CHAPTER 5

PLAN OF PROPOSED WATER SUPPLY SYSTEM

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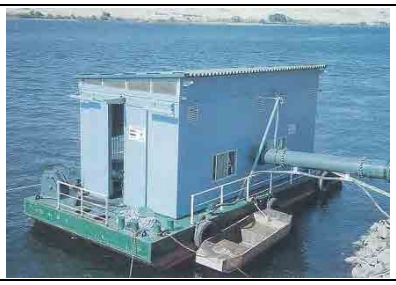
5.1 Water Intake Works

5.1.1 Selection of Water Intake Method

This section reviews the various intake methods such as the intake well, pontoon, rail and canal types in order to decide the most suitable intake method for this Project.

Table 5.1 Comparison of Intake Method

Method	Outline	Image
Intake well	This method is commonly used in lakes and reservoirs. It is an option for vertical intake levels if some intake holes are made on the well's wall. Even if the water level varies significantly a stable intake is expected. Foundation should be stable. The construction cost is higher than other methods if the water depth is large.	
Pontoon	This method is proposed as a tentative facility, if construction on the reservoir is not possible. The pump and electrical panels are installed on a metallic float, which needs to be connected by wire to anchors. The location of the intake can be moved. This method is not suitable if the water level varies significantly. Installation is not difficult and the cost is economical.	
Inclined rail	This method is proposed as a tentative facility, if construction on the reservoir is not possible. A rail is installed on the incline of the bank, and the pump position is moved to suit the water level. Installation is not difficult and the cost is economical.	
Canal Intake	Water is taken from the existing irrigation canal, which is operated by the Irrigation Department. Prerequisite conditions for this type of intake are that approval to its use is required from ID and also that the required quantity of water can be discharged throughout the year. The existing irrigation intake well takes water from the basement sill; therefore water quality has the characteristics of lake bottom water, if the water level is continuously high. Construction cost is economical, but the construction period is limited in out of irrigation season.	

The Irrigation Department, as management entity for the Mahakanadarawa and Wahalkada Reservoirs, considered intake methods for the Project, and decided that only the canal intake method is suitable because of the following reasons.

- The Irrigation Department has experience that the construction of the foundations of intake wells damaged the bank when construction took place in 1986 at the Kantale reservoir. Therefore direct construction on the bank and inside the reservoir is not approved as of now.
- Direct construction on the bank and inside the reservoir will be subject to an EIA Study, which will take time.
- Many farmers, fishermen and persons concerned with environmental organizations are anxious about the new intake well, because of the perception that an excessive amount of water will be drawn out, thus affecting these stakeholders.

The locations of the intake at the canal in Mahakanadarawa and Wahalkada tanks are selected in conjunction with the Irrigation Department and Water Board, with the distance from the banks of the reservoirs being more than 100m at high water level.

The tentative locations for the intakes are shown in **Figure 5.1** and **Figure 5.2**.

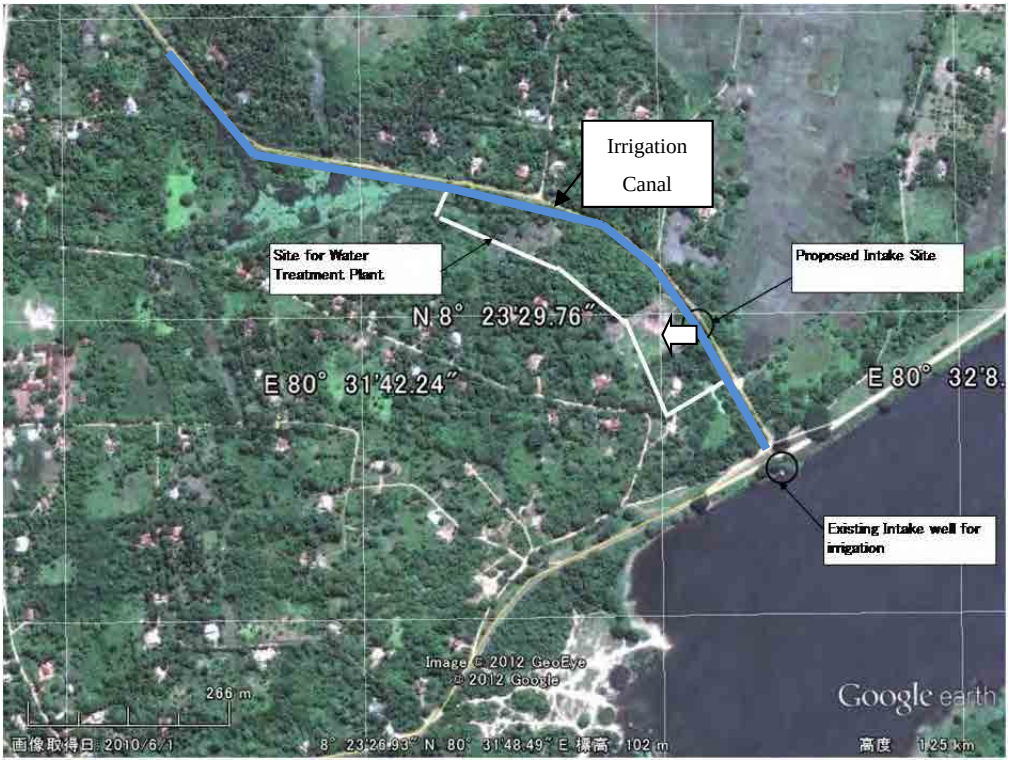


Figure 5.1 Proposed Intake Sites for Mahakanadarawa Wewa

Figure 5.2 Proposed Intake Sites for Wahalkada Wewa

Considerable challenges of this intake method from irrigation canal are as follows.

(a) Aging risk of the facility

Around 50 years have passed after construction of Mahakanadarawa Wewa, and approximately 40 years for the Wahalakda Wewa.

Information of the aged reservoirs is available in the home page of "Dam Safety and Water Resources Planning Project (DSWRPP)" under the Ministry of Irrigation and Water Resources Management. The following 32 dams in **Table 5.2** are designated to be rehabilitated by responsible organization.

Table 5.2 Dams Designated to Be Rehabilitated

Organization	Dam
Department of Irrigation	1) Parakrama Samudraya, 2) Minneriya Wewa, 3) Girithale Wewa, 4) Kawudulla Wewa, 5) Vendrasan Wewa, 6) Kanthale Wewa, 7) Nachchaduwa Wewa, 8) Nuwara Wewa, 9) Thissa Wewa, 10) Rajanganaya Reservoir, 11) Usgala-Siyambalangamuwa, 12) Hurulu Wewa, 13) Inginimitiya Reservoir, 14) Ridiyagama Reservoir, 15) Thabbowa Reservoir, 16) Nalanda Reservoir
Mahaweli Authority	1) Bowathenna Reservoir, 2) Polgolla Diversion, 3) Victoria Reservoir, 4) Randenigala Reservoir, 5) Rantambe Reservoir, 6) Kothmale Reservoir, 7) Kala Wewa, 8) Kandalama Reservoir, 9) Dambulu Oya Reservoir, 10) Maduru Oya Reservoir, 11) Chandrika Wewa
Ceylon Electricity Board	1) Canyon, 2) Castlereigh, 3) Lakshapana, 4) Norton
NWSDB	1) Kalatuwawa

Source : http://www.damsafety.lk/Information/List_of_dams.html

Mahakanadarawa Wewa and Wahalkada Wewa are not listed in **Table 5.2**. However, the condition of its concrete structure and mechanical devices has been observed to have significantly aged. There is possibility that the existing intake wells and installed mechanical devices at the gate may break, and if repairs are not undertaken promptly, then drinking water supply may be disrupted.
Therefore, it is recommended that NWSDB make equipment like submersible water pump and generator available in case of emergency.

(b) Measurement, Record and Control of intake discharge

Water released for irrigation use from Mahakanadarawa Wewa and Wahalkada Wewa is controlled by the operators of Irrigation Department. This is performed using the sluice gate of the intake well, and discharge volume is measured by gate's opening and reservoir's water level.
In the case of the Wahalkada scheme, a Parshall flume is installed near the small bridge to the temple. The Padaviya Irrigation Engineer's Office said the discharge is examined with this device.

Drinking water will be supplied based on the agreement between Irrigation Department and NWSDB. A Memorandum of Understanding (MOU) for extracting water from Mahakanadarawa Wewa and Wahalkada Wewa for the Anuradhapura North Water Supply Scheme is in Article 3 shown in **Table 5.3**.

Table 5.3 Memorandum for Extracting Water

Year	2016	2034	Remarks
Mahakanadarawa	6,700 m3/day	18,800 m3/day	Amount in 2016 will be after completion of WTP Amount in long term plan will be after completion of Upper Elahara Canal Project
Wahalkada	10,500 m3/day	28,800 m3/day	

In case of periods of exceptional water scarcity, Article 9 mentions that the Irrigation Department, Irrigation Management Division, NWSDB, Divisional Secretary, Member of Project Management Committee (established under the Irrigation Ordinance and chaired by the District Secretary) will hold a meeting and decide on water allocation rights.

In conducting water management of the reservoirs with Irrigation Department, the measurement and record of the discharge and sharing of information and control of discharge issues should be considered.

1) Measurement and record of the discharge and sharing of information
Water resource management of both reservoirs with Irrigation Department should be established

under a reliable relationship, thus it is recommended that accurate measurement of discharge should be made and information sharing between agencies be maintained regularly and/or periodically.

Figure 5.3 shows image of the canal intake in Mahakanadarawa Wewa.

For the irrigation canal, there is turn out device to the irrigation area in east side. Therefore, intake for drinking water will be down stream from this point.

The condition of distribution should be clarified, and this entails the measurement of discharges of the following – the main canal at Q1, the branch canal at Q2, and the intake discharge for drinking Q3. In addition, feedback on this data should be provided to the operators of intake well and WTP.

