DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF WATER SUPPLY AND DRAINAGE
NATIONAL WATER SUPPLY AND DRAINAGE BOARD (NWSDB)

PREPARATORY SURVEY REPORT
ON
REHABILITATION OF KILINOCHCHI WATER SUPPLY SCHEME
IN
DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

DECEMBER 2011

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

NJS CONSULTANTS CO.,LTD

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The cost estimates is based on the price level and exchange rate of June 2011.

The exchange rate is:

Sri Lanka Rupee 1.00 = Japanese Yen 0.749 (= US$0.00897)

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Preface

Japan International cooperation Agency (JICA) decided to conduct ‘The Preparatory Survey on Rehabilitation of Killinochchi Water Supply Scheme in Democratic Socialist Republic of Sri Lanka”, and organized a survey team, NJS Consultants Co., Ltd. between February, 2011 to December, 2011.

The survey team held a series of discussions with the officials concerned of the Government of Sri Lanka, and conducted a field investigation. As a result of further studies in Japan, the present report was finalized.

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

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Sri Lanka for their close cooperation extended to the survey team.

December, 2011

Shinya Ejima
Director General
Global Environment Department
Japan International Cooperation Agency

Summary

1. Background of the Project

Killinochchi District is located in the Northern Province and has an urban center of approximately 20,000 populations.

The only water supply system in Killinochchi District, which was constructed in 1982, had been destroyed during the conflict and abandoned. The people in Killinochchi are currently depending on the water tankers for their water needs. The restoration of the water supply system is one of the most urgent issues for the people in Killinochchi.

In August 2010, the Government of the Democratic Socialist Republic of Sri Lanka (hereinafter referred to as "GoSL") requested a financial assistance for "Rehabilitation of Killinochchi Water Supply Scheme (hereinafter referred as "the Project")" to the Government of Japan (hereinafter referred to as "GOJ").

2. Institution for Project Implementation

In Sri Lanka the Ministry of Water Supply and Drainage (MWSD) is in charge of the water/sanitation sector policies.

National Water Supply and Drainage Board (NWSDB) carries out planning, project implementation, and daily management and operation of water services.

3. Contents of the Project

The GoSL requested to support of "Rehabilitation of Killinochchi Water Supply Scheme" to the GOJ and GOJ decided to conduct the Preparatory Study. In the study the scope of works and the priorities of the project have been justified. Based on the result of justification an outline design, implementation plan and cost estimate were prepared. In the period of the preparatory study JICA dispatched three missions, the first one for the fact finding, the second for the outline design and the third for the explanation of the project.

The contents of the project are summarized as follows:

Contents of the Project (Japanese Scope)

Facility	Contents
Water Intake	- New Construction: Water Intake Pit, Intake Pumps (2.85m^3/min×13m×11 kW×2sets), Control Panels, Flow Meter - Rehabilitation: Intake Tank, Intake Pump House
Raw Water Transmission Pipe	- New Construction: 200mm Dia, L=15 m (DI) - Rehabilitation: 200mm Dia , L=0.2 km (DI and PVC)
Water Treatment	- Design Water Flow: 3,800m^3/day (Maximum Daily Water Demand) - New Construction: Roughing Filter, Electrical & Generator House, Wash Water Storage Pond, Washed Sand Storage Yard, Guard House, Internal Pipes within sites, Internal Works within sites, Transmission Pumps

Facility	Contents
	(2.64m^3/min×41m×30kW×2sets, Generator, Panels, Chlorination Facility - Rehabilitation: Intake Tank, Aerator, Slow Sand Filter, Pump & Chemical House (Supporting frame work for chain hoist)
Transmission Pipe	- WTP～Killinochchi Central College Water Tower - New Installation: Dia. 300mm, L=1.7 km (PE & DI) - Killinochchi Central College Water Tower～Paranthan Water Tower - New Installation: Dia. 250mm , L=6.7 km (PE & DI)
Water Tower	- New Construction:1,000m^3×1 (Killinochchi Central College site) - New Construction:450m^3×1 (in Paranthan Town site)
Distribution Pipe	- New Installation: Dia.160mm～400mm、L=41.8km (PVC& DI)
Procurement Equipment	- House Connection Materials of House Connection: 1,500sets (Pipes, Fittings, Ferrules, Saddles and Water Meters) - Laboratory Instruments: Colorimeter×1, Turbidity Meter×1, Microscope×1, Electrical Conductivity Meter×2, pHMeter×2, Residual Chlorine Meter×2, DO Meter×2、Refrigirator×1, Laboratory Equipment×1set (Laboratory Equipment, Shelf, Chair) - Operation & Maintenance Equipment Under-pressure Tapping Machine×2、PC×2、LCD Projector×1

Contents of the Project (Sri Lankan Scope)

Facility	Contents
Miscellaneous Works at Water Treatment Plant and Water Tower Site	- Construction of gates and perimeter fences around the facilities for the water treatment plant, Killinochchi Central College water tower and Paranthan water tower.
House Connection Works	- Installation of 1,500 house connections (Pipes, Fittings, Ferrules, Saddles and Water Meters)
Wastewater Treatment	- Construction of wastewater treatment system for Killinochchi General Hospital and Army Camp
Laying of Distribution Pipe	- Installation of approximately 45km distribution pipe

4. Project Period and Project Cost

The project period is assumed for 24 months in total inclusive 1 month preparation, 4.5 months for the detailed design, 4.5 months for bidding and contract, 13 months for procurement and construction, and another 1 month for soft component execution.

Among the overall costs, Sri Lankan side shall bear the costs partially according to the work sharing between the both governments. Project cost borne by the Sri Lankan side is estimated at approximately JPY 282 million.

5. Project Evaluation

Based on the followings the adequacy of the project is highly evaluated and effectiveness of the project will be expected.

The purpose of the project will be aligned with the objects of the national development plans of GoSL

and the policy of the Grant Aid Program of GOJ. Above all things, the project will benefit the Killinochchi people through providing safe drinking water supply, which is urgently needed in the area.

Indicators to express quantitative effectiveness and qualitative effectiveness will be raised as below:

<Quantitative effectiveness>

Indicators \ Target Year	2011	2016	2020
Water Supply Ratio (%)	14.2*)	65.0	78.9
Water Production (m^3/day)	130	2,300(Daily Average)	2,980(Daily Average)
Served Population (persons)	2,600	12,900	16,600
Number of House Connections (houses)	-	3,100	4,000

*) Currently drinking water from wells is supplied by bowsers.

<Qualitative effectiveness>

The project will contribute to reduce the number of waterborne disease cases and not produce any negative impacts on environment during construction period as well as the operation period after the construction.

Execution of the capacity development program which focuses on operation and maintenance and installation of house connections will also contribute to improve the reliability on water supply service quantitatively and qualitatively.

Qualitative effectiveness will be raised as below:

1) Insufficient water quantity and pressure at faucets will be improved by maintaining water pressure in distribution pipes properly.
2) NRW ratio will be contained by monitoring water leakage from both new and existing pipelines.

Based on the above, it is evaluated that the adequacy of the project is highly evaluated and effectiveness of the project will be expected.

Preparatory Study on Rehabiliataion of Killinochchi Water Supply Scheme in Democratice Socialist Rebublic of Sri Lanka

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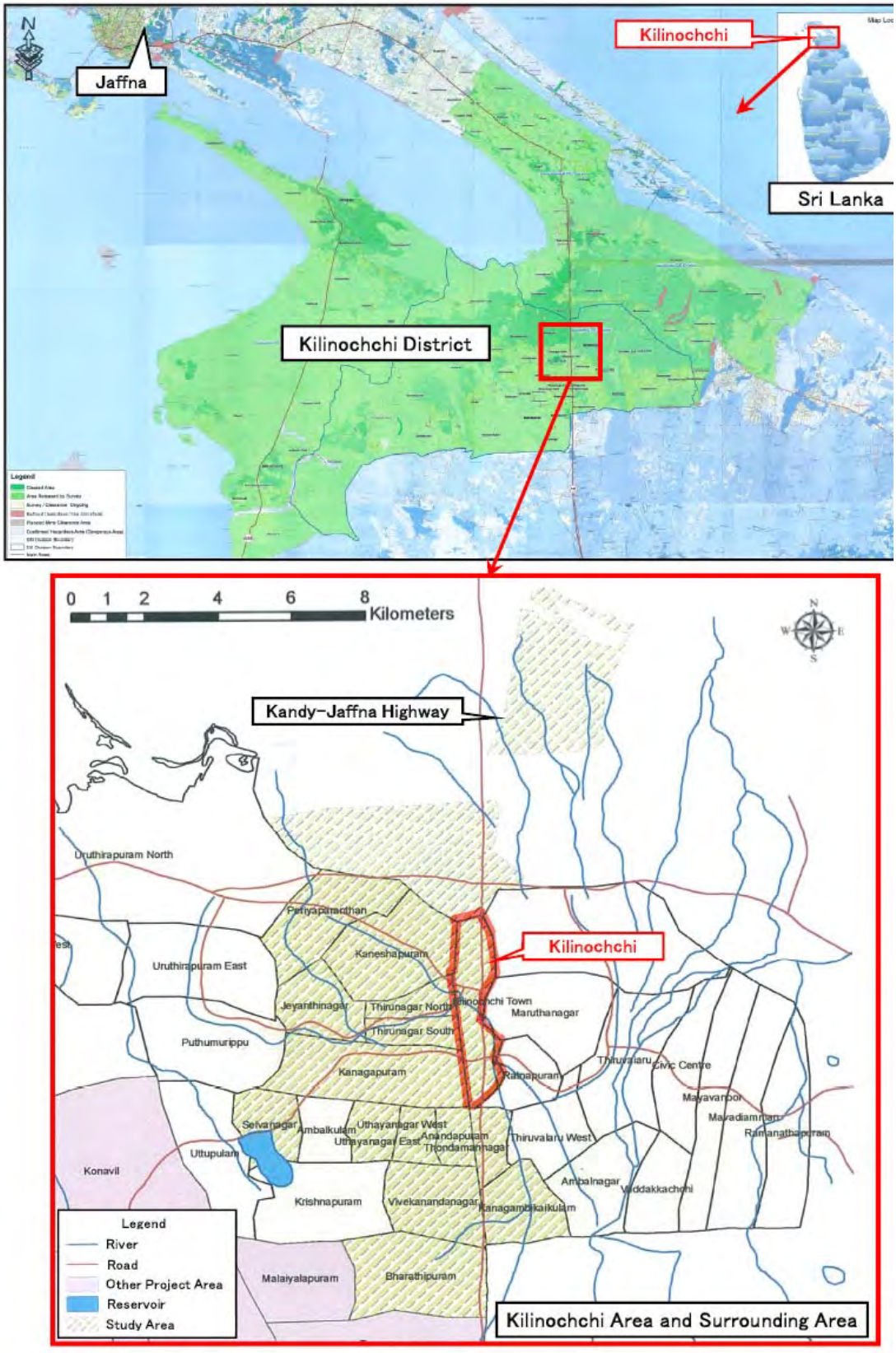
Location Map



Perspective

キリノッチ浄水場

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Abbreviations

1. Abbreviations

ADB	:	Asian Development Bank
CBO	:	Community Based Organization
CEA	:	Central Environmental Authority
CEB	:	Ceylon Electrict Board
CECB	:	Central Engineering Consultantcy Bureau
CIP	:	Cast-iron Pipe
DCIP	:	Ductile Cast-iron Pipe
EIA	:	Environmental Impact Assessment
EOJ	:	Embassy of Japan
GDP	:	Gross Domestic Product
GI	:	Galvanized Iron (Pipe)
GNDs	:	Grama Niladhari Divisions
GOJ	:	Government of Japan
GoSL	:	Government of Sri Lanka
HDPE	:	High Density Polyethylene (Pipe)
HQ	:	Head Quarter
HWL	:	High Water Level
IDP	:	Internally Displaced Persons
JICA	:	Japan International Cooperation Agency
JWWA	:	Japan Water Works Association
LTTE		Liberation Tigers of Tamil Eelam
LWL	:	Low Water Level
M/P	:	Master Plan
MSL	:	Mean Sea Water Level
NWSDB	:	National Water Supply and Dranage Board
NRW	:	Non Revenue Water
PD	:	Project Director
PI	:	Performance Indicator
PIU	:	Project Implementing Unit
PS	:	Pradeshiya Saba
PVC	:	Polyvinyl Chloride (Pipe)
RDA	:	Road Development Autohority
SLS	:	Sri Lanka Standard
UXOs	:	Unexploded Ordnance
WB	:	World Bank
WTP	:	Water Treatment Plant

2. Unit

cm	:	Centimeter
HHs	:	Households
km	:	Kilometer
LKR	:	Sri Lan ka Rupee
Lpcd	:	Litter per capita day
m^2	:	Square meter
m^3/day	:	Cubic meter per day
m	:	Meter
masl	:	Meter above sea level
mbgs	:	Meter below ground surface
mg/L	:	Milligram per litter
Pa	:	Pascal = N/m^2
Rs	:	Sri Lan ka Rupee
USD	:	United States Dollar

Chapter 1 Background of the Project

Chapter 1 Background of the Project

1-1 Background of the Project

Sri Lanka, The Democratic Socialist Republic of Sri Lanka, is a country off the southern coast of the Indian subcontinent. The total population in 2009 is approximately 20.4 million and the Colombo Metropolitan Region covers about 10.8% of the total population i.e. 2.2 million. The recorded GDP per capita in 2009 is 2,063USD.

About 70% of the total population are the Sinhalese, while Tamil are less than 20%. In 1983, there was an on-and-off insurgency against the government by the Liberation Tigers of Tamil Eelam (LTTE) which fought to create an independent Tamil state in the north and the east of the island. After a decades-long internal conflict, the Sri Lankan military defeated the LTTE in May 2009.

With the end of the internal conflict, the government of Sri Lanka called for redevelopment of the nation. And many IDPs have come back to their original land, however, restoration and development of social infrastructures which had been destroyed during the conflict has not been executed yet. Especially the people with expertise are still leaving and the lack of the skilled people is the apprehension in north area. Therefore to recruit proper human resources is the key to success for the restoration of the infrastructure in north area.

The water for living in Killinochchi people are depending on water tankers. The restoration of the water supply system is one of the most urgent issues for the people in Killinochchi.

In August 2010 the Government of the Democratic Socialist Republic of Sri Lanka (hereinafter referred to as "GoSL") requested to support of "Rehabilitation of Killinochchi Water Supply Scheme (hereinafter referred to as "the Project") "to the Government of Japan (hereinafter referred to as "GoJ").

1-2 Natural Conditions

1-2-1 Topography

The average altitude of Killinochchi town is MSL+14 m. At the Iranamadu Junction, the southern end of the Project area, it is about MSL+34 m and at the Paranthan Junction, the northern end; it is about MSL+6.5 m.

1-2-2 Geology

Topography of Sri Lanka is mainly formed by peneplain, hills, and hillside slope between them. In the northern areas, its topography is occupied by peneplain and hilly low land areas. Its geology is mostly of Precambrian age, together with narrow banded granite of Mesozoic era which is distributed from seashore in the northern part to hilly low land in the east-northern part. These areas are presently stable as

tectonic structures.

In this study, geotechnical investigation at five locations was carried out. As a result, the thickness of soil layers at each place differed according to locations but the compositions of soil layers were almost similar. Supporting base at this area is limestone of Cenozoic era and it distributes in the altitude of GL-7 m ～ 15 m. The supporting base is overlain by high density clayey sand layer with N values of 40 to 50. Thus, the clayey sand layer is expected as supporting layer. Occasionally, the clayey sand layer is covered by low density sand layer with N value of about 10. Top surface layer at these places is of decomposed organic soil and it is soft layer with N values of less than 10.

1-2-3 Meteorology and Hydrology

Sri Lanka locates in tropical zone of which weather is characterized by its high temperature and humidity. Especially in Northern and North-eastern area it rains a lot during the monsoon season, from October to December. The average annual rainfall is about 1,000 mm and the average annual temperature is about 32 ^{o}C. The average monthly rainfalls from 2004 to 2011 are as follows.

Table 1-2-1 Average Monthly Rainfall (2004 – 2010)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Rainfall(mm)	35.9	14.5	70.4	51.0	60.1	10.6	34.0	25.2	42.8	198.5	320.2	264.8	1,128.0

Remarks：Department of Meteorology, Colombo

Dry Aru Tank, the water source for the Killinochchi water supply system, stores the water discharged from Iranamadu Tank through the water gates. The gates are controllable artificially. Due to the internal conflict in the project area there have not kept past water level control record of the gates, however, through discussion with the Irrigation Authority officers the water levels of the water intake facilities of the Killinochchi water supply system are determined as LWL shall be MSL+16.2 m and HWL shall be MSL+18.5 m.

1-3 Environmental and Social Considerations

1-3-1 Laws and Regulations Related to Environment and Social Consideration

The laws and regulations related to environmental protection and social consideration are summarized as follows.

Table 1-3-1 Laws and Regulations Related to Environmental Protection and Social Consideration

Laws/Regulations	Contents
General Environmental Laws and Regulations	
National Environmental Act, No. 47 of 1980, (Amended by Act No.56 of 1988 and Act No.53 of 2000)	The authority, function and obligation of CEA; Policy, management and protection of the environment
Guideline for Implementing the Environmental	"Prescribed Projects" for which EIA are necessary.

Laws/Regulations	Contents
Impact Assessment (EIA) Process (No.772/22 dated 24th June 1993; No.859/14 dated 23th February 1995; No. 1104/22 dated 6th November 1999; No. 1159/22 dated 22th November 2000.)	Project Approving Agencies (PAA) and their responsibilities, procedures for compliance with regulations and EIA contents and application format etc.
National Environmental (Noise Control) Regulations, No. 1 of 1996	Noise standards in residential, business and industrial area. As silence zone, regulates courts, hospitals, public libraries, schools, and sacred places and regulates its noise levels as less than 50 dB in daytime and less than 45 dB at night time.
National Environmental (Ambient Air Quality) Standards (Gazette extraordinary No. 850/4 dated 20th December1994)	Sulphur dioxide (SO_2), Nitrogen dioxide (NO_2), Carbon monoxide (CO) and Particular matter (PM_{10}) etc.
National Environmental Act（Vibration Control） of 1966	Vibration Standards in residential, business and industrial area.
Social Consideration	
Land Acquisition Act, 9th March, 1950	Regulates the procedures for the acquisition of land for public purpose.
Public Nuisance Act (1979)	Regulates penal code on public nuisance (dumping of excavating soil and solid waste etc.)
The Antique Ordinance (Gazette of DSRSL, Extraordinary No.1152/14, 4th October, 2000 as amended by Act No.24 of 1988.)	Regulates to protect and maintain archaeological, historical, cultural, and religious heritages and monuments which the nations have designated, and to control the development in those areas.
Environmental Standards	
National Environment Act, No47 of 1980. National Environmental (Protection and Quality) Regulations, No.1 of 1990.	General standards for discharge of effluents into inland surface waters
Drinking Water Quality Standards（SLS 614, 1983）	Bacteriological and chemicals of health significance (inorganic constituents, organic constituents) and substances and parameters that may give rise to complaints from consumers.

1-3-2 Application Procedures of EIA and Environmental Approval Letter by CEA

(1) Procedures of EIA Application

EIA application procedures are regulated by Amendment of National Environmental Act, No.56 of 1988. The details are based on the gazette (extraordinary) No.722/22 dated 24th June, 1993 and No.859/14 dated 23rd February 1995. EIA application procedures are controlled by Central Environmental Authority (CEA), the Ministry of Environment and Natural Resources.

Project proponent (NWSDB in the Project) submits project implementation application form (Basic Information Questionnaire) to CEA. In the application form, information on project name, responsible official, project contents, purpose, fund, location of the project (with a map of a scale of 1/50,000), extent of the project area (in ha), incompatible conditions to constrains described in various laws and regulations, present land use, necessity of deforestation, possibility of resettlement, possibilities of pipe laying and construction of tunnels is requested to be described.

CEA requires consultation to investigative committee on the application form which project proponent

submits and asks judgement on necessity of EIA and IEE. In unnecessary case of EIA and IEE documents, CEA sends environmental clearance permission (environmental approval letter) with constraint conditions on implementation of the project to proponent.

(2) Environmental Approval Letter for the Project by CEA

NWSDB submitted project implementation application form to CEA on April 26, 2011. In response to this application, CEA sent environmental approval letter (NO/KN/08/ER/41/11) with constraint conditions to NWSDB in June 16, 2011. This means that the project doesn't need EIA and IEE reports and it is possible to be implemented if constraint conditions for implementation of the project are satisfied. It was judged that EIA and IEE reports were not necessary due to re-construction project of old water supply system which had operated before internal conflict. (The project team confirmed in the meeting with Jaffna's CEA office that this project is not necessary to prepare EIA/IEE reports in June 23, 2011. Environmental approval letter by CEA and the confirmation note by Jaffna's CEA office are shown in the attachment.)

(3) Constraint Conditions for Environmental Approval Letter by CEA

Constraint conditions for environmental approval letter by CEA and countermeasures and their responsible officer are as follows:

1) General Conditions

- NWSDB shall intimate to CEA the date of commencement of project activity/construction activities, inclusive of phased implementation scheme. (Countermeasures: NWSDB shall inform CEA of them in the stage after determination of project schedule. Responsible office: NWSDB)
- A copy of this approval letter should be kept at the project site at all times for the purpose of perusal by concerned agencies. (Countermeasures: NWSDB should conduct this condition at implementation time. Responsible office: NWSDB)
- Necessary approval from the Karachchi Pradeshiya Sabha, Department of Irrigation and other relevant agencies should be obtained prior to the implementation of the project. (Countermeasures: The Project gets agreements on dumping of surplus excavation soils and of sedimentation soils of water treatment plant from Karachchi Pradeshiya Saba and water intake of 4,000 m^3/day at Dry Aru Tank from Irrigation Department. After basic design stage, RDA and PRDD clearance permission shall be necessary on pipe laying works on the roads. Responsible office(r): NWSDB/Consultant/Contractor)
- NWSDB is responsible for the equity in distribution of drinking water throughout the proposed

project area by adopting appropriate mechanisms, in order to ensure the fairness in distribution and to mitigate of drinking water. (Countermeasures: Implementation conditions by NWSDB. Responsible office: NWSDB)

- Any waste water arising from cleaning and washing shall not be released freely into the environment and such waste water shall be discharged into a properly constructed soakage pit. (Countermeasures: campaign for enhancement of social awareness etc. Responsible office: NWSDB)

2) Noise and Vibration

- Noise levels at the boundary of the site during the construction stage should be maintained at or below 75 dB (A) during day time (between 06:00 hrs to 21:00 hrs) and at or below 50 dB (A) during night time (between 21:00 hrs to 06:00 hrs. (Countermeasures: environmental control in construction period. Responsible officer: Contractor)

- Transport of loading and unloading of material shall be carried out in such a way to minimize the nuisance to the public and adjoining school by way of dust or noise. (Countermeasures: environmental control in construction period. Responsible officer: Contractor)

3) Disposal of Solid Waste

- Solid waste associated with the construction and the work force shall be collected regularly and disposed in consultation with the local Authority – Karachchi Pradeshiya Sabha. (Countermeasures: environmental control during construction period. Responsible officer: Contractor)

In implementation of the Project, re-construction works and the operation of re-constructed water supply system have to be conducted under the constraint conditions described in Environmental Approval Letter NO/KN/08/ER/41/11). As the constraint conditions described in the Environmental Approval Letter are sufficiently reviewed in the environmental and social consideration on adverse impact to environment in construction and operation stages and in its mitigation countermeasures, environment management plan, and monitoring plan, NWSDB and relating officers to the construction works should respect the proposals.

1-3-3 Proposed Sites for Construction of Facilities for the Project

As construction sites for the Project, the following three plans are proposed: (1) re-construction of intake facility at the adjoining land of Dry Aru Tank and of water treatment plant at the old plant site near the intake facility, (2) construction of elevated tank with capacity of 1,000 m^3 and height of 37.2 m at the premises of Central College, (3) construction of elevated tank with capacity of 450 m^3 and height of 30.1 m at the site near Paranthan Junction in Paranthan Town for water supply in northern area. Land area,

land owner, present status, and land use permission at each site are as follows:

(1) Proposed sites for reconstruction of intake facility and water treatment plant

Proposed site (1,348 m^2) for reconstruction of intake facility and reconstruction site (7,267 m^2) of water treatment plant are located near Dry Aru Tank. These sites were of old intake facility and water treatment plant and were originally owned by NWSDB. Thus, the land use of these sites has no problems.

(2) Proposed site for construction of 1,000 m^3 elevated tank, owned by Killinochchi Central College

NWSDB hopes to keep a surplus space of old water treatment plant as a vacant space for future expansion of water supply system. Further, they had an idea that they would like to construct new elevated tank with capacity of 1000 m3 at any other place because old elevated tank was also located at another place. As a proposed site for construction of new elevated tank, NWSDB selected a part of owned land (land area: 80 perches = 2,023.44 m^2) by Killinochchi Central College where was located along A9 National Road. NWSDB submitted a request letter (N, JICA/01/003) of land use to Killinochchi's Zonal Director of Education in May 4, 2011. In response of this request, Zonal Director of Education permitted the land use of owned land by Central College to NWSDB in May 6, 2011. The proposed land is presently used as banana plantation. Thus, the land use has no problem on resettlement of residence. The permission letter is shown in the attachment.

(3) Proposed site for construction of 450m^3 elevated tank, located in Paranthan Town

Proposed site for construction of 450 m^3 elevated tank is located near Paranthan junction of Paranthan Town. The land is a flat land owned by Kadawalai DS Division. Request letter (No.RM/JAF/KILI/2011) for land use for construction of the elevated tank were submitted to government agency of kadawalai DS Division by Jaffna's NWSDB in March 18, 2011. In response of the request letter, Assistant Government Agent permitted land use to NWSDB in April 11, 2011. Thus, the construction of the elevated tank with capacity of 450 m^3 is possible. As the proposed land is a vacant lot, the land use by project implementation has no problems on resettlement of residence. The permission letter is shown in the attachment.

