360,000
STRAINER	0.75	2	1.5	2	1.5	24.0	80	28.8	10,512	7,884,000
BIOLOGICAL FILTER PUMP	15	3	45	2	30	24.0	80	576	210,240	157,680,000
BLOWER	29.2	3	87.6	2	58.4	24.0	80	1121.28	409,267	306,950,400
BACKWASH BLOWER	47.2	2	94.4	1	47.2	0.1	80	4.5312	1,654	1,240,416
BACKWASH PUMP	45	3	135	2	90	0.1	80	8.64	3,154	2,365,200
OZONE REACTOR PUMP	30	3	90	2	60	24.0	80	1152	420,480	315,360,000
OZONE GENERATOR	38	2	76	2	76	24.0	68	1240.32	452,717	339,537,600
O2 PSA	0.1	2	0.2	2	0.2	24.0	90	4.32	1,577	1,182,600
AIR COMPRESSOR	55	2	110	2	110	24.0	65	1716	626,340	469,755,000
CHILLER UNIT	48	2	96	2	96	24.0	76	1751.04	639,130	479,347,200
OZONE TREATMENT UNIT（FOR OZONE UNIT)	1.25	2	2.5	2	2.5	24.0	80	48	17,520	13,140,000
AGITATOR (PH ADJUST)	2.2	2	4.4	2	4.4	24.0	80	84.48	30,835	23,126,400
AGITATOR (RAPID)	2.2	2	4.4	2	4.4	24.0	80	84.48	30,835	23,126,400
AGITATOR (SLOW)	2.2	2	4.4	2	4.4	24.0	80	84.48	30,835	23,126,400
COAGULANT FEED PUMP	0.02	3	0.06	2	0.04	24.0	65	0.624	228	170,820
PH MODIFIER PUMP (ACID INJECTION)	0.03	3	0.09	2	0.06	24.0	65	0.936	342	256,230
MEMBRANE FILTER PUMP	30	3	90	2	60	24.0	80	1152	420,480	315,360,000
OZONE TREATMENT UNIT	3	3	9	2	6	24.0	80	115.2	42,048	31,536,000
COAGULANT TANK BLOWER	2.2	2	4.4	2	4.4	24.0	80	84.48	30,835	23,126,400
AIR COMPRESSOR	15	2	30	1	15	0.9	80	11.28	4,117	3,087,900
WATER SUPPLY PUMP UNIT	3.7	2	7.4	2	7.4	16.0	80	94.72	34,573	25,929,600
HYPOCHLORITE FEED PUMP	0.03	3	0.09	2	0.06	0.2	65	0.00585	2	1,601
ACID FEED PUMP	0.2	3	0.6	2	0.4	0.5	80	0.16	58	43,800
CHEMICAL CLEANING PUMP	1.2	2	2.4	2	2.4	-	80	0	≒0	≒0
CHEMICAL PULLING PUMP	1.5	2	3	2	3	-	80	0	≒0	≒0
THIOSULFURIC ACID PUMP	0.02	2	1	1	0.02	2.3	80	0.0368	13	10,074
SODIUM HYDROXIDE PUMP	0.02	2	0.04	1	0.02	7.0	80	0.112	41	30,660
DRAINAGE PUMP	11	2	22	1	11	6.0	80	52.8	19,272	14,454,000
TRANSMISSION PUMP	55	3	165	2	110	24.0	80	2112	770,880	578,160,000
Total								12,683	4,629,166	3,471,874,301

750 IDR/kWh = Unit rate of electricity

Total Electricity Cost = 3,471,874,301 (IDR/ year)

Table 8.e.7 Chemicals Cost (Case 2)

	Used Amount (kg/day)	Chemical usage rate	Cost/Kg (IDR)	Annual cost (IDR)
Coagulant (PACL)	540.0	1	4,348	856,990,800
Acid (pH)	92.7	1	2,717	91,931,054
Acid (Backwash)	47.0	1	2,717	46,610,135
Sodium Hydroxide	115.0	1	3,261	136,880,475
Hypochlorite	12.0	1	7,609	33,327,420
Thiosulfuric Acid	2.6	1	16,304	15,472,496
Hypochlorite (for Disinfection)	20.0	1	7,609	55,545,700
Total				1,236,758,080

Table 8.e.8 Fuel Cost (Case 1 or Case 2)

For Vehicles Diesel fuel Unit Price = 6,000 IDR/liter

	No of days/ year	Fuel Consumption (liter/hours)	Working Time (hours/day)	Unit cost/ (IDR/liter)	Unit cost/ day*	No of sets	Total cost (IDR/year)
Patrol Car	150	2.6	6	4,500	84,240	1	12,636,000
Tanker Truck	225	5.3	6	6,000	228,960	2	103,032,000
Others (20%)							23,133,600
Total							138,801,600

*Unit cost is including lubricant cost (20%)

For Standby Generator (for maintenance operation)

	Capacity (kVA)	Unit Consumption (liter/kVA/hour)	Working Time (hours/month)	Unit cost/ (IDR/liter)	Unit cost/ day*	No of sets	Total cost (IDR/year)
Treatment Plant	750	0.25	6	6,000	8,100,000	6	48,600,000

Total cost (IDR/year) = 187,401,600

Table 8.e.9 Water Quality Test Cost (Case 1 or Case 2)

