No.

BASIC DESIGN STUDY REPORT

ON

THE BASIC DESIGN STUDY ON THE PROJECT FOR THE IMPROVEMENT OF WATER SUPPLY SYSTEM

OF

MATARA DISTRICT

IN

THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

MARCH 2003

JAPAN INTERNATIONAL COOPERATION AGENCY

NJS CONSULTANTS CO.,LTD

PREFACE

In response to a request from the Government of the Democratic Socialist Republic of Sri Lanka, the Government of Japan decided to conduct a basic design study on the Project for the Improvement of Water Supply Scheme in Matara and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Sri Lanka a study team from 30 July to 10 September, 2002.

The team held discussions with the officials concerned of the Government of Sri Lanka, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Sri Lanka in order to discuss a draft basic design, and as this result, the present report was finalized.

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

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

March, 2003

Takao Kawakami
President
Japan International Cooperation Agency

March, 2003

Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for the Improvement of Water Supply Scheme of Matara in the Democratic Socialist Republic of Sri Lanka.

This study was conducted by NJS Consultants Co., Ltd. under a contract to JICA, during the period from July, 2002 to March 2003. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Sri Lanka and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

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

Very truly yours,

Ikuo Miwa

Project manager,

Basic design study team on
the Project for the Improvement of
Water Supply Scheme of Matara
NJS Consultants Co., Ltd.

EXECUTIVE SUMMARY

The Democratic Socialist Republic of Sri Lanka (hereinafter referred to as “Sri Lanka”) is a island country located near the south end of Indian Peninsula with a land area of 65,610 km^2 and a total population of 18.73 million in 2001 (census), out of which 122 million people, namely 6.5% live in the urban area of Colombo District. The per capita GNP was US$820 in2001. Matara District is one of three districts in the southern province of Sri Lanka, situated approx. 160 km from Colombo on the southern coastal belt. The climate of Matara District is in the rage of 26 to 28ºC in temperature and 1,610 to 1,880 mm in rainfall. The area is climatologically categorized into Wet Zone with a dry season of January to March and a wet season of October to December due to a rainfall throughout the year.

The Government of Sri Lanka gives a priority to “access to safe water and sanitation” in its Poverty Reduction Strategy and has sustained the improvement of this sector over the past 15 years. The goal of the Government is to secure safe water for 85% of the people by 2010. At present, 69 % of the population get safe water throughout the country, but only 57%, if limited to the rural area, and 29% of the people are served by piped water supply systems, which mostly cover the urban area. The requirements for the provision of water and sanitation exceed the institutional and financial capability of the Government.

The served population coverage by water supply in the study area of the Project, namely a part of Matara District (Matara, Malimbada, Devinuwara and Dickwella) in Southern Province is low in the country and the drought occurred in 2001 in the South gave serious damage to the people and threatened their basic living for four months. Furthermore, water is absolutely short in quantity due to an increase in water demand caused by a growth in population and high percentage of non-revenue water (40%), the people are forced to have limited water supply in the almost area except for the core area and to suffer from water-borne diseases such as dysentery and typhoid. It is therefore an urgent matter to provide an adequate water supply system in this area.

The coastal area is served by water supply but the residents especially in the eastern area along the coast have complaints of limited water supply (12 –20 hours), low pressure etc. Matara Office of the National Water Supply and Drainage Board (herein referred to as "NWS&DB) has done its best to distribute water throughout the service area using the existing facilities, but water source development cannot catch up the increase in water demand and the amount of water is absolutely short. The water problem now becomes the social and political issue in Southern Province. While the inland people out of the service area depend on groundwater. However some people do not have their own wells and women and children are engaged in water-fetching work. The shallow wells are not good in quality and have a tendency to be dried up in the drought season. The expansion of service area in the inland is also an urgent matter. In such circumstances, the Sri Lanka Government requested the Japanese Government to provide grant aid assistance to the improvement of water supply scheme of Matara.

The Government of Japan decided to conduct the basic design study upon this request and the Japan International Cooperation Agency (herein referred to as "JICA" dispatched the Basic Design Study Team to Sri Lanka from July 30 to September 11, 2002 for field survey and the Draft Explanation Team during the period of November 5 – 15, 2002.

To improve the water supply condition in the area, JETRO conducted "the Feasibility Study of Water

Supply Scheme in Galle and Matara Districts, Southern Province" in 2001, of which the objectives are to improve such poor water supply conditions in an existing service area and expand a service area toward the inland by augmenting the existing water supply system. The facilities to be constructed in Phase I project with a target year of 2005 is the same as those shown in the scope of work in the original request in Table 1 as described later. The plan intends to lay the new clear water transmission pipeline on the same roads as the existing one running along the coastal line. However, the existing clear water transmission pipeline is mostly laid on the national roads with heavy traffic under the administration of the Road Development Authority (RDA) and an additional pipe-laying on the same road is easily expected to increase the cost largely taking into account the strict conditions for pipe-laying works to be required by RDA. In such circumstances, NWS&DB, has modified the JETRO plan to apply so that a new clear water transmission pipeline, avoiding to run the national road and facilitating the expansion of a service area, will pass an inland area, and that the existing distribution network will be reinforced by connecting to this new pipeline, and applied it (Original Request in Table 1) for the Japanese grant aid assistance.

However, it was required to adjust the scope of work to connect the new clear water transmission pipeline to the existing one, an expansion capacity for Malimbada WTP was resultantly set by 15,000 m^3/day. Proposed new clear water transmission pipeline route running to east through the inland, which was originally connected to another proposed reservoir near Dickwella reservoir, was modified so as to connect to existing Gandara reservoir and coastal clear water transmission pipeline (see the final scope of work in Table 1). Through this new transmission pipeline, additional water is distributed to the existing service area and to the new service area (Diyagaha service area) inland along the pipeline route. Thus, Diyagaha and Gandara service areas and the existing service area east of Gandara will be the direct beneficial area of a new transmission system and the existing service area west of Gandara will be the indirect beneficial area with improvements such as an increase in per capita daily consumption and 24-hour water supply.

A total of 27 months is required for the Project implementation including five (5) months for detailed design, two (2) months for bidding procedures and 20 months for construction works. The project cost to be borne by the Sri Lanka side is estimated at 92.4 million Rupee.

	Present		Upon Completion of the Project	
	Coastal	Inland	Coastal	Coastal
Served Population (Direct Beneficial Area)	69,650	0	75,421	14,507
Served Population (Indirect Beneficial Area)	101,110	—	109,487	—
Per Capita Daily Water Consumption	122 lpcd	—	145 lpcd	145 lpcd
Water Supply (Overall)	31,800 m^3/day		46,800 m^3/day	
Water Supply Time	12-20 hours		24 hours	

Beside the above, the Project will bring the improvement in morbidity of water-borne diseases and reduction in water-fetching time of women and children as byproducts.

As shown in the above Table, the total water supply capacity will increase from 31,800 m^3/day to 46,800 m^3/day by 15,000m^3/day after the completion of the Project and the new beneficiaries to receive water supply will be 28,655 persons*[1], while the population to have benefits such as an increase of per capita daily water consumption from 122 lpcd to 145 lpcd, and improvement of water supply duration time from 12 to 20 hours to 24 hours will amount to 199,415 persons*[2]. Furthermore, the Project will bring the improvement in morbidity of water-borne diseases and reduction in water-fetching time of women and children.

*[1] Incremental served population after Project completion

(75,421 + 14,507 + 109,487) – (69,650 + 101,110) = 28,655

*[2] Total served population after Project completion

75,421 +14,507 + 109,487 = 199,415

The Project is to meet the national goal to increase the coverage for access to safe water as beneficiaries of the general people including the poor and to contribute the improvement of living environment through the supply of safe water. The beneficiaries of the Project is the general people, but consideration is paid for the poor, who is more in Southern Province, in the form of installation of stand posts which will release the poor from the payment for high connection fee and provide easy access to safe water. The facilities to be constructed in the Project are of same type as currently used in Matara, hence the Sri Lanka side has adequate human resource and technology to manage and maintain the facilities. In addition, the increase ratio of water supply volume is expected to be over the increase ratio of O&M expenditures, therefore the O&M expenditures will be fully covered if the water rate collection will be done smoothly.

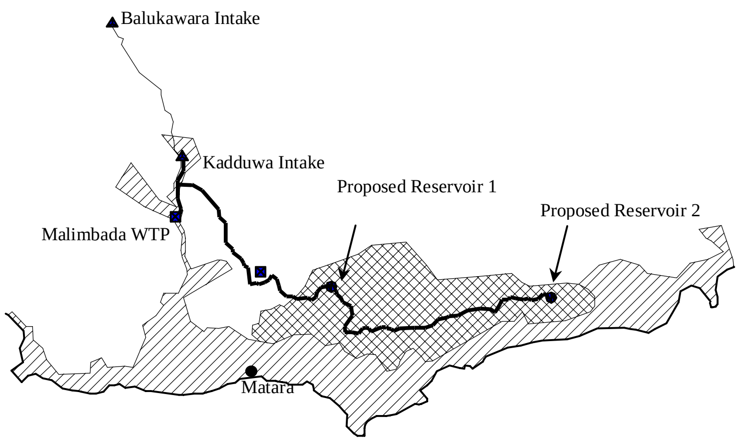
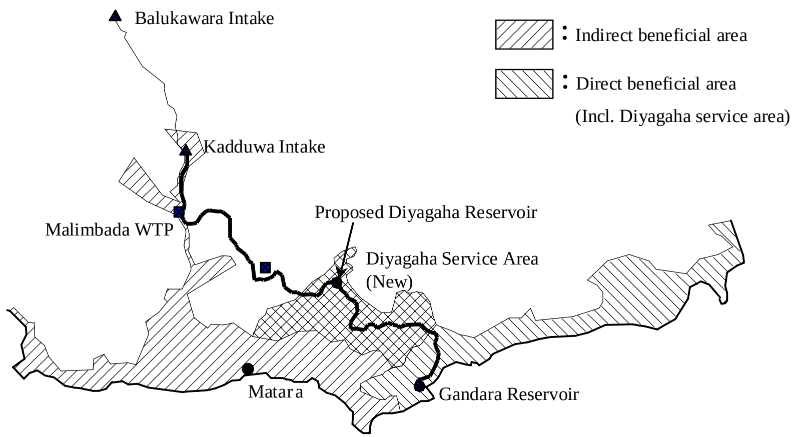
The amount of wastewater will increase by an increase in water to be supplied. However, the drains and road gutters in the study area are mostly dug with piles of soils frequently, therefore wastewater discharged from housings will infiltrate into the ground in flowing or evaporate into the air in stagnating and only a small portion of wastewater can reach to the streams/rivers, that is to say, the loads resulting from the Project implementation will less affect on environment.