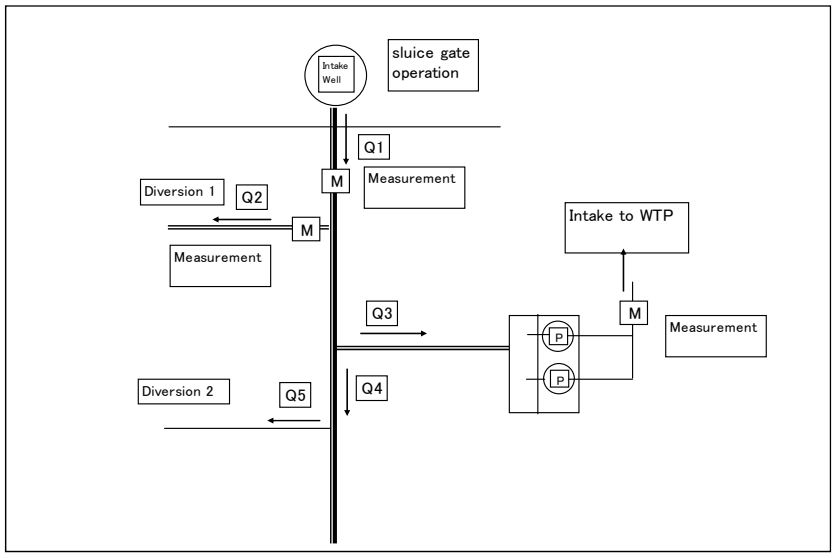


Figure 5.3 Schematic View of Intake Well for Mahakanadarawa WTP

Figure 5.4 shows image of the canal intake in Wahalkada Wewa, which has a measurement device near the small bridge to the Temple. This Parshall flume has a standard size and the width of its throat section is 10'. The limitation of minimum and maximum discharge are as follows.

- Max. discharge: 5.67 m^3/sec
- Min. discharge: 0.17 m^3/sec

By 2016, the water supply for drinking will be 0.12 (m3/sec) and the measuring device is not suitable for such a small dsichage. However, the required discharge for water supply will increase yearly,

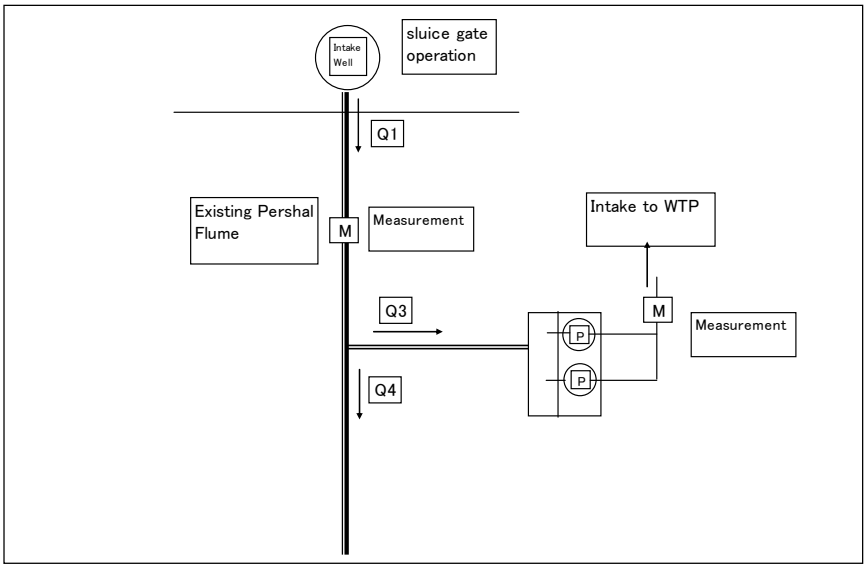


Figure 5.4 Schematic View of Intake well for Wahalkada WTP

2) Control of discharge

The release of water for irrigation from the reservoirs is controlled by the operators of Irrigation Department. The required water is estimated by the gate's opening and reservoir's water level, and adjustments are made on the sluice gate of the intake well.

It is expected that discharge volume for drinking water supply will not be controlled considering that requirements are minimal compared to that required for irrigation water, especially during the no-irrigation periods. **Table 5.4** shows discharge in cubic meter per second. Discharge water for drinking in 2016 is only 3-6% of that discharged for irrigation.

Table 5.4 Discharge for Irrigation and Drinking Water in 2016-2034

(unit : m^3/sec)

Scheme	2016	2024	2034	Irrigation
Mahakanadarawa	0.08	0.11	0.22	0.3～3.0
Wahalkada	0.12	0.16	0.33	1.0～2.0

During periods when irrigation is required, the canal discharge will be composed of irrigation water and drinking water, and it may be necessary to partially allocate water for these two uses. However, in the no irrigation period, the small volume of drinking water may be allowed to flow in the canal.

The following are three studies that can be considered as countermeasures.

Case 1: To install a concrete box connected with pipes and control valves

A concrete box will be installed at the end of sluice and pipes will be connected to the irrigation canal

and to the water treatment plant. Stop Valve for the irrigation canal is closed, and control valve for drinking water is used during the no-irrigation period. However, this location is in the Sanctuary Zone, therefore this construction is likely to be prohibited.

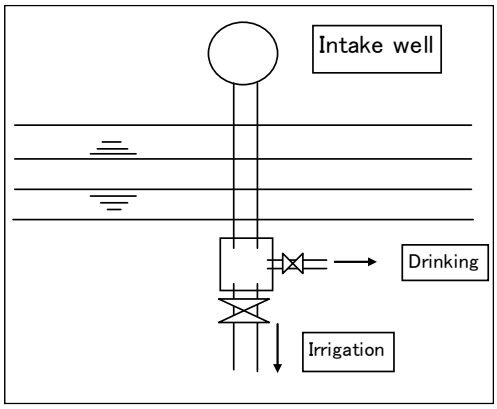


Figure 5.5 Sketch of Solution of Canal Intake (Case 1)

Case 2: To install a control gate in the irrigation canal and use as a buffer tank
In this case, a control gate is installed downstream of the intake diversion to the water treatment plant. In order to arrange difference of discharge between drinking water and released water from the intake well, the irrigation canal shall be used as a buffer tank by the gate to control water level.

If water level is 50cm, and location of weir is 100m from end of sluice, buffer volume can be around 150m3. In this case, the sluice gate at the intake well will require time-controlled operations.

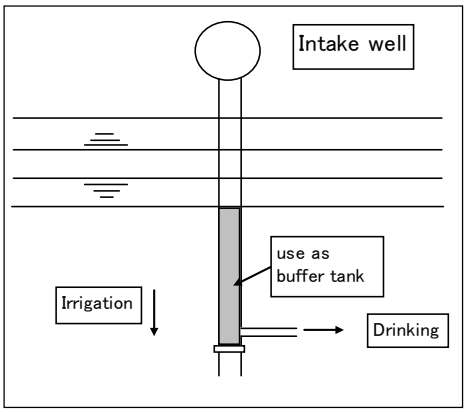


Figure 5.6 Sketch of Solution of Canal Intake (Case 2)

Case 3: Release water from the intake well with a little higher amount than the designed discharge, and remaining water is reverted back to the irrigation canal.

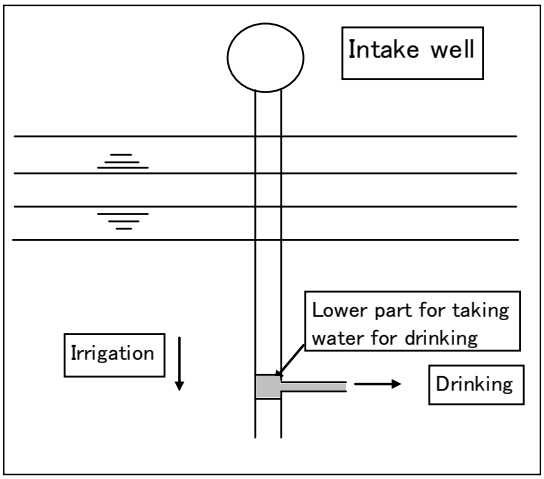


Figure 5.7 Sketch of Solution of Canal Intake (Case 3)

On the other hand, following conditions shall be considered before installing any structure in the canal.

- Length of the irrigation canal from the intake well to the terminal irrigation area is around 15-20km in Mahakanadarawa and Wahalkada Irrigation Schemes. Basically, an intake structure can be minimized to avoid any influence on the canal flow.

- Discharge for drinking water is much smaller than for irrigation, and intake pump is planned to transmit such water to the water treatment plant. The level of the pump intake pit can be installed much lower, meaning, it is not required to maintain the same intake level in the irrigation canal. Therefore, the use of a control gate at the irrigation canal may no longer be required because of the level control for intake.

After analyzing the three cases, Case 3 is chosen to be employed for the design. This design should, however, be reviewed with the Irrigation Department, and the Operational Organization of the Reservoir. Before finalization, it is necessary to re-check the discharge control accuracy of the intake well.

5.1.2 Design Criteria

Design criteria for the intake work are as follows.

(1) The location of the intake facility is more than 100m from high water level.
(2) Design discharge between the sluice and intake for drinking water is the total amount of maximum irrigation water supply and daily maximum of drinking water in 2034.
(3) Mahakanadarawa irrigation scheme has two irrigation canals, i.e., the right bank canal and the left bank canal. Topographic condition of intake in the reservoir is reviewed with reservoir's planning map transferred from the Irrigation Department. Surrounding area of the left bank

intake well is deep, i.e., it is considered to keep enough depth to take water even in dry season. However, the area of the right bank well is relatively shallow, i.e., there is a risk that intake water will decrease in dry season. Finally, the left bank side was selected for the location of the intake facility for drinking water.

(4) The timing of and quantity of discharge of irrigation water supply varies in the Yala and Maha period. Canal discharge is assumed as follows.

- No irrigation period: Discharge for drinking water
- Irrigation period: Discharge for drinking water and irrigation water

5.1.3 Outline of Water Intake Facilities

(1) Mahakanadarawa Intake

Information of the irrigation scheme from Irrigation Department is as follows.

Table 5.5 General Features of Canal (Case: Concrete Lining for Trapezoid)

Item	RB	LB
Q(m^3/sec)	2.83	3.40
FSD(m)	1.22	1.10
FB(m)	0.91	0.91
BW(m)	1.83	3.05
Length(km)	17.18	20.92

Source: Irrigation Department

Table 5.6 Record of Maximum and Minimum Canal Discharge

Year	Max. Discharge (m^3/sec)	Min. Discharge (m^3/sec)
2010	2.51	0.08
2011	3.03	0.21

Source: Irrigation Department

The shape of the canal at the proposed intake point is rectangular, with the canal having a concrete lining. The following design criteria are applied, based on the calculation using Manning's Formula (Calculation sheet is attached in **Appendix 5.1(a)**).