1-3-4 Possibility of Intake at Dry Aru Tank

(1) Background

The project plans to intake water volume of daily maximum 3,800 m^3/day from Dry Aru Tank. The Dry Aru Tank was constructed in 1920. The tank is a facility to store discharged irrigation water for the meantime from Iranamadu Tank which is located upstream with distance of about 5 km. The Iranamadu

Tank has irrigation canals at the left and right banks and irrigation water of Dry Aru Tank is supplied through its left bank canal. The Iranamadu Tank was the first reservoir which was constructed in Sri Lanka for irrigation purpose by irrigation department and it was completed in 1920. It reserves river water of the Kanakarayana Aru, which originates from Semamadu Kulam in central eastern boundary of Vavuiya District located at most southern part and runs in the north direction through Mullaitive District and Kiliochchi District and flows out Jaffna Lagoon in the northern part.

The Project plans to use surplus water from Iranamadu Tank at Dry Aru Tank. Thus, possibility of water intake at Dry Aru Tank depends on water balance of Iranamadu Tank. The water balance study has been preceded by ADB. ADB study "Jaffna Peninsula Water Supply and Sanitation Feasibility Study (March 2006)" had purpose to supply water to Jaffna city and a part of Killinochchi Town by use of Inamarudu Tank water, together with irrigation. It analysed the possibility of water use by using water balance model. This project reviews the results of the ADB study on the possibility of water intake at Dry Aru Tank. The relationship between the Iranamadu Tank and Dry Aru Tank is shown as follows:

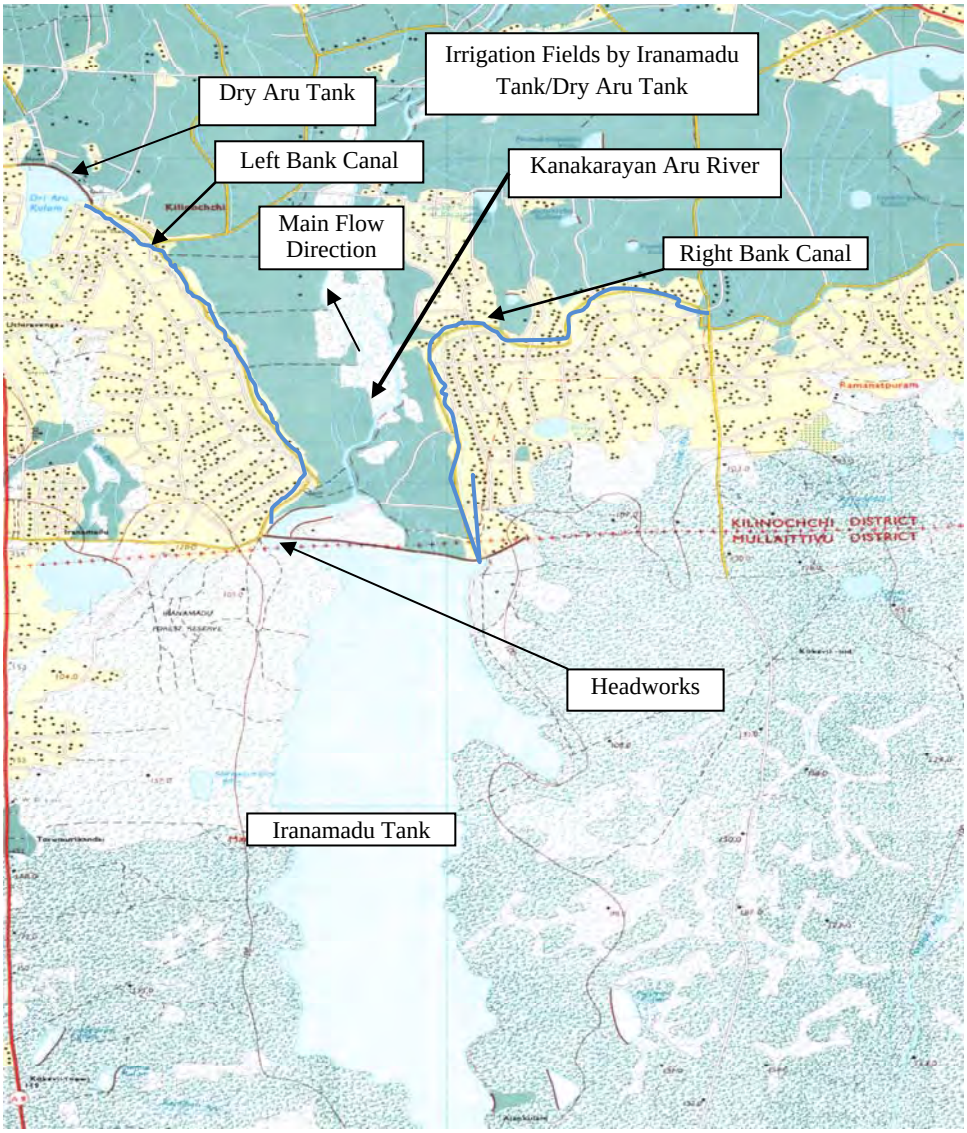


Figure 1-3-1 Relationship among Iranamadu Tank and Dry Aru Tank and Irrigation Canal

(2) Review of ADB Study

1) Outline of Iranamadu Tank

Iranamadu Tank has the structures of earth fill-type embankment with maximum height of 13.7 m and total length of 2,750 m with headwork and spillway with gate, spillway without gate, left bank canal, and right bank canal. Firstly, this dam was designed as total storage volume of 131.4 million m^3 with maximum supply level EL 30.78 m. However, it is presently operated and managed by controlling maximum water level under EL 30.18 m by discharging during rainy season for operation and maintenance of dam due to occurrence of leakage and localized land slide of dam slope at downstream. Maximum total storage volume in this water level is 115.4 million m^3.

2) Review of Water Balance Analysis at Iranamadu Tank

Iranamadu Tank is an artificial reservoir which dams the Kanakarayana Aru River. Catchment area of the river at the upstream side of the dam is about 588 km^2. Water balance on inflow by the river into the Tank, evaporation from the Tank, irrigation volume, and water supply volume for Jaffna city was calculated.

- Inflow into Iranamadu Tank by the River

  To calculate inflow into the Tank by the River, NAM rainfall-runoff model developed by Danish hydraulic Institute was used. This model was calibrated by using monthly rainfall data at Iranamadu Tank and sufficient fit was confirmed based on mean inflow data for 9 years. Inflows to Iranamadu Tank for 44 years-daily rainfall data were calculated. For this calculation, 44 years-rainfall data for 1960 to 2004 at two rainfall stations (Iranamadu and Kanakarayakulam stations) were utilized.

- Irrigation Volume

  Paddy fields of 8,455 ha are irrigated by gravity type-irrigation system through irrigation canals of left and right banks of Iranamadu Tank. Water demand for irrigation was estimated to be 117 million m^3 with maximum supply water level EL 30.9 m based on irrigation area, harvesting pattern, and assumed irrigation efficiency.

- Water Supply Volume for Jaffna City

  Water demand for water supply for Jaffna City was estimated to be 88,500 m^3/day by unit water supply volume 120 L/capita/day and planned water supply population 925, 116 in the target year 2028. To cover the water demand, the project plans to intake average water volume of 50,000 m^3/day from Iranamadu Tank and to cover the other shortage amount by groundwater and

desalination plant.

- Evaporation from Iranamadu Tank

Monthly average evaporation values measured by Class A pan at Iranamadu Tank were used.

Based on the above calculation, the following results of water balance were indicated.

River inflow	:	204 MCM/year (about 559,000 m^3/day)
Irrigation volume	:	117 MCM/year （about 330,000 m^3/day）
Intake Amount for Water Supply for Jaffna City：18.5 MCM/year (about 50,000 m^3/day)		
Evaporation and Leakage	:	31.0 MCM/year (about 85,000 m^3/day)
Spilled volume from Iranamadu Tank：		37.5 MCM/year （about 103,000 m^3/day）

According to the above calculation results, spilled volume from Iranamadu Tank corresponds to 37.5 MCM/year. Maximum daily water intake amount by the Project at Dry Aru Tank is estimated to be 3,800 m3/day (1.387 MCM) and it is equal to about 3.7 percent of yearly spilled water volume at Iranamadu Tank. The intake amount is very little compared with a total of spilled volume. In addition, as the inflow from catchment area is used after storage at Dry Aru Tank, it will average surplus inflow during rainy season by storage. Thus, it results in enough high possibility to intake water volume of 3,800 m^3/day for the Project.

(3) Agreement between Irrigation Department and NWSDB on Intake Amount for Water Supply of Jaffna City at Iranamadu Tank

In Sri Lanka, water right has not been still ruled and there are no formal license procedures for using existing water sources. Water users generally get permission from irrigation department in accordance with the social practice to utilize sources water such as reservoirs, rivers and springs.

Though water supply project for Jaffna City is still in planning stage, NWSDB concluded an agreement with irrigation department to intake raw water of 50,000 m^3/day for the project on July 13, 2007. The agreement is shown in the Attachment.

(4) Agreement between Irrigation Department and NWSDB on Intake Volume for the Project at Dry Aru Tank

Dry Aru Tank was established about 5 km downstream along left bank canal of Iranamadu Tank. Irrigation water is supplied from the left bank of Iranamadu Tank and irrigates paddy field of about 270 acre (109 ha). Its storage volume is 0.345 MCM and high water level is EL 18.29m and low water level is EL 14.94 m. There is no mini-hydro system and it is used for only irrigation. The Project plans to intake maximum daily volume of 3,800 m^3/day. As the project is re-construction

scheme, the old system in past time took water volume of about 4,000 m^3/day from Dry Aru Tank. Irrigation department, District office, NWSDB, and Farmers associations had meeting at District Office Auditorium in October 12, 2010 and agreed to intake water volume of 4,000 m^3/day from Dry Aru Tank. The agreement letters (original and translation documents) on intake volume for the Project are shown in the Attachment.

1-3-5 Natural Environment Protection Area

(1) Forest Reserve around Killinochchi District

There are three forest reserves in the west side of Iranamadu Tank around Killinochchi District. These forest reserves were set up for conservation of native bush and prohibition of deforestation. They are managed by Forest Department, Ministry of Environment and Natural Resources. The project area doesn't include those forest reserves. As forest reserve sometimes include private lands and houses in the areas, they may have some relationships when NWSDB carries out construction works for house connections in the future. Locations of forest reserves are shown in Figure 1-3-2.

1) Iranamadu Forest Reserve、1,358 ha, the area framed by National Road A9 and Iranamadu Tank.
2) Thirumurukkandiya Forest Reserve、3,966 ha, Eastern part of National Road A9.
3) Panikkankulam Forest Reserve, 6,828 ha, the area framed by National Road A9 and Iranamadu Tank.

(2) Nature Reserve

In Killinochchi District, there are no rare species conservation areas of animals such as strict nature reserves, national parks, nature reserve, marine reserves, buffer zones, and sanctuaries which Department of Wildlife Conservation, Ministry of Environment and natural Resources is controlled. In addition, as other important natural environment, there are no important habitats of birds and wet land designated by CEA. The Project received the explanation letter from the Department of Wildlife Conservation, "the project area is not falls under our wild life, therefore, we have no objection or hesitation to carry out said project." This explanation letter is shown in the Appendix.

On the other hand, "Biodiversity Conservation in Sri Lanka - A framework for Action (1998)" divided all the nations into 15 ecological systems on fauna and flora. Of 15 ecological systems, Killinochchi district is included in dry zone, which is characterized by dry climate for 4 or 5 months and wet season of October to January, with dry evergreen mixing forest and elevation of 0 to 500 m and yearly rainfall of 1,250 to 1,900 mm. The dry zone is not selected as priority conservation areas in the criteria of (1) biodiversity, (2) threat against ecosystem, (3) forest ratio, and (4) importance of catchment areas. Thus, Killinochchi District area may be not so important area in view point of ecosystems.

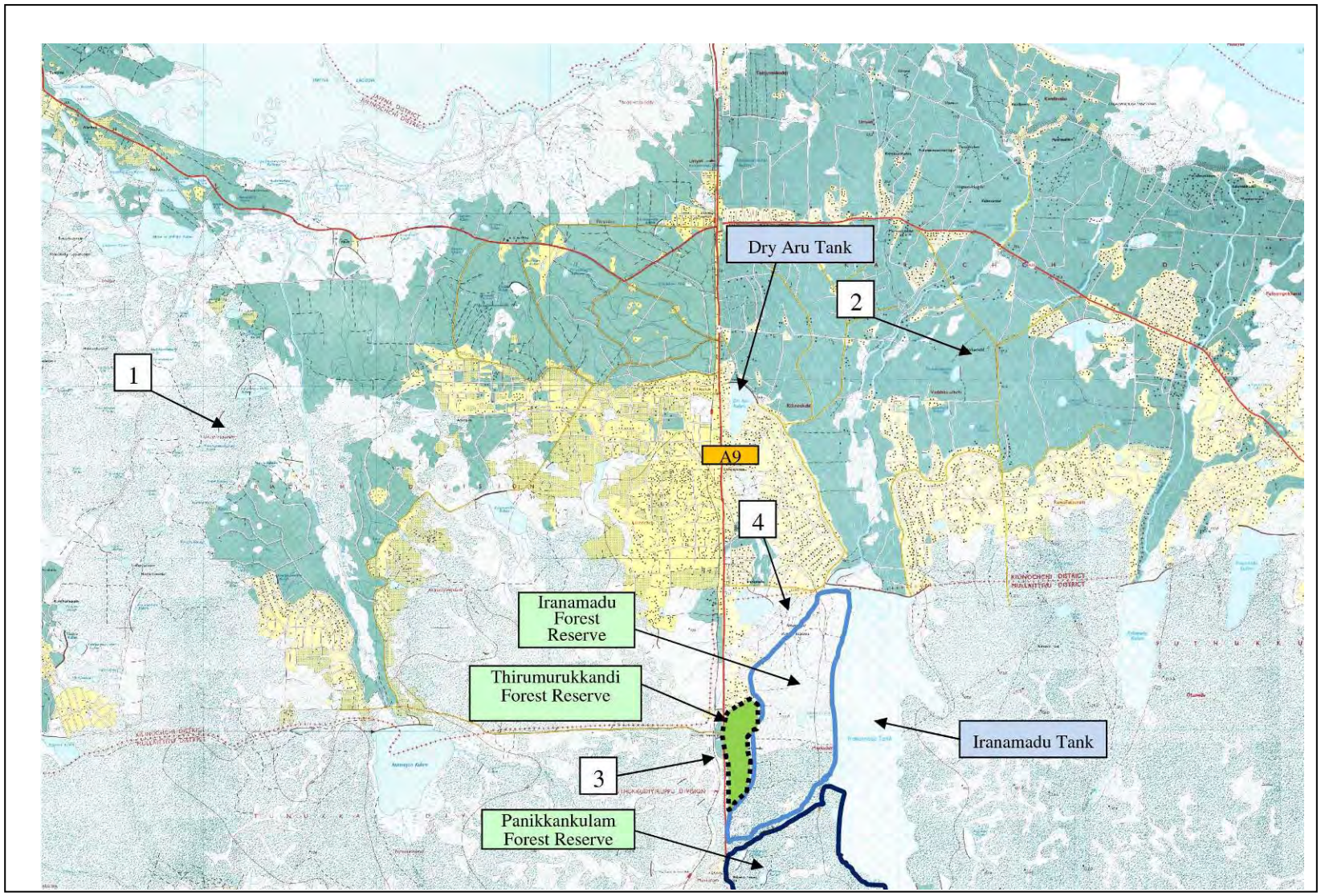


Figure 1-3-2 Locations of Forest Reserved Areas in Killinochchi District and Cultural Heritages

(Note: Premises boundary of Thirumurukandi Forest Reserve is shown in only general location. Vavuniya divisional forest office has no information on its premise boundary.
No: location of cultural heritage of District Office shown in Table 1-3-4.)

1-3-6 Road Conditions of the Project Area

(1) Road Conditions

Road networks are divided into (1) A9 trunk national road connecting from Kandy City to Jaffna City and two main roads running toward the east and the west directions from Paranthan Town managed by Road Development Authority (RDA), the Ministry of Port and Highways and (2) provincial roads managed by Provincial Road Development Department (PRDD). In road criteria, road networks are categorized to 4 classes of A, B, C, D: Class A and B are managed as national roads by RDA and Class C and D are supervised as provincial roads by PRDD. The criteria are as follows:

Table 1-3-2 Road Categories and Road Width

Road Category		Management Organization	Total Width of Road
National Road	A Class	Road Development Authority (RDA)	30 m
	B Class		24 m
Provincial Road	C Class	Provincial Road Development Department (PRDD)	12 m
	D Class		8 m

（Source） Road category depends on RDA Information

Main National Road A9 is in paved condition and has much traffic. Other roads are almost in unpaved condition and their traffic volumes are very small. As there are many expansion and improvement portions in A9 road, it has many passages such as dump trucks for construction, buses, trucks, passage cars, and motorcycles for resident users. In case that the study team surveyed traffic volume near the Killinochchi Temple at 11:00 a.m. of May 30, 2011, 8 vehicles and 10 motorcycles (except bicycles) per a minute passed A9 road. The traffic volume of A9 road is much. Thus, sufficient safety traffic control will be requested when pipe laying work for the Project in the future is conducted.

(2) Expansion Plan of Road Width of National Road A9

National Road A9 is under of jurisdiction of Road Development Authority (RDA), the Ministry of Ports and Highways. At present, the A9 road is utilized for traffic with total width of about 10 m and asphalt of about 6 m. According to RDA, the road is planned to expand to total width of 15.2 m as the first expansion plan in the period of February 2011 to August 2013, and as the second expansion plan, the road width is also planned to expand to total width of 30 m but the implementation schedule is not still fixed. Electrical poles at the end of road are set up with the road width of about 30 m and distribution pipes for water supply are planned to be laid down along the end of the road. In the future plan, setback land for the road expansion in public land belonging to temples and churches may be reduced. In that case, land acquisition shall be conducted based on Land Acquisition Act of 1950.

1-3-7 Wastewater Drainage from Killinochchi District General Hospital

District general hospital was established by ADB fund in 2006. There is one and only one general hospital in the District which have patient number of average 150/day, bed number of 147, and staff number of 211 (medical doctors 18, nurses 59, and other clerks of 134). At the same moment when the hospital was completed, interior war started and wastewater treatment equipment was set up by UNICEF as a temporary facility in 2006. According to administration staff, drawings relating to wastewater treatment equipment were lost due to interior war. Thus, present condition was surveyed by hearing from hospital staff.

Wastewater from the hospital is collected in collection chamber (H 2.4 m×L1.8 m×D1.5 m) located in east and south side of the hospital and after that, its water is conveyed to neighbouring simple septic tank (H4.8 m×L3.2 m×D2.4 m) and its treated water is drained through discharged chamber with decomposed function (weir in central portion, H13.5 m×L0.8 m×H2.4 m) by PVC pipe with diameter 150 mm and length 15 m to outside of hospital area. The wastewater is drained to outside area which is covered by bush trees.

Operation and maintenance of septic tank has not been managed since the completion time of the hospital and supernatant liquid from the septic tank is only discharged to outside area. General domestic water including hand-washed water together with rain water collects to general wastewater collection chamber (same size as wastewater one) and it is discharged through drain side ditches to outside area of the hospital without treatment.

Total discharge amount from the hospital is estimated to be about 80 m^3/day from water supply volume. Outline of layout plan of the wastewater treatment system is shown in **Figure 1-3-3**.

The drainage point of wastewater is in catchment area of Dry Aru Tank. Thus, it is concern that water pollution of the reservoir may be caused, in relation to intake reservoir water of Dry Aru Tank for the Project.

In order to investigate quality of drainage water from the hospital, sampled waters in (1) collection chamber of wastewater and (2) discharged chamber with septic function were collected and analyzed. Analysis items are based on “general standards for discharge of effluent into inland surface waters, National Environment Act, No. 47 of 1980, National Environmental (Protection and Quality) Regulations, No.1 of 1990”. The analyzed results of sampled waters are shown in **Table 1-3-3**. Water quality between the collection chamber and the discharged chamber are not so different in the analysis items of BOD, COD, SO_4, and Pb. Compared with Sri Lanka’s effluent standards for inland surface waters and the analyzed values, the analyzed values of BOD, Oils and Greece, SO_4, Pb, and COD largely exceed the standard values. As a septic tank has not sufficient function, water quality between the collection chamber and the discharged chamber may have not large difference. To drain the polluted wastewater to the catchment area of Dry Aru Tank shall give the influence to water pollution of Dry Aru Tank. Thus, district general hospital should improve the treatment system and its operation and maintenance

conditions as soon as possible.

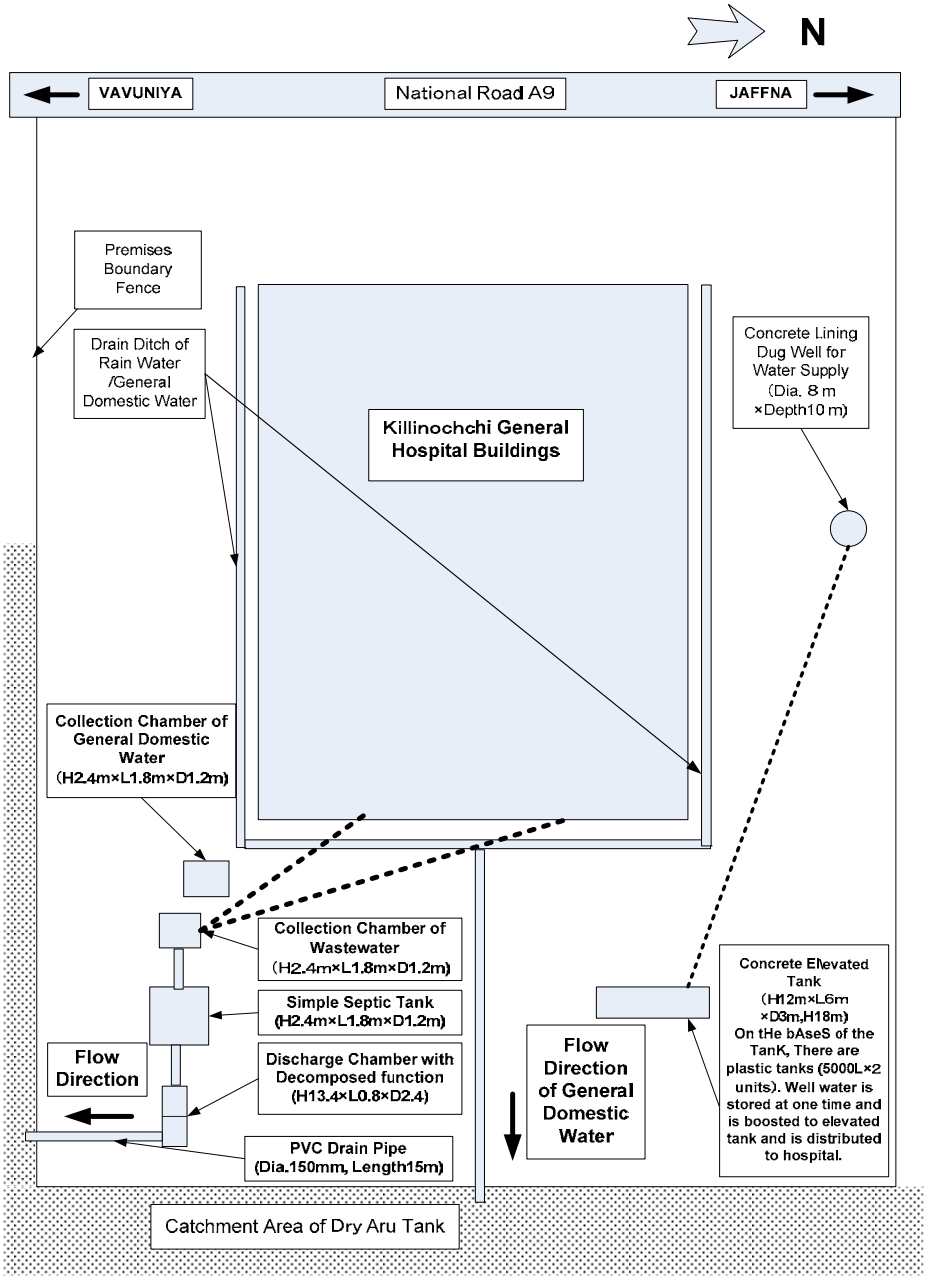


Figure 1-3-3 Outline of Wastewater Treatment Facilities of Killinochchi District General Hospital

Table 1-3-3 Analyzed Results of Drained Wastewater from Killinochchi District General Hospital

No	Water Quality Items	Unit	Collection Chamber, Analysis Result (Sampling Date*)	Discharged chamber with septic function (Sampling Date*)	Effluent Standard for Inland Surface Waters
1	TDS	mg/L	63	23	50
2	pH		7.1	7.1	6.0 – 8.5
3	BOD_5	mg/L	128	101	30
4	Temperature of Discharge		-	-	< 40℃
5	Oils and Greece	mg/L	4.6	18	10.0

No	Water Quality Items	Unit	Collection Chamber, Analysis Result (Sampling Date*)	Discharged chamber with septic function (Sampling Date*)	Effluent Standard for Inland Surface Waters
6	Phenol Compound (as OH)	mg/L	Not detected	Not detected	1.0
7	CN (as CN)	mg/L	Not detected	Not detected	0.2
8	SO_4	mg/L	28	27	2.0
9	F	mg/L	0.1	0.1	2.0
10	As	mg/L	Not detected	Not detected	0.2
11	Cd (total)	mg/L	Not detected	< 0.1	0.1
12	Cr (total)	mg/L	Not detected	Not detected	0.1
13	Cu (total)	mg/L	Not detected	0.4	3.0
14	Pb	mg/L	0.9	1.0	0.1
15	Mg (total)	mg/L	Not detected	Not detected	0.0005
16	Ni (total)	mg/L	-	-	3.0
17	Se (total)	mg/L	-	-	0.05
18	Zn (total)	mg/L	< 1	Not detected	5.0
19	NH_4-N	mg/L	38	1.37	50.0
20	COD	mg/L	218	817	250

（Note） General standard for effluent：National Environmental (Protection and Quality), No.1 of 1990.
Sampling date of sampled water: June 2, 2011.