To elevate the effect of the Project, it is recommended that the following measures will be taken:

- To lay additional pipes at two spans on the existing coastal clear water transmission pipeline and to replace existing pumps at Dickwella Service Reservoir, respectively, by 2007

- To continue the provision of distribution pipes in the service area
- To organize the community-based management system of communal faucets for smooth water rate collection
- To conduct the non-revenue water reduction programme

Table 1 Comparison of Original Request and Final Scope of Work

	Original Request	Final Scope of Work
1. Objectives	1. Improvement of water supply condition of existing coastal service area 2. Expansion of service area at inland	1. Improvement of water supply condition of existing coastal service area 2. Expansion of service area at inland (reduced)
2. Scope of Work	(1) Intake Facility: Capacity 30,000 m^3/day (Pumps included) (2) Raw Water Transmission Pipeline: Capacity 30,000 m^3/day、Length 5 km (3) Water Treatment Plant: Capacity 15,000 m^3/day (4) Treated Water Transmission Pipeline: Capacity 30,000 m^3/day, Length 32 km (5) Transmission P/S: 2 units（constructed together with (6)） (6) Ground Reservoir: 2 units (7) Distribution Pipeline: Length 100 km	(1) Intake Facility: Capacity 15,000 m^3/day (Pumps included) (2) Raw Water Transmission Pipeline: Capacity 15,000 m^3/day、Length 3 km (3) Water Treatment Plant: Capacity 15,000 m^3/day (Pumps included) (4) Treated Water Transmission Pipeline: Capacity 15,000 m^3/day, Length 21 km (5) Transmission P/S: None (6) Ground Reservoir: 1 unit (7) Distribution Pipeline: Length 23 km
3. Plan		

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Chapter 3 Project Evaluation and Recommendation

Abbreviations

GN	Grama Niladhari
HC	House Connection
JICA	Japan International Cooperation Agency
NWS&DB	National Water Supply & Drainage Board
SP	Stand Post
WTP	Water Treatment Plant

CHAPTER 1

BACKGROUND OF THE PROJECT

CHAPTER 1 BACKGROUND OF THE PROJECT

The present population coverage of the country with safe drinking water is estimated at 69%. The Government of Sri Lanka expects to increase the investment of water supply to achieve a coverage target of 85 % in the year 2010 and nearly 100% in the year 2025. A number of projects have been launched with local and foreign funds to achieve this target.

Matara District is one of the three districts in the southern province of Sri Lanka, situated approx. 160 km from Colombo on the southern coastal belt.

The original water supply to the Matara town was developed based on an intake at Nadugala located 10 km upstream of the river mouth of Nilwala Ganga. The capacity of this scheme was only 9,000 m^3/day and could cater for the requirements of the Matara town.

Subsequently, the Matara integrated water supply scheme was commissioned in 1983 to provide drinking water facilities to the Matara municipal area and the urbanized costal townships of Devinuwara, Gandara, Kottegoda, Dikwella and Kudawella. The design capacity of this scheme was 15,000 m^3/day. The intake was located at Kadduwa about 7 km upstream of the Nadugala Intake.

Further, in order to cater for the water demand arising from the increased development in the area, another augmentation was carried out with financial assistance from the Government of UK in 1998. The capacity of this system was 15,000 m^3/day.

Over the years, the water demand in the urbanized costal areas has increased by an increase in population and per capita water consumption. Water supply is done limiting the acceptance of new connection applications and the supply time of water for urban areas 12 to 20 hours a day and for rural areas 4 to 6 hours every two days. The water-borne diseases like dysentery and typhoid occur often especially in Matara and Dickwella.

The drought occurred in 2001 in the South gave serious damage to the inland people. People living in these areas obtain their water from a distant dug well, the nearest piped water system or through a bowsered supply. They have to undergo severe hardships to obtain their water requirements. Women and children have to walk a long distance and carrying water utensils in these areas. In addition, those dug wells are apt to be dry in the drought season and the water quality of groundwater in such dug wells is found to be not suitable for drinking. The iron concentration of groundwater reportedly exceeds the drinking standards at six out of eleven dug wells in Dickwella and one out of one in Devinuwara. According to the water quality investigation by the JICA study team, six out of eight dug wells investigated could not meet the standards in terms of turbidity, similarly seven in pH, six in manganese and seven in bacteria.

JETRO conducted “the Feasibility Study of Water Supply Scheme in Galle and Matara Districts, Southern Province” in 2001, of which the objectives are to improve such poor water supply conditions in an existing service area and expand a service area toward an inland area by augmenting the existing water supply system. Phase I project with a target year of 2005 is composed of construction of 30,000 m^3/day intake facility, 5 km long raw water transmission line, 15,000 m^3/day water treatment facility, 32 km long clear water transmission line, two clear water transmission pump stations and 100 km long distribution pipes for a service population of 218,500. The plan intends to lay the new clear water transmission lines on the same roads as the existing ones running along the coastal line. Phase II project with a target year of 2010 is expected to increase the pump number at Kadduwa Intake, expand the treatment capacity by 15,000 m^3/day at WTP and to construct a permanent salinity protection barrier in the Nilwala River

However, the existing clear water transmission lines are mostly laid on the national roads under the jurisdiction of the Road Development Authority (RDA) and an additional pipe-laying on the same road is easily expected to increase the cost largely taking into account the current heavy traffic and strict conditions for pipe-laying works to be required by RDA. In such circumstances, NWS&DB, which is also in a position to consider the expansion of water supply to the inland areas, has modified the JETRO plan so that a new clear water transmission line, avoiding to run the national road and facilitating the expansion of a service area, will pass an inland area, and that the existing distribution network will be reinforced by connecting to this new line. This modified plan was applied for the Japanese grant aid assistance.

CHAPTER 2

CONTENTS OF THE PROJECT

CHAPTER 2　CONTENTS OF THE PROJECT

2-1　Basic Concept of the Project

(1) Higher Target and Project Target

Current population coverage ratio by safe water in Sri Lanka was estimated as 69 %.　The Government of Sri Lanka has planned to upgrade this ratio to 85 % in 2010 and almost 100 % in 2025 by additional investment.　To achieve this target, numerous projects have been implemented by self-finance and/or by finance of foreign donor agencies.

In such circumstances, proposed project targets of this project were set as follows;

- □ Target year is 2009
- □ Extension of the water supply service area toward inland area of Matara area
- □ Improve the current water supply condition in the existing water supply area along coastline (increase in served population, increase in per capita daily water consumption and 24 hours water supply)

Table 2.1　Project Target

	Present		Upon Completion of the Project	
	Coastal	Inland	Coastal	Coastal
Served Population (Direct Beneficial Area)	69,650	0	75,421	14,507
Served Population (Indirect Beneficial Area)	101,110	—	109,487	—
Per Capita Daily Water Consumption	122 lpcd	—	145 lpcd	145 lpcd
Water Supply (Overall)	31,800 m^3/day		46,800 m^3/day	
Water Supply Time	12-20 hours		24 hours	

Beside the above, the Project will bring the improvement in morbidity of water-borne diseases and reduction in water-fetching time of women and children as byproducts.

However, self-supporting effort of Sri Lanka side is also indispensable to attain these project targets as shown in Table 2.1.　Since there are no surplus capacity in the existing water supply facilities located along the coastal areas, the following system improvement is needed to cope with the increase of water supply volume;

- □ Installation of additional transmission pipelines in the areas where the capacity of existing pipelines is insufficient to cover the future demand.
- □ Replacement of transmission pumps with insufficient pump heads

(2) Outline of the Project

To accomplish the abovementioned project targets, the Sri Lanka Government will invest Rs. 92 million. New water supply system with a capacity of 15,000 m^3/day will be constructed and it is comprised of the elements of intake – transmission – water treatment – storage – distribution.

By water supply service area extension, served population will be raised and water supply condition will be ameliorated. Further, indirect benefits, such as betterment of sanitary condition and reduction in water-fetching works of women and children can also be expected.

Proposed scope of work is as follows;

1) Expansion of Kadduwa Intake (15,000 m^3/day)
2) Installation of raw water transmission pipeline (3 km)
3) Expansion of Malimbada Water Treatment Plant (15,000 m^3/day)
4) Installation of clear water transmission pipeline (21 km)
5) Construction of a service reservoir (1 unit)
6) Development of distribution pipeline network (23 km)

Along with the implementation of above construction works, necessary equipment will be purchased as well.

2-2 Basic Design of the Requested Japanese Assistance

2-2-1 Design Policy

(1) Basic Design Policy

Through the discussion with NWS&DB officials based on the Grant Aid Application Form prepared by the Sri Lanka Government . the following was clarified:

- □ Additional raw water intake from Nilwara Ganga at Kadduwa Intake (15,000 m^3/day)
- □ Additional water treatment at Malimbada WTP (15,000 m^3/day)
- □ Installation of a clear water transmission pipeline through unserved inland area and connection to the existing Gandara reservoir and coastal transmission pipeline at the coastal area. Expansion of service area at the inland and improvement of water supply condition in coastal area will be enabled by this work..

Inland areas are not served by water supply system and thus people are relying on dug and tube wells as living water source. Since well development needs relatively huge budget, some people have no wells and they are using wells belonging to other people. However, groundwater quality pumped through shallow wells in the inland is not always applicable and most of these shallow wells are dried up during the dry season. Therefore, people must look for other available deep wells during the dry season and such water fetching work is mainly imposed to women and children.