Max. irrigation discharge:	3.4 m^3/sec
Max. intake discharge for drinking water:	0.22 m^3/sec（18,800 m^3/day in 2034）
Canal discharge in irrigation period:	0.62～3.62 m^3/sec
Width of existing irrigation canal at intake point:	3.5 m
Height of existing canal:	2.2 m
Max. water depth in canal:	1.45 m
	(1.70 m is observed water mark in the site)

Water depth just for drinking water in 2034: 0.22 m
Design height of lower portion of the canal: 0.30 m
Max. water level for irrigation and drinking water: 1.51 m

Figure 5.8 shows outline of intake facility.

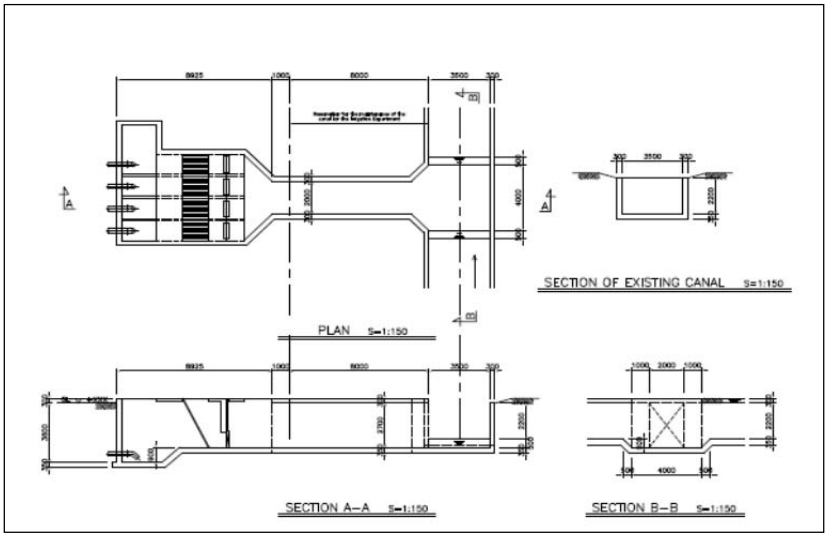


Figure 5.8 Outline of Intake Facility in Mahakanadarawa Wewa

(2) Wahalkada Intake

Information of the irrigation scheme from Irrigation Department is as follows.

Table 5.7 General Features of Canal (Case: Concrete Lining for Trapezoidal)

Item	Dimension
Q(m^3/sec)	1.56
FSD(m)	0.76
FB(m)	0.74
BW(m)	3.05

Table 5.8 Record of Maximum and Minimum Canal Discharge

Year	Max. Discharge (m^3/sec)	Min. Discharge (m^3/sec)
2009	2.0	1.01
2010	2.0	0.87
2011	2.0	0.36

Source: Irrigation Department

The shape of the canal at the proposed intake point is trapezoidal with slopes of 1:1, but it does not have a lining. The following design criteria are applied based on the calculation using

Manning's Formula (Calculation sheet is attached in **Appendix 5.1(b)**).

Max. irrigation discharge: 2.0 m^3/sec
Max. intake discharge for drinking water: 0.34 m^3/sec（28,800 m^3/day in 2034）
Canal discharge in irrigation period: 0.70～2.34 m^3/sec
Width of existing irrigation canal at intake point: 4.5m
Height of existing canal: 2.1m
Max. irrigation water depth in canal: 0.91m
Water depth just for drinking water in 2034: 0.32m
Design height of lower portion of the canal: 0.40m
Max. water level for irrigation and drinking water: 1.00m

Figure 5. 9 shows outline of intake facility.

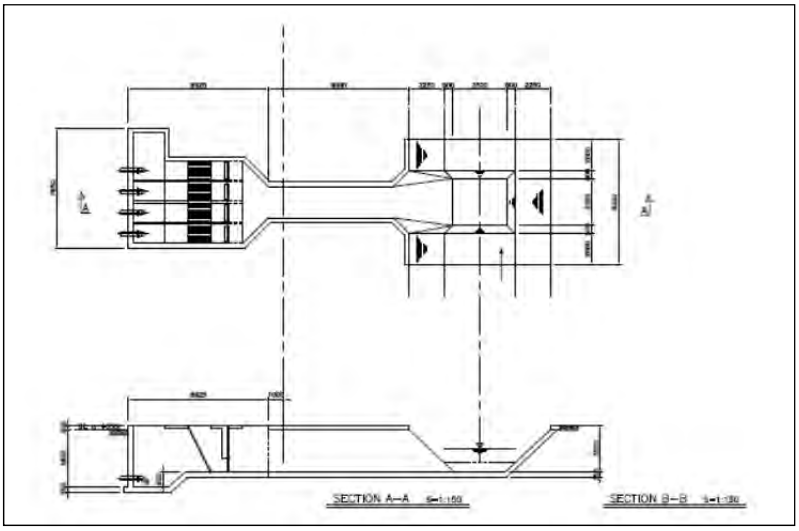


Figure 5.9 Outline of Intake Facility in Wahalkada Wewa

5.2 Water Treatment Plant

5.2.1 Stage Construction of water treatment Plants

Since the water transmission and distribution facilities is constructed with a full design capacity for the year of 2034 due to the difficulty in split construction, the water treatment plant, etc. to which stage construction is applicable, shall be constructed with a capacity for the year of 2024 to reduce an initial investment as much as possible.

The following are the reasons adopting stage construction in this Project:

(1) NWSDB Design Criteria

NWSDB Design Manual (March 1989) describes that "*As a general principle it is recommended that future urban schemes be designed for a 20-year planning horizon in two 10-year stages*". Therefore, it is reasonable to set the target year in 2034 with an interim target year of 2024 for stage construction.

(2) NWSDB Guideline for Rural water Supply

The NWSDB Guidelines suggest the difficulty to increase the population coverage by water supply in the rural area. Although the willingness of the people to connect to the proposed pipe borne water supply system to be operated and maintained by NWSDB seems high due to the high level content of fluoride in groundwater as a water source in the study area, there is a risk to overestimate it.

1) Difficulty to increase the coverage

The change in the number of connections since the commissioning year even at five water supply systems under NWSDB in the study area was very slow. Since the people with high expectation for pipe bore water supply would like to connect to a system as soon as possible, the connection works to a system will have a peak during a few years after the completion of a system and thereafter become slow in general.

2) Alternative water source in rural area

92.8% of the people in the study area have any types of their own water sources (although almost relying on groundwater). Whether the people will connect to a water supply system or not is left to their discretion. There are many cases that the coverage increased less than expected so far. It should be noted that a quarter of the people didn't use a toilet in 2001 and the percentage of the household population below the poverty line was high as 28.2% against the district average of 20.0% in 2002.

3) Selective use of either tap water or groundwater

Even though connected to a water supply system, the people may use either of groundwater or tap water selectively by use, that is to say, a coverage ratio will increase, but water demand will not increase so much. Therefore, it is advisable to watch the change of actual water demand carefully but not the apparent coverage ratio.

According the Census 2011, the major drinking water source survey reveals that 75.4% of the people in the study area rely on groundwater from dug well (72.6%) and tube well (2.8%), respectively, 18.9% on tap water and remaining 5.7% on others such as bowser, bottled water, river, etc. According to the existing CBO water supply facility survey in **Section 3.3.1**, the population coverage by water supply is approximately 27% including those under NWSDB. It may suggest that some customers doesn't regard tap water as the main drinking water source in spite of the connection to a water supply system.

4) Long-term pipe installation work

Even though the pipe borne water supply is applied to GNDs, it will take a long time to attain the full population coverage, since a population density of 100 persons per km^2 means that a

housing unit (HU) is located every 100 m to 400 m, assuming that it is occupied by 4 persons on average as shown in **Figure 5.1**.

100 persons/km^2 = 1 person/ha = 4 persons/4 ha = 1 HU/4 ha

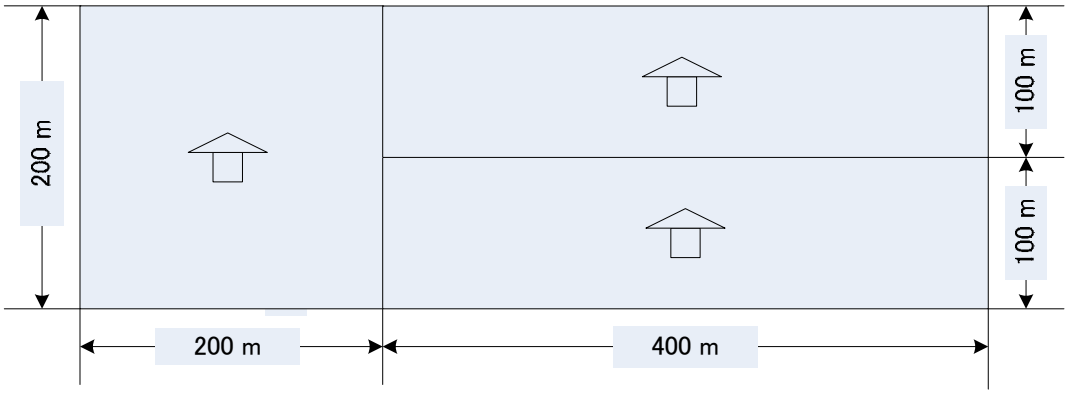


Figure 5.10 Situation of Housing Unit Distribution

(3) Waste in full construction

If the equipment is installed in full construction but not in stage construction, a variety of waste will occur. Some extent of water demand will be maintained through the connection of existing NWSDB and CBO water supply schemes to a new system but thereafter the water supply amount will rely on the growth in the number of connections and per capita water consumption. However, since there is no occurrence of such situation that the water demand will at once reach to a design capacity, the equipment once installed will be unavoidably idle and the following situations will occur.

- The service life of mechanical and electrical equipment is generally ten to fifteen years. It is counted from the time installed and wasted.
- Once the equipment is installed, it is required to operate it in the rotation programme even though the water supply amount is less, which makes plant operation complicated. Since the deterioration occurs leaving it without any maintenance after operation, cleaning and inspection of such equipment are also necessary.
- The replacement of equipment will be concentrated in specific years which will be a big financial burden.