No.	Item	Unit	Cost	Measurement Item	
				(a) Monthly	(b)Semiannual
A.	Physical Parameter				
	1) Smell		3,500	3,500	3,500
	2) Floating Objects		5,000	5,000	5,000
	3) Clarity		5,000	5,000	5,000
	4) Color	TCU	20,000	20,000	20,000
	5) Oil	mg/l	5,000	5,000	5,000
	6) Turbidity	NTU	15,000	15,000	15,000
	7) TDS	mg/l	17,500		17,500
B.	Chemical Parameter				
	1) Al	mg/l	50,000		50,000
	2) Hardness	mg/l	15,000	15,000	15,000
	3) Oxygen absorbed (O2)	mg/l	15,000	15,000	15,000
	4) pH		5,000	5,000	5,000
	5) Residual Chlorine	mg/l	15,000	15,000	15,000
	6) Cu	mg/l	40,000		40,000
	7) Detergent (MBAS)	mg/l	50,000		50,000
	8) BOD	mg/l	30,000	30,000	30,000
	9) Dissolved Oxygen (O2)	mg/l	15,000	15,000	15,000
	10) As	mg/l	50,000		50,000
	11) F	mg/l	25,000		25,000
	12) Cr	mg/l	40,000		40,000
	13) Cd	mg/l	40,000		40,000
	14) Nitrite (NO2)	mg/l	25,000		25,000
	15) Nitrite (NO3)	mg/l	25,000		25,000
	16) CN	mg/l	25,000		25,000
	17) Se	mg/l	40,000		40,000
	18) Fe	mg/l	40,000		40,000
	19) Mn	mg/l	40,000		40,000
	20) Zn	mg/l	40,000		40,000
	21) SO4	mg/l	25,000		25,000
	22) Ammonia (NH3)	mg/l	25,000		25,000
C.	Microbiological Parameters				
	1) Total Coliform	CFU/100ml	42,000	42,000	42,000
	2) Number of Germs	Colonies/ml	42,000	42,000	42,000
Cost for 1 Set				232,500	830,000
Other Cost (100%)				232,500	830,000
Water Sample per year				24	4
Total Cost				11,160,000	6,640,000
				(a)+(b)	17,800,000

Table 8.e.10 Repair and Replace Cost

(1) Case 1

A. Site Preparation

	Capital Cost	Annual repair and maintenance cost	
	(1,000IDR)	% of Capital Cost	(IDR/year)
Structure	5,968,887	0.10%	5,968,887
Total	5,968,887		5,968,887

B. Reclaimed Water Treatment Facility

	Capital Cost	Annual repair and maintenance cost	
	(1,000IDR)	% of Capital Cost	(IDR/year)
Structure	30,427,382	0.10%	30,427,382
Vehicles	2,070,000	3.00%	62,100,000
Equipment	87,646,381	1.50%	1,314,695,715
Membrane Replacement	174,000	100%	174,000,000
Total	120,143,763		1,581,223,097

C. Water Transmission Pipe

	Capital Cost	Annual repair and maintenance cost	
	(1,000IDR)	% of Capital Cost	(IDR/year)
Structure	44,144,600	0.10%	44,144,600
Total	44,144,600		44,144,600

Case1 Cost 1,631,336,584 IDR/year

(2) Case 2

A. Site Preparation

	Capital Cost	Annual repair and maintenance cost	
	(1,000IDR)	% of Capital Cost	(IDR/year)
Structure	6,507,139	0.10%	6,507,139
Total	6,507,139		6,507,139

B. Reclaimed Water Treatment Facility

	Capital Cost	Annual repair and maintenance cost	
	(1,000IDR)	% of Capital Cost	(IDR/year)
Structure	38,054,721	0.10%	38,054,721
Vehicles	2,070,000	3.00%	62,100,000
Equipment	103,325,176	1.50%	1,549,877,636
Membrane Replacement (1)	174,000	100%	174,000,000
Membrane Replacement (2)	174,000	100%	174,000,000
Total	143,449,897		1,998,032,357

C. Water Transmission Pipe

	Capital Cost	Annual repair and maintenance cost	
	(1,000IDR)	% of Capital Cost	(IDR/year)
Structure	56,218,200	0.10%	56,218,200
Total	56,218,200		56,218,200

Case2 Cost = 2,060,757,696 IDR/year

APPENDIX 9

DETAILED PROJECT ACTIVITY PLAN

APPENDIX 9 DETAILED PROJECT ACTIVITY PLAN

This appendix is prepared as the Detailed Project Activity Plan requested in the Minutes of Meetings signed between the Indonesian government and JICA on December 1, 2010. This appendix can be referred as well as Appendix 11 (A Draft TOR for the EIA) in the preparation of the draft KA-ANDAL for this project. The following descriptions of the proposed project activities (i.e. Scope of Work) are prepared mainly in accordance to the Regulation of Ministry of Environment (No.8/2006) on Guideline of EIA Preparation.

9.a   Background of the Project

Bali is one of the famous tourist spots in Asia. The regional economy in Bali relies on its tourism industry and agriculture of wet-rice cultivation. Denpasar City and Badung Regency located in Southern Bali are developing as a center of tourism and commerce and their population is increasing rapidly. The growth in economic and population is increasing water demand and causing water shortage. However, the development of water supply systems in Bali is left behind the growth in economic and population. Water shortage and river water pollution are disturbing the sustainable economic development in Bali.

Groundwater has been used for mitigating the water shortage. However, its overuse caused the salination and depletion of groundwater in the coastal areas of Southern Bali. These difficult situations in groundwater use have recently become obvious. On the other hand, Denpasar Sewerage Development Project is been implemented by Japanese ODA loan in Denpasar City and its surrounding areas having high population density. The collected wastewater is being treated at Suwung WWTP. The treated wastewater from the WWTP is an important water resource which can be recycled.

In order to reduce the water shortage in Southern Bali and mitigate the groundwater salination and depletion, effective uses of the treated wastewater from Suwung WWTP have been studied by Indonesian government agencies. However any reclaimed water project using the treated wastewater has not been realized due to financial difficulties. In these circumstances, a Japanese joint venture (consisting of Toyota Tsusho Corporation, Nihon Suido Consultants Co. Ltd, and METAWATER Co. Ltd) have proposed to JICA to study the possibility of formulating a reclaimed water supply project in Southern Bali as a Public-Private Partnership (referred as PPP) Project. In response, JICA commissioned this preparatory survey to the joint venture at the end of 2010 in order to formulate a feasible reclaimed water supply project in Southern Bali.