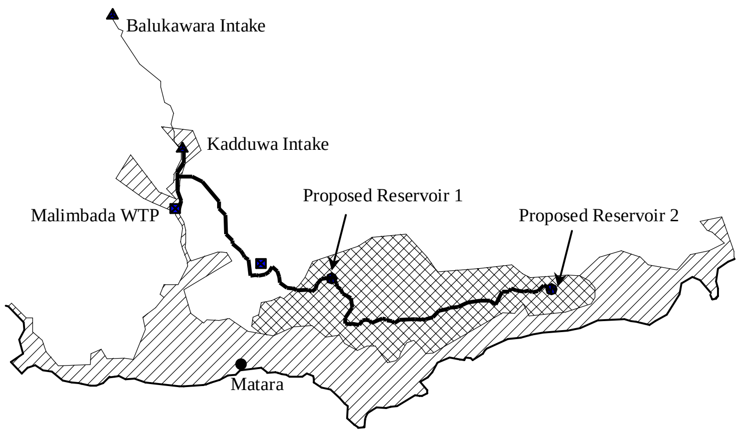
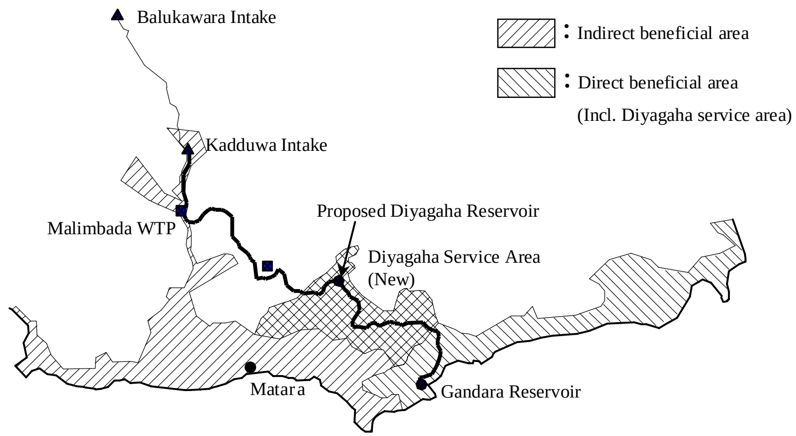
Although coastal areas are served by the existing water supply system, their water supply conditions are not satisfactory. Rational water supply, served duration is between 12 to 20 hours, is common in these areas and there are many low-pressured areas as well. Especially people living in the eastern coastal area, located most far from main water supply system, have been suffered by severe water shortage. Regional Support Center (Southern-Uva) of NWS&DB in Matara has been rendered eager effort to distribute water to entire existing service area by valve operation but water source development could not cope with the rapid water demand increase and said water shortage in Matara has become a serious social problem in Southern Province.

However, as to the connection of new clear water transmission pipeline to the existing one, which was one of the requested items, investigation and hydraulic analysis on existing pipeline network was necessary but this work cannot be completed during the limited study period in Sri Lanka. Therefore, project scope of work was adjusted as follows.

Expansion capacity for Malimbada WTP was set by 15,000 m^3/day. Proposed new transmission pipeline route running to east through the inland, which was originally connected to another proposed reservoir planned near Dickwella reservoir, was modified so as to connect to the existing Gandara reservoir and coastal transmission pipeline. Through this new transmission pipeline, additional water is distributed to the existing service area and to new service area inland along the pipeline route. This new service area was named as Diyagaha service area and distribution network will be newly installed. This new transmission pipeline will also serve the existing Gander service area. Thus, Diyagaha and Gandara service areas and the existing service area east of Gandara will be the direct beneficial area of a new transmission system and the existing service area west of Gandara will be the indirect beneficial area where improvement of water supply conditions can also be expected.

Table 2.2 shows the comparison of original request and final scope of work.

Table 2.2 Comparison of Original Request and Final Scope of Work

	Original Request	Final Scope of Work
1. Objectives	1. Improvement of water supply condition of existing coastal service area 2. Expansion of service area at inland	1. Improvement of water supply condition of existing coastal service area 2. Expansion of service area at inland (reduced)
2. Scope of Work	(1) Intake Facility: Capacity 30,000 m^3/day (Pumps included) (2) Raw Water Transmission Pipeline: Capacity 30,000 m^3/day、Length 5 km (3) Water Treatment Plant: Capacity 15,000 m^3/day (4) Treated Water Transmission Pipeline: Capacity 30,000 m^3/day, Length 32 km (5) Transmission P/S: 2 units（constructed together with (6)） (6) Ground Reservoir: 2 units (7) Distribution Pipeline: Length 100 km	(1) Intake Facility: Capacity 15,000 m^3/day (Pumps included) (2) Raw Water Transmission Pipeline: Capacity 15,000 m^3/day、Length 3 km (3) Water Treatment Plant: Capacity 15,000 m^3/day (Pumps included) (4) Treated Water Transmission Pipeline: Capacity 15,000 m^3/day, Length 21 km (5) Transmission P/S: None (6) Ground Reservoir: 1 unit (7) Distribution Pipeline: Length 23 km
3. Plan		

1) Project target year was set by 2009 and expansion capacity of existing WTP was settled in 15,000 m^3/day.
2) Additional one intake channel will be constructed in Kadduwa Intake. New pumps with larger capacity will replace four existing pumps of which the impellers have been worn down.
3) Additional water treatment facilities with a capacity of 15,000 m3/day will be constructed within the site of Malimbada WTP. Sludge treatment facility will be constructed in private land along the raw water transmission route from Kadduwa Intake.
4) As to treated water transmission pipeline route, route passing the least flooding area was selected. Treated water will be sent to the proposed ground reservoir planned at the hilltop of Diyagaha.
5) A part of treated water stored in Diyagaha reservoir then will be sent to the existing Gandara ground reservoir by gravity and remaining water will be injected in the existing transmission pipeline running along coastal road.
6) Branches shall be installed on transmission pipelines installed between Diyagaha reservoir and Gadara reservoir for future extension. These branches can serve un-served area located in east of Diyagaha reservoir, which was contained as target service expansion area in original request.
7) Distribution network will be developed in the surrounding area of Diyagaha ground reservoir. This new service area named as Diyagaha service area will be served by Diyagaha reservoir.
8) Stand post will also be installed in Diyagaha distribution network. Target household number served by one stand post was set by 130.

(2) Design Policy on Natural Conditions

Additional 15,000 m^3/day of raw water was planned to derive from Nilwala Ganga to cover the increased water demand of Matara Area. However, there is a possibility that this additional river water intake might worsen the saline water intrusion at Nadugala Intake located downstream of Kadduwa Intake. Based on the saline water analysis report issued by NWS&DB, the study team examined the influence of additional intake and found it almost negligible. Besides, NWS&DB has a plan of the construction of salinity protection barrier at the downstream of Nadugala Intake by ADB's assistance from a long-term view.

(3) Design Policy on Socio-economical Conditions

The proposed Diyagaha service area is classified as low-income area and thus, service population ratio of stand post in whole service population was assumed as 70 % in the year of 2005, target project completion year. This service ratio of stand post will be lessened, as water service condition will be developed. For instance, present served population ratio of stand post in the existing service area is only 7 %. For convenience in water use, one stand post will be installed per 130 households.

(4) Construction Conditions/Procurement Conditions

Major construction material for this Project is ductile cast iron pipe with a total length of approximately 30 km and with diameters ranging 200 mm to 600 mm. Japanese products have been adopted in Sri Lanka and have the reputation of high quality although cost is relatively high. Due to the budgetary limitation, Japanese products are not affordable for this Project and thus, pipes shall be procured from third countries. NWS&DB recognized this pipe cost gap between Japanese and third country and requested these of third-country products quality controlled by ISO 9002 and ISO 2531 to lessen the pipe work cost, considering proposed pipe diameter is relatively small.

(5) Policy on hiring the local Engineering Farms

Upon designing of transmission and distribution pipelines, the following items are essential:

□ Confirmation of site condition
□ Discussion and adjustment with relevant agencies
□ Discussion and agreement with beneficiaries

Therefore, design shall be contracted out only to the local consulting companies, which has been experienced design of transmission and distribution pipeline in Japanese ODA projects and Japanese consultant shall perform mainly design instructions and final design inspection.

Since Japanese assisted projects in water supply sector have been continuously implemented in Sri Lanka, local contractor have been well experienced the pipe-laying work.. There will be no obstacles in hiring such experienced local subcontractor.

(6) Implementing Agency's Capability on Project Management and O&M

O&M works on the existing water supply facilities in Matara is carried out by Regional Support Center (Southern – Uva) NWS&DB and they are satisfactory. Since they are familiar with O&M works of the existing facilities, there will be no problem for them to operate and maintain the proposed facilities.

(7) Grade of Facilities and Equipment

Considering the current sound condition of the existing facilities and satisfactory O&M activities, design of the proposed facilities shall correspond to the existing ones. However, since severe impeller defacement of intake pump s anticipated according to the operation records, replacement of existing ones with impellors made of durable material shall be taken into account.

(8) Implementation Period

In case of new water treatment facilities, new intake facilities and relevant equipment planned in this Project, they must be constructed or installed within the site of the existing facilities operating them simultaneously. Therefore, work schedule shall be carefully prepared with close connection and discussion with operating officers.

Total implementation period was set be 27 months, including 5 months for the detailed, 20 months for construction works and 2 months for relating transactions.

The objectives of the Project is to establish a new water supply system comprised of the elements of intake, raw water transmission, water treatment, treated water transmission, storage and distribution. No phased implementation was planned since none of these elements can be lacked to perform the expected function as a total system.

2-2-2 Basic Plan (Construction Plan/Equipment Plan)

2-2-2-1 Water Demand

(1) Population within the existing service areas

Population within the existing service areas was estimated based on the followings:

- Existing distribution network drawings
- GN (Grama Niladhari) Map
- Interview to the water supply engineers in RSC – S/U, NWS&DB.

First, current service areas were delineated. Then, confirmed service areas were compared with GN map and GN contained within the service areas were extracted. Based on the GN population tabulated in the Census 2001, current service population was calculated. In case of GN partially involved in service area, served population was reckoned by proportion of included area.

Current served population was computes as 198,560. Refer to Appendix Table 2.1 for detail.

(2) Future service population

According to the Census in the year of 1981 and 2001, annual population increase ratio in Matara district was calculated as 0.84 %/year. Refer to Appendix Table 2.2 in detail. Thus, design population increase ratio was set as 1 % per annum.

(3) Target year

Target year was set as follows:

- Medium Term Target Year : 2011
- Long Term Target Year : 2021
- Facility Design Target Year : 2009

(4) Current served population

Based on the water charge billing data, existing house connection number was 36,368 units and existing stand post number was 116 units as of July 2002. According to the Census 2001, average residents number per household was ciphered as 4.1. Refer Appendix Table 2.3 for detail. While, average served population per stand post was unknown and therefore, average served population was estimated as 100 based on the design guideline of NWS&DB. Current served population was given as 161,119 by the expression below:

36,468 x 4.1 + 116 x 100 = 149,519 + 11,600 = 161,119

(5) Served population ratio between house connection and stand post

Abovementioned ratio was given as follows:

House Connection : Stand Post = 149,519 : 11,600 = 93 : 7

(6) Service ratio

Service ratio in the existing service areas was given by (1) and (4):

161,119/198,560 = 80 %

(7) Per capita daily water supply volume

As to the present water supply volume, the following two data are available as of July 2002:

- Outlet water volume from reservoirs (including Unaccounted for Water) : 32,934 m^3/day
- Billed water volume (excluding Unaccounted for Water) : 7,156,098 m^3/year (19,606 m^3/day)

According to these data, per capita daily water distribution volume and per capita daily water supply volume were computed as follows:

Per Capita Daily Water Distribution Volume = 32,934/161,119 = 204 lpcd

Per Capita Daily Water Supply Volume = 19,606/161,119 = 122 lpcd

(8) Unaccounted for Water ratio

Unaccounted for Water ratio was estimated based on the monthly total production volume and billed water volume. As for the detail, refer to Appendix Table 2.4.