(4) Deterioration of FIRR

In case of full construction of a water treatment plant, it is possible to reduce the price of materials used for the construction work through a mass order, cut the expenses by shortening the overall construction period, and to finally reduce the construction cost as a whole. However, by full construction, an initial investment will increase and some mechanical and electrical equipment will be installed earlier than scheduled resulting in their earlier replacement. Here assuming that the total construction cost will be reduced by 10%, the comparative study of FIRR is done between the stage construction and full construction. As there will be no increase in water demand

and revenue even though the full construction will be adopted, and the increase in an initial investment, FIRR will be worsened as shown in **Table 5.9**.

Table 5.9 FIRR Comparison between Stage and Full Constructions

(1) Stage Construction

Year	Investment	Revenues	Expenditures	Cash flow
2012	0.0			0
2013	82.2			-82.2
2014	437.5			-437.5
2015	1,093.1			-1,093
2016	3,508.7			-3,509
2017	3,641.5			-3,642
2018	960.1	56	34	-938.1
2019	14.9	78	46	17.1
2020		82	48	34
2021		86	49	37
2022		90	51	39
2023		94	53	41
2024	786.5	98	54	-742.5
2025		108	66	42
2026		117	71	46
2027		127	76	51
2028		137	80	57
2029		147	85	62
2030		157	90	67
2031		167	95	72
2032		177	100	77
2033		187	104	83
2034		197	109	88
2035		207	114	93
2036		217	119	98
2037		227	124	103
2038		237	128	109
2039	-4,674	247	133	4,788
FIRR				-2.65%

(2) Full Construction (10% Reduction)

Year	Investment	Revenues	Expenditures	Cash flow
2012	0.0			0
2013	81.8			-81.8
2014	437.2			-437.2
2015	1,126.9			-1,127
2016	3,645.1			-3,645
2017	3,777.9			-3,778
2018	994.0	56	34	-972
2019	14.6	78	46	17.4
2020		82	48	34
2021		86	49	37
2022		90	51	39
2023		94	53	41
2024		98	54	44
2025		108	66	42
2026		117	71	46
2027		127	76	51
2028		137	80	57
2029		147	85	62
2030		157	90	67
2031		167	95	72
2032		177	100	77
2033	786.5	187	104	-703.5
2034		197	109	88
2035		207	114	93
2036		217	119	98
2037		227	124	103
2038		237	128	109
2039	-4,950	247	133	5,064
FIRR				-2.69%

(5) Progress of irrigation projects

According to the plan, the NCP Canal and Yan Oya Reservoir projects that supplement the water supply condition of Mahakanadarawa and Wahalkada Tanks will be completed around the time that new water supply systems will be completed. However, these projects have not yet started and the completion time of them has not been assured. In addition, the possibility that the delay and/or suspension of their construction works will occur, should be taken into account. Since the farmers' association will never allow to use water with more than the amount admitted as the water right for drinking water supply, as long as the proposed irrigation projects will not be completed, there is a high risk to construct a water treatment plant at once with a full design capacity for the year of 2034.

5.2.2 Selection of Water Treatment Process

(1) Existing WTPs

1) Capacity, Water Source and Treatment Processes of Existing WTPs

There are three existing WTPs in Anuradhapura City, with the water source for all the WTPs being irrigation tanks. The water treatment process of the WTPs consists of coagulation, flocculation, sedimentation and rapid sand filtration. The capacity and water source of the WTPs are shown in **Table 5.10**.

Table 5.10 Existing WTPs in Anuradhapura

WTP	Capacity (m^3/d)	Source
New Town	13,500	Nuwara Tank
Sacred City	4,500	Thissa Tank
Thuruwila	21,000	Thuruwila Tank

2) Raw water quality

The raw water quality of each of the existing WTPs, which is shown in **Appendix 5.2(a)**, is similar. Turbidity and color tend to increase slightly at the beginning of the rainy season, but these do not fluctuate significantly throughout the year. The pH is comparatively high, nearly 8.0 on average and 8.5 as a maximum.

3) Odor in the supply water

In May 2012, muddy odor from tap water was detected in one of the water-supplied areas. In other areas, the similar odor was not detected. With respect to the areas that have odor problems previously, Thuruwila WTP may be the cause of the odor problem since the area with odor problems are located in the area served by Thunuwila WTP. It has been observed that as the water level in the tank is reduced, the odor problem starts to show up in other water supply areas too, where the water is supplied from other WTPs. This problem usually continues until the beginning of rain season, starting from the middle of October.

(2) Proposed WTPs

1) Raw water quality

The water quality of Mahakanadarawa and Wahalkada irrigation tanks is shown in **Table 5.11** and **Table 5.12**. Both irrigation tanks will be the water source for the proposed WTPs in the project. Turbidity and color in both water sources are low, but the pH is high and similar to that in the water sources of the existing WTPs.

Table 5.11 Water Quality of Wahalkada Tank

	Date	Water Temperature (℃)	Dissolved Oxygen [1)] (mg/L)	pH	Turbidity (degree)	Color (degree)	Odor
Surface water	17/05/2012	30.1	8.3	8.89	12.4	26.5	None
Bottom water	Ditto	30.0	7.2	-	-	-	ditto

1) Saturated concentration of dissolved Oxygen is 7.53mg/L at water temperature 30-degree Centigrade
2) The measuring instruments for turbidity and color manufactured by Kyouritsu Rikagakukenkyusyosei Corporation are used. To measure color, turbidity is not removed prior. Therefore, color is different from true color. This condition also applies to Section 5.2.

Table 5.12 Water Quality of Mahakanadarawa Tank

	Date	Water Temperature (℃)	Dissolved Oxygen [1)] (mg/L)	pH	Turbidity (degree)	Color (degree)	Odor
Surface water	15/05/2012	29.4	7.2	8.46	7.3	22.5	None
Bottom water	ditto	29.3	6.2	8.36	10.9	31	ditto

[1)] Saturated concentration of dissolved Oxygen is 7.53mg/L at water temperature 30-degree Centigrade

July 4th, 2012: Wahalkada Tank water has muddy or musty odor.
July 8th, 2012: Mahakanadarawa Tank water does not have odor.
July 17th, 2012: Thuruwila Tank water has strong muddy odor.
July25th, 2012: Wahalkada Tank water does not have odor.
July 28th, 2012: Wahalkada Tank water does not have odor.

2) Jar Test (Coagulation Test)

Jar tests were performed on Mahakanadarawa Tank water. The results of the jar tests are shown in the following pictures and table.

A dosage rate of aluminum sulfate of 40mg/L or higher resulted in developing large floc and clear water. The turbidity and color both decreased as the aluminum sulfate dose rate increased. The optimum coagulant dose is determined to be 60mg/L as turbidity and color is low enough and the formed floc settled down quickly. The quality of Wahalkada Tank water is similar to Mahakanadarawa water so the results of the jar test can be applied to Wahalkada water.

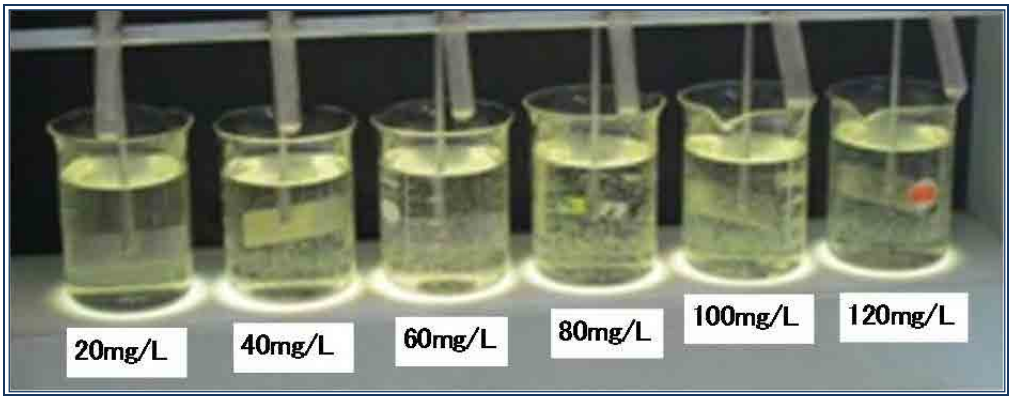


Figure 5.11 Jar Test under Stirring

Table 5.13 Results of the Jar Tests (Surface Water of Mahakanadarawa Tank)

Parameter	Raw water	Aluminum sulfate dosage rate (mg/L)					
		20	40	60	80	100	120
pH	8.46	7.83	7.44	7.37	7.13	6.93	6.8
Turbidity (degree)	7.3	4.9	2.6	1.3	0.5	0.1	0.0
Color (degree)	22.5	16.0	9.5	7.0	4.5	3.0	2.0

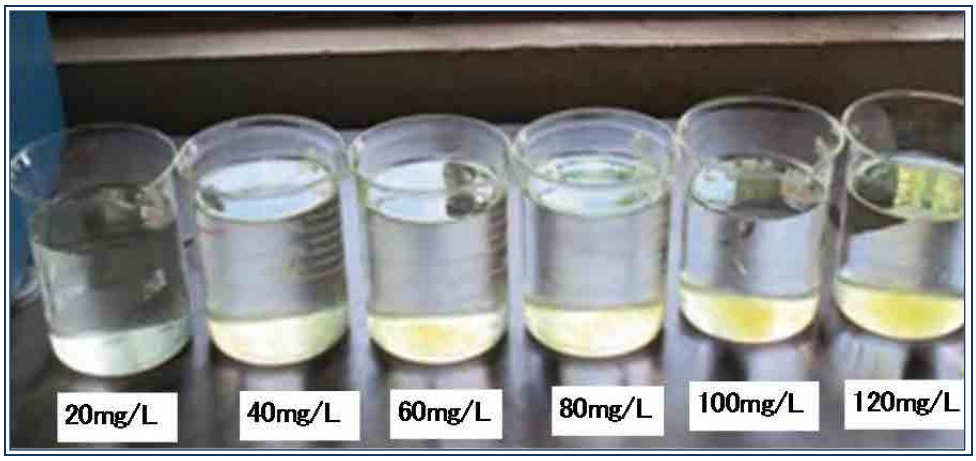


Figure 5.12 Results of the Jar Tests

3) The amount of sludge and sludge treatment

Since the pH in the raw water is high, more aluminum sulfate is required to form large floc and achieve good coagulation. This results increase in sludge production.