1-3-8 Cultural and Historical Heritage (Ruins)

In Killinochchi District, there are no world heritage, important ruins, archaeological heritage and cultural monument which correspond to Antiquities (Amendment) Act, No. 24 of 1998 and Gazette of Extraordinary No.1152/14 (October 4, 2000). However, there are cultural heritages (Hindu temples constructed in about 300 years ago) designated by Cultural Department of District Office. Thus, in case that pipe laying works near these heritages are conducted in the future, the agreement with neighbouring villages shall be needed. However, as all the temples are not in the Project area, there are no problems in the construction works for the Project. Cultural heritage designated by Cultural Department of District Office and their locations are shown in **Table 1-3-4** and **Figure 1-3-2**, respectively.

Table 1-3-4 Cultural Heritage Designated by Cultural Department of District Office

No	Name of Cultural Heritage	Contents
1	Uruthrapuram Sivankovil Temple	Hindu temples constructed in about 300 years ago
2	Mayavanoor Sivankoviol Temple	- ditto -
3	Murukandy Camulith Mullithivu Temple	- ditto -
4	Kanakanpikaikulam Amman Kovil	- ditto -

(Source) Cultural Department of Killinochchi District Office

1-3-9 Ethnic Minority and Indigenous People

In Killinochchi District, there are no indigenous people. However, majority Tamil people of Hindu religious, Moor people of Muslim religious, and Sinhala people of Buddhist keep their residence in the District area. Based on the statistical data of Killinochchi District, the population ratio is shown in Table

2-2-6. Of total population, majority is occupied by Tamil people and corresponds to 99.4 %, with Moor people of 0.5 % and Sinhala of 0.1%. At present, interior war was finished and Sinhala people who are working in administration offices of Central and Provincial Government are increased and their ratio shall be also increased. However, the ratio in the whole population is still in low level. Moor and Sinhala peoples belong to minorities.

According to NWSDB, minorities of Moor and Sinhala peoples are living in town area in mixed conditions and water supply system and the Project can supply water without distinction. Thus, there are no problems on ethnic minority and indigenous people in the Project.

Table 1-3-5 Ratio of Ethnic People in the Project Area

No	D.S. Division	GNs	Tamil	Moor	Sinhala	Sub-total
1	Kandawalai	Kumarapuram	1,159	0	0	1,159
2	-Ditto-	Paranthan	2,029	0	0	2,029
3	Karachchi	Ponnagar	900	0	0	900
4	-Ditto-	Bharathipuram	2,381	0	0	2,381
5	-Ditto-	Viveganthanagar	1,535	0	2	1,537
6	-Ditto-	Uthayanagar East	1,926	0	1	1,927
7	-Ditto-	Ananthapuram	1,812	0	2	1,814
8	-Ditto-	Thondarmannagar	846	0	0	846
9	-Ditto-	Kanagambikaikulam	1,502	78	0	1,580
10	-Ditto-	Ratnapuram	1,139	0	0	1,139
11	-Ditto-	Killinochchi Town	951	25	3	979
12	-Ditto-	Maruthanagar	1,335	0	0	1,335
13	-Ditto-	Kanagapuram	1,078	0	0	1,078
14	-Ditto-	Thirunagar South	1,015	2	6	1,023
15	-Ditto-	Thirunagar North	1,249	1	0	1,250
16	-Ditto-	Kaneshapuram	686	0	0	686
Total			21,543	106	14	21,663
(%)			99.4	0.5	0.1	100.0

（Note） Statistical Data of Planning Department of Killinochchi District Office, (As of December 31, 2010)

1-3-10 Adverse Impact at Construction Stage and Mitigation Measures

Adverse impact against environment at construction stage and mitigation measures is shown as follows:

Table 1-3-6 Adverse Impact against Environment at Construction Stage and Mitigation Measures

No	Adverse Impact	Mitigation Measures	Relating Regulation and Organizations
1	Erosion from cut and fill and temporary sedimentation of natural waterways and artificial reservoir	To plan careful construction schedule. To maintain stable slope of filled surface. To avoid unnecessary exposure of soils. To protect drainage channel by embankment. To conduct adequate compaction of filled slope surface. To conduct vegetation (grass) on erodible surface (especially filled areas) as soon as possible.	

No	Adverse Impact	Mitigation Measures	Relating Regulation and Organizations
2	Adverse impacts on surface hydrology	Minimum disturbance to surface drainage pattern by construction activities (to remove soil sedimentation).	
3	Ground and surface water contamination by oil, grease and fuel	To avoid setting up of construction equipment near drainage channel and artificial reservoir. To keep safe disposal and storage of grease etc. To clean labour camp and storage sites of construction equipment, and to avoid environmental pollution by spill of fuel and oil.	
4	Creation of stagnant water bodies in dumping site of surplus excavation soils, borrow pits, and quarries, etc. suited for mosquito and other vectors to breed, impairing aesthetics or posing danger to humans/animals	To fill or drainage to avoid creating aquatic habitats. To keep original landscaping after use.	Public Nuisance Act of 1979
5	Dumping of surplus excavation soils caused by pipe laying	Dumping to Umayalpuram public dumping site where Karachchi Pradeshiya Saba owns . At the dumping time, to have a meeting with Pradeshiya Saba on dumping lot, pilling height, compaction manners etc.	Karachchi Pradeshiya Saba
6	Noise and vibration pollution at the time of pipe laying and re-construction of treatment plant and intake facility and elevated tanks.	Near schools, hospitals, courts, and libraries which are designated as silent zones by National Environmental (Noise control) Regulations No.1 of 1996, the Contractor should complete the construction works in short time by proper arrangement of work schedule. According to CEA environmental approval letter, it requires to keep less than 75dB at daytime (6:00-21:00) and less than 50 dB at night time (21:00-6:00) near the premise boundary during construction works. Then, by using small scale of back hoe etc and equipment with silencer etc, the Contractor should make an arrangement so as not to cause large noise and vibration.	CEA, Public Nuisance Act of 1979, CEA environmental approval letter
7	Fog and dust during construction works	To avoid fog and dust caused by construction works and by water spray before or during construction works.	Public Nuisance Act of 1979
8	Traffic accidents and disturbance during pipe laying works in national road	In case that pipe laying works are conducted at national road A9 with heavy traffic condition, the Contractor must get RDA clearance permission from RDA before start of construction works, by submission of drawings of pipe laying works in the roads, schedules, safety traffic control plan. In addition, the Contractor should conduct pipe laying works in each single lane, and put construction sign and post with colour taping and temporary fences, and put watchmen. In addition, at night time, the Contractor must put electric lightning signal equipment indicating construction site for safety traffic control.	RDA, In advance to start of pipe laying works, the Contractor must get RDA clearance permission by submission of drawings of pipe laying works in the roads, schedules, safety traffic control plan. CEA environmental approval letter

No	Adverse Impact	Mitigation Measures	Relating Regulation and Organizations
		The Contractor must conduct safety traffic control so as not to cause traffic disturbance of passers and bicycles and have to safely lead them by watchmen. Further, in provincial roads which have a little traffic, the Contractor must take the same safety traffic control manners as that of national road A9.	
9	Traffic disturbance and accidents in provincial roads	Provincial roads have generally a little traffic. However, when pipe laying works are conducted, it is necessary to conduct safety traffic control measures in the similar way to national road A9 for safety control.	PRDD, In advance to start of pipe laying works, the Contractor needs to get PRDD clearance permission by submission of drawings of pipe laying works in the roads, schedules, safety traffic control plan. CEA environmental approval letter.
10	Accidents caused by coming and going of construction vehicles at construction site	In the entrances and exits of construction sites such as treatment plant and elevated tanks, the Contractor must all the time and safely control construction vehicles by standing plural watchmen. In addition, the Contractor must teach thoroughly to drivers on safety traffic control for no traffic accidents. The Contractor should ban intrusiveness of the public and put fence and sign board of no trespassing.	-Ditto-
11	Dirtied road by adhering tires of wetted soils and fallen objects by vehicles for transportation of equipment and materials and surplus excavation soils	In case that transportation vehicles for construction works drop fallen object, the Contractor must build organization system to be able to pick up and remove them. The Contractor should confirm drops of any hazard materials which may disturb traffic by going around roads at least three times per day. Further, the Contractor should make clean the tires of transportation vehicles so as not to dirt roads by dirty tires with wetted soils and conduct cleaning of dirty parts of roads.	-Ditto-
12	Discharge of wastewater by construction works	Waste water caused by construction works has to drain to vacant area, trench, and pond. If in neighbouring places of construction sites, proper drain ones are not found, the Contractor should lay temporary drain pipes and build provisional trenches not to provide nuisance to residential houses.	Public Nuisance Act of 1979
13	Wastewater and solid waste caused by construction sites and camps	In the neighbouring area of construction sites and workers camp, environment must be always kept in clean condition. Waste must be properly dumped by bins and cans segregating oils, general rubbish, and hazard materials etc. In the neighbouring area of construction sites and labourer's camp, portable toilets and temporary	-Ditto-

No	Adverse Impact	Mitigation Measures	Relating Regulation and Organizations
		water supply system for cleaning and hand wash should be set up for cleanliness.	
14	Safety control of construction workers	Any worker and personnel who enter into construction sites have to bear safety shoes and hats for construction works. Site manager of the Contractor must conduct morning assembly every day by collecting all the labourers and give instructions to them on safety control of construction site and thoroughly conduct safety management of the site. In the construction site where heavy machines for construction are operated, intrusiveness except concerned parties should be banned.	

(1) Disposal of Surplus Excavated Soil Caused by Pipe Laying Works

Surplus excavated soil is possible to dump at public dumping sites for solid wastes owned by Karachchi Pradeshiya Saba. The dumping site is located in Umayapuran DS Division of Kandavalai Pradeshiya Saba and about 5 km north along A9 national road from Paranthon Janction and about 100 m at left side of the point. The area of the dumping site is a size of 400 m (SN direction) ×200 m (EW direction) with the area of 82,500 m^2.

Figure 1-3-4 General Location of Dumping Site Owned by Karachchi Pradeshiya Saba

The dumping site is located in isolated area without houses and the site is almost in a flat condition with bush trees in some places and dumping volume of solid wastes is presently very little. At the field survey time, waste pickers cannot be founded. The pradeshiya Saba collects dumping fee of Rs 496/m^3 as dumping treatment fee from users. The sufficient space for dumping of surplus excavated soils is reserved. In prior to its dumping, the Contractor shall have a meeting in dumping manners such as dumping lot, pilling height, and compaction method by bulldozer etc. The location of public dumping site is shown in **Figure 1-3-4**. Confirmation note on dumping of surplus excavated soil between survey team and Karachchi Pradeshiya Saba is shown in Appendix.

1-3-11Adverse Impact at Operation Stage and Mitigation Measures

Adverse impact at operation stage and mitigation measures is as shown in follows:

Table 1-3-7 Adverse Impact at Operation Stage and Mitigation Measures

No	Adverse Impact	Mitigation Measures (Environmental Management Plan)	Relating Regulations and Organizations
1	Dumping of sedimentation sand (about 2 m^3/month) in concrete pit which stores cleaning water of filter in slow sand filter	Dumping to Umayalpuram public dumping site. The sedimentation sand is possible to dump in the similar way to surplus excavation soils due to no hazard substances. At the dumping time, to have meeting with Karachchi Pradeshiya Saba which owns the dumping site.	Public Nuisance Act of 1979 Karachchi Pradeshiya Saba
2	Noise pollution caused by booster pumps (2 units) at water treatment plant and a generator	To decrease noise level, a generator (100 KVA) with silencer for emergency which is set up at treatment plant should be arranged. Noise of booster pump shall be reduced to set up in the pump house. The noise by operating generator and booster pump doesn't cause noise problem by keeping less than standard level of noise control regulation (less than 50 dB at day time in silent zone and less than 50 dB at night time in residence areas) due to the distance of about 110 m to neighbouring school and of about 37 m to irrigation department's residence from generator and pump.	National Environmental (Noise control) Regulations No.1 of 1996. CEA

(1) Noise Occurrence by Booster Pumps and a Generator for Emergency Use at Water Treatment Plant

1) In intake facility, noise does not occurred due to setting up of submersible pumps.
2) In water treatment plant, two booster pumps are planned to set up. One unit is prepared for emergency and only one unit is generally used. Booser pump with capacity of 30 kw is planned to be set up and at operating time, pump noise shall be 65 dB at noise source.
3) A generator for emergency is planned to set up equipment of 100 KVA and noise of generator

with silencer shall be 85 dB at noise source

According to noise control regulation, school areas are categorized in silent zone and its noise shall be kept less than 50dB at daytime (6:00-21:00). Its regulation is not applied during night time because school is closed. The distance from generator to school is about 110 m and also, it from booster pump to school is about 118 m. The magnitude of noise shall become 24dB in case of operation of a generator and a booster pump at the same time.

Further, an official residence for staff of irrigation department is located at the shortest distance from booster pump and generator. Its distance is about 37 m from a generator and about 47 m from booster pump. As the official residence correspondences to ordinary houses, noise control regulation regulates to be less than 50dB at night time. According to the calculation, the magnitude of noise shall become 34dB in case of operation of a generator and a booster pump at the same time.

The noise analysis resulted in no problems on noise levels at neighbouring school and official residence due to lower level than standard level of noise control regulation if a generator and a booster pump at water treatment plant operated at the same time. For noise calculation, the following equations were used.

Noise calculation equations

- Calculation equation: $L2 = L1 - 20 \log_{10} (d2/d1)$,
  L2: noise level at prediction distance (dB)
  L1: noise level at reference distance (dB)
  d2: prediction distance (at point sound source)
  d1: reference distance (at point sound source)

- Magnitude of noise in case of overlapping noise:
  Magnitude of noise (dB) = $10 \log_{10} (10^{A/10}+10^{B/10})$
  Magnitude of noise in case of overlapping of noise A dB and noise B dB.

2-2-3-12 Environment Management Plan (EMP)

(1) Construction Stage of Water Supply System

The aim of safety management (safety traffic control and labourers' safety working management) in construction site and environmental control is, to avoid injuries arising from construction activities, produce a healthy working environment, create less disturbance to the public. Environmental Management Program shall be implemented in order to protect all personnel at site/the public and minimize the risk of accidents and incidents and ensure the health of the working personnel and vicinities and the public of the area and ensure the minimum damage to the environment. The safety management shall be continuously implemented throughout the duration of the construction works.

Environmental Management shall be conducted at the site, work areas outside the site, such as equipment

and material storage sites and construction sites. Special care shall be paid for the traffic control during construction time.

Project manager of the Contractor who controls re-construction works must select and arrange Safety Environmental Supervisor under Site Manager. He shall select an enlightened and experienced engineer as the Safety Environmental Supervisor from engineering staff and must engage in safety environmental management for whole construction works. The Safety Environmental Supervisor has to plan a safety environmental management by checking site environment of construction sites, establishing necessary plan, discussing Project Manager and Site Manager, and notifying necessary safety environmental management countermeasures to all the workers. Following figure shows implementation framework for safety environmental management. The Consultant Supervisor must safely implement the construction works by adequately discussing Contractor's Project Manager and NWSDB of implementation agency.

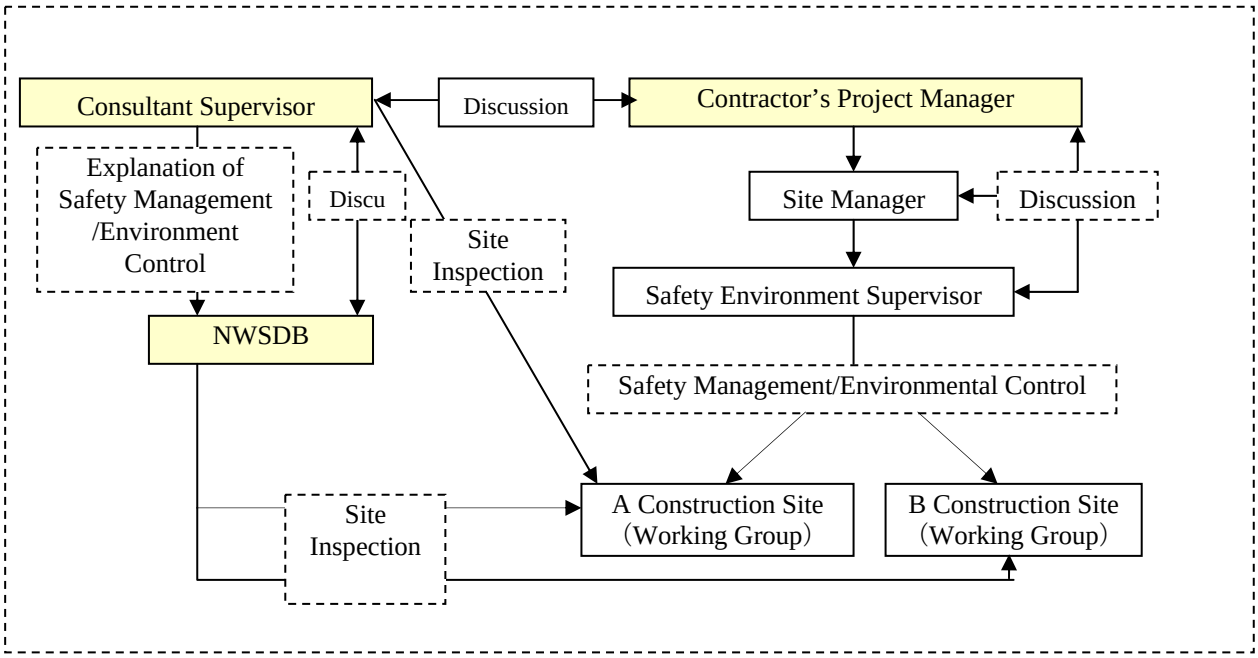


Figure 1-3-5 Implementation Framework of Safety Environment Management

1-3-12 Monitoring Plan

Adverse impacts in construction and operation stages and their mitigation measures, and monitoring plan for environmental protection are shown in the following table. Monitoring results should be recorded and stored by format papers. (CEA does not directly get involved in this monitoring plan because the Project does not need EIA/IEE. The monitoring plan is implemented by Contractor of implementer and Consultant and NWSDB. However, as CEA environmental approval letter requires the close furnish of project information, appropriate response by NWSDB is desired.

Table 1-3-8 Monitoring Plan for Environmental Protection at Construction and Operation Stages

No.	Adverse Impact and Countermeasures	Monitoring Parameters	Monitoring Locations	Monitoring Manners	Frequency	Responsibility of Monitoring
Construction Stage						
1.	Soil erosion from cut and fill and temporary sedimentation at natural waterways and artificial reservoir and soil erosion protection	Soil erosion and turbidity of surface water	Construction site of intake facility	Physical observation	Often during construction,	Contractor's Safety Environment Supervisor, Consultant Supervisor, NWSDB
2.	Adverse impacts on surface hydrology and mitigation countermeasures	Disturbance to discharge channel of surface water	Construction site of intake facility	Physical observation	Often during construction	-Ditto-
3.	Ground and surface water contamination by oil, grease and fuel	Ground and surface water contamination by oil, grease and fuel	Mainly construction site of intake facility	Physical observation	Often during construction	-Ditto-
4.	Creation of stagnant water bodies in dumping site of surplus excavation soils, borrow pits, and quarries, etc.	Keeping of no stagnant water bodies in environment	Dumping site of surplus excavation soils, borrow pits, and quarries, etc.	Physical observation	Often during construction	-Ditto-
5.	Dumping of surplus excavation soils caused by pipe laying	Keeping safety and sanitary dumping site	Dumping site (Public general dumping site)	Physical observation	Often during construction	-Ditto-
6.	Protection of Noise and vibration pollution at the time of pipe laying and re-construction of treatment plant and intake facility	Noise and vibration	All construction site	Complain by people	Often during construction	-Ditto-
7.	Protection of fog and dust during construction works	Fog and dust	All construction site	Complain by people	Often during construction	-Ditto-
8.	Protection of Traffic accidents and disturbance during pipe laying works in national and provincial road	Adequate safety traffic control manners	All pipe laying work	Physical observation	Often during construction	Contractor's Safety Environment Supervisor, Consultant Supervisor, NWSDB, RDA, RDD
9.	Protection of accidents by entrance and exit of construction vehicles at construction sites	Adequate safety traffic control manners	Entrance and exit for construction of intake facility and treatment plant and elevated tanks	Physical observation	Often during construction	-Ditto-

No.	Adverse Impact and Countermeasures	Monitoring Parameters	Monitoring Locations	Monitoring Manners	Frequency	Responsibility of Monitoring
10.	Protection of dirtied road by adhering tires of wetted soils and fallen objects by vehicles for transportation of equipment and materials and surplus excavation soils	Dirty grade of roads	Passage roads of vehicle for transportation of equipment, materials and surplus excavation soils	Physical observation	Often during construction	-Ditto-
11.	Discharge of wastewater by construction works and countermeasures	Confirmation of adequate discharge countermeasures of wastewater	All construction sites	Physical observation	During construction	Contractor's Safety Environment Supervisor, Consultant Supervisor, NWSDB
12.	Wastewater and solid waste caused by construction sites and camps and countermeasures	Adequate treatment and countermeasures of wastewater and solid waste	All construction sites, labourers camp and its neighbouring area	Physical observation	Often during construction	-Ditto-
13.	Safety control of construction workers	Wear of safety shoes and hats and safety control manners at construction sites	All construction sites	Physical observation	Often during construction	-Ditto-
Operating Stage						
1.	Dumping of sedimentation sand (about 2 m^3/month) in concrete pit which stores cleaning water of filter in slow sand filter	Proper dumping of sedimentation sand to public dumping site	Water treatment Plant	Physical observation	Every month	NWSDB
2.	Noise pollution caused by booster pumps (2 units) and a generator at water treatment plant	Noise	Water treatment plant	Complain by people	During operation time	NWSDB

1-3-13 Environmental Check List

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
1 Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a) N (b) N (c) N (d) N	(a) EIA is not required due to re-construction project (Confirmation letter issued on June 23, 2011 by Jaffna CEA office is shown in attachment) . (b) Not applicable. (c) Not applicable. (d) Not applicable.
	(2) Explanation to the Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(a) Y (b) N	(a) Project director of NWSDB explained project outline to officials of iggigation department and district office, and representatives of farmers association on October 12, 2011 and obtains their consent. (b) There are no comment from the public due to reconstruction project of existing water supply system. In the assembly, distirct official requested to accelerate the early-stage start. .
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) N	(a) Thee is no alternative plan due to only one reconstruction project.
2 Pollution Control	(1) Air Quality	(a) Is there a possibility that chlorine from chlorine storage facilities and chlorine injection facilities will cause air pollution? Are any mitigating measures taken? (b) Do chlorine concentrations within the working environments comply with the country's occupational health and safety standards?	(a) N (b) Y	(a) In ordinary handling, there is no air pollution from stored utilities and automatic injection equipment of chlorination. (b) Thus, its equipment matches to labor safety order. However, to make ready leakage accidents of chlorine gas by any possibility, training of workers and preparation of safety protection masks and manuals should be prepared.
	(2) Water Quality	(a) Do pollutants, such as SS, BOD, COD contained in effluents discharged by the facility operations comply with the country's effluent standards?	(a) N	(a) In operation of water treatment plant, effluent which may cause water pollution shall not be occurred.
	(3) Wastes	(a) Are wastes, such as sludge generated by the facility operations properly treated and disposed in accordance with the country's regulations?	(a) N	(a) In operation of water treatment plant, waste such as sludge shall not be occurred.
	(4) Noise and Vibration	(a) Do noise and vibrations generated from the facilities, such as pumping stations comply with the country's standards?	(a) Y	(a) Noise which is occurred by operating a boozer pump (30 KVA) and a generator for emergency (100KVA) with silencer has no problems due to values of less than Sri Lanka's noise control regulation (school: less than 50 dB at day time; ordinary residence: less than 50 dB at night time).