Unaccounted for Water ratio = 30 %

(9) Non-domestic water use ratio

Water consumption by water use categories as of July 2002 was shown in Appendix Table 2.5 and non-domestic water consumption occupied around 17 % of total water consumption. Water consumed by people dwelling in governmental quarters was also included in “Domestic use”.

(10) Capacity of existing water treatment plant

The existing Malimbada WTP (see Appendix Drawing 2.1) and Nudugala WTP (see Appendix Drawing 2.2) have been suffered by drought occurred from 2001 up to July 2002, which resulted in extreme decrease of raw water intake volume. As shown in Appendix Table 2.6, average intake volume during January to July 2002 in Malimbada WTP was computes as 24,600 m^3/day and that of in Nadugala WTP was reckoned as 4,500 m^3/day. Total capacity was estimated as 29,100 m^3/day, which was much less than nominal capacity of 39,000 m^3/day. Design WTP capacity was set as follows based on the maximum raw water intake volume in 2001:

Malimbada WTP	27,500 m^3/day
Nadugala WTP	5,500 m^3/day
Total Capacity	33,000 m^3/day

(11) Future water demand projection

Based on the results of design examination carried out in section (1) to (9), design frame values in the year of 2021 was established as follows:

Table 2.3 Design Frame Values in 2021

		Coastal Area	Inland Area
Population Service Ratio		95%	80%
Water supply Connction	House Connection	100%	80%
	Stand Post	0%	20%
Per Capita Daily Water Supply Volume	House Connection	180 lpcd	180 lpcd
	Stand Post	45 lpcd	45 lpcd
Unaccounted for Water Ratio		25%	25%
Annual Population Increase Ratio		1%	1%
Non-domestic Water Demand Ratio		17%	17%
Total Capacity of Existing WTP		33,000 m^3/day	

Adopting these design frame values, future water demand was projected as shown in Table 2.4 and Figure 2.1:

Table 2.4 Future Water Demand Projection

Design Frame Values			Target Year				
			2001	**2009**	**2010**	**2011**	**2021**
Annual Population Increasing Ratio		(%)	-	1.0	1.0	1.0	1.0
(against year 2001)				(1.083)	(1.094)	(1.105)	(1.220)
Population	Diyagaha		20,611	22,319	22,542	22,767	25,149
	Gandara		16,213	17,556	17,732	17,909	19,783
	East of Diyagaha		14,094	15,262	15,414	15,569	17,197
	East of Gandara		64,777	70,144	70,846	71,554	79,040
	Western Area		117,570	127,311	128,585	129,870	143,458
	Total		233,265	252,593	255,118	257,670	284,628
Design Frame Values for Existing Service Area	Population Service Ratio	(%)	80.0	86.0	86.8	87.5	95.0
	Demand by House Connection	(%)	93.0	95.8	96.2	96.5	100.0
	Demand by Stand Post	(%)	7.0	4.2	3.8	3.5	0.0
	Per Capita Water Supply Volume						
	House Connection	(lpcd)	122	145	148	151	180
	Stand Post	(lpcd)	45	45	45	45	45
	Unaccounted for Water Ratio	(%)	30.0	28.0	27.8	27.5	25.0
	Factor (A)		**0.133**	**0.168**	**0.173**	**0.178**	**0.228**
Design Frame Values for New Service Area	Population Service Ratio	(%)		65.0	67.5	70.0	80.0
	Demand by House Connection	(%)		70.0	55.0	60.0	80.0
	Demand by Stand Post	(%)		30.0	45.0	40.0	20.0
	Per Capita Water Supply Volume						
	House Connection	(lpcd)		145	148	151	180
	Stand Post	(lpcd)		45	45	45	45
	Unaccounted for Water Ratio	(%)		25.0	25.0	25.0	25.0
	Factor (B)		**0**	**0.082**	**0.091**	**0.101**	**0.163**
Domestic Water Consumption	Diyagaha	(m^3/day)	0	2,232	2,051	2,300	4,099
	Gandara	(m^3/day)	2,156	2,949	3,068	3,188	4,511
	East of Diyagaha	(m^3/day)	0	1,526	1,403	1,572	2,803
	East of Gandara	(m^3/day)	8,615	11,784	12,256	12,737	18,021
	Western Area	(m^3/day)	15,637	21,388	22,245	23,117	32,708
	Total		26,408	39,879	41,023	42,914	62,142
Non-domestic Water	17 % of total water demand	(m^3/day)	5,409	8,168	8,402	8,790	12,728
Total Water Demand		(m^3/day)	31,817	48,047	49,425	51,704	74,870
Existing WTP Capacity		(m^3/day)	33,000	33,000	33,000	33,000	33,000
Additional Capacity		(m^3/day)	-1,183	15,047	16,425	18,704	41,870

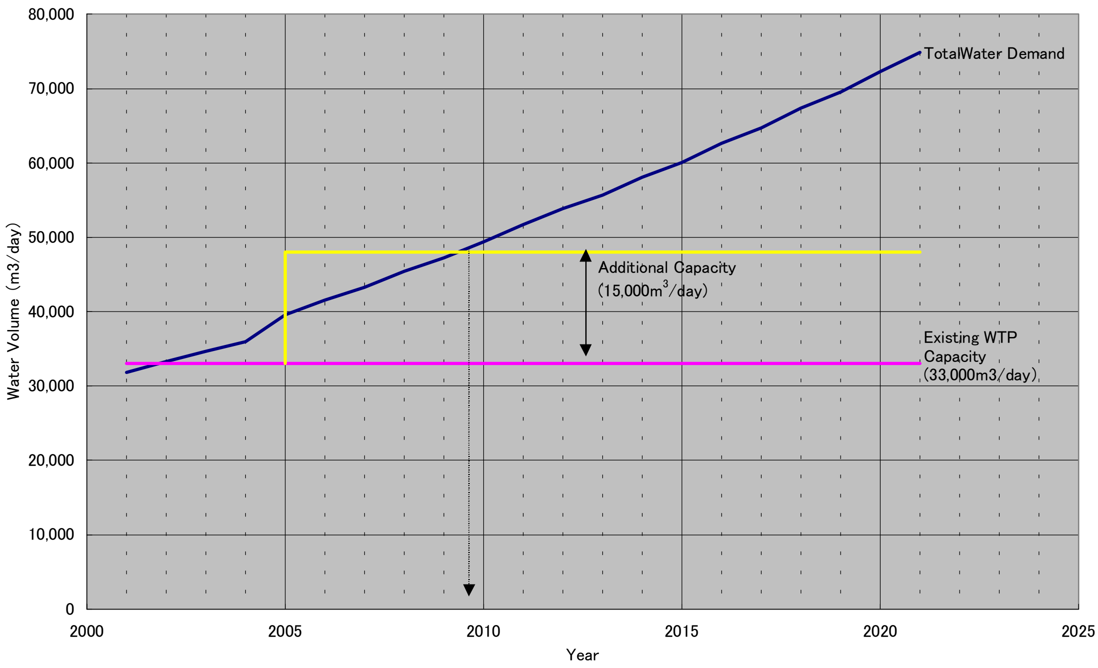


Figure 2.1 Water Demand and Water Treatment Capacity

2-2-2-2 Facility Planning

(1) General

Facility plan was prepared based on the following policies:

- □ Confirmation on capacity of the existing facilities
- □ Optimization of the existing facility capacity (minimization of construction cost, maximization of investment effect)
- □ If the existing capacity is insufficient to cover the projected future water demand, this capacity deficiency shall be compensated by the newly constructed facilities.

On the target year of 2009, water demand deficiency was estimated as 15,047 m^3/day and therefore, design expansion capacity for intake facility and water treatment plant was set by 15,000 m^3/day.

As to treated water transmission pipeline, design policy was set as follows:

- □ The existing pipeline, started from Malimbada WTP running through Uyanwatta P/S and Brownshill reservoir then running along coastal belt to east was fully applied
- □ New pipeline running across inland area and reaching to the existing Gandara ground reservoir was proposed to supply additional water to Diyagaha area and to the existing pipeline in the coastal belt

New ground reservoir was also planned in Diyagaha area to supply water to un-served inland area. Water will be served by gravity.

As to the water supply system development during 2010 to 2021 after the target year of this project, further strengthening of the existing system is needed to cope with water demand increase in the existing service area in coastal belt. System expansion to Diyagaha East is also necessary. Additional water demand was assessed as 27,000 m^3/day and raw water shall still be derived from Nilwara Ganga and therefore, intake and water treatment facilities will be implemented nearby the existing ones. Although similar population growth is anticipated in both coastal and inland areas, water demand growth in coastal area is regarded as greater than that of inland area and so, strengthening of the existing pipeline in coastal belt shall be conducted. System expansion plan up to the year of 2021 was prepared provided that the existing pipeline will be expanded to supply additional water to the eastern areas. To expand the proposed inland service area to east, the following works shall be implemented:

- Capacity strengthening of distribution pumps in Malimbada WTP
- Expansion of Diyagaha reservoir
- Expansion of distribution pipeline and construction of Eastern reservoir

Treated water is supplied to the proposed Diyagaha reservoir through the proposed transmission pipeline.

(2) Kadduwa Intake

1) Present status of the existing pumping station

The specifications and operational conditions of the existing four pumps in Kadduwa Intake are as follows:

No.1 to 3 : Dia. 200 x 93 L/s x 59 m x 75 kW x 3 units (1 unit stand-by) (installed in 1985)
No.4 : Dia 200 x 93 L/s x 55 m x 75 kW x 1 unit (stand by) (installed in 1995)

- Total pump head of No.1 to No.3 pump was originally 55 m at installation year of 1985 but it was converted to 59 m by replacement of impellor to cope with the increased head loss caused by connection of new raw water transmission pipeline from new Balukawala Intake constructed in 1997. During the field survey period, pump capacity test was conducted and capacity diminution of 10 % was observed. Especially No.3 pump has been heavily deteriorated and shaft vibration was also severe.
- Pump impellor of No.4 pump was not replaced in 1997 and capacity diminution was estimated as 50 % according to the pump capacity test. It was assumed that pump capacity decrease was caused by impellor defacement.

To prevent such pump capacity decrease caused by impellor defacement due to sand suction, existing inlet channel (grit chamber) shall be expanded in proportion to pump capacity augmentation. At present, there is only one inlet channel in Kadduwa Intake so, pump operation is forced to suspend during sediment removal work for around one month. If another inlet channel is built, such operational problem will be solved.

Power receiving equipment and generator equipment shall be upgraded to cope with pump capacity increase. Existing control panels have also been heavily deteriorated during 17 years operation and soonest replacement is recommended to maintain sound intake/pumping functions.