<Example>

When the turbidity of the raw water is 10 degrees, 60mg/L of aluminum sulfate is required for coagulation. The ratio of the aluminum sulfate sludge to the turbidity sludge is 1.5 to 1.0, which means that aluminum sulfate sludge accounts for 60% of the total sludge.

(3) Selection of the Water Treatment Process

Generally there are two major treatment process alternatives to purify water; rapid sand filter and

slow sand filter (including ecological filter). The rapid sand filter is primarily used where raw water has a high turbidity. Slow sand filters can be used for low turbidity water, as in the case of Mahakanadarawa and Wahalkada waters. This section discusses the best option between rapid sand filter and slow sand filter for the proposed water treatment plants.

1) Odor in supplied water

It is difficult for rapid sand filters to remove odor. The rapid sand filter is currently used in Thuruwila WTP and this plant produces water with muddy smell. Slow sand filters are able to remove or reduce odor. People in the proposed service area of the project are using ground water, which does not smell at all, for their daily water consumption. It is recommended that water with no odor should be supplied to the area, otherwise residents will complain a lot.

The following table shows the tap water quality in the proposed area to be served by the project.

Table 5.14 Tap Water Quality in Proposed Served Area

Location	Odor	pH	Turbidity (degree)	Color (degree)	Fluoride (mg/L)
1) Kebithigollewa	none	7.34	0.2	0.5	0.64
2) Near Wahalkada Tank	none	6.9	0.2	0.1	0.14
3) Tap water located at between 1) and 2)	none	7.48	0.1	0.0	1.17

2) The production and the treatment of the sludge

Figure 5.13 and **Figure 5.14** show general sludge treatment processes for rapid sand and slow sand filters.

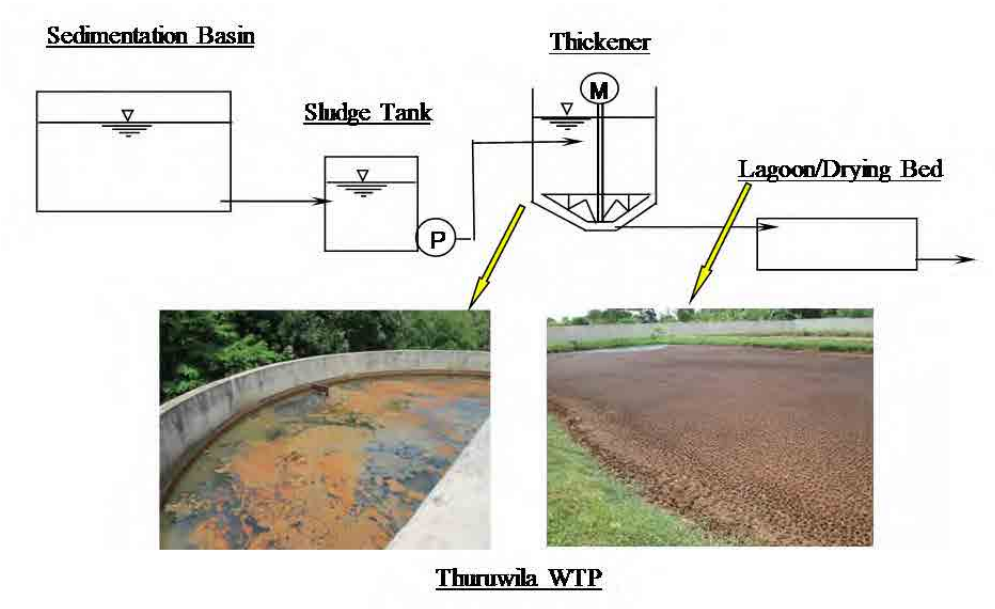


Figure 5.13 Sludge Treatment Process for Rapid Sand Filter

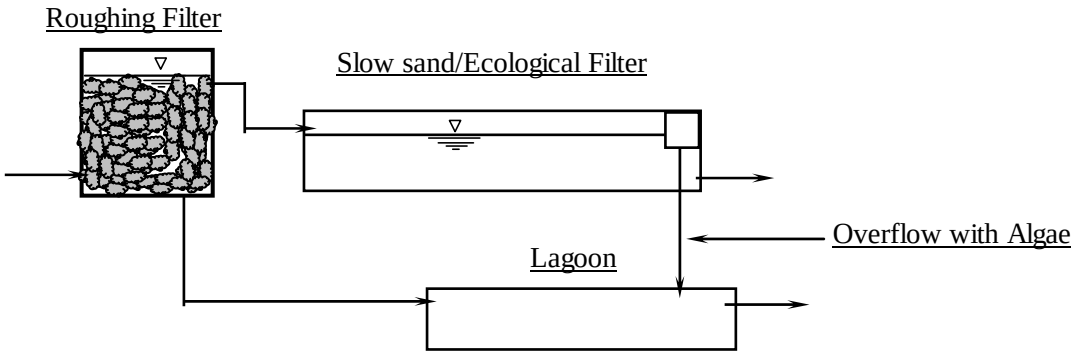


Figure 5.14 Sludge Treatment Process for Slow Sand Filter

The sludge treatment process for rapid sand filters consists of a sludge tank with pumps, a thickener with a mixer and a lagoon or drying beds. On the other hand, slow sand filters need only lagoon treatment. Sludge and backwash waste produced by the rapid sand filter system includes aluminum, as this process uses aluminum sulfate as a coagulant, but the slow sand filter process does not require the addition of aluminum sulfate.

The rapid sand filter system produces twice as much sludge as the slow sand filter system, because of the coagulant that is added to the process. The ratio of the aluminum sulfate sludge to the turbidity sludge is 1.5 to 1.0, as stated previously. Sludge from the slow sand filter system consists of mainly turbidity and small quantities of algae. Furthermore, dried sludge from the slow sand filter can be used as fertilizer for agriculture, while sludge from the rapid sand filter is difficult to use for this purpose.

3) Removal of Fluoride

The rapid sand filter system uses aluminum sulfate and it can remove some of the fluoride that is present in the raw water.

Table 5.15 shows the results of the jar tests, which were carried out to ascertain how much fluoride can be removed by aluminum sulfate at different dosage rates. This shows that the fluoride removal rate was between 15 and 22%.

Table 5.15 Results of the Jar Tests

	Raw water (silt added)	Aluminum sulfate dosage rate (mg/L)					
		20	40	60	80	100	120
pH	7.5	7.48	7.38	7.3	7.19	7.14	7.07
Turbidity (degree)	13.9	0.4	0.0	0.0	0.0	0.0	0.0
Color		0.5	0.5	0.5	1.5	1.5	2.5
Fluoride (mg/L)	1.03	0.81	0.88	0.87	0.86	0.82	0.80
Removability of Fluoride (%)		21	15	16	17	20	22

4) Pilot Plant of the Slow Sand Filter (Including Ecological Filter)

The JICA study team conducted pilot plant tests on the slow sand filter system shown in **Figure 5. 15** and **Table 5.16**.

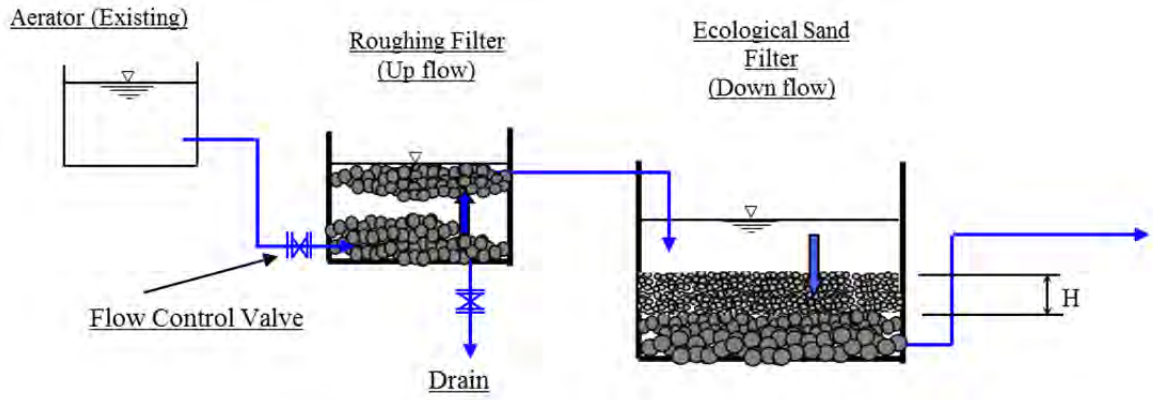


Figure 5.15 Pilot Plant Test Flow Diagram

Table 5.16 Detail of Ecological Sand Filters in the Pilot Plant

No.1	No.2	No.3
Filter speed (Down flow)		
7 – 10m/d	**5m/d**	**5m/d**
Filter media Depth (H)		
15cm	**10cm**	**10cm**
Filter Media Size		
		
Commencement Day of Pilot Plant Operation		
July 3rd	**July 6th**	**July 24th**
***The water source for sand filter No.2 at the beginning was the raw water, not the treated water by the roughing filter. For increase in the filtration head loss, the water source was changed to the treated water by the roughing filter.**		

5) Results of the pilot plant test (Refer to **Appendix 5.2.2** for more details)

a. Comparison of Treated Water Quality in Each Sand Filter Nos: 1, 2 and 3

The following figures show the turbidity and color of the treated water for each sand filter Nos.1, 2 and 3. Based on the results, the turbidity and color of the water in each sand filter was improved. The water quality did not show any progressive improvement and hit equilibrium state 3 to 4 weeks (1 week for sand filter No.3) after the commencement of the pilot plant

operation. In addition, due to deterioration in the raw water quality, the treated water quality was also similarly worsened. The similar results were observed from each sand filter without noticeable difference.