9.b Objectives and Benefits of the Project

The objectives of the reclaimed water supply project proposed in the preparatory survey are as follows:

1) To utilize the treated wastewater from Suwung WWTP for producing reclaimed water with suitable quality for showering, bathing and pool
2) To supply the reclaimed water to the hotels in Nusa Dua, Sawangan, Benoa where water shortage and overuse of groundwater are serious
3) To make the PDAM water more available to the domestic customers in the service areas of Estuary Water Purification Plant

The objects of this project are also explained in 7.1 of the main report. The main benefits of this project are as follows:

a) The reduction of the effluent from Suwung WWTP which have negative impacts on the environment around its discharge point.

b) The mitigation of the serious water shortage in the service areas of Estuary Water Purification Plant, which will contribute to:
    i. the improvement of the targeted hotels and the development of new hotels in the target areas of the project;
    ii. the reduction of the excessive extraction of groundwater in the targeted hotels and the new hotels; and
    iii. the increase of drinking/clean water available for the domestic users.

c) The establishment of local experiences regarding wastewater reclamation, which will be important for the formulation of other reclaimed water supply projects in Indonesia in the future.

The results of the economic analysis on the project including the evaluation of these benefits are explained in Chapter 13 of the main report. These benefits are also explained as the positive impacts of the project in the environmental scooping (see 10.4.3 of the main report and 10.c of Appendix 10).

9.c Scope of the Project and Alternative Project Components

The proposed scope of the project is explained in 7.2 to 7.4 of the main report.

Although the route of the transmission pipeline along the existing main road (Ngurah Rai By-pass Road) was selected in this preparatory survey, the alternative analysis on the route of the transmission pipeline (see 10.b (3) of Appendix 10) should be reviewed in the EIA and the detailed design study in order to mitigate the traffic congestion to be caused by the pipe installation. Moreover, it is not yet confirmed that the proposed wastewater reclamation facilities can meet the existing Indonesian water quality standards for pool and public bath continuously. The size of the biological filter for the pretreatment may need to be larger than its proposed design if the existing water quality standards cannot be continuously met with the proposed design. In case that new Indonesian water quality standards for reclaimed water is established before the implementation of the detained design study and the EIA, the wastewater reclamation facilities should be re-designed based on the new water quality standards. The ratio of mixing the reclaimed water with the PDAM water at the target hotels may also be revised in the detailed design study based on the results of the reclaimed water demand confirmation to be conducted before the signing of the PPP contract.

9.d Maps and Social and Environmental Descriptions of the Project Sites

Figures 9.d.1 to 9.d.5 shows the overall layout of the facilities related to the project including the tentative route of the transmission pipeline, the site plan of the proposed water reclamation plant, and the routes of the existing trunk distribution pipes in Nusa Dua and new trunk distribution pipes to Benoa and Sawangan. Detail maps of the route for the transmission pipeline are shown in 6.c of Appendix 6.

The proposed site for the wastewater reclamation plant is located at the edge of Ngurah Rai Mangrove Forest Area which is owned by the Ministry of Environment as shown in Figure 9.d.2. The land use in this area is controlled by the ministry through a land use permission process. The Forestry Agency of Bali Provincial Government is in charge of the forestry management in this area.

Nusa Dua has many new large resort hotels. Benoa has some large resort hotels and many middle size hotels and small villas. New large resort hotels are currently under construction in Sawangan.

General natural conditions and socio-economic conditions of Bali Island are also described in 2.1 and 2.2 of the main report.

9.e Project Activities from Pre-Construction Stage to Post-Operation Stage

Section 9.7 of the main report shows the implementation schedule of the project.

The project activates in each stage of the project are explained in the following, which are in consistency with those listed in the comprehensive environmental scoping matrix (see Table 10.c.1 of Appendix 10).

(1) Pre-Construction Stage

In the pre-construction stage of the project, several types of permissions and agreements are required before starting the construction, which include the land use permit from the Ministry of Forestry, the PPP contract, the purchase agreement with PDAM Badung, the approvals on KA-ANDAL and the EIA documents, etc. The project also needs a further survey for confirming the targeted hotels' demand on the reclaimed water. The feasibility of the project has to be also examined by a PPP team from the Indonesian/Balinese side in the pre-construction stage.

1. Acquisition of Land Use Permit

   DINAS PU/Bali Provincial Government needs to acquire the land use permit from the Ministry of Forestry (in coordination with the Forestry Agency of Bali Provincial Government) for using the land of the proposed water reclamation plant site.

2. Acquisition of Other Approvals and Agreements

   The project needs a PPP contract with Bali Provincial Government and a purchase agreement with PDAM Badung. New reclaimed water standards (if necessary) and new tariffs for the reclaimed water supply may needs to be prepared before the signing of the PPP contract. The project also needs approval on the draft KA-ANDAL and the final EIA documents. The permissions to use the treated wastewater and to supply the reclaimed water should be included in these approvals and agreements.

3. Study and Field Survey

   More studies and filed surveys are required for the EIA, the detailed design, the confirmation of reclaimed water demand in the target hotels, the confirmation of achievable water quality and the establishment of new reclaimed water quality standards (if necessary).