2) Alternatives

Total pump capacity must be raised but acquisition of another construction site was quite difficult. The following two alternatives were proposed:

Case-1 : Construction of additional pump house within the existing site. Additional capacity is 15,000 m3/day (pump 2 units).

Case-2 : Replacement of existing four pumps by pumps with larger capacity.

3) Comparison and examination of alternatives

Outline of Case-1 and Case-2 is shown in Figure 2.2 and 2.3. Comparison of both alternatives in terms of work contents, workability, operation and maintenance and project cost is shown in Table 2.5.

4) Results of comparison and examination

Adoption of Case-2 is recommended due to the following reasons:

- Replacement of all existing pumps, which were needed to replace, is preferable to secure the stable intake of design intake volume.
- Ease in implementation
- Less pump number in one pump room is advantageous for O&M works. Since new pumps with same specification will be planted, common spare parts can be applied and this will contribute to the reduction in repair and maintenance cost consequently.

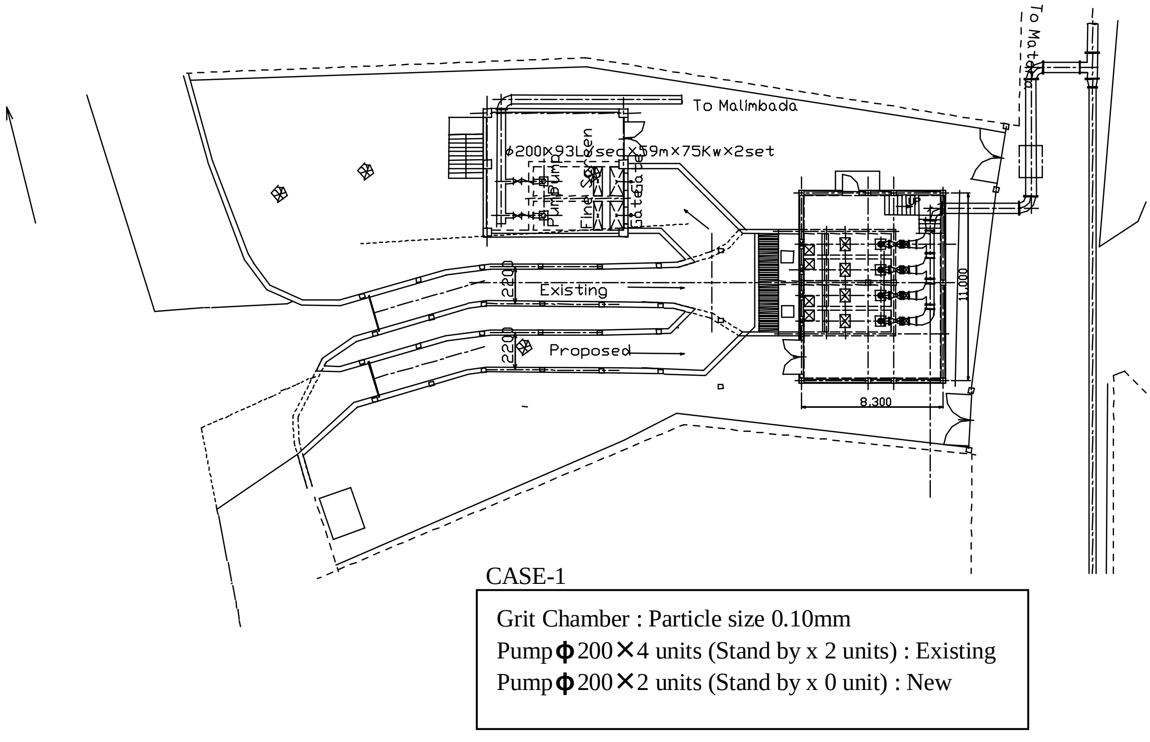


Figure 2.2 Case-1 : Construction of Additional Pump House

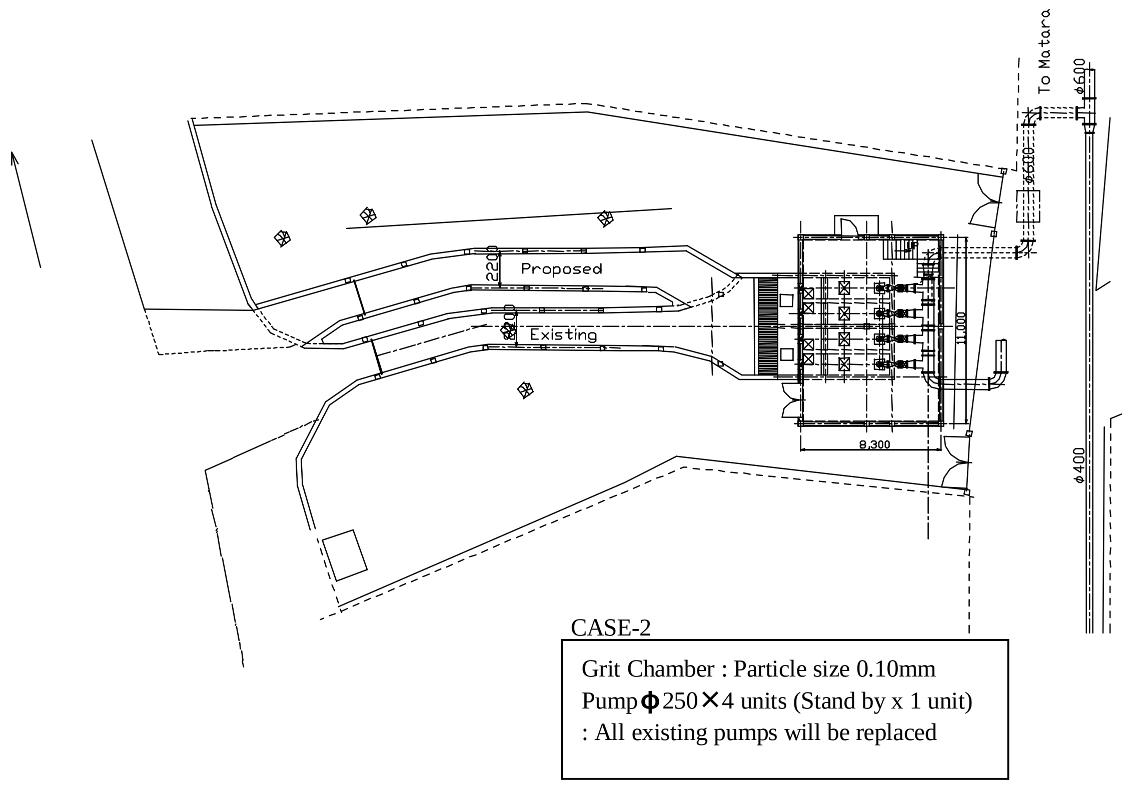


Figure 2.3 Case-2 : Replacement of Pumps

Table 2.5 Comparison of Alternatives for Kadduwa Intake Improvement

Items	Case-1 : Construction of Additional Pump House	Case-2 : Replacement of Pumps
1. Outline ・ Design intake capacity ・ Pump Specifications	30,000 m^3/day （Existing Pumps） φ200×93 L/s×59 m×75 kW×3 units (1) φ200×93 L/s×55 m×75 kW×1 unit (1) （Additional Pumps） φ200×93 L/s×59 m×90 kW×2 units Total 6 units（2 units stand by） Note) 90 kW counting some surplus capacity was set as motor output of additional pumps.	30,000 m^3/day (Replacement) φ250×124 L/s×59 m×110 kW ×4 units (1 unit stand by)
2. Work Contents ・ Civil/ Architectural Works	・ Additional inlet channel（Grit chamber） ・ Additional pump house（2 units of pumps）	・ Additional inlet channel（Grit chamber） ・ Partial reconstruction of existing pump house (Reconstruction of pump pit due to pump diameter alternation, reinforcement due to pump weight increase)
・ Mechanical Works	・ Installation of φ200 pump x 2 units ・ Installation of auxiliary equipment (screen, gate)	・ Replacement of pumps (4 units) and valves
・ Electrical Works	・ Replacement of power receiving equipment（630 KVA） ・ Replacement of generator equipment（300 KVA） ・ Replacement/addition of control panels	・ Replacement of power receiving equipment（630 KVA） ・ Replacement of generator equipment（375 KVA） ・ Replacement of control panels
3. Maintenance	・ Proposed construction site is narrow and thus workability is quite low.	・ Only partial reconstruction of the existing pump house is needed.
4. Operation	・Inferior to Case-2 in terms of O&M activities divided to two pump houses. ・ Raw water flow from inlet channel to the additional pump house makes acute angle and it is unfavorable from a viewpoint of sedimentation. ・ Improvement of existing pumps are needed to cope with deterioration and capacity diminution (pump replacement or impellor replacement by one made of durable materials)	・ Advantageous in operation since activities can be concentrated in one pump house. ・ Maintenance and repair cost will be decreased by less pump number and common spare parts.
5. Project Cost	176,200 thousand Yen	176,900 thousand Yen

(3) Raw water transmission pipeline

Currently Ductile Cast Iron Pipe (DCIP) with diameter of 600 mm is used as raw water transmission pipeline starting from Kadduwa Intake reaching to Malimbada WTP. Another DCIP with diameter of 400 mm, raw water transmission pipeline from Balukawala Intake is connected to the said pipeline near Kadduwa Intake. Since Kaduwa pipeline (Dia. 600 mm) has no surplus capacity, another DCIP with diameter of 600 mm will be installed from Kadduwa Intake to Malimbada WTP to comply with intake volume increase in Kadduwa Intake. By inter-connection between this additional pipeline to the existing Kadduwa pipeline, mutual capacity shortage compensation and buffer function as total transmission system can be secured.

(4) Malimbada WTP

Along to the existing aeration tanks, raw water receiving tank/distribution chamber will be built at hillside. Pumped raw water will be distributed in this tank by the proportion of 2:1 and the former amount will be sent to the existing plant and the latter amount will be poured into the proposed plant. Aeration facility shall be installed for the proposed one.

Considering the followings, there is no reason for alternation of treatment method in clarifier:

- No major problems have been recorded by operation of the existing treatment method
- Plant operators are familiar with O&M procedures for the existing treatment method

Cloth sludge cones have been adopted for control of top level of sludge blanket zone in clarifiers and they are under the British patent. Although the patent has already expired, sounding to the British manufacturer will be needed upon adoption of this method. Procurement of cloth cone will be easy, since it has been used in the existing plant for long period.

Existing sand filter is European type. Sand grain is relatively large and air-water filter backwashing is employed. As no major operational constrains has been recorded, same type should be introduced for the plant expansion.

Clear water reservoir shall be constructed at site of the existing contact tank located next to the existing clear water reservoir. Since this tank has not been operated, it will be demolished.