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(5) Subsidence	(a) In the case of extraction of a large volume of groundwater, is there a possibility that the extraction of groundwater will cause subsidence?	(a) N	(a) Land subsidence is not occurred due to usage of surface water.
3 Natural Environment	(1) Protected Areas	(a) Is the project site or discharge area located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) N	(a) Project site including construction sites is not located in and near protection areas. Thus, the Project does not affect protected areas.
3 Natural Environment	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)?(b) Does the project site or discharge area encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions?(c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem?(d) Is there a possibility that the amount of water used (e.g., surface water, groundwater) by project will adversely affect aquatic environments, such as rivers? Are adequate measures taken to reduce the impacts on aquatic environments, such as aquatic organisms?	(a) N(b) N(c) N (d) N	(a) The Project site does not include primeval forests, tropical rain forests, ecologically valuable habitats (e.g. coral reefs, mangroves, or tidal flats). (b) The Project site does not include protected habitats of endangered species designated by the country's law or international treaties and conventions.(c) Not applicable due to the above reasons.(d) Water level of Dry Aru Tank at all times fluctuates by supply of irrigated water from Iranamadu Tank which is located upstream about 5 km from Dry Aru Tank and with adjustment by watchman of Irrigation Department. Further intake by the Project shall not affect aquatic environments to intake a part of stored water in the Tank.
	(3) Hydrology	(a) Is there a possibility that the amount of water used (e.g., surface water, groundwater) by the project will adversely affect surface water and groundwater flows?	(a) N	(a) On the water usage at Iranamadu Tank for agricultural irrigation which is located upstream about 5 km of Dry Aru Tank, ADB Study "Jaffna Peninsula Water Supply and Sanitation Feasibility Study (March 2006) conduct water balance investigation of Iranamadu Tank. According to this study, (River inflow: 204 MCM/year) - (Irrigation volume: 117 MCM/year) - (Intake amount for water supply for Jaffna City: 18.5 MCM/year) - (Evaporation/leakage/year: 31 MCM/year) = (Spilled volume from Iranamadu Tank: 37.5 MCM) . Planned intake volume for the Project is daily maximum 3,800 m3/day and this water volume is equal to 1.387 MCM/year which is 3.7 % of spilled amount from Iranamadu Tank. This amount is very little compared with the spilled amount and it is sufficiently possible to intake because much spilled water from Iranamadu tank in rainy season is at one time stored in Dry Aru Tank and is used by averaging. Further, only a part of water volume stored at Dry Aru Tank is taken. Thus, water level of the Tank is not largely fluctuated and its intake does not affect groundwater flow in the vicinity.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Is the compensations going to be paid prior to the resettlement? (e) Is the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?	(a) N (b) N (c) N (d) N (e) N (f) N (g) N (h) N (i) N (j) N	(a) Implementation of the Project does not cause involuntary resettlement because the Project sites has no residents with vacant lots. (b) Not applicable due to the above reason. (c) Not applicable due to the above reason. (d) Not applicable due to the above reason. (e) Not applicable due to the above reason. (f) Not applicable due to the above reason. (g) Not applicable due to the above reason. (h) Not applicable due to the above reason. (i) Not applicable due to the above reason. (j) Not applicable due to the above reason.
4 Social Environment	(2) Living and Livelihood	(a) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary?(b) Is there a possibility that the amount of water used (e.g., surface water, groundwater) by the project will adversely affect the existing water uses and water area uses?	(a)(b)	(a) Implementation of the Project does not affect living conditions of inhabitants. Adversely, water supply shall provide positive impact to inhabitants. (b) As inflow of irrigation water to and spill from Dry Aru Tank is artificially managed and is stored at all times, intake by the Project shall not affect the existing water uses and water area uses.
	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a) N	(a) There are no archaeological, historical, cultural, and religious heritages and monuments in Project sites.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) N	(a) There are no special landscapes in Project sites.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources respected?	(a) N (b) N	(a) There are no indigenous people in Project sites. Moor and Sinhala people belong to ethnic minorities but they are living with Tamil people in urban area. Thus, the Project does not affect the culture and lifestyle of ethnic minorities. (b) Construction sites for the Project belong to public lands. Thus, it doe not affect the rights of ethnic minorities.
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?	(a) Y (b) Y (c) Y (d) Y	(a) To keep and respect "Adverse Impact against Environmental at Construction Stage and Mitigation Measures, Environmental Management Plan (EMP), and Monitoring Plan" described in this report. (b) The same as the above description. (c) The same as the above description. (d) The same as the above description.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
5 Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts? (c) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts? (d) If the construction activities might cause traffic congestion, are adequate measures considered to reduce such impacts?	(a) Y (b) N (c) N (d) Y	(a) To keep with respect "Adverse Impact against Environmental at Construction Stage and Mitigation Measures, Environmental Management Plan (EMP), and Monitoring Plan" described in this report. (b) This Project is not for construction of new water supply system but for reconstruction of existing one. Thus, it does not affect adverse impact to natural environment (ecosystem). In addition, mitigation measures on pollution to water channel and soil erosion in construction of intake facility are prepared. (c) Construction activities shall provide positive influence to social environment. Residents strongly hope that the water supply system is reconstructed. (d) Pipe laying at National Read A9 is supposed to somewhat cause traffic congestion. Mitigation measures against the traffic congestion are shown in "Adverse Impact against Environment at Construction Stage and Mitigation Measures".
5 Others	(2) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts?(b) What are the items, methods and frequencies of the monitoring program?(c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)?(d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a) Y(b) Y(c) Y(d) Y	(a) As the Project does not need EIA/IEE, CEA does not get directly included in monitoring plan. The monitoring plan is conducted by Contractor and NWSDB. The monitoring plan is shown in this report. The Contractor and NWSDB should conduct the monitoring plan during construction stage and after completion of the facilities. (b) In construction stage, adverse impacts by the project implementation were supposed and monitoring parameters were selected. Monitoring measures and monitoring frequency is based on past experiences which conducted construction supervising at rural water supply project.. (c) Monitoring is carried out by Contractor during construction and by NWSDB after completion of the facilities. At present, Killinochichi's NWSDB does not exist because there is no office due to interior war. However, NWSDB is nationwide organization and monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework) shall be well-established because NWSDB manages utilities at every place. In the Project, Jaffna City's NWSDB supports this study. (d) As mentioned in the above, as the Project does not need EIA/IEE, regulatory submissions pertaining to the monitoring report system to CEA (regulatory authorities) are not requested. However, according to environmental approval letter, CEA generally requests to intimately get project information from NWSDB.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
6 Note	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Dam and River Projects checklist should also be checked.	(a) N	(a) Not applicable.
	Note on Using Environmental Checklist	(a) If necessary, the impacts to trans-boundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as trans-boundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a) N	(a) Not applicable.

1) Regarding the term “Country’s Standards” mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are required to be made. In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan's experience).
2) Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which the project is located.

Chapter 2 Contents of the Project

Chapter 2 Contents of the Project

2-1 Basic Concept of the Project

The main purpose of the project is to rehabilitate former existed water supply system in Killinochchi which had been constructed before the conflict and the system will supply safe and secured water people in the planning area, the population is forecasted approximately 21,000 in 2020.

To achieve the purpose of the project existing water intake and purification facilities shall be rehabilitated and necessary equipment shall be procured and newly reinstalled. In addition to the rehabilitation works necessary operation and maintenance capacity building shall be conducted simultaneously.

The contents of the project are summarised as follows:

Table 2-1-1 Contents of the Project

Facility	Components
Japanese Scope	
1) Water Intake	New Construction: Water Intake Pit, Intake Pumps (2.85m^3/min×13 m×11 kW×2sets), Control Panels, Flow Meter Rehabilitation: Intake Tank, Intake Pump House
2) Raw Water Transmission Pipe	New Construction: Diameter 200mm, L=15 m (DI) Rehabilitation: Diameter 200mm , L=0.2 km (DI and PVC)
3) Water Treatment	Design Water Flow: 3,800m^3/day (Maximum Daily Water Demand) New Construction: Roughing Filter, Electrical & Generator House, Wash Water Storage Pond, Washed Sand Storage Yard, Guard House, Internal Pipes within sites, Internal Works within sites, Transmission Pumps (2.64m^3/min×41m×30kW×2set), Generator, Panels, Chlorination Facility Rehabilitation: Intake Tank, Aerator, Slow Sand Filter, Pump & Chemical House (Supporting frame work for chain hoist)
4) Transmission Pipe	WTP ~ Killinochchi Central College Water Tower New Installation: Diameter 300mm, L=1.7 km (PE & DI) Killinochchi Central College Water Tower ~ Paranthan Water Tower New Installation: Diameter 250mm , L=6.7 km (PE & DI)
5) Water Tower	New Construction: 1,000m^3×1 (Killinochchi Central College site) New Construction: 450m^3×1 (Paranthan Town site)
6) Distribution Pipe	New Installation: Diameter 160mm ~ 400mm, L=41.8km (PVC& DI)
7) Procurement Equipment	House Connection Materials of House Connection: 1,500sets (Pipes, Fittings, Ferrules, Saddles and Water Meters) Laboratory Instruments Colorimeter×1, Turbidity Meter×1, Microscope×1, Electrical Conductivity Meter×2, pH Meter×2, Residual Chlorine Meter×2, DO Meter×2、Refrigirator×1, Laboratory Equipment×1set (Laboratory Equipment, Shelf, Chair) Operation and Maintenance Equipment Under-pressure Tapping Machine×2, PC×2, LCD Projector×1
8) Soft Component	1) Water Treatment Plant Operation and Maintenance 2) Water Distribution System Operation and Maintenance 3) House Connection and Meter Installation 4) Mechanical / Electrical Facility Maintenance

Facility	Components
	5) Water Quality Monitoring and Control
Sri Lankan Scope	
1) Miscellaneous Works at Water Treatment Plant and Water Tower Site	- Construction of gates and perimeter fences around the facilities for the water treatment plant, Killinochchi Central College water tower and Paranthan water tower.
2) House Connection Works	- Installation of 1,500 house connections (Pipes, Fittings, Ferrules, Saddles and Water Meters)
3) Wastewater Treatment	- Construction of wastewater treatment system for Killinochchi General Hospital and Army Camp
4) Laying of Distribution Pipe	- Installation of approximately 45km distribution pipe

2-2 Outline Design of the Japanese Assistance

2-2-1 Design Policy

(1) Overall Goal and Project Purpose

- Overall Goal: To improve life condition of the people in the project area
- Project Policy: To increase population who will be supply water safely and sustainably

Concretely, supplies water flow and population served will increase, and water quality will be improved to meet required water quality level by SLS 614 (1983).

(2) Law, Institution and Standard

In Sri Lanka a drinking water standard is legislated. The water supply system shall be selected and designed to meet this standard.

(3) Utilization of Local Contractors and Materials

For the implementation works, reconstruction of Water Intake, WTP, transmission pipes, water towers, water distribution networks, Sri Lankan local big contractors are available. Especially relating to the A9 Road reconstruction works, close coordination with NWSDB, RDA, and road construction contractors will be required.

In terms of construction materials, for the transmission pipe HDPE shall be applied in consideration of water tight and workability aspects. As to DIP, DIPs are not produced in Sri Lanka; however, imported pipes are available in Sri Lankan market.

(4) Capacity of Operation and Maintenance

Former existed water supply system, long termination of operation, had been destroyed in 2006 by the internal conflict. The former existed system had been operated by operators belong to of Killinochchi Office-In-Charge (OIC) under control of Jaffna Regional Manager of NWSDB. During the operated period NWASB Jaffna Office had monitored water quality and in 2005 and 2006 occasionally 4 parameters, i.e., Turbidity, Colour, Iron and Phosphorus exceeded the standardized levels. Those cases suggest some failure of operation and maintenance in spite of serious raw water quality of Dry Aru. The water in Dry Aru have problem of eutrophication which causes breeding algae.

Although prior to the project NWSDB is reconstructing Killinochchi OIC and operating staffs will be transferred to the OIC soon or lasted, .it is not clear that skilled operators will be assigned or not. Therefore to secure sustainable and proper operation and maintenance some capacity building programs are required.

In addition, laboratory instruments will be procured as project components. This means water quality monitoring capacity building is also required.

In the context of assuring the proper operation and maintenance to establish a certain organization is

necessary. To support smooth commencement of the system soft components shall be conducted in the project term.

(5) Quality Level of Facility and Equipment

Water treatment system shall be designed to meet the water quality standard and facility and equipment shall have simple operation and maintenance to minimize the consumption of power and mainly operated by not automatically but manually.

(6) Construction Method, Procurement Process and Schedule

Storm water discharge in rainy season will cause the water level rise in Dry Aru. This will affect reconstruction works for water intake and still some areas are difficult to enter for Japanese persons due to under military control. Those aspects shall be taken into consideration to select construction method and procurement process and organize construction organization and schedule.

2-2-2 Basic Plan

(1) Planning Area

The planning area consists of 14 GNs; i.e. 2 GNs in Kandawalai Division and 12 GNs in Karachchi Division as shown in the following table.

Table 2-2-1 GNs in the Planning Area

Sr	P-Codes	DS Division	GNs
1	4506043	Kandawalai	Kumarapuram
2	4506044	-ditto-	Paranthan
3	4509010	Karachchi	Viveganantha nagar
4	4509012	-ditto-	Uthayanagar East
5	4509016	-ditto-	Ananthapuram
6	4509017	-ditto-	Thondarmannagar
7	4509018	-ditto-	Kanagambikaikulan
8	4509022	-ditto-	Ratnapuram
9	4509023	-ditto-	Killinochchi Town
10	4509024	-ditto-	Maruthanagar
11	4509026	-ditto-	Kanagapuram
12	4509027	-ditto-	Thirunagar South
13	4509028	-ditto-	Thirunagar North
14	4509029	-ditto-	Kaneshapuram

(2) Planning Horizon

Generally water supply systems are planned to meet the future demand in 20 years in Sri Lanka.

The water supply system which will be rehabilitated under the project is assumed to be constructed utilizing Japan’s grant aid, and this means the land acquisition shall be taken care of by Sri Lankan

Government. As to the water treatment plant NWSDB plans to rehabilitate it with its original capacity i.e. 3,000 m3/day (daily average). Meanwhile as to water towers and distribution networks NWSDB plans to reinstall them with their capacities to meet the forecasted water demand in 2030 because they will be reconstructed newly instead of the original one which had been installed and then destroyed by the conflict.

Taking into consideration of the differences of the planning horizons the capacity of each facility of the water supply system will be planned to meet the water demand in its planning horizon year as follows.

- Water Intake : 2020 (Rehabilitation)
- Water Treatment Plant : 2020 (Rehabilitation)
- Water Towers / Water Distribution Networks : 2030 (Reconstruction)

(3) Planning Area Population

In the conflict affected area the contamination of land by landmines and UXO remained is still a threat to the physical security of returnees. In Killinochchi most areas had been cleared, but some residual contamination remained. The return of people to the original land suffers from this fact.

Based on the NWSDB's previous study, "Killinochchi District Water Supply Development Programme/NWSDB, February 2003", the population in Karachchi Division in 2002 was 71,354. In another NWSDB's study, "Killinochchi Water Supply Scheme Preliminary Proposal/NWSDB, October 2005", the population in Karachchi Division in 2003 was 69,998. On the other hand the present population in Karachchi Division is 66,056, based on "Resettlement – Population in Killinochchi District as at 15, 02, 2011". Those population data suggest the most people displaced by the conflict have returned already but it still on the process of to recover completely.

In the planning area, 12 GNs in Karachchi Division and 2 GNs in Kandawalai Division, GN-wise population and households' numbers are as shown in the following table.

Table 2-2-2 Population and Household Numbers in the Planning Area (in Feb 2011)

DS Division	P-Codes	GNs	Members	Families	Per Family
Kandawalai	4506043	Kumarapuram	1,150	380	3.03
	4506044	Paranthan	2,017	648	3.11
Karachchi	4509010	Viveganthanagar	1,537	507	3.03
	4509012	Uthayanagar East	1,927	673	2.86
	4509016	Ananthapuram	1,814	661	2.74
	4509017	Thondarmannagar	846	274	3.09
	4509018	Kanagambikaikulan	1,580	559	2.83
	4509022	Ratnapuram	1,139	390	2.92
	4509023	Killinochchi Town	979	385	2.54
	4509024	Maruthanagar	1,335	441	3.03
	4509026	Kanagapuram	1,078	415	2.60
	4509027	Thirunagar South	1,023	373	2.74

DS Division	P-Codes	GNs	Members	Families	Per Family
	4509028	Thirunagar North	1,250	472	2.65
	4509029	Kaneshapuram	686	261	2.63
		Total	18,361	6,439	2.85

Source: Resettlement – Population in Killinochchi District as at 15,02,2011

In the previous study of NWSDB, "Killinochchi District Water Supply Development Programme /NWSDB, February 2003", the future population in Karachchi Division in 2002 is forecasted as 57,269. The annual population growth rate is assumed as 1.5%.

Table 2-2-3 Future Population in Karachchi Division

Division	Population	Forecast Population			
	2002 (data)	2002	2005	2015	2025
Karachchi	71,345	57,269	60,001	70,291	81,576

Source: Killinochchi District Water Supply Development Programme/NWSDB, February 2003

Based on the same assumption, i.e. the annual population growth rate is 1.5%, the population in 2011 is forecasted as 66,175. This figure is almost equal to the present population in February 2011 as 66,056.

In accordance with this similarity the same annual population growth rate in Karachchi Division is applied to Kandawalai Division, the future GN-wise population in the planning area is forecasted as shown following table.

Table 2-2-4 Future Forecasted Population in the Planning Area

DS Division	P-Codes	GNs	2011	2015	2020	2025	2030
Kandawalai	4506043	Kumarapuram	1,150	1,221	1,315	1,417	1,527
	4506044	Paranthan	2,017	2,141	2,307	2,486	2,678
Karachchi	4509010	Viveganthanagar	1,537	1,631	1,757	1,893	2,039
	4509012	Uthayanagar East	1,927	2,045	2,204	2,375	2,559
	4509016	Ananthapuram	1,814	1,925	2,074	2,235	2,409
	4509017	Thondarmannagar	846	898	967	1,042	1,123
	4509018	Kanagambikaikulan	1,580	1,677	1,807	1,947	2,098
	4509022	Ratnapuram	1,139	1,209	1,302	1,403	1,511
	4509023	Killinochchi Town	979	1,039	1,120	1,207	1,300
	4509024	Maruthanagar	1,335	1,417	1,527	1,645	1,772
	4509026	Kanagapuram	1,078	1,144	1,232	1,327	1,430
	4509027	Thirunagar South	1,023	1,086	1,170	1,261	1,358
	4509028	Thirunagar North	1,250	1,327	1,430	1,540	1,659
	4509029	Kaneshapuram	686	728	784	844	909
		Total	18,361	19,488	20,996	22,622	24,372

(4) Planning Water Supply Population

In generally, to extend the he water supply system which is planned to supply water to each household, continuous capital investments to contract water distribution are required and under those investments the water supply area will extend synchronizing to the water supply networks. However, there is a

particularity of this study area i.e. the clearance of landmines and UXO remained, and this issue makes it difficult to forecast the future progress of network extension.

Utilizing the base map which the JICA Study Team prepared in this study, the JICA Study Team have drawn the former installed pipelines' routes on the map. Based on the pipelines which had supplied water to the people before the conflict the JICA Study Team assumed the population served by counting the approximate numbers of houses in each GN. Consequently among the total population of 18,361, the population served is assumed as 11,248 in the planning area.

Table 2-2-5 Calculation of Population Served based on the Current Population in 2011

DS Division	P-Codes	GNs	GN Population	Service Rate	Population Served
Kandawalai	4506043	Kumarapuram	1,150	50%	575
	4506044	Paranthan	2,017	80%	1,614
Karachchi	4509010	Vivegananthanagar	1,537	50%	769
	4509012	Uthayanagar East	1,927	50%	964
	4509016	Ananthapuram	1,814	50%	907
	4509017	Thondarmannagar	846	90%	761
	4509018	Kanagambikaikulan	1,580	90%	1,422
	4509022	Ratnapuram	1,139	50%	570
	4509023	Killinochchi Town	979	100%	979
	4509024	Maruthanagar	1,335	50%	668
	4509026	Kanagapuram	1,078	50%	539
	4509027	Thirunagar South	1,023	50%	512
	4509028	Thirunagar North	1,250	50%	625
	4509029	Kaneshapuram	686	50%	343
		Total	18,361		11,248

Land mind and UXO clearance will precede the return of the people and the area to serve water will extend. As a result the population served will increase. Based on the assumption that up to 2020 the security for the people will be preserved and up to 2030 the water supply area will extend to the entire planning area, the population served could be forecasted as shown in the following table.

Table 2-2-6 Future Population Served

DS	Codes	GNs	2015			2020			2030		
			①	②	③	①	②	③	①	②	③
Kandawalai	4506043	Kumarapuram	1,221	50%	611	1,315	70%	921	1,527	100%	1,527
	4506044	Paranthan	2,141	80%	1,713	2,307	100%	2,307	2,678	100%	2,678
Karachchi	4509010	Vivegananthanagar	1,631	50%	816	1,757	70%	1,230	2,039	100%	2,039
	4509012	Uthayanagar East	2,045	50%	1,023	2,204	70%	1,543	2,559	100%	2,559
	4509016	Ananthapuram	1,925	50%	963	2,074	70%	1,452	2,409	100%	2,409
	4509017	Thondarmannagar	898	90%	808	967	100%	967	1,123	100%	1,123
	4509018	Kanagambikaikulan	1,677	90%	1,509	1,807	100%	1,807	2,098	100%	2,098
	4509022	Ratnapuram	1,209	50%	605	1,302	70%	911	1,511	100%	1,511
	4509023	Killinochchi Town	1,039	100%	1,039	1,120	100%	1,120	1,300	100%	1,300
	4509024	Maruthanagar	1,417	50%	709	1,527	70%	1,069	1,772	100%	1,772

DS	Codes	GNs	2015			2020			2030		
			①	②	③	①	②	③	①	②	③
	4509026	Kanagapuram	1,144	50%	572	1,232	70%	862	1,430	100%	1,430
	4509027	Thirunagar South	1,086	50%	543	1,170	70%	819	1,358	100%	1,358
	4509028	Thirunagar North	1,327	50%	664	1,430	70%	1,001	1,659	100%	1,659
	4509029	Kaneshapuram	728	50%	364	784	70%	549	909	100%	909
		Total	19,488		11,939	20,996		16,558	24,372		24,372

Remarks: ①GN Population, ②Water Supply Rate ③Population Served

(5) Future Water Demand Forecast

1) Domestic Water Demand

a) Per Capita Water Consumption

Per capita water consumption, one of the key factors of the water supply system planning, differs from in-house connections to community standpoints drastically. The original water supply system in Killinochchi had been planned and designed around 1975 on the conditions that water would be distributed by in a mixture of in-house connections and community standpoints. After destroyed by the conflict the water supply system had been reconstructed under a project supported by the World Bank in 2004 once. At that time a full in-house connection water supply system had been introduced without any major planning condition investigations. Unfortunately soon after the reconstruction the conflict became the stage of the termination and the reconstructed water supply system were destroyed again. This is why, there are no operation and maintenance record which will dedicate to plan and design a new system properly to fit to the local situation remained. Therefore, as to planning and design conditions such as per capita daily water consumption some generalized figures in Sri Lanka are adopted referring to the other projects' conditions.

① NWSDB's Guidelines

NWSDB's Guidelines "Design Manual, Water Quality and Treatment" were compiled in 1989 and currently those are on the process of revision editing. According to the NWSDB water supply systems are generally on the condition of 120L per capita day. Actually in "Killinochchi District Water Supply Development Programme/NWSDB, February 2003" the water supply system is planned as the per capita daily water consumption is 120 L/person/day.

② Referring to Other Project

For Matale urban water supply system the domestic water consumption is calculated on the basis of that the per capita daily water consumption is 120L L/person/day. The system is planned to supply water to 69,650 persons and the total water supply flow is 31,800 m^3/day in daily average.

Hence for this scheme, Killinochchi Water Supply Scheme, the domestic water consumption is calculated on the condition that the per capita daily water consumption is 120 L/person/day.

b) Domestic Water Demand

Domestic water demand is calculated by the per capita daily water consumption and water supply population.

2) Non-Domestic Water Demand

Taking current administration and industry water demand into consideration the future non-domestic demand is forecasted. Generally in Sri Lanka the non-domestic water demand is assumed as 20% of the domestic water demand. The above-motioned Matale water supply system the non-domestic water demand is forecasted based on the operation and maintenance record for several years and calculated as 17% of the domestic water demand.

In the planning area in Killinochchi there are no outstanding industries so far. However, there are three major army camps along A-9 road in the stretch of the project route for about 10km, and some agricultural enhancement support centres and vocational training facilities for retuned former IDP people have been constructed.

Constructions of urgent road rehabilitation works in Northern Province are on process of implementation. Especially the A-9 Road, Kandy – Jaffna Road, rehabilitation works has already been contracted and the Contractor had stated the mobilization in February 2011 they will implement all contracted works up to August 2013. Many administration offices have been constructed and planned along the A-9 Road. Sooner or later along the A-9 road and its peripheral areas will be develop and a lot of public facilities, offices, and religious places are supposed to be constructed, then the water demand in this area will increase considerably[1].
In March 2011 the JICA Study Team conducted an interview survey along the A-9 Road from Paranthan Junction to Iranamadu Junction. The result of the survey is as shown in the following table. As to the facilities and offices which could not provide clear responses the JICA Study Team assumed and show in italic figures.

Table 2-2-7 Water Demand Assumption in Public Facilities and Offices

No.	Details	Location	Members	Per Person (l/d)	Consumption (m3/d)
1	Regional Agriculture and Research Development Center	Iranamadu Junction	18	25	0.45
2	Kannaibal Mill (Office)	A-9 Road	9	25	0.23
3	Sivam Temple	A-9 Road	*30*	15	0.45
4	Milk Board (Office)	A-9 Road	*10*	25	0.25
5	CECB Contractors	A-9 Road	40	25	1.00
6	Fisheries (Office)	A-9 Road	18	25	0.45
7	Divisional Survey office Bear Land	A-9 Road	*10*	25	0.25
8	IOM - WFP	A-9 Road	16	25	0.40
9	R.D.D. Office	A-9 Road	30	25	0.75
10	SSP - Office	A-9 Road	45	25	1.13
11	Department of Animal Production Health Office	A-9 Road	27	25	0.68
12	Kali Temple	A-9 Road	*30*	15	0.45
13	Advance Inventory Training Center	150, mile post	20	25	0.50
14	RDA Office	150, mile post	80	25	2.00
15	NHDB Office	150, mile post	30	25	0.75
16	Water Board	150, mile post	15	25	0.38
17	Youth Service Council	150, mile post	28	25	0.70

[1] Investment Plan for the 'Wadakkil Wasantham' 2010 – 2012/ Department of National Planning

No.	Details	Location	Members	Per Person (l/d)	Consumption (m3/d)
18	Sri Lanka Telecom	150, mile post	18	25	0.45
19	R.C. Church	150, mile post	8	15	0.12
20	District General Hospital	150, mile post	650	120	78.00
21	Sanasa Development Bank	150, mile post	12	25	0.30
22	Zonal Education Office	150, mile post	112	25	2.80
23	Central College	150, mile post	156	15	2.34
24	Institution of Technical Education and Naita Training Center	150, mile post	300	15	4.50
25	Commercial Bank	150, mile post	12	25	0.30
26	HNB	150, mile post	14	25	0.35
27	Church		*30*	15	0.45
28	Court		*30*	15	0.45
29	Reservation of People Bank		*20*	25	0.50
30	Agriculture Office		*20*	25	0.50
31	Pradeshiya Sabha Office		*20*	25	0.50
32	Kachcheri		*50*	25	1.25
33	Regional Wave House	A-9 Road	12	25	0.30
34	Medical Office of Health	A-9 Road	20	25	0.50
35	Maloqua Office	A-9 Road	11	25	0.28
36	Regional Medical Office	A-9 Road	16	25	0.40
37	RDHS Office	A-9 Road	22	25	0.55
38	Sathosa	A-9 Road	12	25	0.30
39	Lumala Traders	A-9 Road	8	25	0.20
40	St. Theresa Church	A-9 Road	4	25	0.10
41	Sierra Office	A-9 Road	8	25	0.20
42	Goseph Church	A-9 Road	*30*	15	0.45
43	Green Tech Contractors	A-9 Road	18	25	0.45
44	Killinochchi District Field Office	A-9 Road	12	25	0.30
45	Kandaswamy Kovil	A-9 Road	*10*	25	0.25
46	Killinochchi Teaching Department	A-9 Road	13	25	0.33
47	People Leasing Company	A-9 Road	10	25	0.25
48	People Bank	A-9 Road	16	15	0.24
49	Catholic Church	A-9 Road	*30*	15	0.45
50	Sri Lanka Insurance	A-9 Road	12	25	0.30
51	Commercial Bank	A-9 Road	16	25	0.40
52	Hero Honda Singer	A-9 Road	14	25	0.35
53	Hullo Treest	A-9 Road	28	25	0.70
54	Budhist Temple	A-9 Road	*30*	15	0.45
55	Seylan Bank	A-9 Road	14	25	0.35
56	Sampath Bank	A-9 Road	21	25	0.53
57	NSB Bank	A-9 Road	20	25	0.50
58	Bank of Ceylon	A-9 Road	22	25	0.55
59	***** Studies	A-9 Road	12	15	0.18
60	St. Theresa School	A-9 Road	752	15	11.28
61	Paddy Seed Production Exchange	A-9 Road	40	25	1.00
62	Assistant Director of Agriculture	A-9 Road	28	25	0.70
63	Paranthan Telecom	A-9 Road	12	25	0.30
64	Exchange Department Paranthan	A-9 Road	16	25	0.40
65	Rest Lam Hotel	A-9 Road	12	120	1.44
66	Post Office Paranthan	A-9 Road	6	25	0.15
67	Ministry Economic Department	A-9 Road	*20*	25	0.50
68	NEHRP Office	A-9 Road	18	25	0.45
69	Paranthan People Bank	A-9 Road	16	25	0.40
70	Destrict Co.op Asest corre	A-9 Road	17	25	0.43
71	Mur		*5*	25	0.13
72	Keng dox Hall	Kardy Port Road	12	15	0.18
73	DRC (NGO)	Kardy Port Road	16	25	0.40
74	Hmida College student	Kardy Port Road	897	15	13.46
	Hmida College staff		38	25	0.95
75	Central Bus Stand	Depot Road	0	0	0.00
76	Market	Depot Road	60	25	1.50
77	Royal Education Center	Depot Road	16	25	0.40
78	Apperentice Training Center	Depot Road	24	25	0.60
79	Irrigation Department	Wilson Road	26	25	0.65

No.	Details	Location	Members	Per Person (l/d)	Consumption (m3/d)
80	Maha Vidyalaya student	Wilson Road	1,582	15	23.73
	Maha Vidyalaya staff	Wilson Road	70	25	1.75
81	Army Camp	Paranthan	*400*	120	48.00
82	Army Camp	Killinochchi Town	*400*	120	48.00
83	Army Camp	Kanagambikaikulam	*400*	120	48.00
	Total	Number of People =	7,832	Demand=	318.29

In accordance with the interview survey result the non-domestic water demand is assumed as about 25% of the domestic water demand, i.e. in 2015 the domestic water demand is supposed 1,362 m3/day (11,356 persons× 120 L/person/day＝1,362m^3/day) and the non-domestic demand will be calculated as 23.3 % of domestic demand (318.3／1,362 = 0.233).