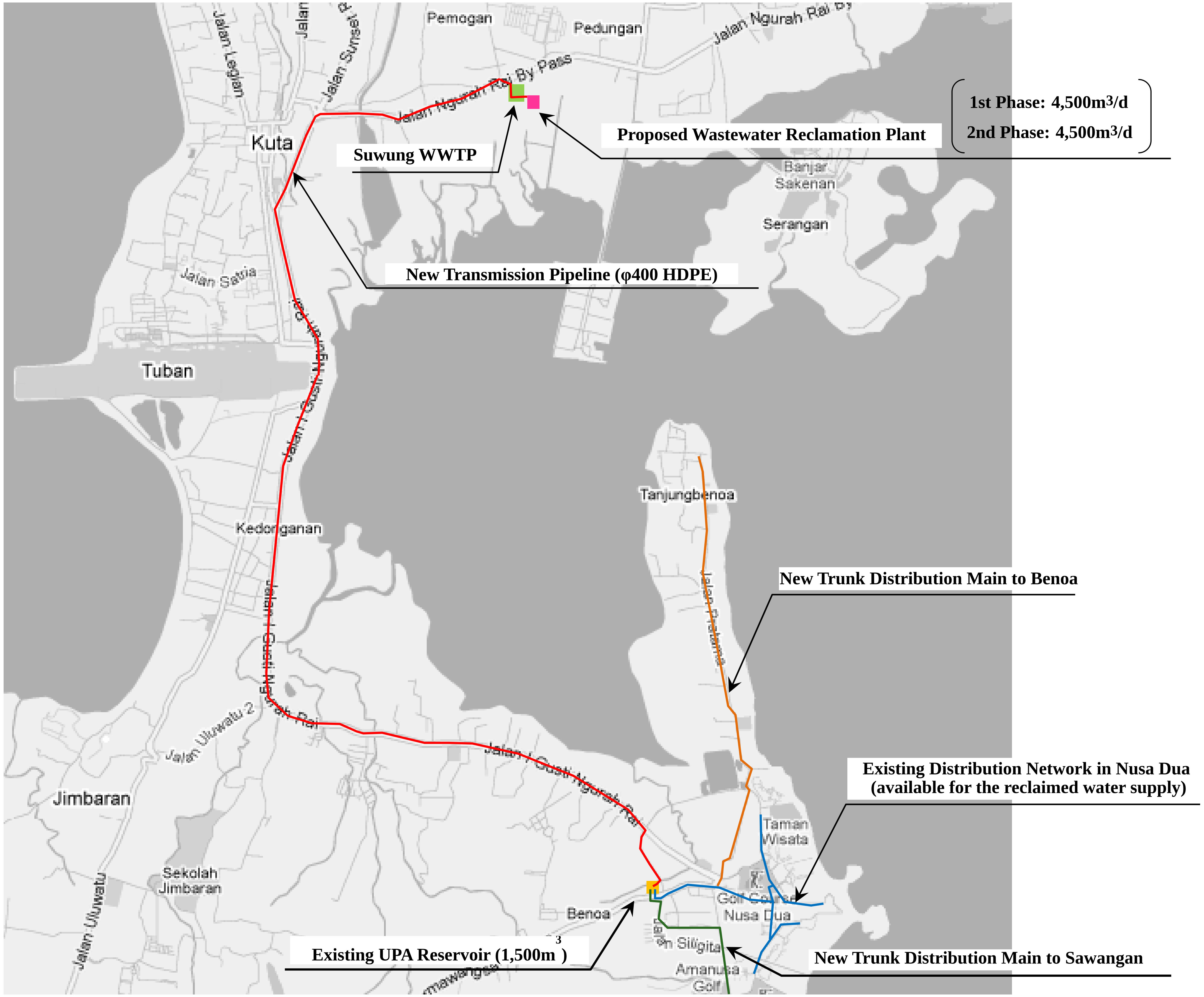


Figure 9.d.1 Overall Layout of the Facilities related to the Project