Expansion of chemical building is needed to cope with the increased plant capacity. Accounting the ease in operation, additional building shall be built next to the existing one. As part of the planned construction site enters into the slope of hill behind the plant, rock excavation is needed upon construction work.

By the construction of abovementioned additional treatment facilities, there will be no surplus area for construction within the existing plant site on hilltop. Therefore, wastewater treatment facility receiving sedimentation basin sludge and backwashing wastewater will be constructed in the acquired private land nearby. The existing raw water transmission pipeline from Kadduwa Intake running A24 road enters into this private land, then it is raised to Malimbada WTP. As this private land has already been felled and landowner also offered the land purchase to NWS&DB, wastewater treatment facility shall be built here. Sludge lagoon method mainly comprised of sedimentation and separation was employed as a treatment method.

(5) Treated water transmission pipeline (Existing route and new inland route)

The relationship between proposed and existing water supply systems is shown in Figure 2.4 and hydraulic analysis on new transmission pipeline is attached to Appendix 2.1. New treated water transmission pipeline will connect Malimbada WTP and newly built Diyagaha ground reservoir by DCIP with a diameter of 450 mm and then will connect Diyagaha reservoir and the existing Gandara ground reservoir by DCIP with a diameter of 400 mm. Branch pipeline will also be connected to the existing transmission pipeline at A2 road running along coastline to supply additional water to the existing service areas.

1) Current status of the existing pipeline (Coastal Area)

Capacities of the existing pipelines are shown in Figure 2.5. Capacity of pipeline, gravity flow, starting from Malimbada WTP to Uyanwattta P/S is 21,000 m^3/day. Adding pipeline capacity to Isadeen reservoir to that of to Uyanwatta P/S, total pipeline capacity by gravity flow is equivalent to the present plant capacity of 30,000 m^3/day. Capacities of the existing facilities are presented in Appendix 2.1.

Pipe capacity to Brownshill ground reservoir, located on the water transmission route to the study area, is 13,700 m^3/day, while that to Dickwella ground reservoir is 4,200 m^3/day. To buffer with the projected water demand in the year from 2007 to 2009, the following improvement works for the existing pipelines will be needed:

Table 2.6 Improvement Works needed by Water Supply Volume Increase

Target Implementation Year	Location	Work Items	Specifications
2007	(1) Dickwella reservoir to Naigala E.T.	Ditto	Dia. 225 mm x 2,256 m
	(2) Dickwella reservoir	Pump replacement to send water to Medagoda reservoir	Pump head upgrade (61 m to 78 m)
	(3) Devinuwara Jct to Devinuwara E.T.	Additional pipeline	Dia. 110 mm x 400 m

Note 1) Jct = Junction, E.T. = Elevated Tank

Note 2) For the spans of (1) and (3), a C value of 130 is used assuming the usage of PVC pipe.

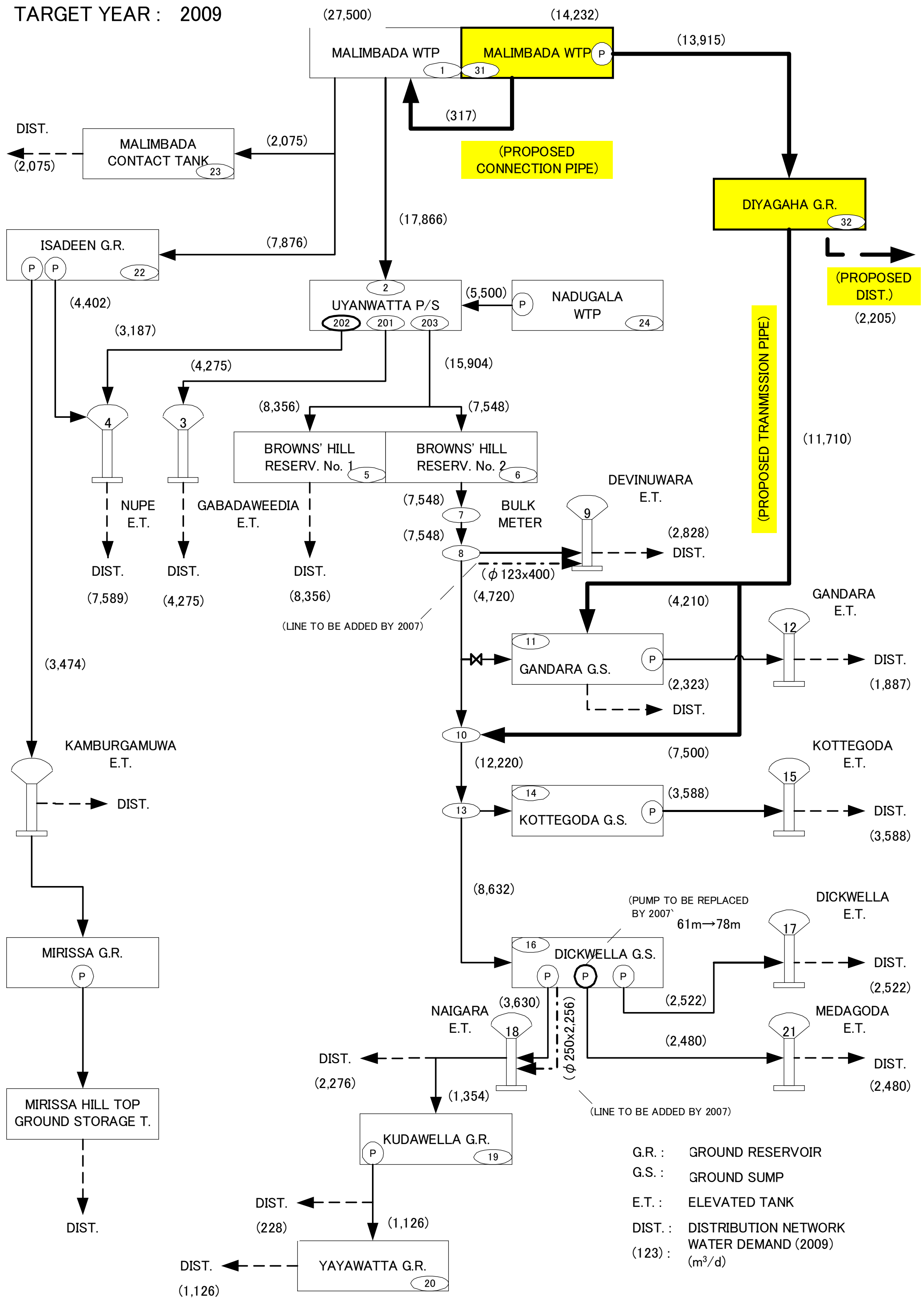


Figure 2.4 Proposed and Existing Transmission Pipelines

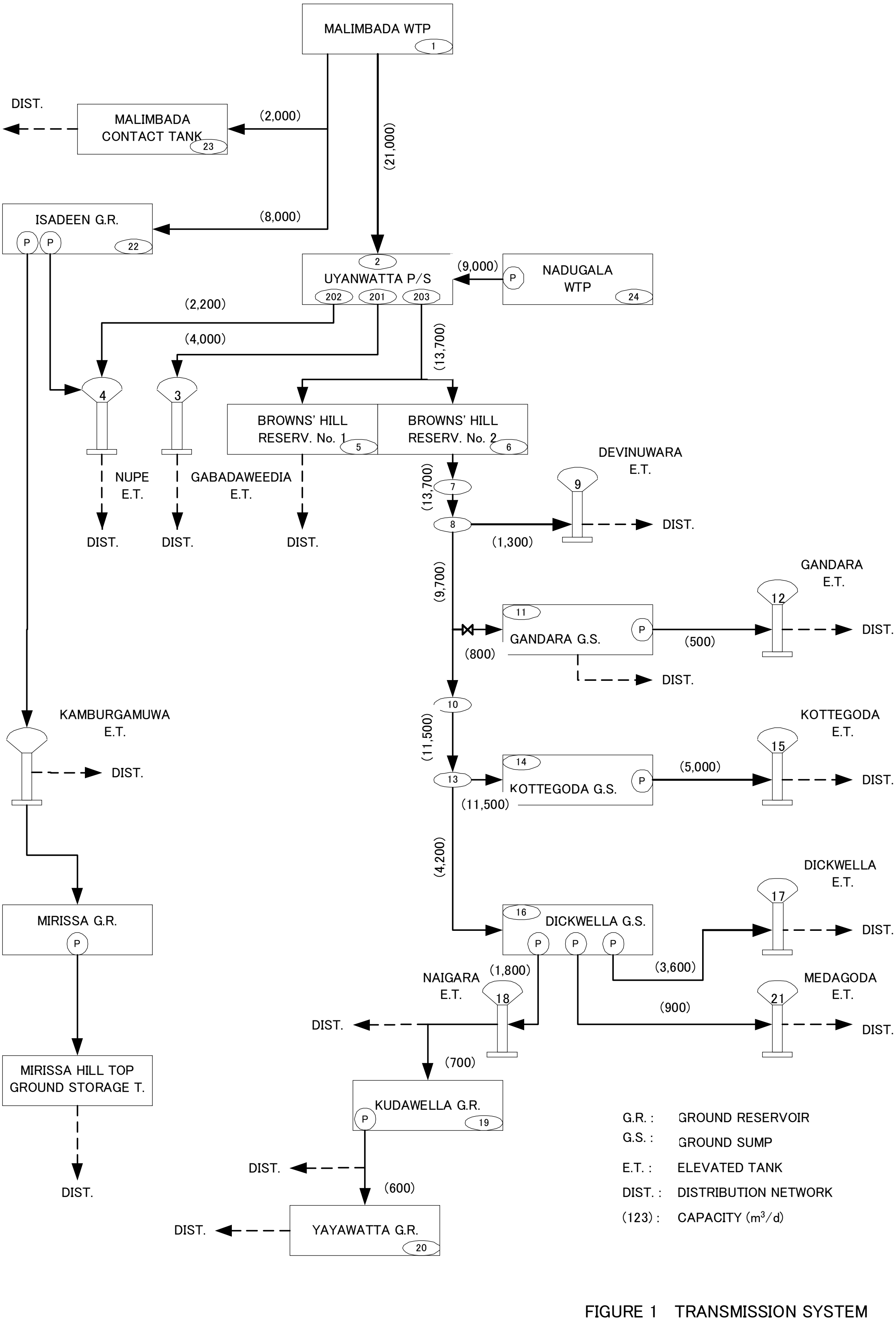


Figure 2.5 Flow Capacity of Existing Transmission Pipeline

2) Proposed pipeline in inland area

Capacity of pipeline from Malimbada WTP to Uyanwatta P/S, with diameter of 500 mm and length of 10 km is 21,000 m^3/day and this capacity only afford to send water up to Gandara reservoir. This resulted in insufficient water supply to further eastern areas.