Generally for urban water supply system in Sri Lanka the rate of non-domestic water to domestic is assumed at the range from 15% to 25%.

Taking into the above-mentioned survey result and the general assumption range for the water supply system in Killinochchi the non-domestic water demand is 25 % of domestic water demand.

3) Non-Revenue Water

In case the existing operation and maintenance water supply records are available the target volume of non-revenue water is possible to be defined based on the actual operation performance. On the other hand, for the water supply systems which have not kept previous operation and maintenance record such as Killinochchi water supply system, a generalized rate of now-revenue water to supplied waster is applied.

Generally for urban water supply system in Sri Lanka the rate of non-revenue water to supplied water is assumed at the range from 20% to 25%. In the above-motioned Matale water supply system the non-revenue water is justified based on the operation and maintenance record for several years and calculated as 30% of the supplied water flow, and the target of the newly planned water supply system is assumed as 25%.

The water supply system in Killinochchi is to be rehabilitated system; however, as a matter of fact its water distribution network is a newly reconstructed one. This means water leakage from the network is assumed to be comparatively little; accordingly, the non revenue water is assumed as 20% of the supplied water flow.

4) Maximum Day Peaking Factor

Generally for urban water supply systems in Sri Lanka the maximum day peaking factor is assumed as 1.25 times the average daily water demand. As to the NWSDB's previous study, "Killinochchi District Water Supply Development Programme/NWSDB, February 2003" the maximum day water demand is calculated as 1.25 times average daily water demand.

Therefore, for the water supply system in Killinochchi, the maximum day peaking factor is assumed as 1.25 times average daily water demand.

5) Future Water Demand

In accordance with the above-mentioned assumption future water demand in the planning area is forecasted as shown in the following table.

Table 2-2-8 Forecasted Future Water Demand

Item	Unit	2015	2020	2030	Remarks
Total Served Population		11,939	16,558	24,372	①
Per Capita Consumption Lpcd =		0.12	0.12	0.12	②
Domestic Demand	(m3)	1,433	1,987	2,925	③=①x②
Non Domestic/Domestic Ratio =		0.25	0.25	0.25	④
Non Domestic Demand	(m3)	358	497	731	⑤=③x④
UFW Ratio =		0.2	0.2	0.2	⑥
UFW	(m3)	358	497	731	⑦=(③+⑤)x⑥
Total Average Day Demand =	(m3)	2,149	2,981	4,387	⑧=③+⑤+⑦
Maximum Day/Average Day =		1.25	1.25	1.25	⑨
Total Maximum Day Demand	(m3)	2,686	3,726	5,483	⑩=⑧x⑨

An issue worthy of special mention is the agreed with the irrigation authority regarding water flow to the water supply system in Killinochchi from Dry Aru is 4,000m^3/day. This means up to about 2020 some additional water resources arrangement will be required.

(6) Necessity of Water Supply Plan in Future

The population density in the southern area is comparatively high and this mean water demand in the southern area is higher than northern area of Killinochchi District as shown in the following figure, but the capacity of the current water resources nevertheless unable to supply sufficient water to meet the demand.

The water supply system in Killinochchi is planned to rehabilitate the system as what had been before the conflict. The system to be rehabilitated will be able to supply water up to around 2020; however, after that the agreed flow is insufficient to meet the future water demand and some additional water resources arrangement will be required.

Concretely two optional arrangements are supposed. First one is to discuss with the irrigation authority to increase water demarcation in future, secondly to look for other water recourses. In the area surrounding Killinochchi it is difficult to find major rivers which are sufficient to provide water to Killinochchi people. It is evitable to negotiate with the irrigation authority to provide additional water from some water reservoirs surrounding Killinochchi town to meet the future water demand.

The previous study, “Killinochchi Water Supply Scheme Preliminary Proposal/NWSDB, October 2005” suggests that, in addition to the current water supply system which will be rehabilitated, to meet the increasing water demand in Killinochchi District a new water treatment plant is to be constructed in southern area, and the water to this new treatment plant will be taken from not Dry Aru but Iranamadu Tank itself.

It is necessary that to justify future water demand and plan proper water supply system to meet the demand in the area based on a comprehensive master plan and feasibility study.

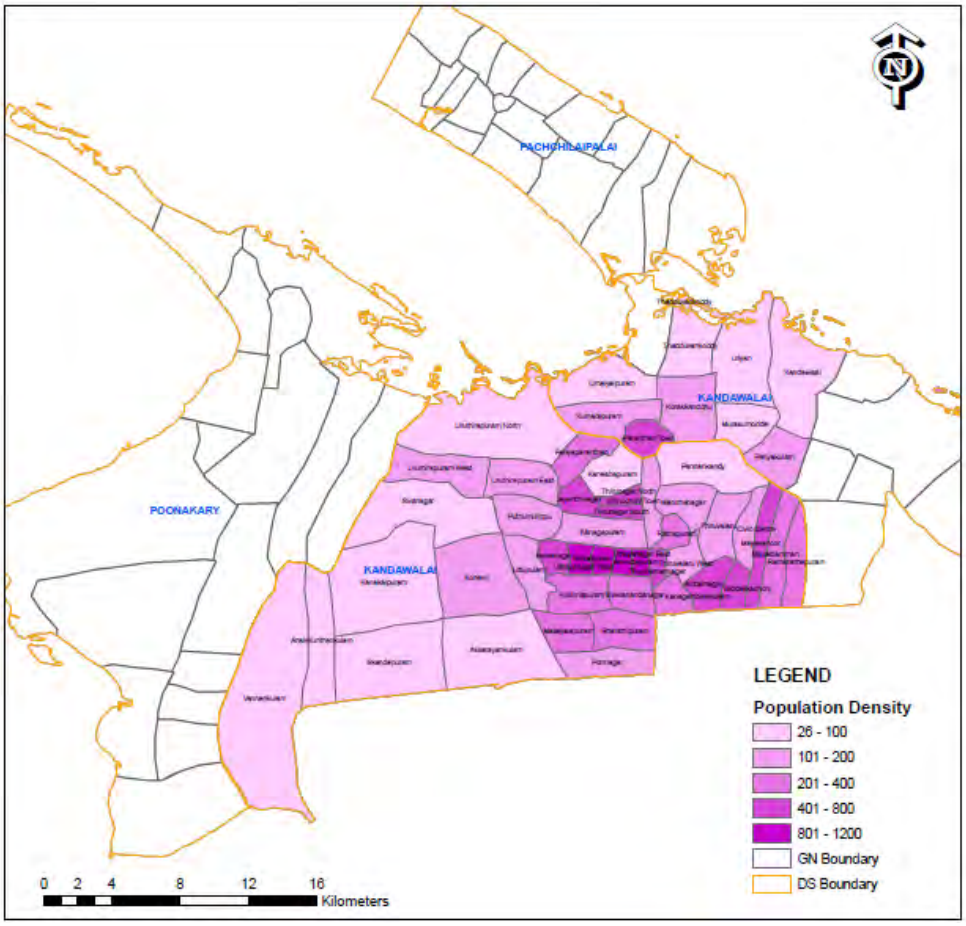


Figure 2-2-1 GN-wise Population Density in Killinochchi District

(7) Design Water Flow

1) Water Intake and Water Treatment Plant

Water intake and water treatment plant will be designed to meet the maximum daily water demand in 2020.

Maximum Daily Water Demand = 3,726 (m^3/d) → 3,800 (m^3/d)

2) Water Distribution System

Water distribution system will be design to meet the design maximum hourly water supply in 2030. The design maximum hourly water supply is calculated taking into consideration into peak factor. The peak factor varies from system to system mainly in accordance with the capacity of the system. For the Killinochchi water supply system it is difficult to assume the peak factor based on the previous water supply operation and maintenance record; however, the previous study, "Killinochchi Water Supply Scheme Preliminary Proposal/NWSDB, October 2005" suggests it as 2.0 times the maximum daily water demand. It is same as that the peak factor is 2.5 times average water demand.

Regarding the sites for water towers NWSDB suggested following candidates.

① Government Land at Umayalpuram in Paranthan
② Inside the premises of existing water treatment plant
③ Inside the premises of NWSDB OIC
④ Government Land for future administration complex in Vivegananthanagar
⑤ Inside the premises of Killinochchi Central College

Among the candidates of the water tower sites two southern ones, i.e. the premises of NWSDB OIC and future administration complex site in Vivegananthanagar, are better to be kept for future plan. Therefore NWSDB discussed with relative authorities and agreed to arrange the Government Land in Paranthan and the Land of Killinochchi Central College.

The initial purpose of the Project is to rehabilitate the water supply system in Killinochchi as what had been before the conflict. In this context, the water towers which will be reconstructed are designed as the capacities which the original water towers had been, i.e. 1,000m^3 for the tank in the Killinochchi Central College and 450m^3 for the tank in Paranthan.

The water distribution system will be designed based on the following principles.

- The two towers will cover the water supply planning area and each tank has its distribution zone.
- The tower in Paranthan will cover 2 GNs in Kandawalai Division and this zone be named as Kandawalai Distribution Zone and the capacity of the water tower is 450m^3.
- The tower which will be constructed in Killinochchi Central College will cover 12 GNs in Karachchi Division and this zone be named as Karachchi Distribution Zone and the capacity of the water tower is 1,000m^3.

(8) Optional Study for Water Distribution System

Water distribution system shall be designed based on comparison of several water distribution systems considering both advantages and disadvantages aspects. As to the distribution system for the Killinochchi water supply system following three options are supposed to be introduced.

Option 1: One (1) Water Tower

- To construct one (1) water tower in the Killinochchi Central College site

Option 2: Two (2) Water Towers in One (1) Distribution Zone

- To construct one (1) water towers in the Killinochchi Central College site and a new balancing tank in a new site in Paranthan respectively
- To distribute water in a single water distribution system

Option 3: Two (2) Water Towers in Two (2) Distribution Zones

- To construct one (1) water towers in the Killinochchi Central College site and a new

balancing tank in a new site in Paranthan respectively

- To distribute water in two water distribution systems

Comparisons of pros and cons of the three options are summarized as follows.

Table 2-2-9 Comparison Summary of Options

	Option 1	Option 2	Option 3
Capacity of Water Tower	− 1,450 m^3	− 1,000 m^3 − 450 m^3	− 1,000 m^3 − 450 m^3
Location of Water Tower	− WTP site	− WTP site − Paranthan	− WTP site − Paranthan
Advantages	− Only one water tower shall be constructed. − The water transmission shall be installed inside in the WTP site only. − The control of the system will be very simple.	− The distribution system will flexibly apply to the water fractural consumption. − The water transmission shall be installed inside in the WTP site only.	− The distribution system will flexibly apply to the water fractural consumption. − Water will be able to distribute division-wisely i.e. Kandawalai and Karachchi respectively.
Disadvantages	− The distribution system will be difficult operated appropriately to the water fractural consumption. − The water pressure in Paranthan will become high.	− Two water towers shall be constructed. − Two water towers shall be operated in a proper balanced condition.	− Two water towers shall be constructed. − Two water towers shall be operated in a proper balanced condition.
Evaluation	Better	Better	Best

In accordance with the comparison result two water towers in two distribution zones is the best option for the Killinochchi water supply system.

(9) Design Factors for Water Distribution System

The design principles for the water distribution zone are summarized as follows.

1) Design Daily Maximum Water Supply in 2030

- ✧ Kandawalai Distribution Zone : 945 m^3/day
- ✧ Karachchi Distribution Zone : 4,541 m^3/day

2) Design Peak Hour Daily Flow

Table 2-2-10 GN-wise Design Factors in Kandawalai Distribution Zones

P-Codes	4506043	4506044
GNs	Kumarapuram	Paranthan
Population	1,527	2,678
Per Capita（Lpcd）	0.12	0.12
Domestic Demand (m3)	183	321
Non Domestic/Domestic Ratio =	0.25	0.25
Non Domestic Demand（m3)	46	80
UFW Ratio =	0.2	0.2
UFW(m3)	46	80

P-Codes	4506043	4506044
GNs	Kumarapuram	Paranthan
Total Average Day Demand(m3)	275	481
Maximum Day/Average Day =	1.25	1.25
Total Maximum Day Demand(m3)	**344**	**601**
Peak Hour/Average Hour Ratio =	2.0	2.0
Peak Hour Day Demand =	**644**	**1,128**

Table 2-2-11 GN-wise Design Factors in Karachchi Distribution Zones

P-Codes	4506010	4509012	4509016	4509017
GNs	Vivekanandanagar	Uthayanagar East	Ananthapuram	Thondarmannagar
Population	2,039	2,559	2,409	1,123
Per Capita（Lpcd）	0.12	0.12	0.12	0.12
Domestic Demand (m3)	245	307	289	135
Non Domestic/Domestic Ratio =	0.25	0.25	0.25	0.25
Non Domestic Demand（m3)	61	77	72	34
UFW Ratio =	0.2	0.2	0.2	0.2
UFW(m3)	61	77	72	34
Total Average Day Demand(m3)	367	461	433	203
Maximum Day/Average Day =	1.25	1.25	1.25	1.25
Total Maximum Day Demand(m3)	**459**	**576**	**541**	**254**
Peak Hour/Average Hour Ratio =	2.0	2.0	2.0	2.0
Peak Hour Day Demand =	**861**	**1,080**	**1,016**	**475**
P-Codes	4506018	4509022	4509023	4509024
GNs	Kanagambikaikulam	Ratnapuram	Killinochchi Town	Maruthanagar
Population	2,098	1511	1300	1772
Per Capita（Lpcd）	0.12	0.12	0.12	0.12
Domestic Demand (m3)	252	181	156	213
Non Domestic/Domestic Ratio =	0.25	0.25	0.25	0.25
Non Domestic Demand（m3)	63	45	39	53
UFW Ratio =	0.2	0.2	0.2	0.2
UFW(m3)	63	45	39	53
Total Average Day Demand(m3)	378	271	234	319
Maximum Day/Average Day =	1.25	1.25	1.25	1.25
Total Maximum Day Demand(m3)	**473**	**339**	**293**	**399**
Peak Hour/Average Hour Ratio =	2.0	2.0	2.0	2.0
Peak Hour Day Demand =	**886**	**636**	**548**	**748**
P-Codes	4509026	4509027	4509028	4509029
GNs	Kanagapuram	Thirunagar South	Thirunagar North	Kaneshapuram
Population	1430	1358	1659	909
Per Capita（Lpcd）	0.12	0.12	0.12	0.12
Domestic Demand (m3)	172	163	199	109
Non Domestic/Domestic Ratio =	0.25	0.25	0.25	0.25
Non Domestic Demand（m3)	43	41	50	27
UFW Ratio =	0.2	0.2	0.2	0.2
UFW(m3)	43	41	50	27
Total Average Day Demand(m3)	258	245	299	163
Maximum Day/Average Day =	1.25	1.25	1.25	1.25
Total Maximum Day Demand(m3)	**323**	**306**	**374**	**204**
Peak Hour/Average Hour Ratio =	2.0	2.0	2.0	2.0
Peak Hour Day Demand =	**605**	**573**	**700**	**383**

3) Water Level in Water Tower

- Water Tower for Paranthan Distribution Zone
  - ✧ Capacity: 450m^3
  - ✧ H.W.L 32.50m
  - ✧ L.W.L 26.50m
- Water Tower for Karachchi Distribution Zone
  - ✧ Capacity:1,000m^3
  - ✧ H.W.L 52.60m
  - ✧ L.W.L 45.60m

(10) Water Intake and Water Treatment Facility Plan

The existing Water Treatment Plant (WTP) intakes pond water as raw water and water treatment is composed of Slow Sand Filter and Chlorine Disinfection, mainly targeting turbidity removal. Based on the examination on the current status of the existing treatment facilities, the following reformation of the existing facilities and installation of pre-treatment facility is needed to produce potable water in safe water quality stably.

Raw water is directly taken from Dry Aru Tank, aerated by Aerator, treated by bio-film through Slow Sand Filter and disinfected by chlorine to serve as potable water. Though raw water quality on WTP commissioning in 1980 is not obvious, water quality data from 2004 when NWSDB decided to re-build the plant is available and referred to water treatment method examination. During 1st field survey of JICA Study Team, water analysis on raw water of Dry Aru Tank and Dug Well was conducted.

Flow chart of the existing intake facility and WTP is as follows:

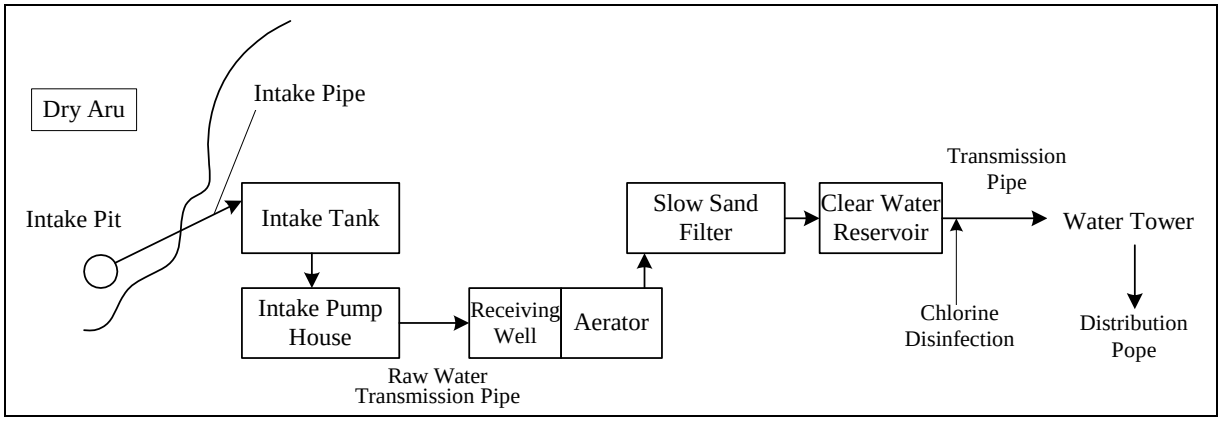


Figure 2-2-2 Flow Chart of the Existing Intake Facility and WTP

1) Water Quality

a) Water Quality of Dry Aru

NWSDB Jaffna conducted raw water quality of Dry Aru Tank in 15 water quality parameters including pH, turbidity, colour, electric conductivity, residual chlorine and so on, 19 times during 2004 to 2011. JICA Study Team further added algae and BOD to the abovementioned induces and carried out the water quality test.

As shown in the following figure turbidity and colour are comparatively high. In the Sri Lankan water quality standard, i.e.," SLS 722 (1985)", turbidity and colure are not stipulated. However, referring to the drinking water standard, i.e., SLS 614 (1983), almost of the all data exceeds the Maximum Permissible Level.

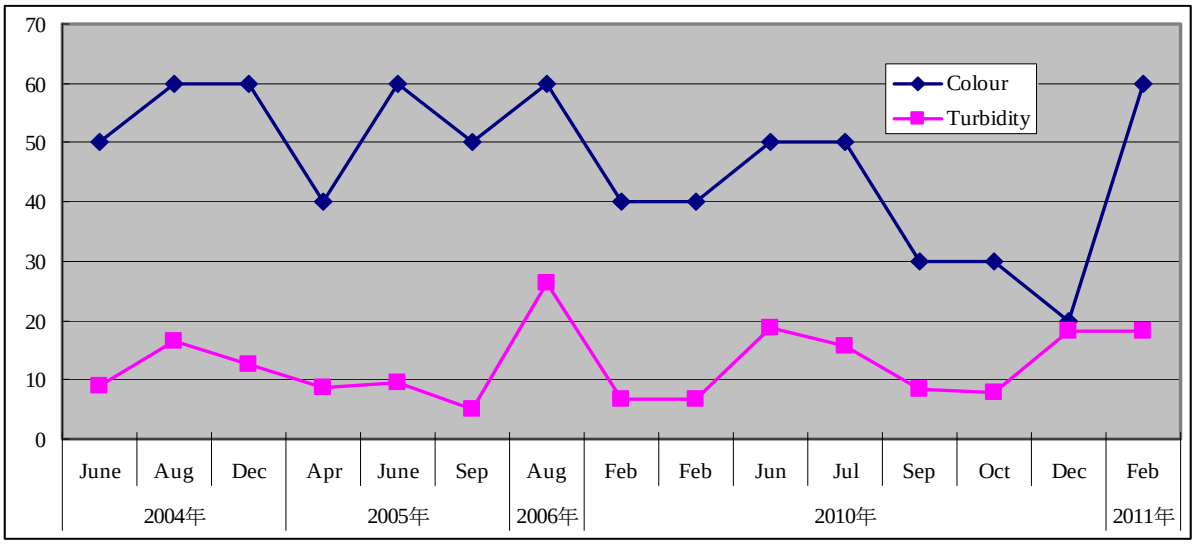


Figure 2-2-3 Yearly Fluctuation of Turbidity and Colour of Raw Water (2004 – 2011)

It can be assumed that turbidity is slightly increasing; however, it is still uncertain. Colour is looks decreasing; however, in February in 2011 it raised to 60-unit. Therefore it is presumed that these two parameters will be constant n generally in future.

Regarding Nitrogen and Phosphorous, whish yield eutrophication and originate algae, NO_2 and PO_4 went beyond the standard limitations. Generally Phosphorous causes algae breeding trouble when PO_4 reaches to 0.2mg/L. In Dry Aru all of the measured PO_4 figures are over 0.2mg/L. This means algae breeding is caused by high Phosphorus concentration in the water.

In tropical area water in reservoirs, such as Dry Aru Tank, vegetable are dissolved quickly due to the high temperature of water. In addition to that, high value of pH suggests dissolved oxygen are consumed and consequently Iron and Manganese are discharged from the bottom of the tank.

b) Water Quality of Treated Water

Treated water quality was also measured by NWSDB Jaffna on 2005 and 2006 before destruction of the plant. Above figure shows yearly fluctuation of colour and turbidity of raw water and **Figure 2-2-4** indicates turbidity treatment status.

Measured data implied that occasionally turbidity of the raw water exceeded the standard level and the turbidity of the treated water failed to be below the standard; however, it is difficult to justify the cause of the treatment failure, lack of treatment capacity of the system or ill-operation. In the outline design stage, the system which will treat turbidity and algae to the desirable levels is proposed and in addition to the On the Job Training soft component programs for operation and maintenance are to be proposed.