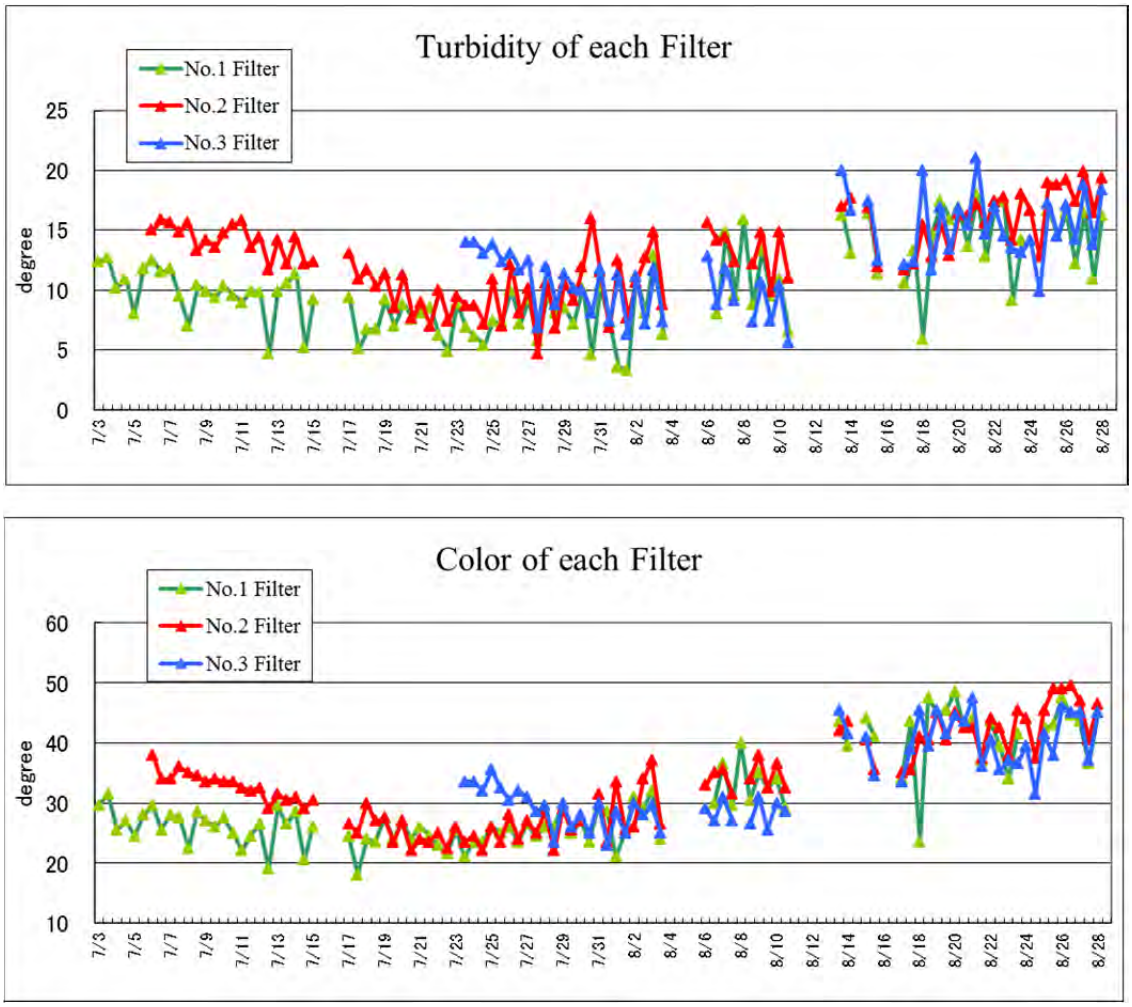


Figure 5.17 Comparison of Treated Water Quality in Each Sand Filter

b. Raw Water and Treated Water Quality

The following table shows the turbidity and color of the raw water and the treated water for each sand filter. Since the turbidity and color of the water source is in high value, the quality of the pilot plant treated water is not good. The removal of turbidity and color of the treated water in comparison with the raw water is 50 to 60 % and 30 to 40% respectively. During the water treatment process, the color removal rate is not good results.

Table 5.17 Raw Water and Treated Water Quality

	No1 filter	No2 filter	No3 filter
Duration of Pilot Plant	Jul.3rd-Aug.28th (57days)	Jul.6th-Aug.28th (54days)	Jul.24th-Aug.28th (36days)
Raw water			
Turbidity Ave.(degree)	26.5	26.8	30.2
Color Ave.(degree)	49.1	49.9	56.1
Roughing filter water			
Turbidity Ave.(degree)	17.5	17.7	20.1
Color Ave.(degree)	39.5	40.2	45.2
Removal Rate Comparing with Raw water			
Turbidity (%)	34	34	33
Color (%)	20	19	19
Filter Water			
Turbidity Ave.(degree)	10.3	12.9	12.6
Color Ave.(degree)	30.6	33.1	34.1
Removal Rate Comparing with Raw Water			
Turbidity (%)	61	52	58
Color (%)	38	34	39
Removal Rate Comparing with Roughing Filter Water			
Turbidity (%)	41	27	37
Color (%)	23	18	25

c. Comparison of Color

The colors of raw water and the treated water were compared as shown in the pictures below:

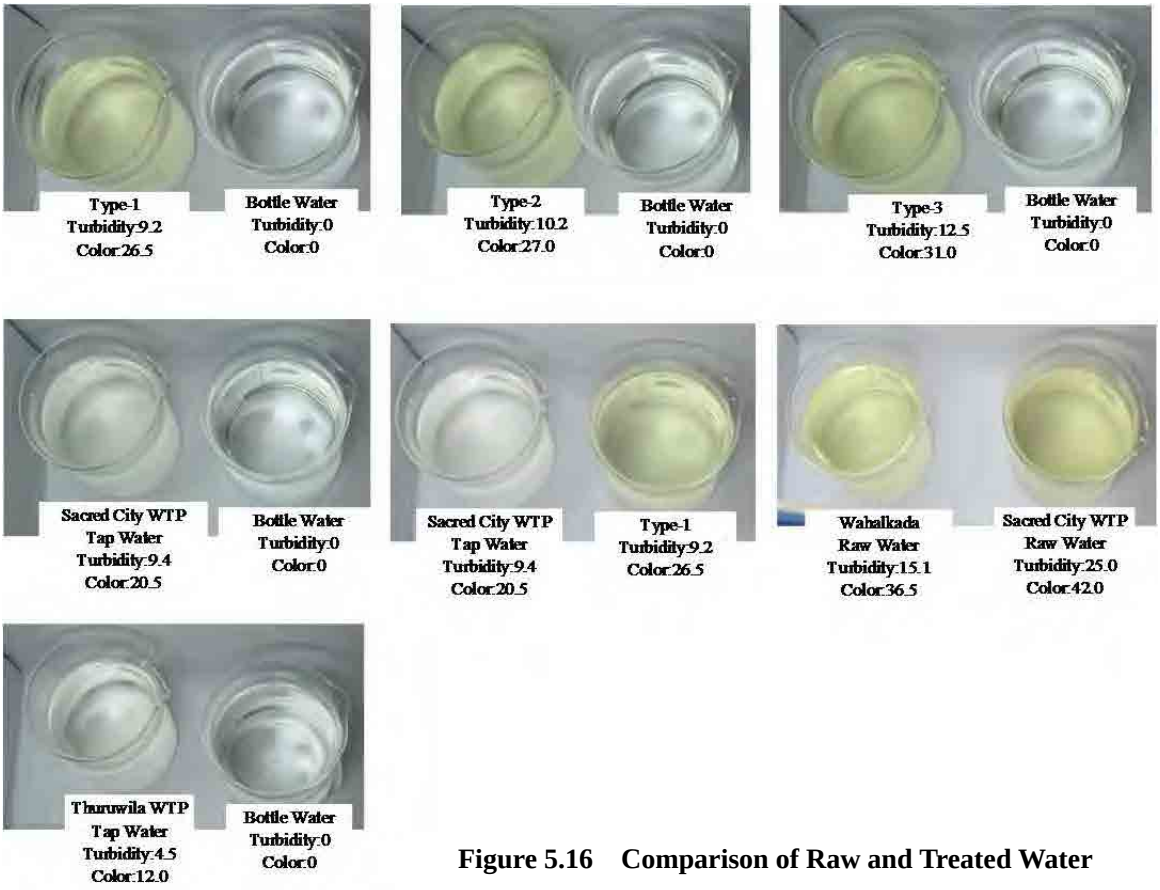


Figure 5.16 Comparison of Raw and Treated Water

The treated water in the pilot plant was compared with the treated water from the Sacred City

WTP and Thuruwila WTP where water was treated using rapid sand filter system, the treated water from the pilot plant was much more yellowish green color. Since the water in Wahalkada Tank, which is one of the project water sources, in comparison with the water in Thissa Tank, which is water source for Sacred City WTP, had the similar color of yellowish green. Therefore with the result of the pilot plan, the implementation of slow sand system will not improve the color of the water in the Wahalkada Tank. In addition, the removal rate of the turbidity in pilot plant is worse than that in Thuruwila WTP. The turbidity of the treated water in Sacred City WTP is higher due to the treatment process was not functioned properly since the facilities have been aged and the filter sand was contaminated by over used. Near the end of the pilot plant operation, the existing sand filter was started to be replaced with new.

6) Selection of the water treatment process

There are two major treatment processes to select: slow sand filters and rapid sand filters.
Slow sand filters are simple, cost effective, reliable, and easy to operate. However slow sand filters generally treat source water turbidity of less than 10 degrees successfully. Rapid sand filters can treat high turbidity water if the water is properly coagulated and settled out. The turbidity of Mahakanadarawa and Wahalkada water is higher than 10 degrees and ranges 1 to 20 degrees. There is a possibility that roughing filters can serve as a pretreatment to reduce the turbidity loading to the slow sand filters. To determine the applicability of the slow sand filters with help of roughing filters, pilot plant tests were conducted.

During the pilot plant operation, the water in the water source and the water treated by roughing filter contained much higher turbidity than water suitable for slow sand filter systems. Therefore, this condition was not suitable for slow sand filters to function properly and efficiently. Even the velocity in the sand filters were set lower than the original calculated velocity, the turbidity was insufficiently removed, less than 5 degrees. For the color, no difference was observed and the treated water was yellowish green color.