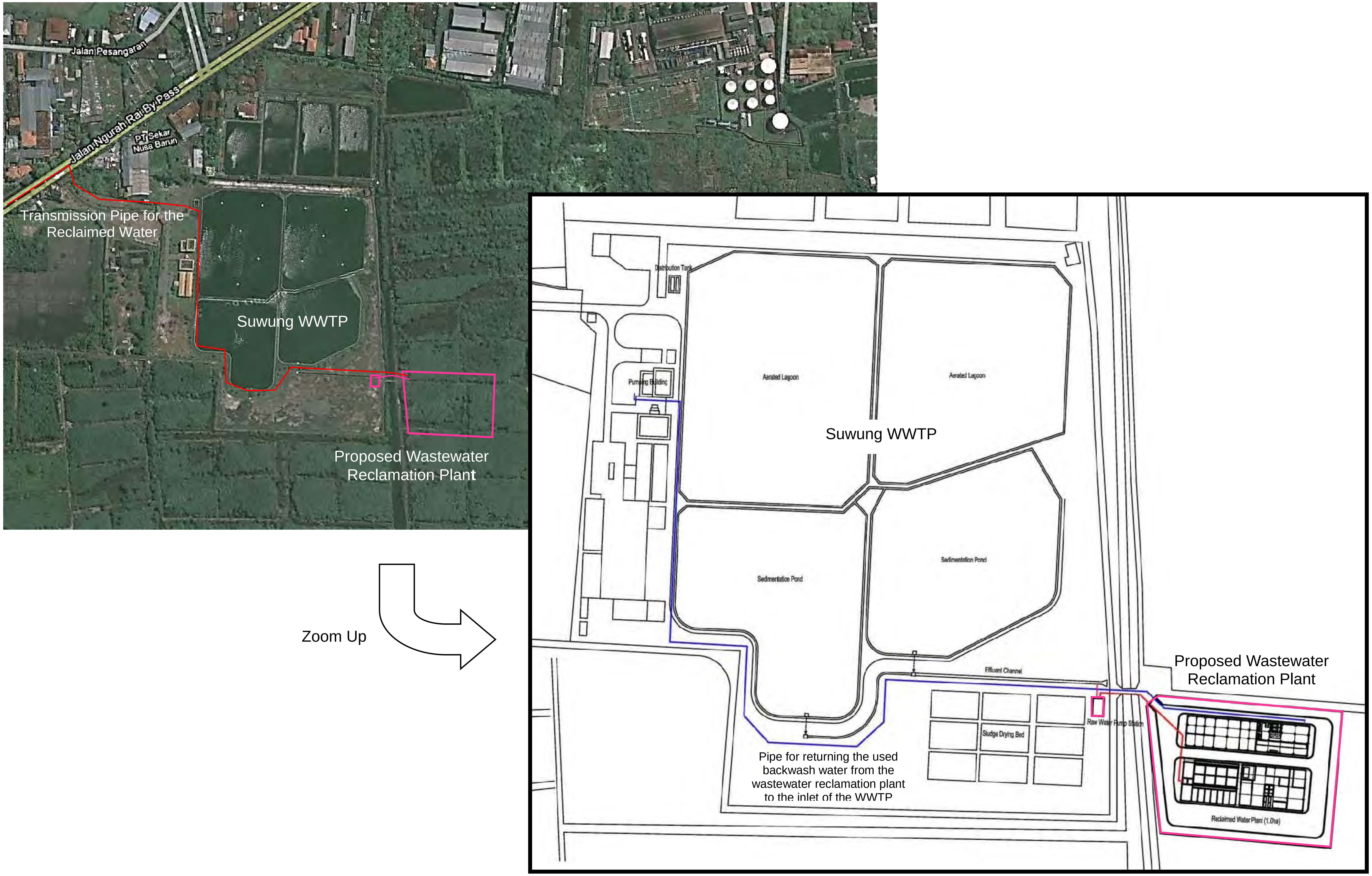
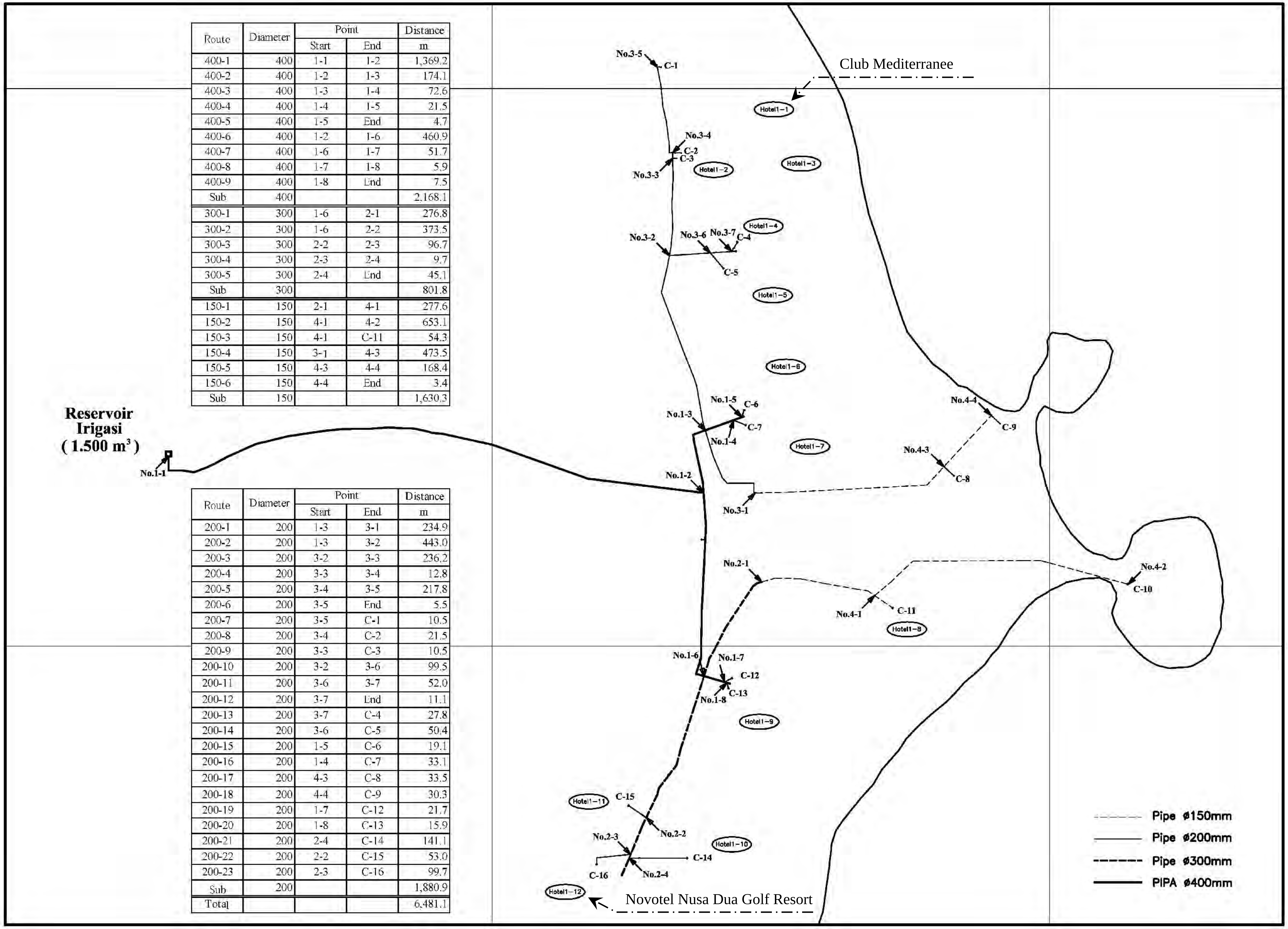