Installation of additional transmission pipeline with length of 10 km to upgrade the water supply capacity will be expensive. Water sent to Uyanwatta P/S will be transferred to Brownshill reservoir and then it will be sent to eastern areas. However, sending water to eastern areas by gravity needs additional pipeline along with A2 National Road. This road is narrow two-lane road with existing transmission pipeline and telephone cable, constant heavy traffic and there is no major detour routes. Therefore, getting permission from RDA for the additional pipe installation work in this road will be quite difficult. Even if permission is given, the work will be forced to night shift and due to the difficulty of night work, construction cost will be higher.

In this study, inland transmission pipeline was planned not only to serve Diyagaha area but also to ameliorate the abovementioned water shortage in eastern areas. Therefore, proposed transmission pipeline started from Diyagaha Reservoir was connected directly to the existing Gandara reservoir. Proposed inland pipeline route has function of detour for coastal route and it can stabilize the water supply status. The inland transmission pipeline was planned as reinforcement measure for the existing pipeline, accounting the followings:

- □ Water demand covered by Gandara ground reservoir and elevated tank will be supplied to Gandara reservoir through the proposed inland pipeline
- □ Another pipe branched from the proposed inland pipeline will be connected to the existing pipeline running A2 road to cover water supply in further eastern areas.

Water meter will be installed both of pipelines to Gandara reservoir and to the existing pipeline. Flow will be adjusted by valve operation.

(6) Diyagaha ground reservoir

1) Examination on distribution method

Water distribution methods can be roughly divided into “Pumping Method” and “Gravity Flow Method”. “Gravity Flow Method” can be classified to “Ground Reservoir Method” and “Elevated Tank Method”. Characteristics of these methods are shown in the table below:

Table 2.7 Comparison of Water Distribution Methods

	Pumping Method	Gravity Flow Method
Characteristics	Distribution pumps must be controlled based on the fluctuation of water demand. For precise and timely pump discharge flow control, control equipment receives signals transmitted from measuring devices of water pressure, flow and valve opening installed in water distribution network. Pump capacity shall be set by the hourly maximum water demand.	Water demand fluctuation will be buffered by reservoir capacity. If enough elevated tank capacity is not available, lift pump capacity must be set by hourly maximum water demand. Pump is operated by constant flow and On-Off operation is conducted based on the water levels in reservoir and elevated tank and therefore pump operation is easy. It is advantageous if reservoir can be constructed at elevated site.
Ease in O&M	Needs computer controlled precise regulation. High operational technique is requisite for stable water distribution.	Both of pump operation and O&M are easy. It enables stable water distribution.
Equipment Cost	Expensive	Cheaper
O&M Cost	Expensive	Cheaper
Total Evaluation	Not applicable	Applicable

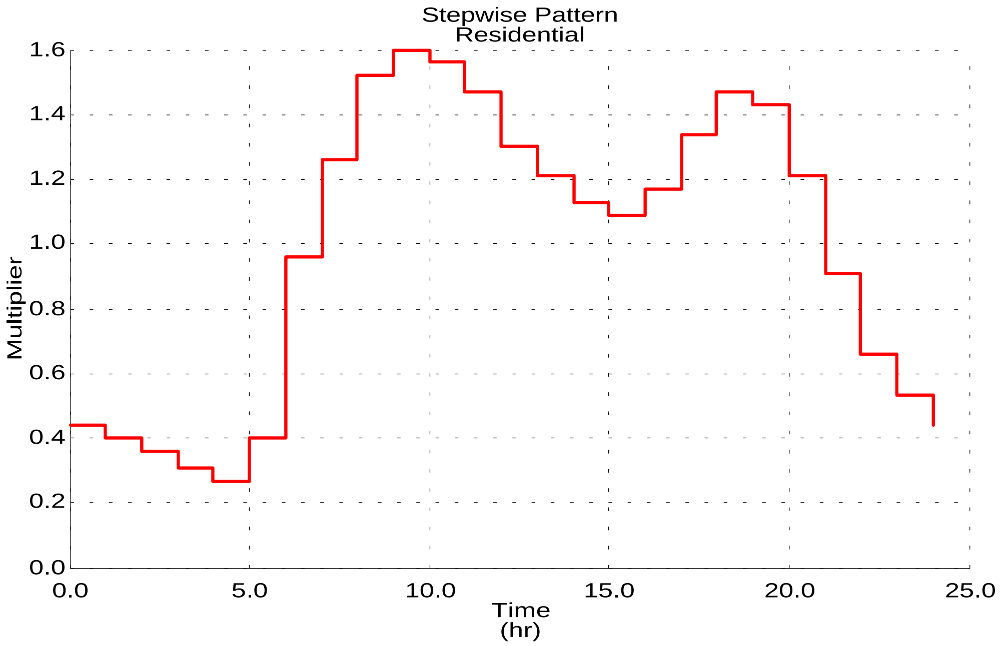
There are other intermediate methods such as “Pressure Tank Method” or “Inline Booster Method”, but they are applicable for small-scaled service area, not for vast service area like study area of this project. Reservoirs and elevated tanks have been adapted in the existing water supply system. “Gravity Flow Method” was employed since reservoir can be constructed in the elevated land in Diyagaha area.

2) Water distribution pattern

No water distribution pattern in Matara district is available. Further, since the current water supply status is unfavorable, water distribution pattern based on the measured water supply volume cannot be reflected to the facility design. Some distribution patterns are shown in NWSDB Design Manual, page 9-1 “Service Reservoir – Storage Capacity” which shall be applied when no water distribution data is available.

However, this pattern has no distribution flow during PM 10 to AM 5, showing typical water usage pattern in domestic housings but generally, there are some distribution volume from reservoir even during nighttime. Therefore, water distribution pattern with hourly peak factor of 1.60 was employed referring to the measured distribution patterns shown in the water supply facility design guideline issued by Japan Water Works Association.. The pattern is shown below:

Figure 2.6 Water Distribution Pattern (Hourly Peak Factor K = 1.60)



3) Water distribution volume

Diyagaha reservoir will serve Diyagaha area. Adding east Diyagaha area, future expansion area, total water distribution volume was calculated as follows:

Table 2.8 Water Distribution Volume

Target Year	Water Distribution Volume		Total Volume
	Diyagaha Area	East Diyagaha Area	
2009	2,688 m^3/day	1,839 m^3/day	4,527 m^3/day
2021	4,939 m^3/day	3,377 m^3/day	8,316 m^3/day

The proposed service area until 2009, the target year of this study, is Diyagaha area. After 2009, service area is scheduled to expand to further eastern areas but it needs additional water intake, treatment, transmission and distribution facilities.

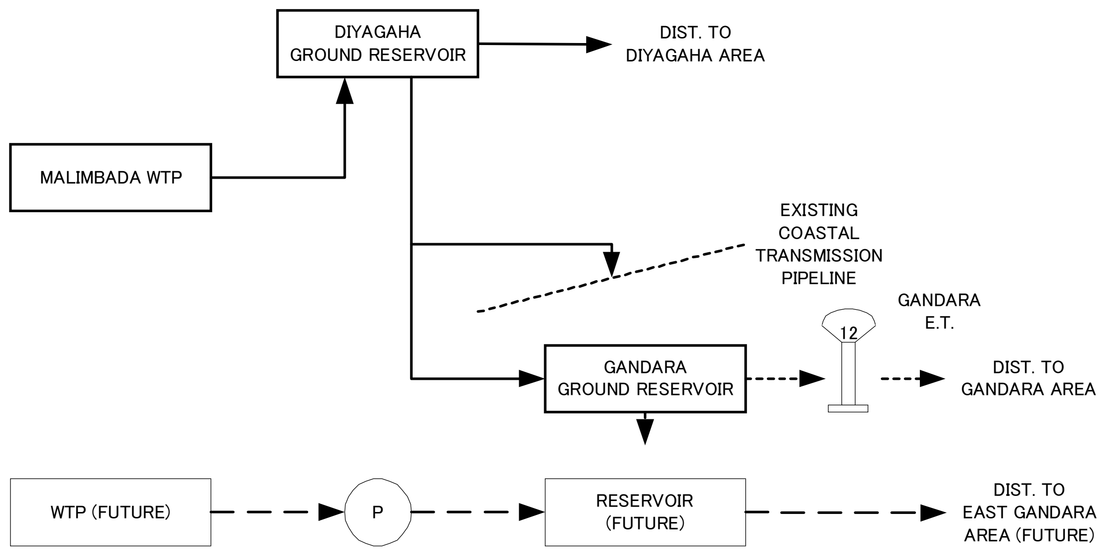
In this case, raw water will also be derived from Nilwala Ganga and water will be sent through the same transmission route as well. Therefore, facility design accounting the water distribution volume in 2021 is possible but due to the budgetary restriction, facility design was limited aiming to the water demand in 2009. Outline of the project is shown in Figure 2.7.

4) Reservoir capacity

If east Diyagaha is included in the scope of this study, the following issues shall be examined:

Figure 2.7　Proposed and Existing Transmission and Distribution Pipeline

Case 1 （Without Precedent Work）



Case 2 （With Precedent Work）

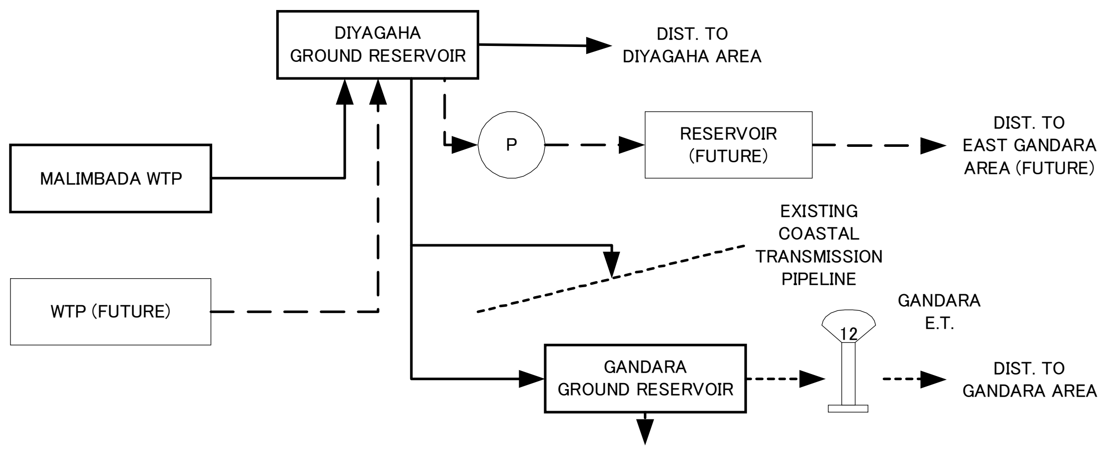


Figure 2.7　Proposed and Existing Transmission and Distribution Pipeline

- □ Distance from the proposed Diyagaha reservoir to East Diyagaha is more than 30 km
- □ When service by gravity flow is planned, pipe diameter will be larger and be uneconomical.