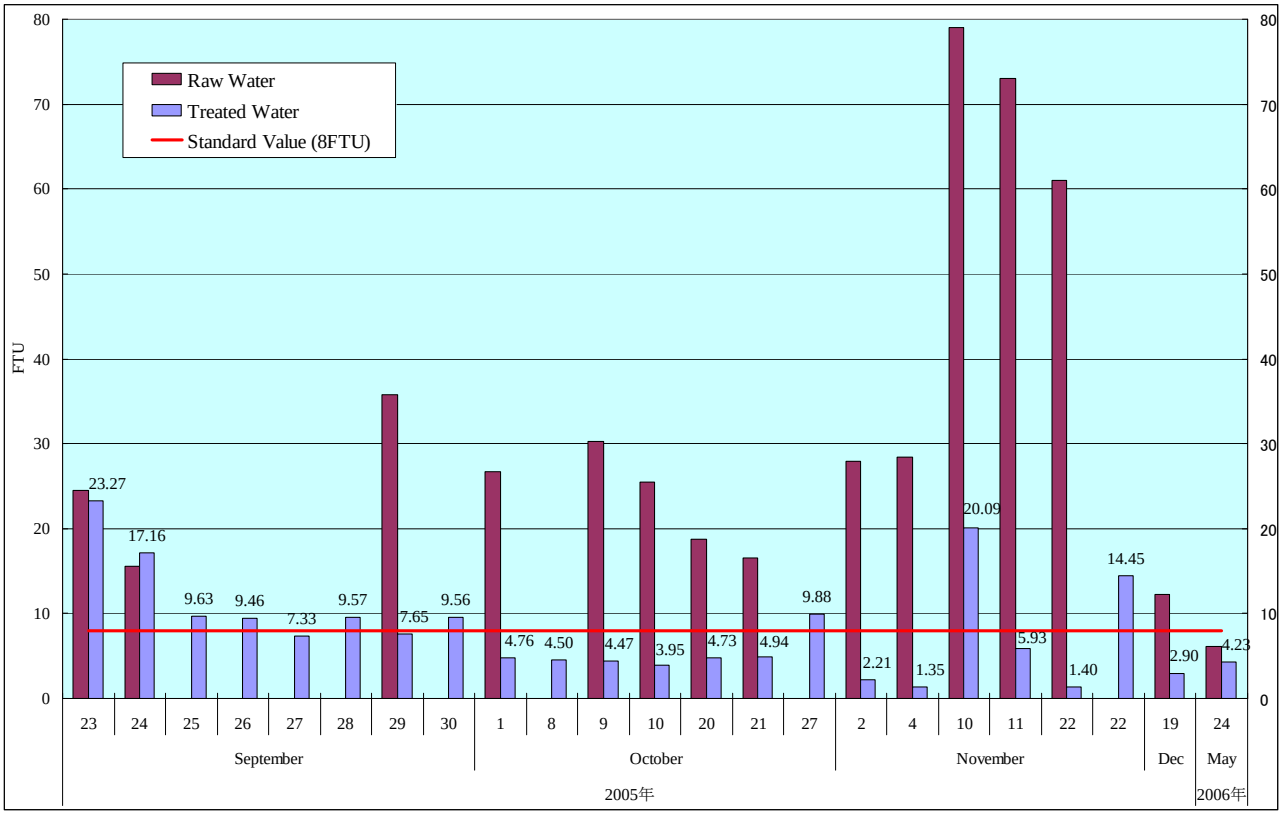


Figure 2-2-4 Turbidity Treatment Condition in WTP (2005 and 2006)

2) Consideration and Countermeasures on Water Treatment

Upon restructuring the existing plant, examination on past water quality analysis data on raw water and treated water was executed and following countermeasures shall be take into consideration.

a) Turbidity Countermeasure

Turbidity of Dry Aru Tank raw water has been mainly fluctuated from 10 to 20 degree based on the past analysis data from 2004 to 2011. According to the analysis conducted by the JICA Study Team, turbidity was less than 1 degree and other water quality parameter were also applicable to Slow Sand Filter. However, as turbidity was raised to 87 to 197 degree during rainy season, same degree of turbidity is dully anticipated every year during rainy season.

Judging from yearly turbidity fluctuation, it has no increasing tendency and this owes to the regulation function of the tank.

Countermeasure for High Turbidity

- To mitigate the turbidity load to Slow Sand Filter, two facilities shall be newly constructed, i.e., an Intake Pit installing filtering crusher run and gravel around it, and a Roughing Filter as pre-treatment facility

b) Colour Countermeasure

As shown in **Figure 2-2-3**, colour is high and 60 to 80 degree has been frequently observed. This seemed comes from humic material*) colour mainly generated by decomposition of plants. However, it was less than 5 degree by the JICA Study Team's analysis. High colour is supposed to be generated from tank bottom agitation by rainwater incoming. According to the treated water analysis, colour was largely decreased after slow sand filtration, high colour might include turbidity.

Though humic material colour causes no health hazard, it lowers visual quality of treated water. Turbidity removal in sand filter is expected to remove colour as well.

*) Colour in natural water is mainly generated by humic materials and colour is yellowish or brownish yellow. Origination materials are plant cellulose and organic polymer compound generated by lignin decomposed by microorganism and they are roughly categorized into four kind, humic acid, hymatomelanic acid, fulvic acid and humic material. Though humic material cause no health hazards, it prevent comfortable water usage and as it also designated as purity/turbidity index, it is quite troublesome compound that deflate the value of water.

Countermeasure for Colour

- No special facility is planned for removal of humic materials but Roughing Filter is to be constructed as pre-treatment facility. Through the existing facilities, such as Aerator and Slow Sand Filter, large part of colour is expected to be removed.
- According to the plant operation data on 2005 and 2006 shown in Table-1, colour of treated water sometime exceeds the standard value of 30 but about 50% of colour was removed only by slow sand filter. Through this project, intake pit and roughing filter will be newly constructed and soft component will also be implemented to upgrade plant O&M technology and therefore, further colour removal is anticipated by the restructured plant compared by the previous one.

Table 2-2-12 Colour Removal in Past WTP Operation

Date	Colour in Raw Water	Colour in Treated Water	Removal Ratio
20 October 2005	50～70	40～50	0～43%
19 December 2005	50～60	10～20	60～83%
24 May 2006	60～70	20～40	33～71%

c) Algae Countermeasure

Though no algae were detected by the JICA Study Team's water analysis, phosphate concentration

was high in raw water. It is not obvious whether this caused by decomposition of microorganism settled in tank bottom or not but as this is the largest cause for algae breeding, algae inflow might cause filter clogging. Since breeding of blue-green algae was reported in the past, Dry Aru Tank has tendency of eutrophication.

Countermeasure for Algae

- The existing raw water intake pit is RC made and as top cover is not water proof structure and cracked, surface water is inflowing together with algae and floating dirt. Intake pit with intake mouth which can take raw water from middle depth of the tank shall be newly installed. Gravels and Crusher run shall be allocated around the pit as filter to prevent inflow of algae.
- Roughing filter is to be newly constructed. As roughing filter acts as filter and gravel contact oxidation process, removal of algae, phosphate, NO_2 and NO_3 is dully expected.

d) Iron Removal

According to the results of water quality analysis conducted during 2004 to 2011, iron content in raw water of Dry Aru Tank is high. Concentration is ranging from 0.12 to 1.92 mg/L. This is determined as iron elusion from plants settled on tank bottom. Though iron was not detected by the JICA Study Team's water quality analysis, as said iron concentration is exceeding the inlet quality standard for slow sand filter, any reduction measures shall be employed. Since iron content in the existing dug well groundwater located near to the intake facility is 0.5 mg/L, iron is deemed to be generated from tank bottom mud.

The largest concentration of 1.92 mg/L was recorded during rainy season and this was supposed to be caused by iron elusion from plants and mud settled on tank bottom accelerated by rainfall agitation. Supposedly, reduced ferrous hydrogen carbonate (colourless) was oxidized and turned to ferric hydroxide and ferric oxide (brown).

Manganese was also detected by average concentration of 0.1 mg/L. Generally, iron and manganese exist together. Average iron concentration was 0.57 mg/L.

Countermeasure for Iron

- Iron and manganese removal to some extent is expected by the existing aerator

3) Water Treatment Facility Restructuring Plan

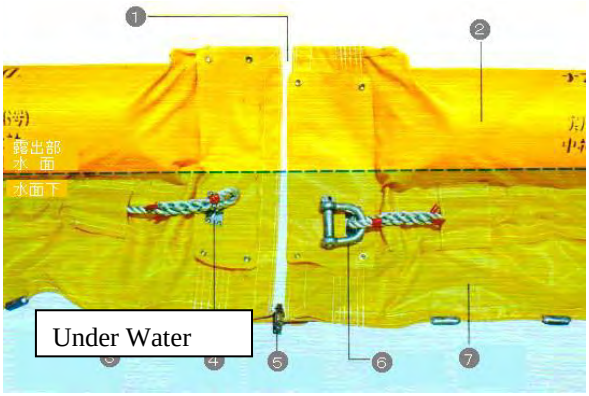
Slow sand filter method purifies raw water by penetration fine sand layer. This method utilizes sand layer and microorganism attached to surface of sand layer to trap impurity contained in water and to oxidize and decompose it. By this biological treatment, not only turbidity but also trace amount of NH_3, manganese, virus, odor and colour is reduced.

Based on the water quality analysis results, even though there are some items to be improved, the existing slow sand filter still have treatment capacity. The followings are WTP restructuring plan.

a) Installation of Intake Pit

Raw water intake pit shall be newly installed to intake raw water in better quality. As top cover of the existing pit has crack, floating dirt and algae are incoming. Further, intake from tank bottom is risky since settled plants, mud and less oxygen water might be incoming. To stabilize the pit body and to activate supplemental treatment of turbidity, nitrogen and phosphorus removal by gravel contact oxidation, outside of pit is filled with crusher run stone with grain size of φ50～60mm and inside of it, gravel with grain size of φ150～200mm is filled at the bottom. Intake pipe mouth is covered with gabion to equalize incoming flow. As safety device for blue-green algae, installation of silt curtain around the pit is also planned.

Photo of Silt Curtain



Section of Oil Fence

b) Intake Tank (Rehabilitation)

According the result of existing concrete strength test the existing intake tank will become durable after simple rehabilitation works. Inner stagnant water shall be drained out at first and internal surface shall be cleaned by pressured water. Resided cracks shall be fixed by epoxy resin injection.

Former exited pumps were horizontal shaft type single suction volute pumps. This type is afraid of lack of pressure when the water level of Dry Aru becomes lower. In this context, submerge pumps are proposed and the new pumps shall be installed in the existing intake tank. Lifting equipment is also proposed for periodical maintenance of the pumps. In addition to that, level switch shall be installed for preventing vacant water operation.

c) Intake Pump House (Rehabilitation)

Intake Pump House (Outsied)

Intake Pump House (Inside)

As shown in the photos currently there are no roof, windows and doors. According the result of existing concrete strength test the existing intake tank will become durable after simplified rehabilitation works. After chipping out the deteriorated surface mortar, new mortar shall be plastered and new roof, windows and doors shall be fitted.

In the Intake Pump House Local Panel and Intake Flow Meter shall be installed.

d) Construction of Roughing Filter (New Construction)

To upgrade the water quality of Dry Aru Tank raw water within the standard raw water quality for slow sand filter and to stably produce treated water in good quality by robust bio-film, roughing filter is planned.

Major removal target of water quality parameter are turbidity and algae. Other parameter expected to be removed are NH_3 and NO_3. As algae countermeasure, oil fence around intake pit, raw water intake at 1.0 to 1.5 m below water surface and filter composed of crusher-run stone and gravel filled outside of intake pit are planned and by these measures, algae inlet is prevented to some extent and they are anticipated to effective in blue-green algae prevention.

Easy maintenance structure was examined. To minimize filter material washing works, upper flow type was employed and filter is composed of three layers, namely upper, middle and lower layer. Filter backwashing utilizing water stored in water tower was applied owing to its efficiency and experiences in many WTP.

According to raw water quality record, turbidity was fluctuated from 87 to 197 during October to December 2005. As Dry Aru Tank, the raw water source is vast pond, it can be regarded as huge sedimentation tank and therefore, larger water quality fluctuation is not expected in future. Since slow sand filter exists in subsequent stage, turbidity is not needed to be removed completely. Thus, the filtration rate was set by LV=1.5m/h, allowable limit by design standard. Filter is composed of two tanks to allow one tank operation. Normally, raw water is sent to receiving well directly, aerated and flows into slow sand filter. If it is projected that raw water turbidity exceeds 30 degree continuously for more than 30 days, raw water is converted to roughing filter by valve operation to

improve raw water quality applicable to slow sand filter.

Backwashing is carried out completely in short time utilizing water from clear reservoir in WTP. Therefore no stand-by tank is planned providing that filter clogging can be solved by periodical backwashing.

e) Aerator (Rehabilitation)

Existing Aerator

Existing Aerator (Cascade)

According the result of existing concrete strength test and water leakage test the existing aerator will become durable after simple rehabilitation works. Currently the external finishing is mortar plastering with paint, the internal finishing is mortar plastering. After removal of existing mortar coating new water proof mortar on concrete basis shall be plastered on both side, i.e., internal and external sides. External finishing paint will not be required.

f) Slow Sand Filter (Rehabilitation)

Slow Sand Filter (Internal Wall)

Slow Sand Filter (External Wall)

According the result of existing concrete strength test the existing slow sand filter will become durable after simple rehabilitation works. Currently the external finishing is mortar plastering with paint. There are roughness, hair cracks and some remains of repairing works on the internal surface. At first those internal remains shall be removed and cracks shall be filled by resin injection. Then water proof mortar shall be plastered with water proof paint finishing. Existing under-drain systems, i.e., PVC

pipes and water colleting boxes, shall be removed and new ones shall be installed.

Layer composition in the existing slow sand filter is as follows:

Water depth over sand：1,350mm
Sand layer depth：900mm (uniformity coefficient 1.78, effective particle size 0.32mm)
Gravel layer depth 1st Layer：75mm (particle size 5.0～9.0mm)
2nd Layer：75mm (particle size 5.0～16mm)
3rd Layer：225mm (particle size 9.0～62mm)
Total gravel layer depth 375mm

By this restructure plan, layer composition of slow sand filter is proposed as follows:

Water depth over sand：1,000mm
Sand layer depth：1,000mm (uniformity coefficient less than 3.0, effective particle size 0.15 to 0.35mm)
Gravel layer depth 1st layer：100mm (particle size 2.0～5.0mm)
2nd layer：100mm (particle size 5.0～9.0mm)
3rd layer：100mm (particle size 9.0～16.0mm)
4th layer：100mm (particle size 16.0～62.0mm)
Total gravel layer depth： 400mm

g) Pump & Chemical House (Rehabilitation)

Pump & Chemical House consists of Clear Water Reservoir, Transmission Pump Room, Chlorination, Laboratory, Meeting Room, etc. As shown in the photos currently there are no roof, windows and doors. According the result of existing concrete strength test the existing intake tank will become durable after simplified rehabilitation works. After chipping out the deteriorated surface mortar, new mortar shall be plastered and new roof, windows and doors shall be fitted.

Administration Building

Upper Slug of Clearwater Reservoir

The rehabilitation works of this building will be implemented by NWSDB under 2KR fund program prior to the Project. In this Project only Mechanical & Electrical works and installation of supporting

frame work for hoist chain will be implemented.

In the Office Room monitoring panels shall be installed and information on operation and maintenance situation shall be integrated and monitored.

It is decided that the rehabilitation works of the Pump & Chemical House will be implemented under another Japanese Aid scheme. Therefore, it is excluded from the scope of the Project.

h) Clear Water Reservoir (Rehabilitation)

Clearwater Reservoirs Slab

Clearwater Reservoirs Slab (Chipped out for test)

As shown in the photos currently some coating such as water proof mortar remain and the remained coating are very fragile. According the result of existing concrete strength test the surface has weak strength. After chipping out the deteriorated surface mortar, new water proof mortar shall be plastered and water proof coating shall be painted.

The rehabilitation works of the Clearwater Reservoir will be implemented by NWSDB under 2KR fund program prior to the Project.

Clear Water Reservoir Level shall be installed to monitor and detect pump pit level for the transmission pump control.

It is decided that the rehabilitation works of the Clearwater Reservoir will be implemented under another Japanese Aid scheme. Therefore, it is excluded from the scope of the Project.

i) Transmission Pump (New Installation)

Transmission pumps shall be installed to pump up clear water from the Clear Water Reservoir to the Water Tower. Horizontal centrifugal pump, in door type, which is same as existed pumps, shall be installed. Pumps shall be operated under control system which monitor water level signal. Surrounding to the pumps local panel and transmission flow meter shall be installed.

j) Chlorination Facility (New Installation)

As same as former system, chlorine gas shall be applied to sterilize treated water. The feeding point of

chlorination shall be at transmission discharge point with booster pump for synchronized feeding. A chlorine gas detector and neutralization tank shall be installed to reduce the risk of gas leakage.

k) Sand Wash Facility (New Installation)

Clogged filter sand in slow sand filter must be scraped once every 2 to 6 months depending on turbidity and algae condition in raw water. About 2 cm in thickness on of surface filter sand is scraped by man power. Scraped filter sand is washed hereby filter tank by Mobile Type Sand Washer. Washed water is once stored in Storage Pond, and supernatant is discharged to Dry Aru. Washed filter sand is once stored in Washed Sand Storage Yard, and to be replaced when the thickness of filter sand layer in slow sand filter lower the effective height.

l) Electrical & Generator House (New Construction)

Existing buildings have not been provided for sufficient room for the all of electric equipment. Therefore a new building, Electrical & Generator House, shall be constructed to store necessary equipment. In the Electric Room LV incoming pane, LV distribution panel, pump starter pane, instrumentation panel shall be installed. Power and control circuit shall be integrated and operational sustainability shall be secured. In addition a standby diesel generator set shall be installed due to frequent power failures. The generator shall be installed in the generator room next door to the electric room. The type of the generator shall be turbocharged radiator cooling type.

Following figures show a layout of proposed water intake and treatment system and its system flow chart.

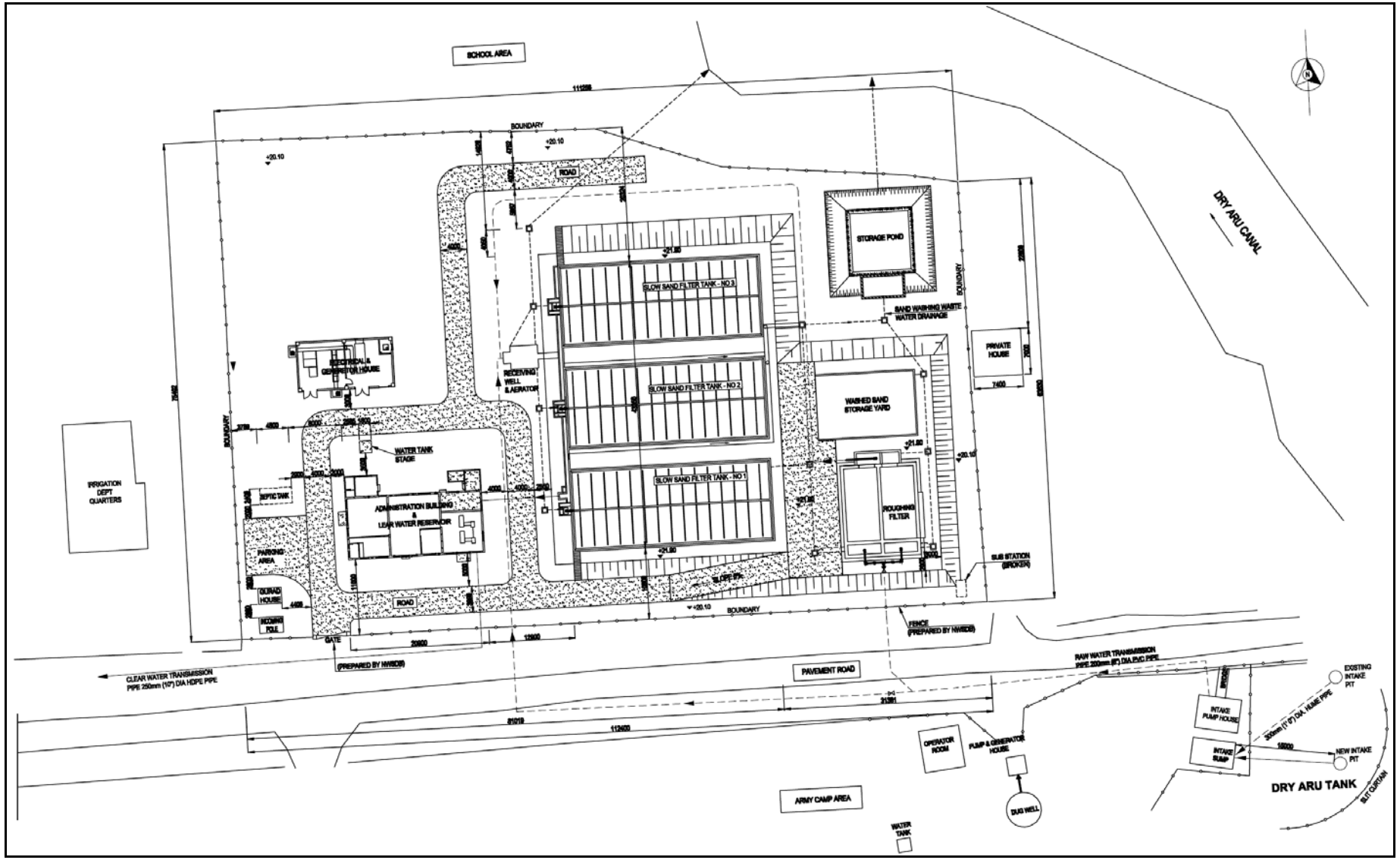


Figure 2-2-5 Layout of Water Intake and WTP

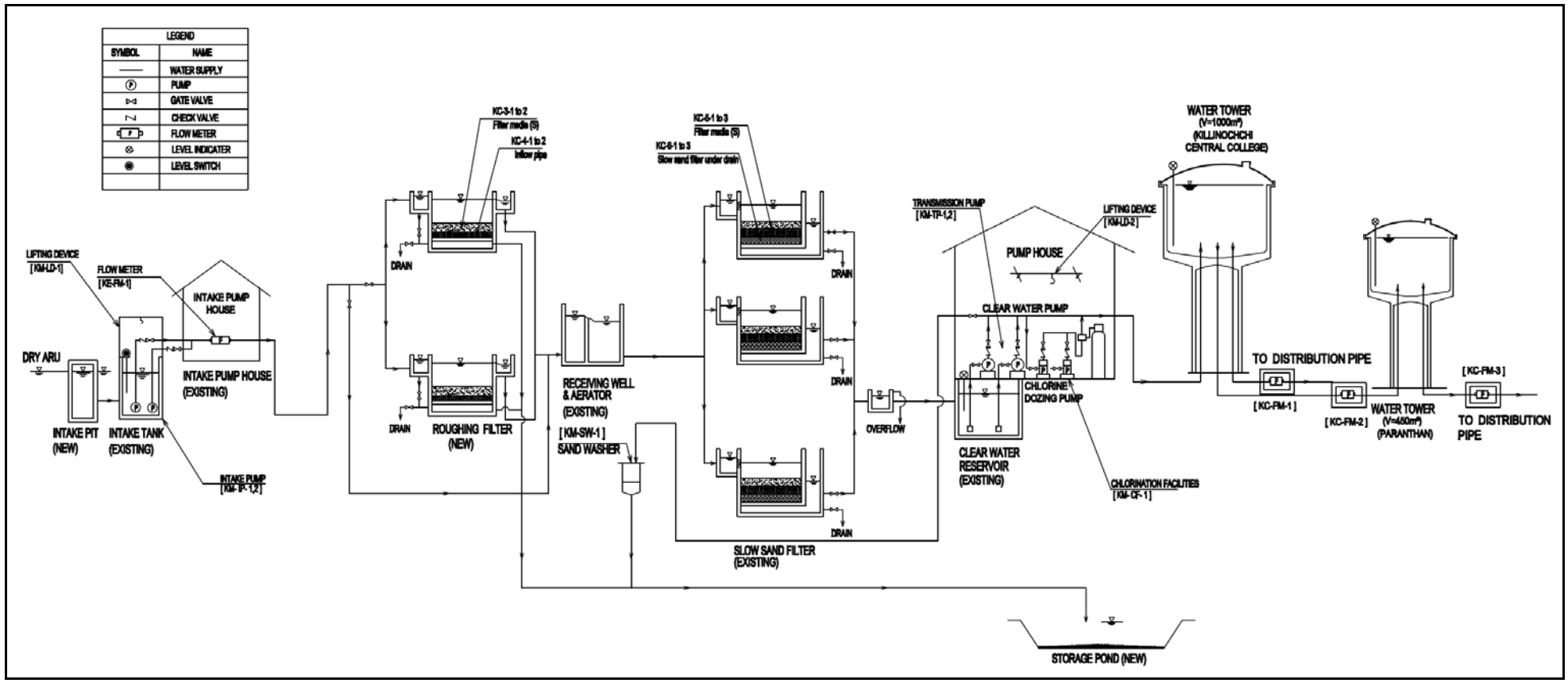


Figure 2-2-6 Flow of WTP after Rehabilitation

(11) Transmission Facility

Transmission pipe, which will connect WTP and Killinochchi Central College Water Tower, will be about 1.7 km length and 300 mm diameter. The pipe will be made of HDPE and DIP. Another transmission pipe, which will connect Killinochchi Central College Water to Paranthan Water Tower, will be about 6.6 km length and 250 mm diameter. The pipe will be also made of HDPE and DIP. The design flow of transmission from WTP is 5,200m^3/day (Daily Maximum).