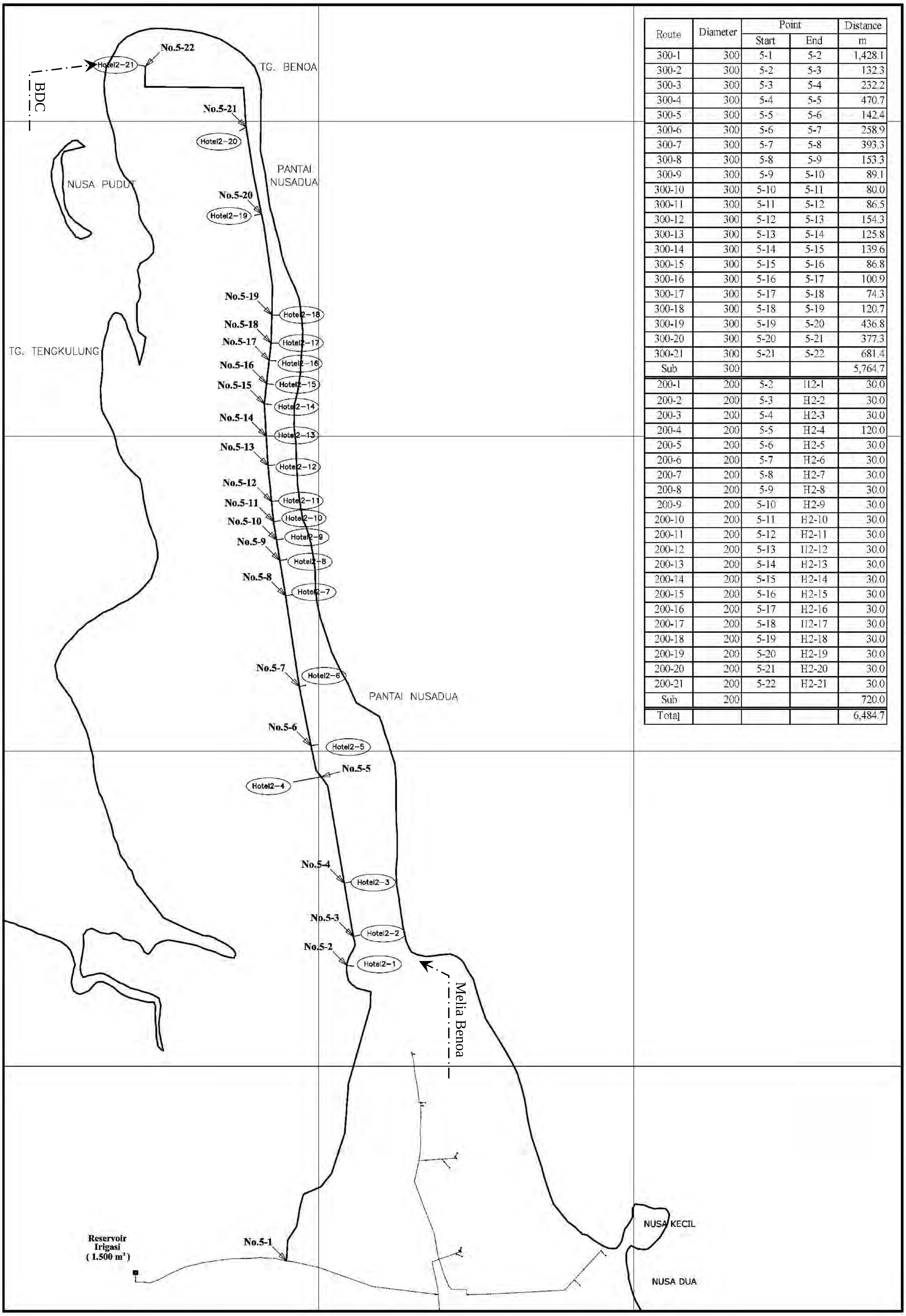
Figure 9.d.2 Site Plan for the Proposed Water Reclamation Plant



Route	Diameter	Point		Distance
		Start	End	m
400-1	400	1-1	1-2	1,369.2
400-2	400	1-2	1-3	174.1
400-3	400	1-3	1-4	72.6
400-4	400	1-4	1-5	21.5
400-5	400	1-5	End	4.7
400-6	400	1-2	1-6	460.9
400-7	400	1-6	1-7	51.7
400-8	400	1-7	1-8	5.9
400-9	400	1-8	End	7.5
Sub	400			2,168.1
300-1	300	1-6	2-1	276.8
300-2	300	1-6	2-2	373.5
300-3	300	2-2	2-3	96.7
300-4	300	2-3	2-4	9.7
300-5	300	2-4	End	45.1
Sub	300			801.8
150-1	150	2-1	4-1	277.6
150-2	150	4-1	4-2	653.1
150-3	150	4-1	C-11	54.3
150-4	150	3-1	4-3	473.5
150-5	150	4-3	4-4	168.4
150-6	150	4-4	End	3.4
Sub	150			1,630.3