Accordingly, new reservoir or elevated tank shall be installed in the area.

Necessary capacity of Diyagaha reservoir was calculated summing up the following water volumes:

- Water distribution volume based on distribution pattern (Gandara area)
- One hour water supply volume to the existing Gandara ground reservoir and elevated tank
- One hour water supply volume to the existing water transmission pipeline in A2 Road
- One hour water distribution volume based on distribution pattern (East Gandara area)

Demand of east Diyagaha area was added because NWSDB is planned to implement water distribution pipelines in east Diyagaha by their own fund. As shown in Appendix 2.2, the minimum storage volume was estimated as 533 m^3. Total water volume was 1,084 m^3 and capacity of reservoir was set by 1,080 m^3.

Table 2.9 Necessary Capacity for Diyagaha Reservoir

Items	Water Volume (m^3)	Water Volume Calculation
1.To Diyagaha Area	533	270 m^2 × (4.20 m-2.228 m)= 533 m^3
2.To Gandara GR・ET	162	1 hour (3,881 m^3/day)/24= 162 m^3
3.To Existing Pipeline	312	1 hour (7,500 m^3/day)/24= 312 m^3
4.To East Diyagaha	77	1 hour (1,839 m^3/day)/24= 77 m^3
Total Water Volume	1,084	adapted 1,080 m^3

5) Soil conditions

According to the soil test results, soil surface of the proposed reservoir construction site is clay and coarse sand and supporting layer is located at around 7 m below the ground surface level (elevation = +77 m).

As proposed reservoir bottom was set by +67.0 m, direct foundation was adopted as foundation structure. Basement level was set by +68 m and design high water level was set by +72 m. As design high water level of the existing Gandara reservoir is +30.53 m, water stored in Diyagaha reservoir can be sent there by gravity.

(7) Distribution pipeline (Diyagaha service area)

Target service area is Diyagaha area. Diyagaha reservoir was planned in the elevated land located in the center and water is distributed by gravity. Distribution pipelines were planned only within Diyagaha area and east Diyagaha area, the proposed future expansion area, was not included.

As to east Diyagaha area, further study is necessary to confirm the construction site of the proposed elevated tank and to prepare the distribution pipeline development plan. However, residents in east Daiagaha are strongly requesting the water supply system development and NWSDB is also insisting the system development in this area by their own fund. To cope with this future system development, some branches were planned in transmission pipeline.

Proposed distribution pipelines with total length of 32 km are trunk pipelines and small branch pipelines are not included. Diameter of these pipelines were determined based on the water demand in 2021 due to the following reasons:
(If pipelines were planned based on the water demand in 2009, additional pipeline shall be installed later)

- Some routes are too narrow to install the additional pipeline
- At routes near to Diyagaha reservoir, additional pipe diameters are large and installation of additional DCIP pipeline is uneconomical
- NWSDB must conduct the installation works of these additional pipelines

By future installation of small branch pipelines by NWSDB, water demand and water charge will be increased. This enables stable management of water supply system. Some branches were planned in distribution pipelines for these future small branch pipelines.

42 stand posts were planned along with the proposed distribution pipelines and their detailed location will be confirmed at Detailed Design Stage. As to O&M and water charge collection for stand post, possibility of residents' participation shall be examined. Basic design policies on water distribution pipelines are as follows:

1) Major distribution pipeline routes were determined based on NWSDB's request and confirmed by field survey and discussions. In this study, areas where can be gravity served by Diyagaha reservoir were regarded as service area. Elevated areas need booster pumps were excluded from the scope of work.
2) Pipelines located near to Kekanadura area where future development of residential area and commercial area is anticipated, pipe diameter was estimated as 250 to 400 mm accounting future water demand increase.
3) In this study, only trunk distribution pipelines were designed but 53 branches were planned for future branch pipeline development by NWSDB.
4) The minimum water pressure was set by 10 m. However, in case of elevated land where said minimum water pressure cannot be obtained, 7 m is allowable to attain direct service to 1st floor.
5) The following pipe materials were introduced:
    - D>250 mm : Ductile Cast Iron Pipe

- D<225 mm : Poly Chrolide Vinyl Pipe

6) The minimum diameter was set by 50 mm (outer diameter)
7) Sluice valve, air valve, blow off pipe, siphon and water pipe bridge will be installed as required

2-2-2-3 Scope of Work

(1) Intake Facility

Name of Facility	Dimension and Specifications	Quantity	Remarks
Inlet Channel (Grit Chamber)	2.20 mW	1 set	Removal grain size : 0.10 mm Flow velocity : 7.9 cm/sec Surface load : 237 mm/min
Transmission Pump	Dia. 250 mm x 124 L/s x 59 m x 110 kW	4 units	Replacement, 1 unit stand by
Generator	375 kVA	1 unit	Replacement, 50% of actual load
Electric Equipment		1 set	Replacement

(2) Raw Water Transmission Pipeline

Name of Facility	Dimension and Specifications	Quantity	Remarks
Raw Water Transmission Pipeline	DIP 600 mm x 3,000 mL	3,000 m	
Water Pipe Bridge		2 units	

(3) Water Treatment Plant

Name of Facility	Dimension and Specifications	Quantity	Remarks
Receiving Well/Distribution Chamber	5.70 mW x 5.15 mL x 4.15 mH	1 unit	
Aeration Tank	10.00 mW x 3.70 mL	1 unit	
Clarifier	10.00 mW x 10.00 mL	3 units	Sedimentation Time = 2.5 hr
Rapid Sand Filter	6.00 mW x 5.88 mL x 5.00 mH	4 units	Filtration Rate = 106 m/day
Clear Water Reservoir	6.80 mW x 10.6 mL x 4.54 mH	2 units	Retention Time = 1 hr With Transmission P/S
Chemical Building	10.00 mWw x 36.35 mL x 3.95 mH	1 unit	Additional
Wastewater Treatment Tank	6.00 mW x 30.00 mL x 3.05 mH	3 units	Retention Day = 1 day
Transmission Pump			Including 1 unit of stand by
Generator		1 unit	50% of pump load
In-plant Piping		1 set	
Electric Equipment		1 unit	

(4) Treated Water Transmission Pipeline

Name of Facility	Dimension and Specifications	Quantity	Remarks
Treated Water Transmission Pipeline	DI 450 mm	14,007 m	
	DI 400 mm	6,750 m	
	DI 350 mm	20 m	
	DI 200 mm	530 m	

(5) Reservoirs

Name of Facility	Dimension and Specifications	Quantity	Remarks
Ground Reservoir	13.30 mW x 10.40 mL x 4.50 mD	1 unit	
Site Piping		1 set	

(6) Diyagaha Distribution Pipelines

Name of Facility	Dimension and Specifications	Quantity	Remarks
Distribution Pipeline	DIP 400	100 m	
	DIP 300	1,523 m	
	DIP 250	3,687 m	
	PVC 225 (198)	2,411 m	
	PVC 140 (123)	3.916 m	
	PVC 110 (97)	3,134 m	
	PVC 90 (79)	5,410 m	
	PVC 75 (65)	1,996 m	
	PVC 50 (44)	1,453 m	
Stand Post		42 unit	21,448/(130 HH x 4.1) = 42

DIP : Ductile Iron Pipe PVC : Polyvinyl Chloride Pipe
Note 1) Figures in ( ) mean Nominal Diameter
Note 2) 21,448 : served population in Diyagaha Area in 2005

2-2-2-4 Equipment Procurement Plan

Major equipment to be procured in this project are as listed below:

(1) Mechanical/Electrical Equipment for Kadduwa Intake

Name of Facility	Dimension and Specifications	Quantity	Remarks
Intake Pump	Vertical Mixed Flow Pump (2 story type) ϕ250 × 124 L/s × 59 m × 110 kW	4 units	
Water Hammer Measure		1 set	
Valves		1 set	
Pipes		1 set	
Power Transformer	33kV/415V 500kVA	1 unit	Oil sealed, Outdoor type
Power Receiving Panel	415V MCCB 800AF	1 unit	Indoor self standing type
Low Voltage Distribution Panel	415V	1 unit	Indoor self standing type
Emergency Generator	415V 375kVA Diesel	1 unit	Indoor type
Intake Pump Panel	415V 110kW Auto-transformer Starter	4 units	Indoor self standing type
Intake Flow Meter	Electromagnetic type, ϕ400	1 unit	

(2) Mechanical/Electrical Equipment for Malimbada WTP

Name of Facility	Dimension and Specifications	Quantity	Remarks
Movable Weir No.1	W 2,000 x ST 500	1 unit	
Movable Weir No.2	W 1,000 x ST 500	1 unit	
Sand Filter	26.4 m^2	4 units	
Transmission Pump	φ200×/150×74 L/s × 90 kW	3 units	
Alum Tank	7 m^3, 0.4 kW	2 units	
Lime Tank	5.5 m^3, 0.75 kW	2 units	
Chlorinator	2.0 $kgCl_2$/hr	8 units	
Chlorine Detector		1 set	
Clarifier	W 10×L 10	3 units	
Valves		1 set	
Pipes		1 set	
Power Transformer	33 kV/415V 300 kVA	1 unit	Oil sealed, Outdoor type
Power Receiving Panel	415 V MCCB 600 AF	1 unit	Indoor self standing type
Low Voltage Distribution Panel	415 V	1 unit	Indoor self standing type
Emergency Generator	415 V 300 kVA Diesel	1 unit	Indoor type
Fuel Tank	Copper made, 300 L	1 unit	Outdoor type
Air Backwashing Panel	415V 15kW x2 Star-delta Starter	1 unit	Indoor self standing type
Backwashing Pump Panel	415V 11kW x2 Star-delta Starter	1 unit	Indoor self standing type
Chlorinator Equipment MCC-2	415V	1 set	Indoor self standing MCC type
Chlorinator Pump Panel	415V	1 unit	Indoor wall type
Chlorinator Room Ventilation Fan Panel	415V	1 unit	Indoor wall type
Transmission Pump Panel	415V 110kW Auto-transformer Starter	1 unit	Indoor self standing type
Inlet Flow Meter (Existing)	Electromagnetic Type, φ600	1 unit	
Inlet Flow Meter (Proposed)	Electromagnetic Type, φ400	1 unit	
Transmission Flow Meter (Existing)	Electromagnetic Type, φ300	1 unit	
Transmission Flow Meter (Proposed)	Electromagnetic Type, φ350	1 unit	
Central Control Panel		1 unit	Indoor wall type
Pump Room Control Panel		1 unit	Indoor wall type