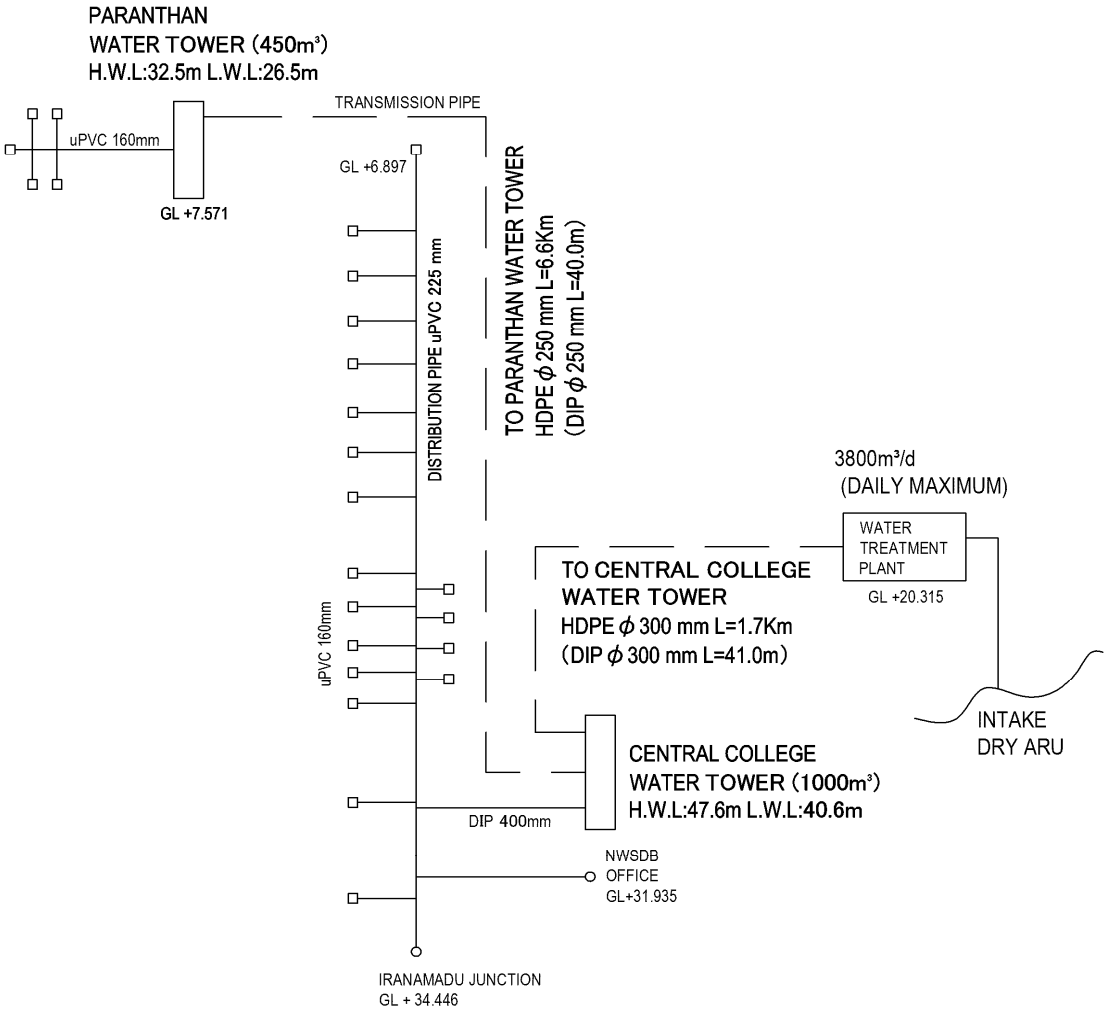


Figure 2-2-7 Outline of Transmission Pipes

(12) Water Distribution Facility

1) Killinochchi Central College Water Tower (New Construction)

The site of the Killinochchi Central College Water Tower locates in the premises of Killinochchi Central College 1 km south of the WTP site. The reservoir designed to be 1,000 m^3 to store water for about 5.3 hours considering into daily demand of 4,541m^3/day.

A water tower level meter shall be installed to monitor the water level. The water level signal will be sent to WTP by a GMS mode.

2) Paranthan Water Tower (New Construction)

The site of the Paranthan Water Tower locates in the premises of GN government 280 m west of the Paranthan Junction. The reservoir designed to be 450 m^3 to store water for about 12 hours considering into daily demand of 945m^3/day.

A water tower level meter shall be installed to monitor the water level. The water level signal will be sent to WTP by a GMS mode.

3) Distribution Networks (New Construction)

Among 14 GNs 2 GNs which belong to Kandawalai, water will be supplied from Paranthan Water Tank and other 12 GN which belong to Karachchi, water will be supplied from Killinochchi Central College Water Tower.

The population served from Paranthan Water Tower will be 4,205 and water flow will be 945 m^3/day. Meanwhile, the population served from Killinochchi Central College Water Tower will be 20,167 and water flow will be 4,541 m^3/day.

Table 2-2-13 Flow of Distribution Networks

No.	GN Code	Area	GN	Population(2030)	Daily Flow
1	4506043	Kandawalai	Kumarapuram	1,527	344 m^3/day
2	4506044	- ditto-	Paranthan	2,678	601 m^3/day
Total				4,205	945 m^3/day
3	4509010	Karachchi	Vivegananthanagar	2,039	459 m^3/day
4	4509012	- ditto-	Uthayanagar East	2,559	576 m^3/day
5	4509016	- ditto-	Ananthapuram	2,409	541 m^3/day
6	4509017	- ditto-	Thondarmannagar	1,123	254 m^3/day
7	4509018	- ditto-	Kanagambikaikulan	2,098	473 m^3/day
8	4509022	- ditto-	Ratnapuram	1,511	339 m^3/day
9	4509023	- ditto-	Killinochchi Town	1,300	293 m^3/day
10	4509024	- ditto-	Maruthanagar	1,772	399 m^3/day
11	4509026	- ditto-	Kanagapuram	1,430	323 m^3/day
12	4509027	- ditto-	Thirunagar South	1,358	306 m^3/day
13	4509028	- ditto-	Thirunagar North	1,659	374 m^3/day
14	4509029	- ditto-	Kaneshapuram	909	204 m^3/day
Total				20,167	4,541 m^3/day

Water distribution networks of the project are designed based on the following conditions.

① The networks of the project are main distribution pipes. The diameters of the pipes are 225mm and 16omm.

② The pipe from Killinochchi Central College to A9 Road, about 200 m length, the diameter of the pipe is designed as 400mm due to the quantity of the flow. Therefore DIP is applied for this pipe line.

③ In the discussion and site visiting with RDA and NWSDB 16 crossings have been conformed along A9 Road. The road crossings 450 mm reinforced concrete pipe will be installed prior to the project implementation and PVC pipes will be installed inside of the concrete pipe. Those road crossing pipes also will be installed by NWSDB prior to the project implementation.

④ Basically the position of the distribution pipes shall be out of A9 Road Future Renovation width (total width of 30 m) and the partially out of the First Stage Renovation with (width of 15.2 m) where some premises and/or buildings have been constructed currently.

⑤ Paranthan Water Tower will distribute water to Paranthan area and Killinochchi Central College Water Tower will distribute water up to Iranamadu Junction.

⑥ The minimum hydrodynamic water pressure shall be 6 m.

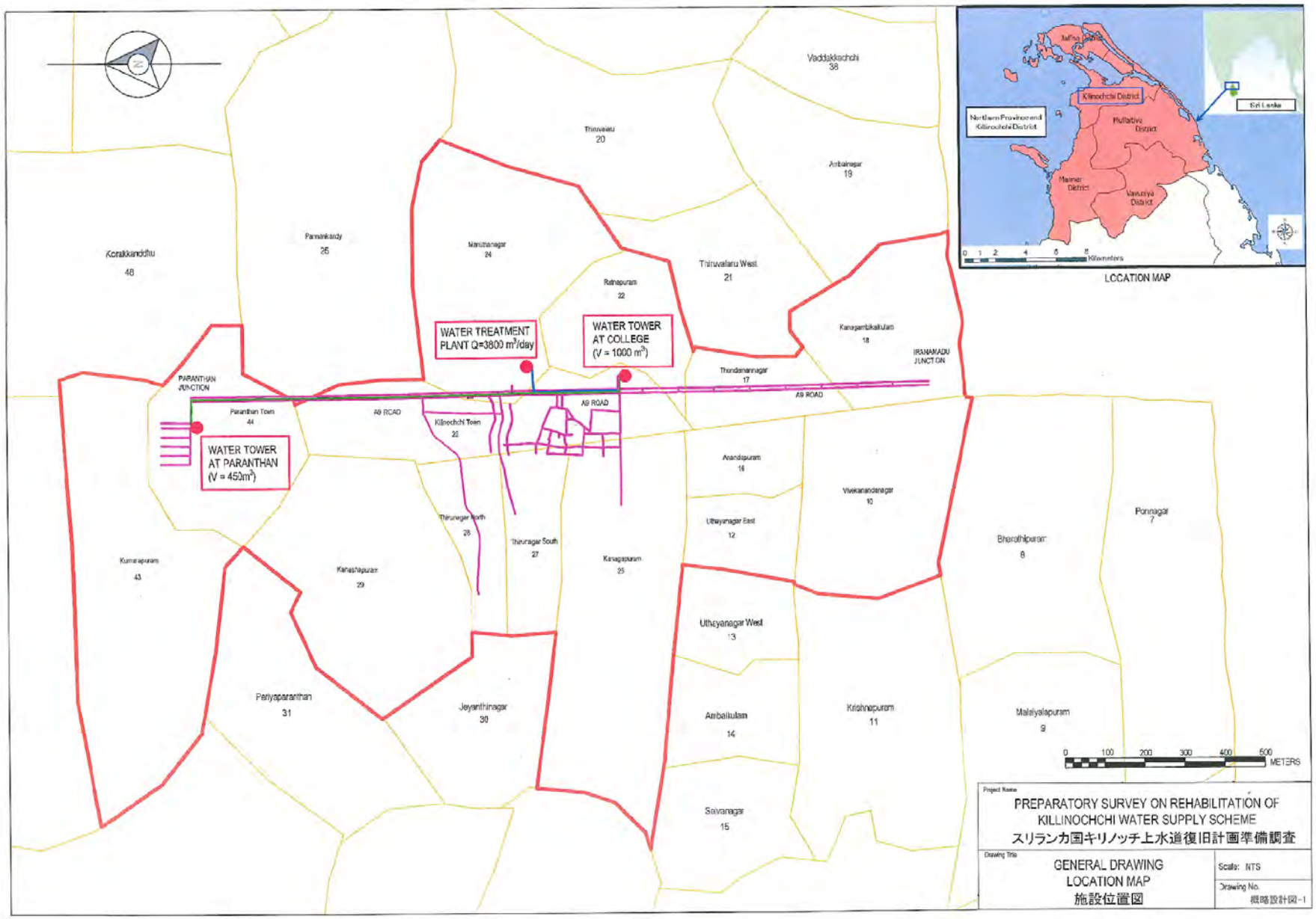
⑦ Sluice valves, air valves and others shall be installed at necessary points of the networks.

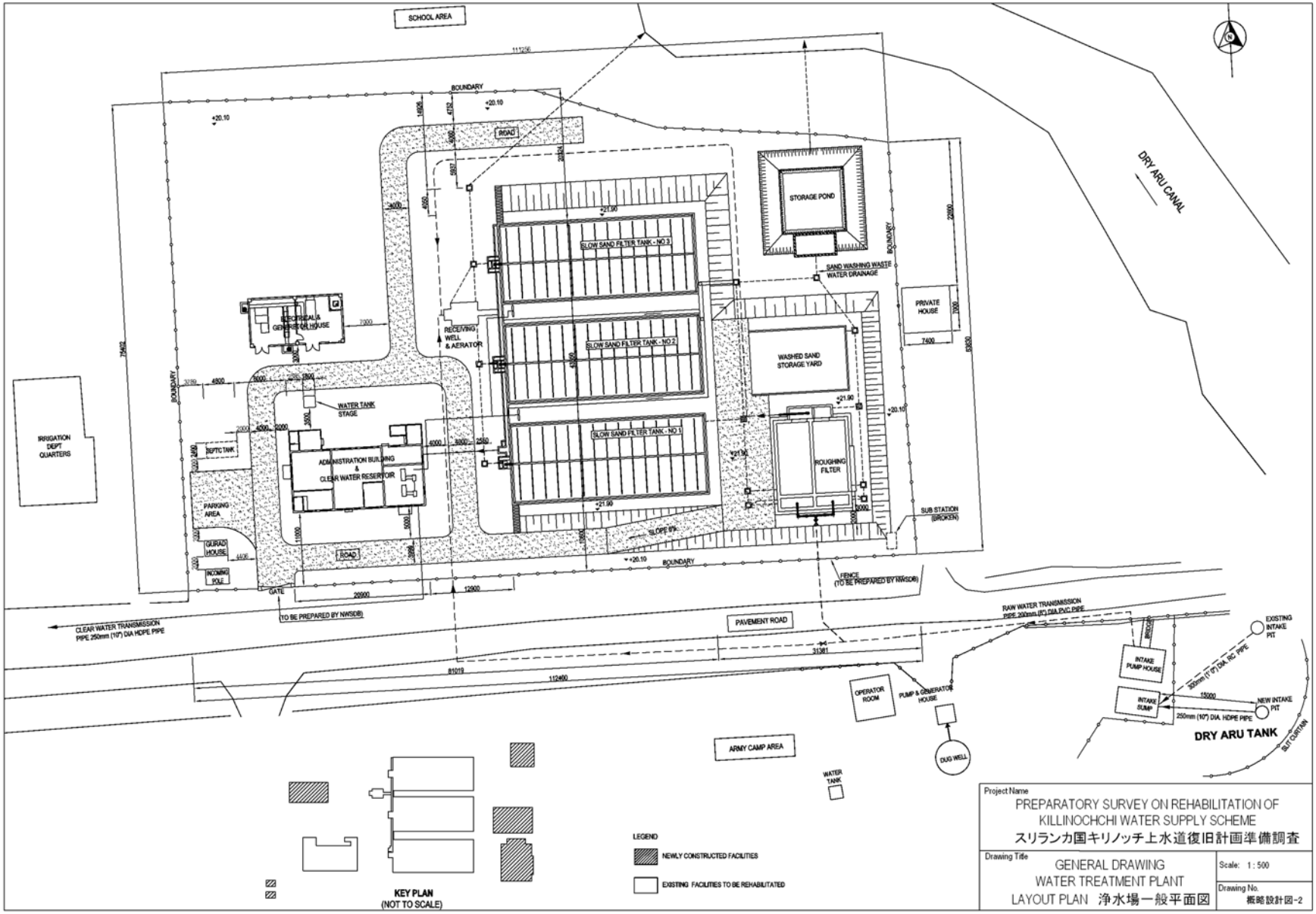
2-2-3 Outline Design Drawings

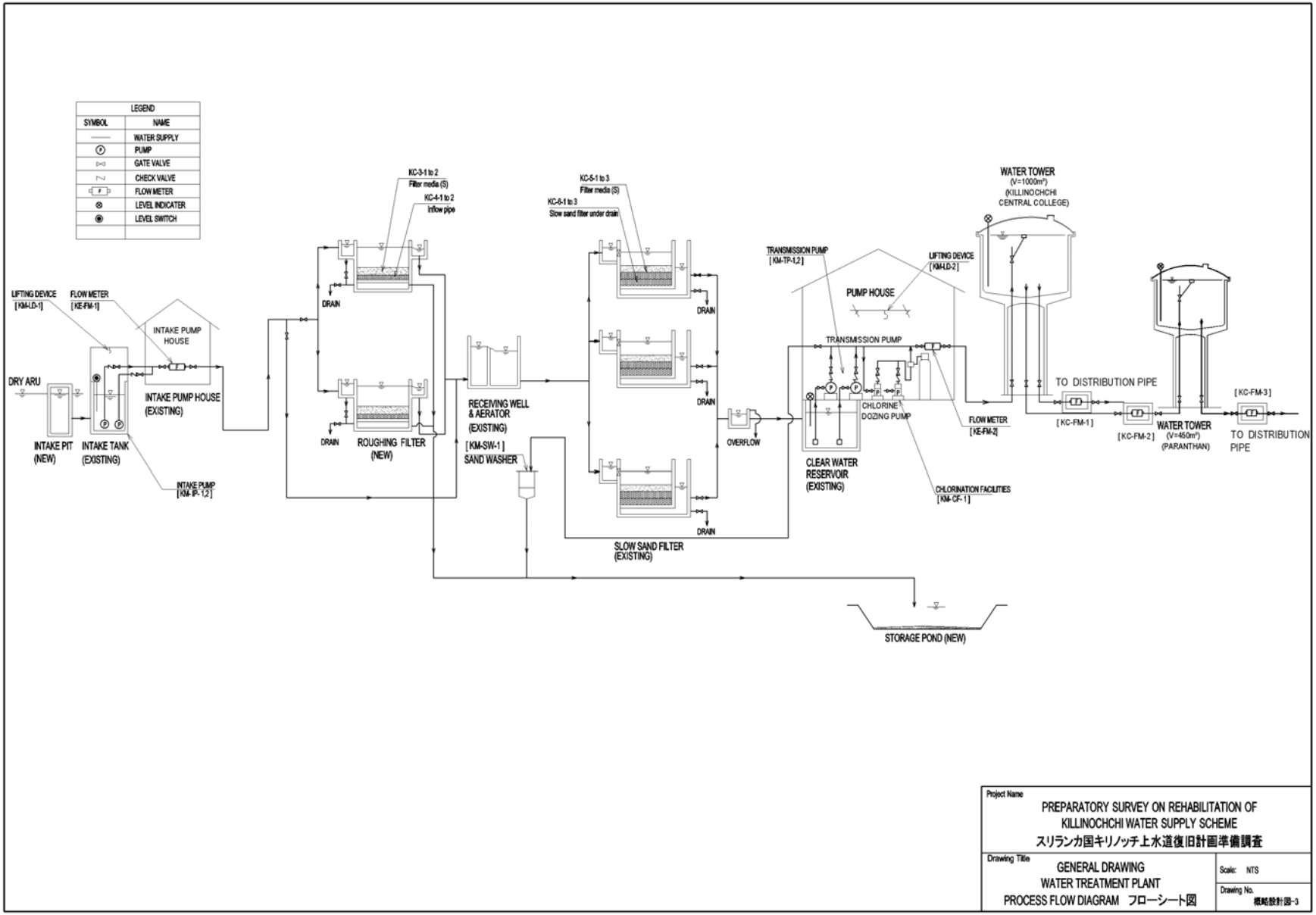
Outline design Drawings are tabulated in **Table 2-2-14**.

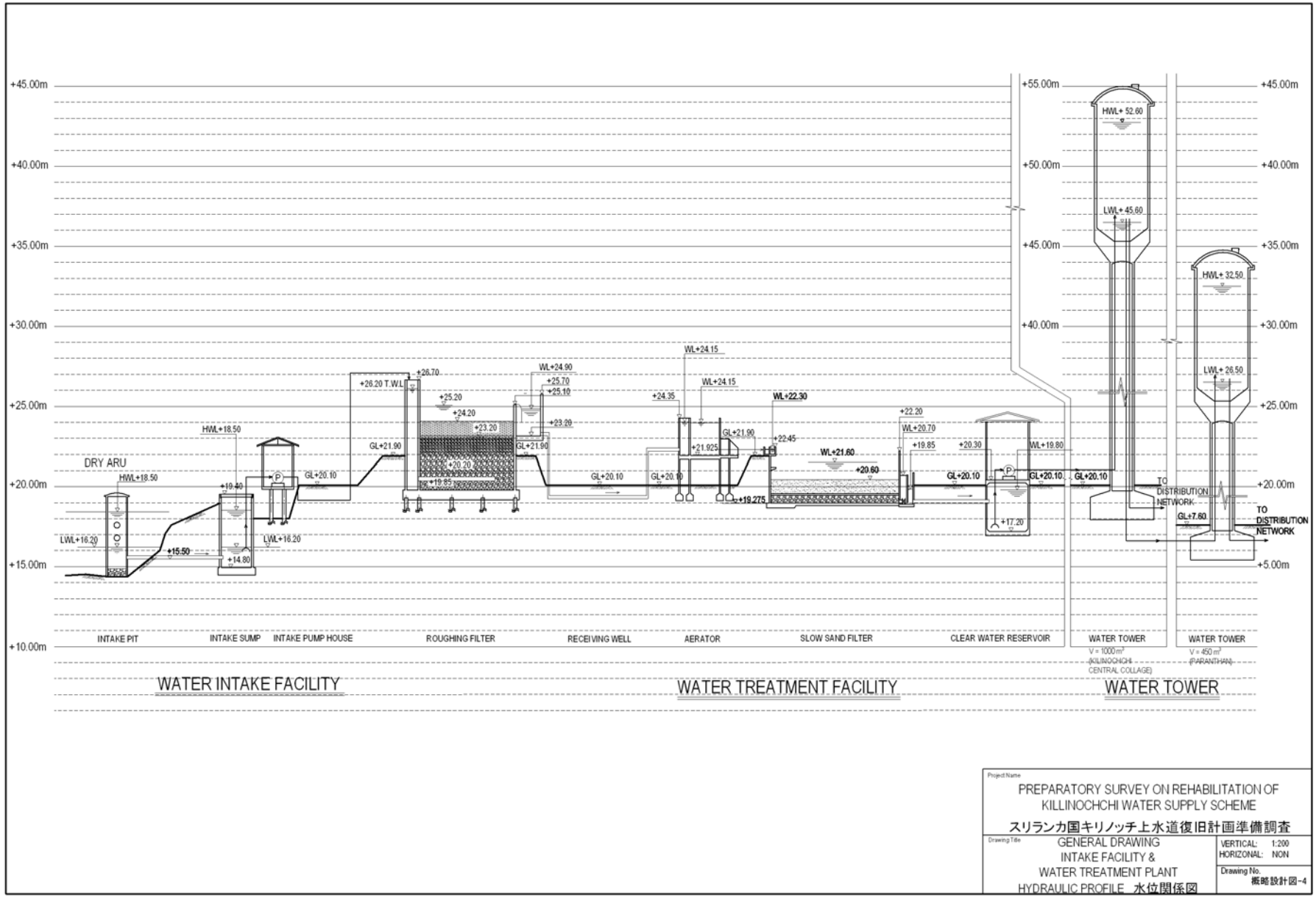
Table 2-2-14 List of Outline Design Drawings

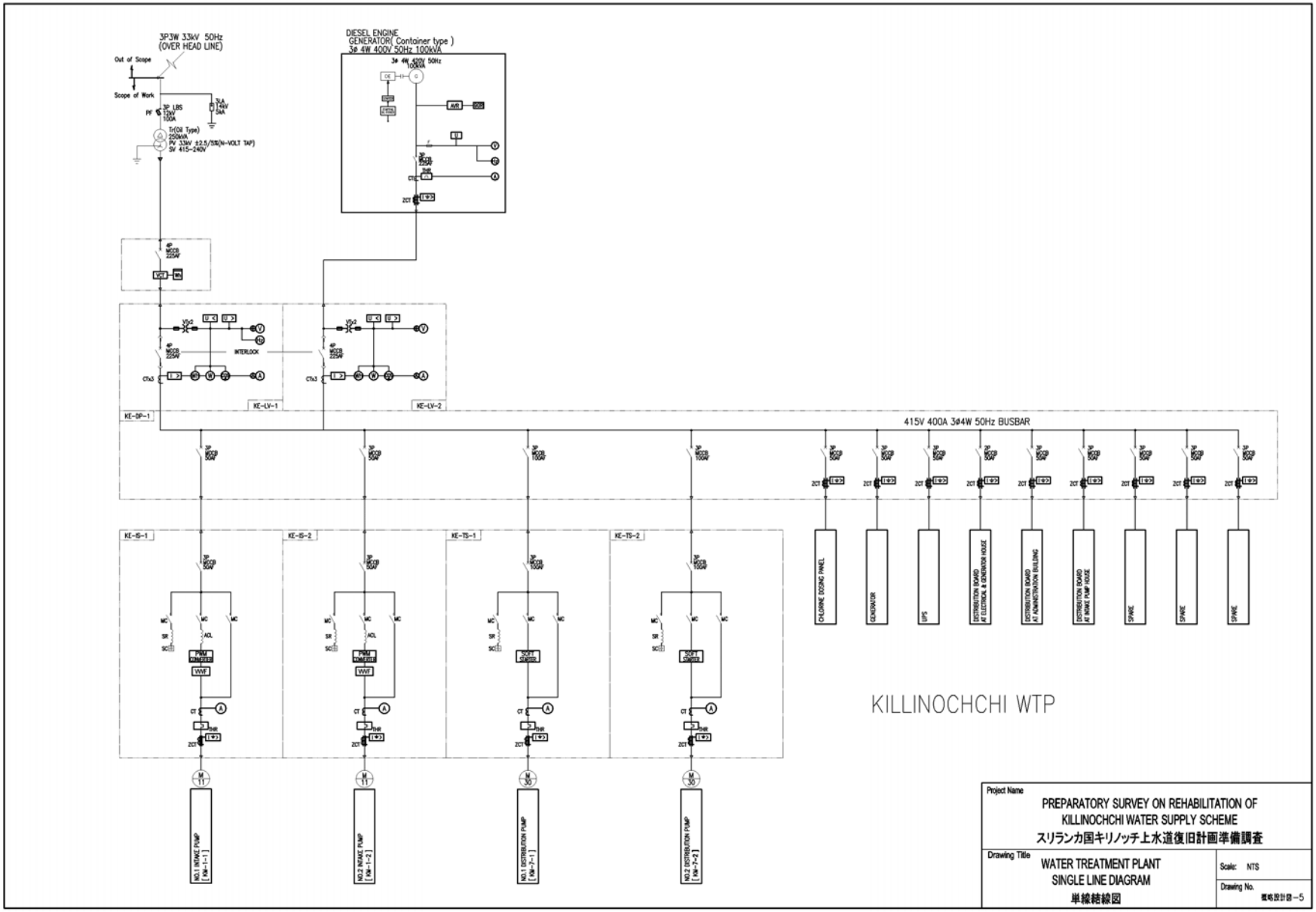
Category	No	Title	Remarks
General	1	Location Map	
	2	Water Treatment Plant Layout Plan	
	3	Water Treatment Plant Process Flow Diagram	
	4	Water Treatment Plant Hydraulic Profile	
	5	Water Treatment Plant Single Line Diagram	
Water Intake Facility	6	Intake Plan & Section	
	7	Intake Pit Plan & Details	
Water Treatment Plant	8	Roughing Filter Plan	
	9	Roughing Filter Section	
	10	Aerator, Receiving Well Plan & Section	
	11	Slow Sand Filter Top Plan & Details	
	12	Slow Sand Filter Section (1)	
	13	Slow Sand Filter Section (2)	
	14	Administration Building / Clear Water Reservoir Plan	
	15	Administration Building / Clear Water Reservoir Elevation	
	16	Storage Pond Plan & Section	
	17	Washed Sand Storage Yard Plan & Section	
	18	Electrical & Generator House	
	19	Guard House	
Water Tower	20	Killinochchi Central College Water Tower Layout	
	21	Killinochchi Central College Water Tower Plan & Section	
	22	Paranthan Water Tower Layout	
	23	Paranthan Water Tower Plan & Section	
Pipe Line	24	Location Map (Pipe Line of A9 Road)	
	25	Transmission Pipe (WTP to Central College Water Tower) Plan & Profile (1)	
	26	Transmission Pipe (WTP to Central College Water Tower) Plan & Profile (2)	
	27	Transmission Pipe (Central College Water Tower to Paranthan Water Tower) Plan & Profile (1)	
	28	Transmission Pipe (Central College Water Tower to Paranthan Water Tower) Plan & Profile (2)	
	29	Transmission Pipe (Central College Water Tower to Paranthan Water Tower) Plan & Profile (3)	
	30	Transmission Pipe (Central College Water Tower to Paranthan Water Tower) Plan & Profile (4)	
	31	Transmission Pipe (Central College Water Tower to Paranthan Water Tower) Plan & Profile (5)	
	32	Transmission Pipe (Central College Water Tower to Paranthan Water Tower) Plan & Profile (6)	
	33	Distribution Pipe General Map of A9 Road	
	34	Distribution Pipe Key Plan for Killinochchi Area	
	35	Distribution Pipe Key Plan for Paranthan Area	
Standard Drawing	36	Pipe Laying Position	
	37	Pipe Trench Details in East Side of A9 Road	
	38	General Pipe Laying Section	
	39	Service Connection Details	