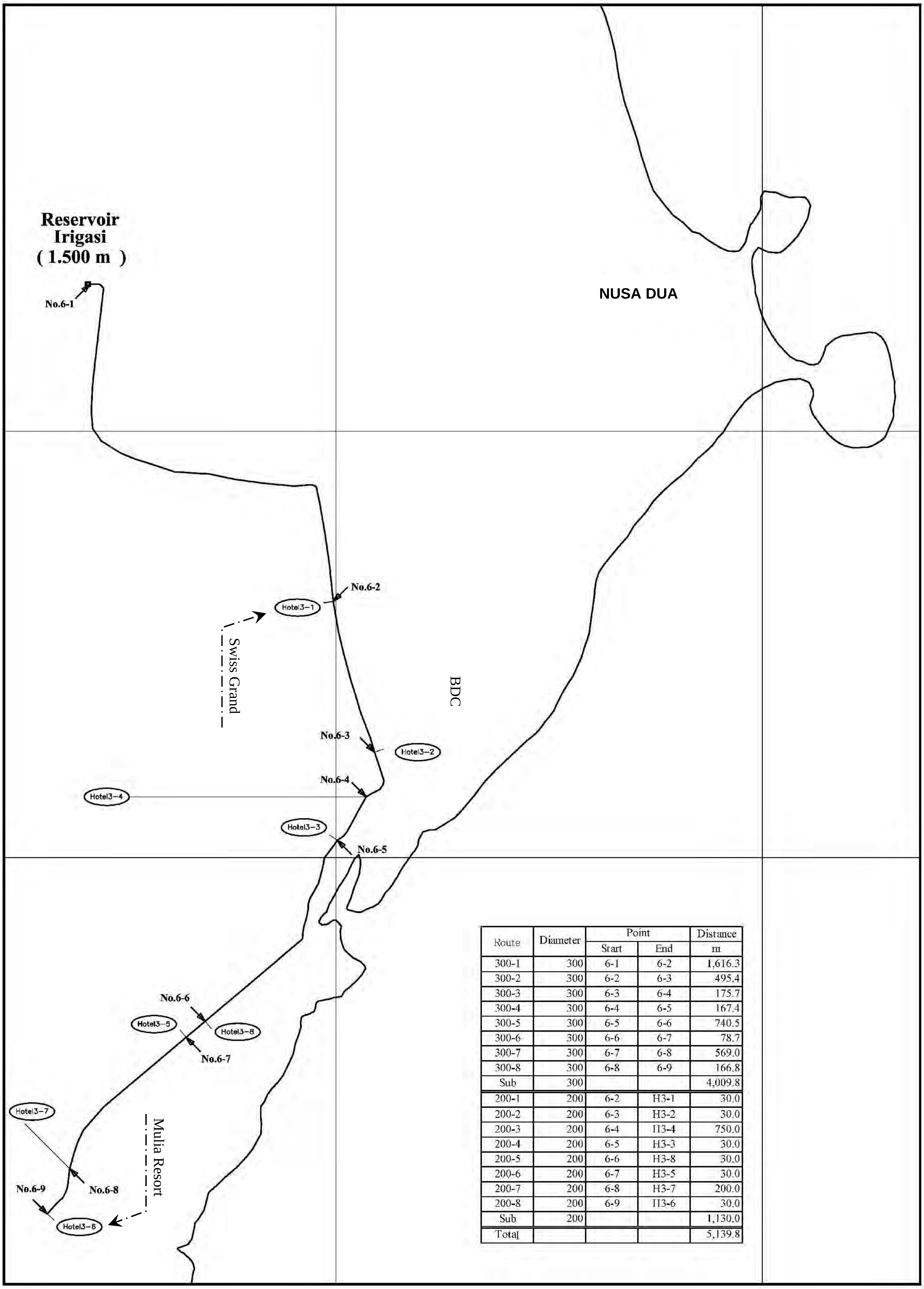
Route	Diameter	Point		Distance
		Start	End	m
200-1	200	1-3	3-1	234.9
200-2	200	1-3	3-2	443.0
200-3	200	3-2	3-3	236.2
200-4	200	3-3	3-4	12.8
200-5	200	3-4	3-5	217.8
200-6	200	3-5	End	5.5
200-7	200	3-5	C-1	10.5
200-8	200	3-4	C-2	21.5
200-9	200	3-3	C-3	10.5
200-10	200	3-2	3-6	99.5
200-11	200	3-6	3-7	52.0
200-12	200	3-7	End	11.1
200-13	200	3-7	C-4	27.8
200-14	200	3-6	C-5	50.4
200-15	200	1-5	C-6	19.1
200-16	200	1-4	C-7	33.1
200-17	200	4-3	C-8	33.5
200-18	200	4-4	C-9	30.3
200-19	200	1-7	C-12	21.7
200-20	200	1-8	C-13	15.9
200-21	200	2-4	C-14	141.1
200-22	200	2-2	C-15	53.0
200-23	200	2-3	C-16	99.7
Sub	200			1,880.9
Total				6,481.1

Figure 9.d.3 Existing Distribution Network in Nusa Dua available for the Reclaimed Water Supply



Route	Diameter	Point		Distance
		Start	End	m
300-1	300	5-1	5-2	1,428.1
300-2	300	5-2	5-3	132.3
300-3	300	5-3	5-4	232.2
300-4	300	5-4	5-5	470.7
300-5	300	5-5	5-6	142.4
300-6	300	5-6	5-7	258.9
300-7	300	5-7	5-8	393.3
300-8	300	5-8	5-9	153.3
300-9	300	5-9	5-10	89.1
300-10	300	5-10	5-11	80.0
300-11	300	5-11	5-12	86.5
300-12	300	5-12	5-13	154.3
300-13	300	5-13	5-14	125.8
300-14	300	5-14	5-15	139.6
300-15	300	5-15	5-16	86.8
300-16	300	5-16	5-17	100.9
300-17	300	5-17	5-18	74.3
300-18	300	5-18	5-19	120.7
300-19	300	5-19	5-20	436.8
300-20	300	5-20	5-21	377.3
300-21	300	5-21	5-22	681.4
Sub	300			5,764.7
200-1	200	5-2	H2-1	30.0
200-2	200	5-3	H2-2	30.0
200-3	200	5-4	H2-3	30.0
200-4	200	5-5	H2-4	120.0
200-5	200	5-6	H2-5	30.0
200-6	200	5-7	H2-6	30.0
200-7	200	5-8	H2-7	30.0
200-8	200	5-9	H2-8	30.0
200-9	200	5-10	H2-9	30.0
200-10	200	5-11	H2-10	30.0
200-11	200	5-12	H2-11	30.0
200-12	200	5-13	H2-12	30.0
200-13	200	5-14	H2-13	30.0
200-14	200	5-15	H2-14	30.0
200-15	200	5-16	H2-15	30.0
200-16	200	5-17	H2-16	30.0
200-17	200	5-18	H2-17	30.0
200-18	200	5-19	H2-18	30.0
200-19	200	5-20	H2-19	30.0
200-20	200	5-21	H2-20	30.0
200-21	200	5-22	H2-21	30.0
Sub	200			720.0
Total				6,484.7

Figure 9.d.4 New Distribution Pipes to Benoa



Route	Diameter	Point		Distance
		Start	End	m
300-1	300	6-1	6-2	1,616.3
300-2	300	6-2	6-3	495.4
300-3	300	6-3	6-4	175.7
300-4	300	6-4	6-5	167.4
300-5	300	6-5	6-6	740.5
300-6	300	6-6	6-7	78.7
300-7	300	6-7	6-8	569.0
300-8	300	6-8	6-9	166.8
Sub	300			4,009.8
200-1	200	6-2	H3-1	30.0
200-2	200	6-3	H3-2	30.0
200-3	200	6-4	H3-4	750.0
200-4	200	6-5	H3-3	30.0
200-5	200	6-6	H3-8	30.0
200-6	200	6-7	H3-5	30.0
200-7	200	6-8	H3-7	200.0
200-8	200	6-9	H3-6	30.0
Sub	200			1,130.0
Total				5,139.8

Figure 9.d.5 New Distributing Pipes to Sawangan

4. Public Consultation and Socialization

   Public consultation and socialization are required for 1) the transaction of this PPP project (See 14.3.2 of the main report), 2) the establishment of new water quality standards for reclaimed water (if necessary), 3) the establishment of new tariffs for the reclaimed water supply, 5) the approval on the EIA documents, and 6) the start of construction at each project site (as planned in the environmental management plan).