The water source used for the pilot plan operation was taken during the middle of dry season which could affect the experiment results. For a purpose of the portable water sources, the Anuradhapura North Water Supply project is proposed to intake the water from Mahakandarawa Tank and Wahalkada Tank, which currently used only for the irrigation purpose. With the additional intake of the water for the portable water purpose, the water levels in both tanks can be lower than the current condition, and the similar condition to the Anuradhapura City Water Supply can be predicted. In considerations of the above conditions and results, the implementation of slow sand filter system for the project is not suitable and recommended. In conclusion, the implementation of rapid sand filter system is recommended for the Anuradhapura North Water Supply project. Rapid sand filter systems are widely used in Sri Lanka so that Water Board will have no difficulties in operation and maintenance. Also it is recommended to install ACF (Active Carbon Filter) as soon as possible to remove

the odor, if a bad odor occurred in the treated water for a long period, after operation of Phase - 1 facility started. Wooden and coconut granular carbon produced in Sri Lanka is available there. Some water treatment plants in Sri Lanka use powder and granular activated carbon.

5.2.3 Design Criteria

Target water quality of treated water is shown in **Table 5.19**.

Table 5.19 Target Turbidity of Treated Water by Process

	Unit	Target
Settled water	NTU	1 – 5
Filtered water	NTU	0 – 1
Treated water	NTU	To meet the Sri Lankan drinking water standard

The design criteria of the facilities are shown in **Table 5.18**.

Table 5.18 Design Criteria

Facility Name	Item	Value
Receiving Well/distribution tank	Detention Time	More than 1.5min
Flocculator	Detention Time	20-40 min
	G value	10 - 75/s
	GT value	23,000 to 210,000
Sedimentation tank (plate settler)	Surface load of the plate settler	7 – 14mm/min
	Upward flow velocity	< 80 mm/min
Sand filter	Filtration rate	< 200m/d (when one tank is stand by)
ACF (Active Carbon Filter) sump (future)	Detention Time	5-25 min
ACF (Active Carbon Filter: future)	Space velocity	SV=5 – 10 /hr
Clear water reservoir	Detention Time	1 hr
Backwash water recycle tank	Capacity	> amount of backwash water of 2 sand filters
Thickener	Detention Time of sludge	24 – 48 hr
	Loading rate of sludge	10 – 20 kg/m2/d
Drying bed	Loading rate of sludge	40 – 80 kg/m2

Source: "Design Criteria for Waterworks Facilities", Japan Water Works Association, 2000
"Integrated Design of Water Treatment Facilities", Susumu Kawamura, 1991

The more detailed design criteria shall be studied and determined during the detailed design stage.

5.2.4 Mahakanadarawa WTP

(1) Location

The location of Mahakanadarawa WTP is shown in **1**.

(2) Flow Diagram

The flow diagram of Mahakanadarawa WTP is shown in **Figure 5.18**.

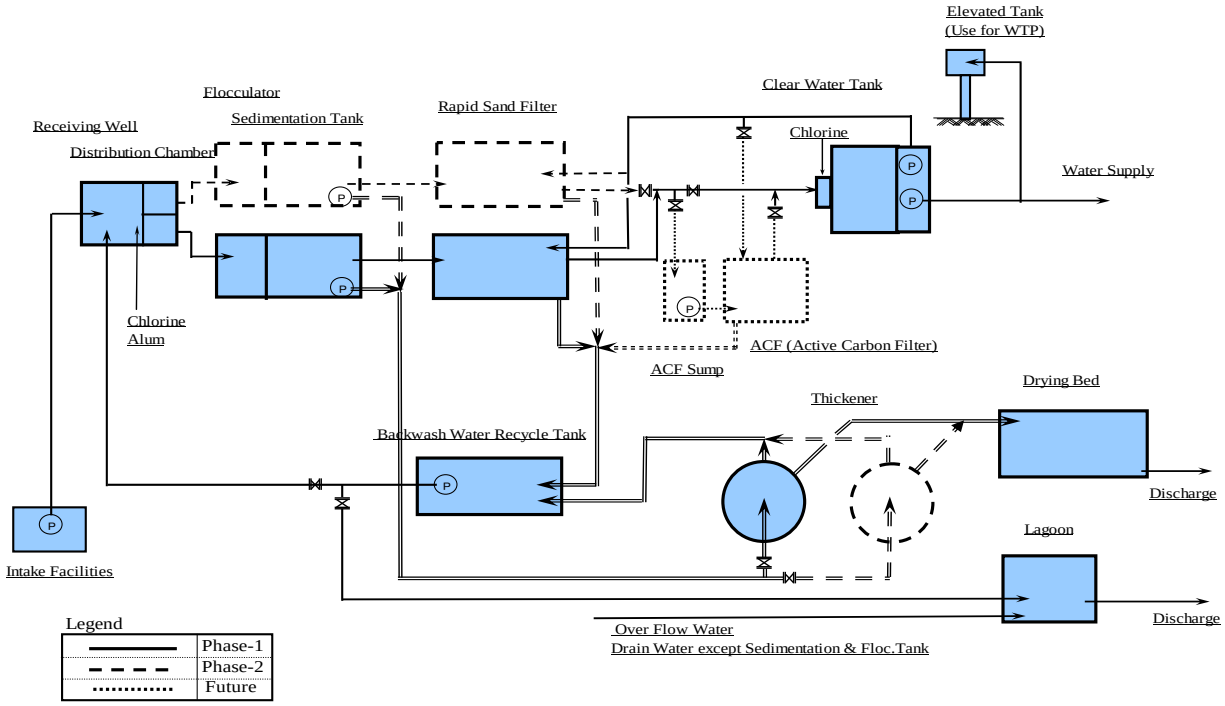


Figure 5.18 Flow Diagram of Mahakanadarawa WTP

(3) Layout

The layout of the facilities in Mahakanadarawa WTP is shown in **Figure 5.19**.

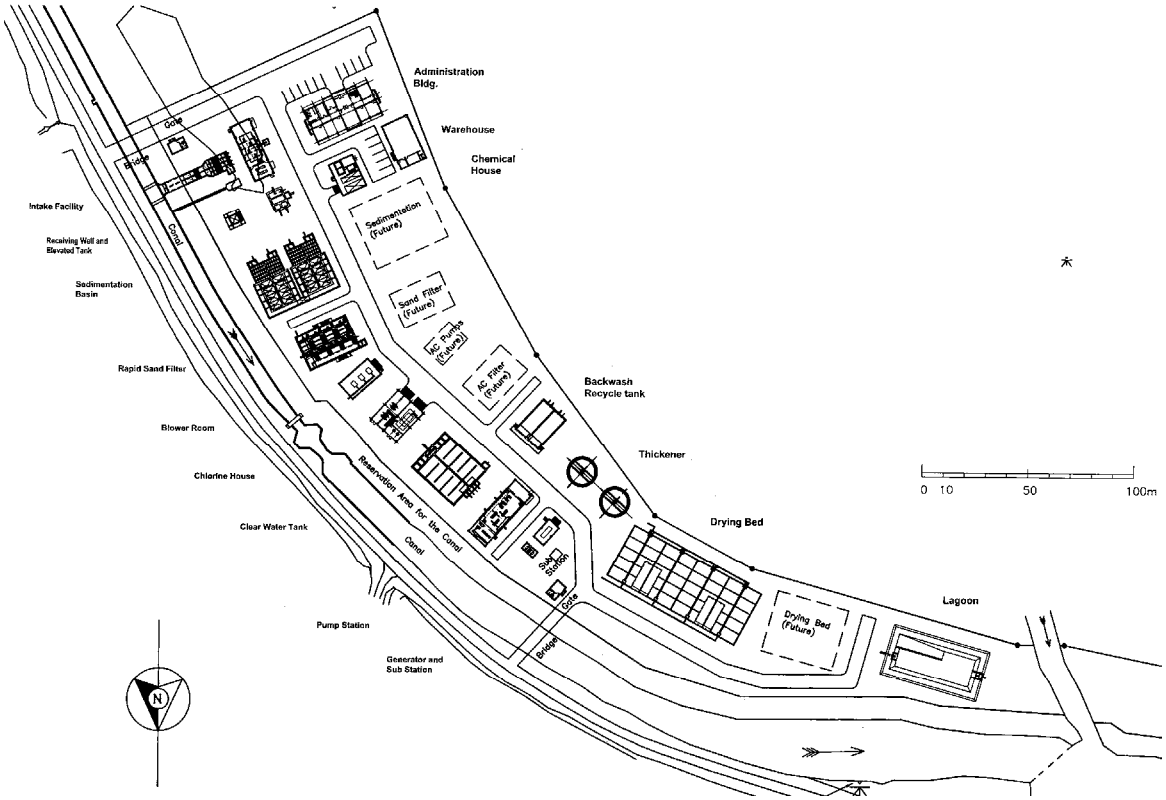


Figure 5.19 Layout of Mahakanadarawa WTP

(1) Outline of Mahakanadarawa WTP

Mahakanadarawa WTP takes water from an irrigation canal from Mahakanadarawa Tank at approximately 120m downstream of Mahakanadarawa Tank. The WTP is located on the left of the irrigation channel. The capacity of the WTP including 5% treatment process loss is shown in **Table 5.20**.

Table 5.20 Capacity of Mahakanadarawa WTP

Year	Stage-1 (2024)	Stage-2 (2034)	Remarks
Water rights (m3/d)	—*	18,800	
Water demand (day ave.) (m3/d)	7,154	14,414	According to water demand projection
Water demand (day Max.) (m3/d)	8,600	17,300	day ave. x 1.2
Production capacity of WTP(m3/d)	8,900	17,900	Output of WTP; Capacity of WTP x 0.95
Capacity of WTP (m3/d)	9,400	18,800	Input to WTP

Note: * Water right is set at 6,700 m3/day for 2016 and 18,800 m3/day for 2034 in the MOU between the Irrigation Department and NWSDB. Therefore, it is supposed that an amount of 6,700- 18,800 m3/day will be available for the year of 2024.

The intake water is delivered to the receiving well, which includes distribution chambers to supply water evenly to the flocculator tank that will be constructed in the Phase-1 and long term plan. At the outflow of the receiving well, both chlorine and aluminum sulfate will be injected.

A weir and a valve are installed at the entrance at each flocculator tank to control the inflow. The outflow from the vertical baffled channel flocculator is conveyed to the inclined plate sedimentation tank, which removes sludge. The outflow from the sedimentation tank without sludge is conveyed to a rapid sand filter, and then the filtered water is conveyed to the clear water reservoir, to which chlorine is added.

After the start the operation of Phase-1 facilities, if strong bad odor occurs for a long term in the treated water, ACF is proposed to be added to remove the odor. The outflow from the rapid sand filter is proposed to be pumped into the ACF by an ACP sump pump. The filtered water is conveyed to the clear water reservoir by gravity, and the treated water is supplied to the served area by transmission pumps. The necessity of ACF shall be studied and determined during the detailed design stage.