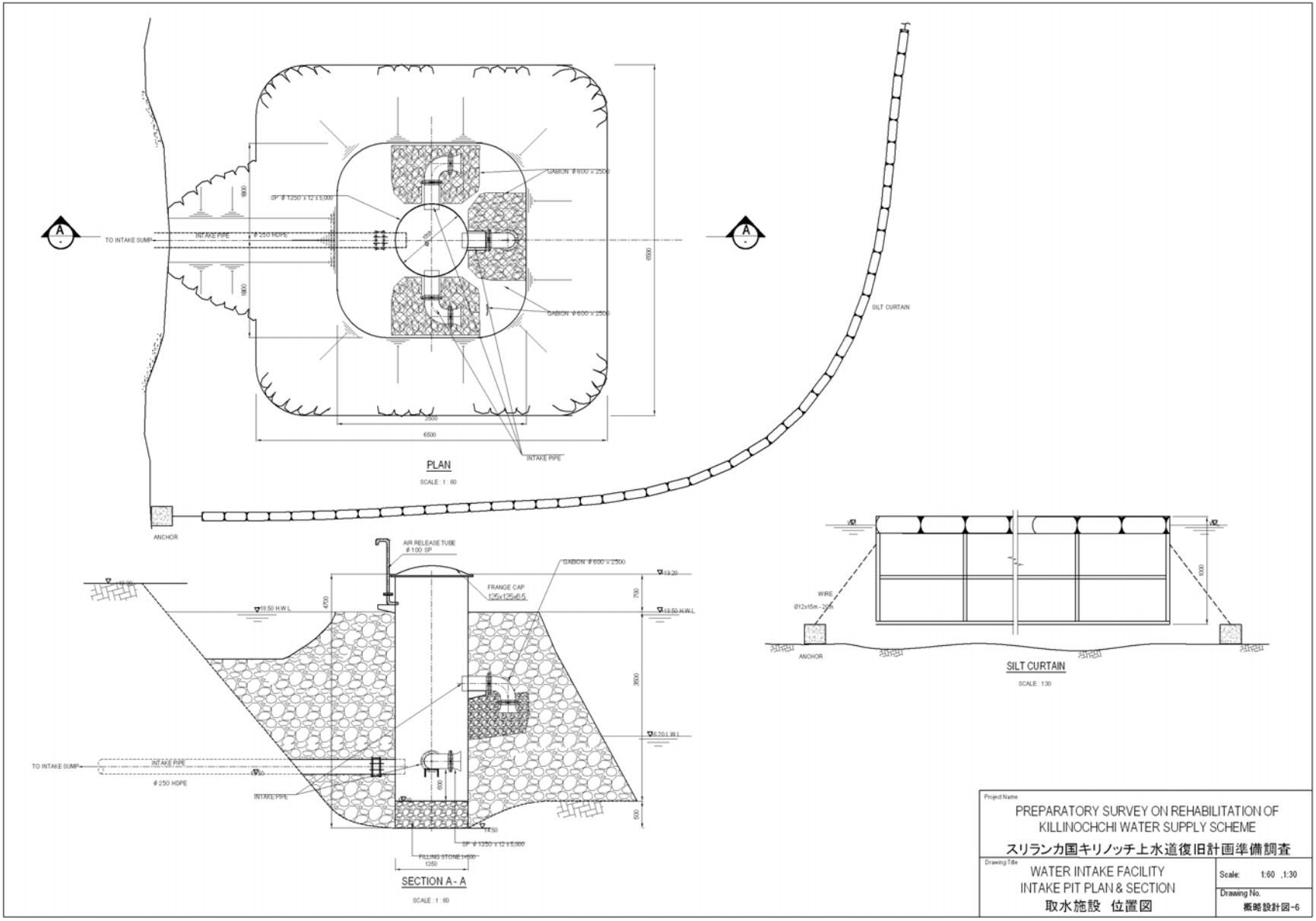

WATER TREATMENT PLANT Q=3800 m³/day
WATER TOWER AT COLLEGE (V = 1000 m³)
WATER TOWER AT PARANTHAN (V = 450m³)
PARANTHAN JUNCTION
IRANAMADU JUNCTION
A9 ROAD
Paranthan Town 44
Killinochchi Town 22
Vaddakkachchi 38
Thiruvaiaru 20
Ambalnagar 19
Parnankandy 25
Manthanagar 24
Ratnapuram 22
Thiruvalaru West 21
Kanagambikaikulam 18
Thondamannagar 17
Anandapuram 16
Vivekanandanagar 10
Uthayanagar East 12
Thirunagar North 28
Thirunagar South 27
Kanagapuram 25
Kumarapuram 43
Kanachchapuram 29
Uthayanagar West 13
Periyaparanthan 31
Jeyanthinagar 30
Ambalkulam 14
Krishnapuram 11
Saivanagar 15
Bharathipuram 8
Ponnagar 7
Malaiyalapuram 9
Northern Province and Killinochchi District
Killinochchi District
Mullaitivu District
Mannar District
Vavuniya District
Sri Lanka
Kilometers
LOCATION MAP
0 100 200 300 400 500 METERS
PREPARATORY SURVEY ON REHABILITATION OF KILLINOCHCHI WATER SUPPLY SCHEME
スリランカ国キリノッチ上水道復旧計画準備調査
GENERAL DRAWING
LOCATION MAP
施設位置図
Scale: NTS
Drawing No.
概略設計図-1

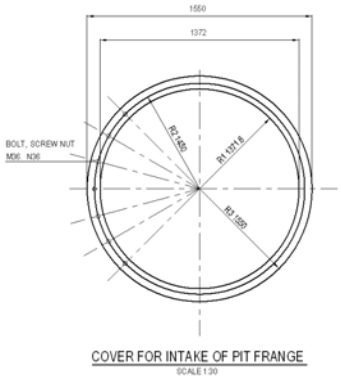

SCHOOL AREA
BOUNDARY
ROAD
DRY ARU CANAL
STORAGE POND
SLOW SAND FILTER TANK - NO 3
SLOW SAND FILTER TANK - NO 2
SLOW SAND FILTER TANK - NO 1
SAND WASHING WASTE WATER DRAINAGE
PRIVATE HOUSE
WASHED SAND STORAGE YARD
ROUGHING FILTER
SUB STATION (BROKEN)
ELECTRICAL & GENERATOR HOUSE
RECEIVING WELL & AERATOR
WATER TANK STAGE
ADMINISTRATION BUILDING & CLEAR WATER RESERVOIR
SEPTIC TANK
PARKING AREA
GUARD HOUSE
INCOMING POLE
GATE
IRRIGATION DEPT QUARTERS
SLOPE 6%
FENCE (TO BE PREPARED BY NWSDB)
TO BE PREPARED BY NWSDB)
CLEAR WATER TRANSMISSION PIPE 250mm (10") DIA HDPE PIPE
PAVEMENT ROAD
RAW WATER TRANSMISSION PIPE 300mm (8") DIA PVC PIPE
EXISTING INTAKE PIT
INTAKE PUMP HOUSE
INTAKE SUMP
NEW INTAKE PIT
250mm (10") DIA. HDPE PIPE
DRY ARU TANK
SILT CURTAIN
OPERATOR ROOM
PUMP & GENERATOR HOUSE
DUG WELL
ARMY CAMP AREA
WATER TANK
KEY PLAN
(NOT TO SCALE)
LEGEND
NEWLY CONSTRUCTED FACILITIES
EXISTING FACILITIES TO BE REHABILITATED
Project Name
PREPARATORY SURVEY ON REHABILITATION OF KILLINOCHCHI WATER SUPPLY SCHEME
スリランカ国キリノッチ上水道復旧計画準備調査
Drawing Title
GENERAL DRAWING
WATER TREATMENT PLANT
LAYOUT PLAN 浄水場一般平面図
Scale: 1 : 500
Drawing No.
概略設計図-2


LEGEND
SYMBOL
NAME
WATER SUPPLY
PUMP
GATE VALVE
CHECK VALVE
FLOW METER
LEVEL INDICATER
LEVEL SWITCH
LIFTING DEVICE [KM-LD-1]
FLOW METER [KE-FM-1]
INTAKE PUMP HOUSE
DRY ARU
INTAKE PUMP HOUSE (EXISTING)
INTAKE PIT (NEW)
INTAKE TANK (EXISTING)
INTAKE PUMP [KM-IP-1,2]
KC-3-1 to 2 Filter media (S)
KC-4-1 to 2 Inflow pipe
DRAIN
ROUGHING FILTER (NEW)
RECEIVING WELL & AERATOR (EXISTING)
[KM-SW-1] SAND WASHER
KC-5-1 to 3 Filter media (S)
KC-6-1 to 3 Slow sand filter under drain
SLOW SAND FILTER (EXISTING)
OVERFLOW
TRANSMISSION PUMP [KM-TP-1,2]
PUMP HOUSE
LIFTING DEVICE [KM-LD-2]
TRANSMISSION PUMP
CHLORINE DOZING PUMP
CLEAR WATER RESERVOIR (EXISTING)
CHLORINATION FACILITIES [KM-CF-1]
FLOW METER [KE-FM-2]
WATER TOWER (V=1000m³) (KILLINOCHCHI CENTRAL COLLEGE)
TO DISTRIBUTION PIPE
[KC-FM-1]
[KC-FM-2]
WATER TOWER (V=450m³) (PARANTHAN)
[KC-FM-3]
TO DISTRIBUTION PIPE
STORAGE POND (NEW)
Project Name
PREPARATORY SURVEY ON REHABILITATION OF KILLINOCHCHI WATER SUPPLY SCHEME
スリランカ国キリノッチ上水道復旧計画準備調査
Drawing Title
GENERAL DRAWING
WATER TREATMENT PLANT
PROCESS FLOW DIAGRAM フローシート図
Scale: NTS
Drawing No.
概略設計図-3

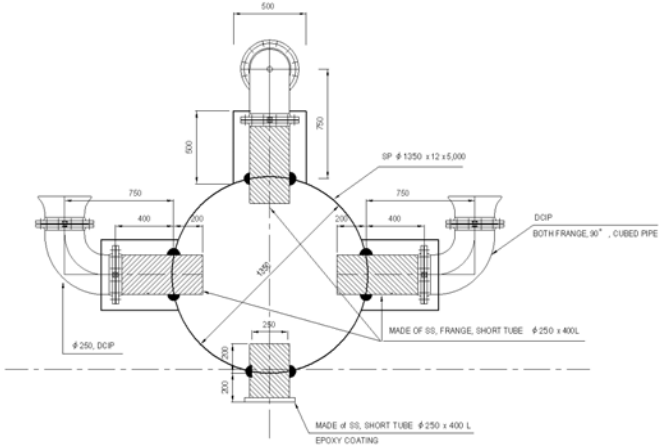

+45.00m
+40.00m
+35.00m
+30.00m
+25.00m
+20.00m
+15.00m
+10.00m
+55.00m
+50.00m
+45.00m
+40.00m
+5.00m
DRY ARU
HWL+18.50
LWL+16.20
+15.50
+19.40
+14.80
HWL+18.50
LWL+16.20
GL+20.10
+26.70
+26.20 T.W.L
+25.20
+24.20
+23.20
GL+21.90
+20.20
+19.85
WL+24.90
+25.70
+25.10
+23.20
GL+21.90
GL+20.10
WL+24.15
+24.35
WL+24.15
GL+21.90
GL+20.10
+21.925
+19.275
WL+22.30
+22.45
WL+21.60
+20.60
+22.20
WL+20.70
+19.85
+20.30
WL+19.80
GL+20.10
+17.20
GL+20.10
GL+20.10
HWL+ 52.60
LWL+ 45.60
TO DISTRIBUTION NETWORK
HWL+ 32.50
LWL+ 26.50
GL+7.60
TO DISTRIBUTION NETWORK
INTAKE PIT
INTAKE SUMP
INTAKE PUMP HOUSE
ROUGHING FILTER
RECEIVING WELL
AERATOR
SLOW SAND FILTER
CLEAR WATER RESERVOIR
WATER TOWER
V = 1000m³
(KILINOCHCHI CENTRAL COLLAGE)
WATER TOWER
V = 450 m³
(PARANTHAN)
WATER INTAKE FACILITY
WATER TREATMENT FACILITY
WATER TOWER
Project Name
PREPARATORY SURVEY ON REHABILITATION OF KILLINOCHCHI WATER SUPPLY SCHEME
スリランカ国キリノッチ上水道復旧計画準備調査
Drawing Title
GENERAL DRAWING
INTAKE FACILITY &
WATER TREATMENT PLANT
HYDRAULIC PROFILE 水位関係図
VERTICAL: 1:200
HORIZONAL: NON
Drawing No.
概略設計図-4


3P3W 33kV 50Hz
(OVER HEAD LINE)
Out of Scope
Scope of Work
DIESEL ENGINE
GENERATOR(Container type)
3ø 4W 400V 50Hz 100kVA
KE-DP-1
KE-LV-1
KE-LV-2
415V 400A 3ø4W 50Hz BUSBAR
KE-IS-1
KE-IS-2
KE-TS-1
KE-TS-2
CHLORINE DOSING PANEL
GENERATOR
UPS
DISTRIBUTION BOARD AT ELECTRICAL & GENERATOR HOUSE
DISTRIBUTION BOARD AT ADMINISTRATION BUILDING
DISTRIBUTION BOARD AT INTAKE PUMP HOUSE
SPARE
SPARE
SPARE
NO.1 INTAKE PUMP [Kil-1-1]
NO.2 INTAKE PUMP [Kil-1-2]
NO.1 DISTRIBUTION PUMP [Kil-7-1]
NO.2 DISTRIBUTION PUMP [Kil-7-2]
KILLINOCHCHI WTP
Project Name
PREPARATORY SURVEY ON REHABILITATION OF KILLINOCHCHI WATER SUPPLY SCHEME
スリランカ国キリノッチ上水道復旧計画準備調査
Drawing Title
WATER TREATMENT PLANT
SINGLE LINE DIAGRAM
単線結線図
Scale: NTS
Drawing No.
概略設計図－5

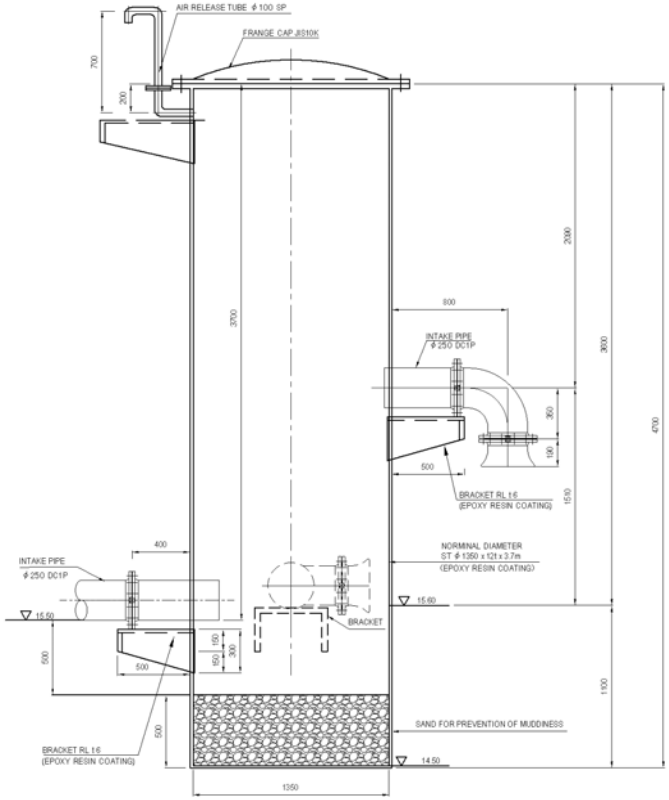

PLAN
SCALE : 1 : 60
SECTION A - A
SCALE : 1 : 60
SILT CURTAIN
SCALE : 1:30
PREPARATORY SURVEY ON REHABILITATION OF KILLINOCHCHI WATER SUPPLY SCHEME
スリランカ国キリノッチ上水道復旧計画準備調査
WATER INTAKE FACILITY
INTAKE PIT PLAN & SECTION
取水施設 位置図
Scale: 1:60 ,1:30
Drawing No.
概略設計図-6



COVER FOR INTAKE OF PIT FRANGE
SCALE 1:30



PLUMBING OF INTAKE PIT
SCALE 1:30



STRUCTURE FIGURE OF INTAKE PIT
SCALE 1:30

INSIDE OUTSIDE PAINT SPECIFICATION

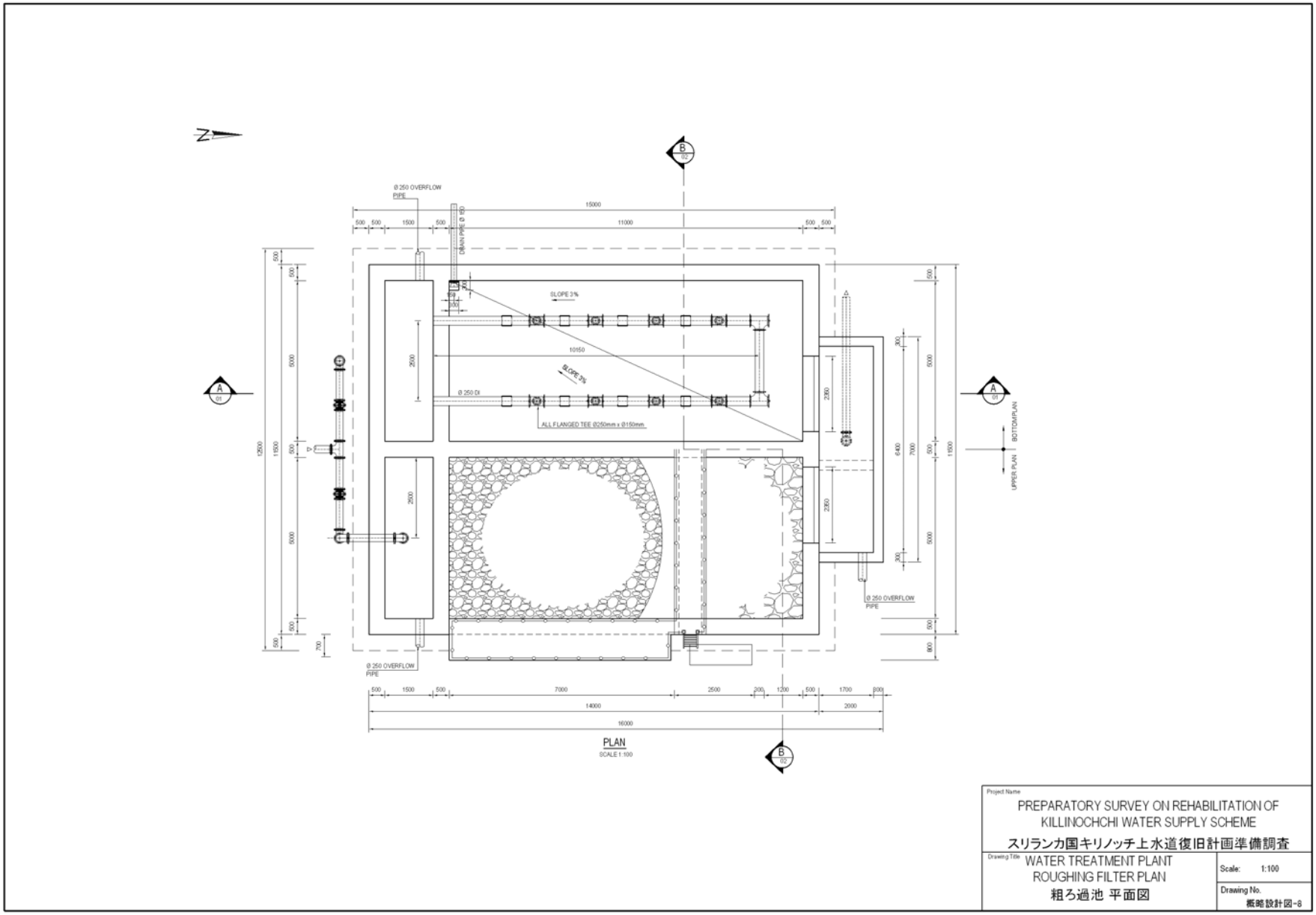
ITEM	NAME OF PAINT	MINIMUM DRY FILM THICKNESS
1. SURFACE PREPARATION	SSPC - SR10	—
2. FIRST COAT	EPOXYRESIN	125 (MICRONS)
3. SECOND COAT	DITTO	125 (MICRONS)
4. FINISH COAT	DITTO	125 (MICRONS)

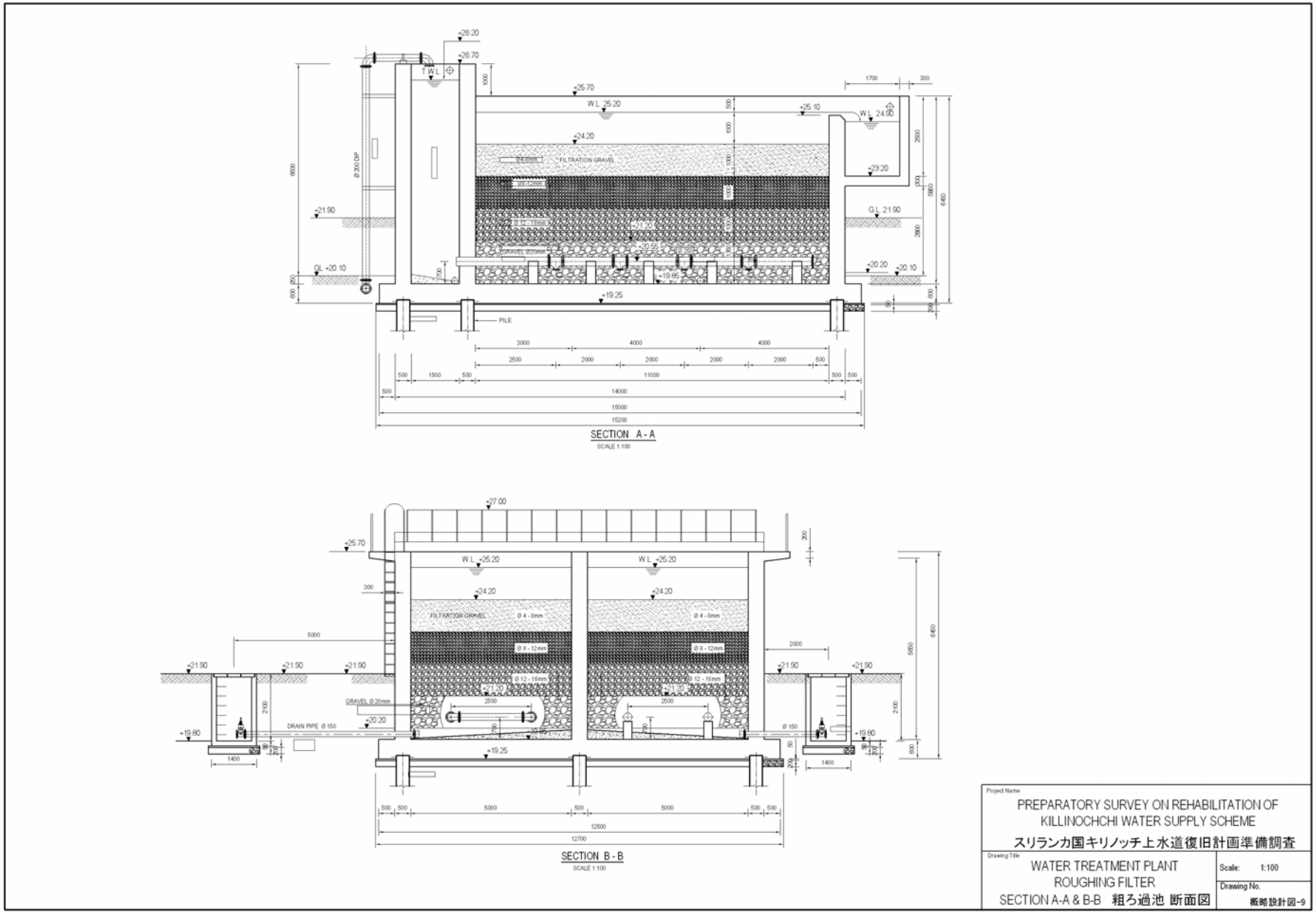
Project Name
PREPARATORY SURVEY ON REHABILITATION OF KILLINOCHCHI WATER SUPPLY SCHEME
スリランカ国キリノッチ上水道復旧計画準備調査

Drawing Title
WATER TANK FACILITY
INTAKE PIT - PLAN & DETAILS
取水ピット 平面図・断面図

Scale: 1:6 1:30

Drawing No.
概略設計図-7


N
Ø 250 OVERFLOW PIPE
DRAIN PIPE Ø 450
15000
11000
SLOPE 3%
10150
Ø 250 DI
ALL FLANGED TEE Ø250mm x Ø150mm
BOTTOM PLAN
UPPER PLAN
Ø 250 OVERFLOW PIPE
Ø 250 OVERFLOW PIPE
14000
16000
PLAN
SCALE 1:100
Project Name
PREPARATORY SURVEY ON REHABILITATION OF KILLINOCHCHI WATER SUPPLY SCHEME
スリランカ国キリノッチ上水道復旧計画準備調査
Drawing Title
WATER TREATMENT PLANT
ROUGHING FILTER PLAN
粗ろ過池 平面図
Scale: 1:100
Drawing No.
概略設計図-8


SECTION A - A
SCALE 1:100
SECTION B - B
SCALE 1:100
PREPARATORY SURVEY ON REHABILITATION OF KILLINOCHCHI WATER SUPPLY SCHEME
スリランカ国キリノッチ上水道復旧計画準備調査
WATER TREATMENT PLANT
ROUGHING FILTER
SECTION A-A & B-B 粗ろ過池 断面図
Scale: 1:100
Drawing No.
概略設計図-9