(2) Construction Stage

The construction stage includes personal mobilization, base camp operation, material/equipment mobilization, construction works, equipment demobilization and personal demobilization. The construction works can be divided to those for the new wastewater reclamation plant and the existing distribution reservoir and those for the installation of transmission, distribution and service pipes. The construction works for the new wastewater reclamation plant can be further divided into land clearing, excavation/embankment, building the structures/installation of equipment and landscaping.

1. Personal Mobilization

   The SPC needs to establish a construction management team and need to make contracts with local sub-contractors.

2. Base Camp Operation

   A based camp needs to be established by lending office and accommodations or constructing prefabrication buildings. Utilities and office appliances needs to be ready to use in the base camp.

3. Material/Equipment Mobilization

   Materials and equipment required for the construction works need to be brought close to the construction sites.

4. Land Clearing

   The mangrove trees at the proposed site for the wastewater reclamation plant needs to be removed.

5. Land Excavation/Embankment

   The construction of the new wastewater reclamation plant requires the excavation of unstable surface soil after the removable of mangrove trees. Then, the site should be embanked up to the base ground level of the existing WWTP with stable soil for the construction. Soil excavation is also required to the construction of the new raw water pumping station for the wastewater reclamation within the existing WWTP.

6. Building of Structures/Installation of Equipment

   The proposed wastewater purification plant consists of several buildings for raw water transmission, biological treatment, ozone treatment, membrane treatment, chlorination, treated water transmission, etc.

7. Landscaping

The main gate and the buildings of the wastewater purification plant should follow building code regulations of Bali.

8. Installation of Pipe Facilities

   In order to supply the reclaimed water to the targeted areas, it is required to install 1) a transmission pipeline from the wastewater reclamation plant to the existing distributing reservoir in Nusa Dua, 2) two trunk distribution pipelines from the distribution reservoir to Benoa and Sawangan, and 3) service pipes from the existing distribution pipes in Nusa Dua and the new distribution pipes in Benoa and Sawangan to each hotel in the target areas. The rehabilitation of the existing distribution pipes in Nusa Dua and the installation of the new distribution pipes and service pipes are part of the responsibility of PDAM Badung according to the plan proposed in the preparatory survey.

9. Equipment Demobilization

   Equipment used in the construction is removed from the construction sites.

10. Personal Demobilization

    The construction workers need to move out of the base camp.

(3) Operation Stage

The operation stage of this project includes the personal mobilization of SPC and PDAM Badung, the operation and maintenance of reclaimed water treatment facilities (including the operation of pumps and valves for raw water intake, transmission and distribution and the maintenance of the pipes), meter reading, billing & revenue collection and customer services. The main components of the operation stage are explained as follows:

1. Personal Mobilization

   SPC needs to mobilize operational staff at the wastewater reclamation plant and PDAM Budung needs to assign O&M and administration tasks for the retail supply of the reclaimed water to their existing or new staff.

2. Water Treatment Operation

   The proposed treatment process for the wastewater reclamation includes the use of biological filter, pre-zonation, coagulation/flocculation, ceramic membrane and chlorination. The residual ozone after the pre-zonation is removed at the wastewater reclamation plant.

3. Backwash Water Management

   The biological filter and ceramic membrane needs to be backwashed regularly. It is planned to send back the used backwash water to the inlet of the WWTP. Therefore, no sludge will be generated from the used backwash water in the wastewater reclamation plant.

4. Rotating Machinery Operation

   In addition to the pumps for raw water intake, the pumps for water transmission and water distribution, the blowers for the diffuser of biological filters and the feed pump for ceramic membrane need to be operated continuously. The operation of power generator is also required during power failures.

5. Reclaimed Water Supply and Use

   The reclaimed water will be transmitted and sold by the SPC as bulk water to PDAM Badung at the existing reservoir in Nusa Dua that was used for irrigation water in the past. PDAM Badung will be in charge of the reclaimed water distribution to the hotels in the target areas and billing & collection. The hotels can deliver the reclaimed water with the existing pipes inside the hotels to each guest room after mixing it with PDAM's drinking/clean water.

6. Pipe Maintenance

   All the pipes used for the reclaimed water supply requires maintenance to reduce leakage of the reclaimed water. The maintenance work is also required to avoid water quality degradation in the pipes.

7. Office Management

   The office for management and administration staff and the workshop and resting place for technical staff need to be maintained.

8. Tariff Collection

   Reclaimed water charges will be collected from the hotels using the reclaimed water, based on their consumptions of the reclaimed water measured with water meters. PDAM Badung will be in charge of the tariff collection.

(4) Post-Operation Stage

Since this project is planned as a BOT of 25 years. The facilities to be constructed for the project will be handed over to Bali Provincial Government 25 years after the signing of PPP contract. The machinery and electrical equipment to be installed will reach its lifetime expectancy at the time of handing over. In order to continue the reclaimed water service, the replacement of the machineries and electrical equipment are required. After the cease of the operation, land rehabilitation and personal demobilization are required as explained in the following.

1. Land Rehabilitation

   After the cease of the operation, the land for the water reclamation plant needs to be rehabilitated before being returned to the Ministry of Forestry.

2. Personal Demobilization

   The staff working exclusively for the project may need support to find new jobs.