Both the sand filter and ACF are cleaned with air and water. The backwash water flows into the backwash water recycle tank and then pumped to the receiving well for recycling water.

Sludge collected at the bottom of the sedimentation tank is regularly released by opening a valve and pumped to the thickener. In the thickener, water is separated from the sludge, the sludge is conveyed to the drying bed, and the water is conveyed to the backwash water recycle tank for a purpose of recycling water. Accumulated sludge in the drying bed is removed after this is dried. The total capacity of lagoons is designed to handle the overflow water, drainage water, and the water from the backwash water recycle tank for emergency.

The facilities in Mahakanadarawa WTP are summarized in **Table 5.21**.

Table 5.21 Detail of Mahakanadarawa WTP

Facility	Stage-1	Stage-2	Remarks
Receiving Well	W4.0m x L4.6m x H6.0m x 1unit	-	*
Distribution Chamber	W2.0m x L2.0m x H5.0m x 2units	-	*
Flocculator tank	5 stages x 62.8m3 x 4 units	5 stages x 62.8m3 x 4 units	
Sedimentation tank	W4.0m x L10.4m x H4.0m x 4units	W4.0m x L10.4m x H4.0m x 4unit	Plate settler
Rapid sand filter tank	W3.0m x L5.5m x 4units	W3.0m x L5.5m x 4units	
ACF sump	W8.0m x L12.0m x H3.0m x 1unit		future
ACF tank	W2.5m x L5.0m x 4units		future
Chlorine Mixing Chamber	W2.0m x L5.0m x H4.0m x 2units	-	*
Reservoir	W8.0m x L17.0 x H4.0m x 2units	-	*
Backwash water recycle tank	W4.0m x L14.0 x H3.0m x 2units	-	*

Facility	Stage-1	Stage-2	Remarks
Thickener	Dia 10.0m x H4.0m x 1unit	Dia 10.0m x H4.0m x 1unit	
Drying bed	W12.5m x L20.0m x H1.0m x 4units	W12.5m x L20.0m x H1.0m x 2units	
Lagoon	W10.0m x 27.0m x 1.0m x 1unit	-	*
Administration Bldg.	W12.0m x L25m x 2 stories	-	*
Chemical house	W11.5m x L12.0m	-	*
Chlorine House including neutralization facilities	W12.0m x L14.0m	-	*
Pump House	W8.0m x L26.5m	-	*
Blower House	W7.3m x L13.5m		*
Generator House	W4.5m x L8.0m	-	*
Ware House	W10.0m x L17.0m	-	*

*The capacity of the facilities constructed in Stage-1 includes the whole capacity required for the Project up to Stage-2.

Attention be paid for the following:

- The necessity of the central laboratory shall be shall be studied and determined during the detailed design stage.
- The necessity, location and contents of a complete workshop shall be studied and determined during the detailed design stage.
- The material of the outlet weir launders, lamellar of the clarifies, uniformity coefficient of proposed lapid sand filters shall be studied and determined during the detailed design stage.

5.3.5 Wahalkada WTP

(1) Location

The location of Wahalkada WTP is shown in **Figure 5.20**.

(2) Flow diagram

The flow diagram of Wahalkada WTP is shown in **Figure 5.21**.

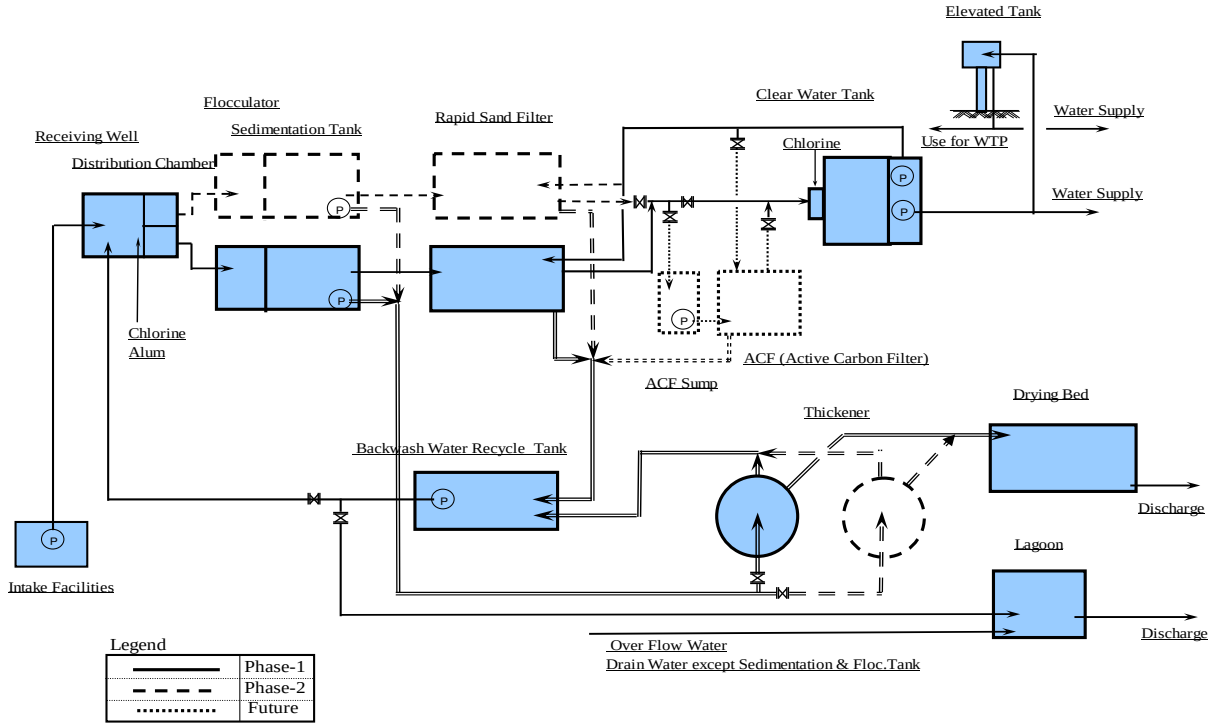


Figure 5.20 Flow Diagram of Wahalkada WTP

(3) Layout of the facilities

The layout of the facilities in Wahalkada WTP is shown in **Figure 5.23**.

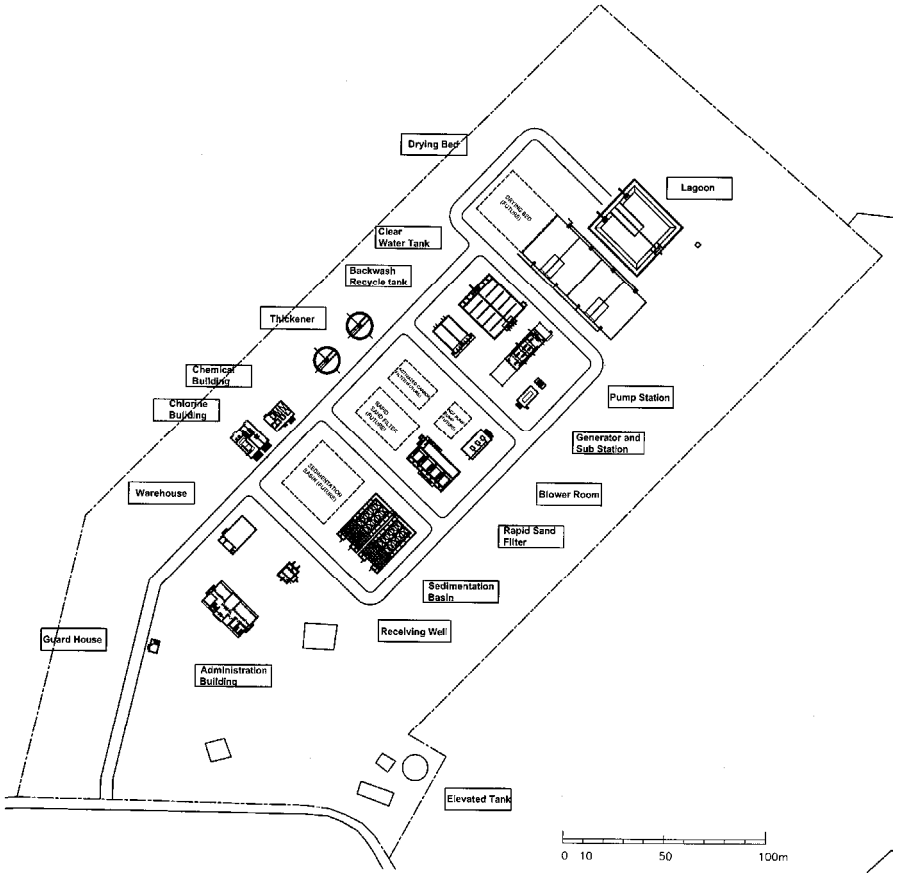


Figure 5.21 Layout of Wahalkada WTP

(4) Outline of Wahalkada WTP

Wahalkada WTP takes water from an irrigation canal from Wahalkada Tank at approximately 420m downstream from Wahalkada Tank. The capacity of the WTP is determined in consideration of water rights, daily maximum water demand and 5% treatment process loss in **Table 5.22**.

Water demand in 2024 is projected to be mostly half of that in 2034 so that major treatment facilities in 2024 such as sedimentation basin and rapid sand filter should be half capacity of the long term plan in 2034 in order to increase operational efficiency, ratio of utilization and the service life of the facilities.

Table 5.22 Capacity of Wahalkada WTP

Year	Stage-1 (2024)	Stage-2 (2034)	Remarks
Water rights (m3/d)	－*	28,800	
Water demand (day ave.) (m3/d)	11,098	22,392	According to water demand projection
Water demand (day Max.) (m3/d)	13,300	26,900	day ave. x 1.2
Production capacity of WTP(m3/d)	13,700	27,400	Output of WTP; Capacity of WTP x 0.95
Capacity of WTP (m3/d)	14,400	28,800	Input to WTP

Note: * Water right is set at 10,500 m3/day for 2016 and 28,800 m3/day for 2034 in the MOU between the Irrigation Department and NWSDB. Therefore, it is supposed that an amount of 10,500-28,800 m3/day will be available for the year of 2024.

The treatment process is the same as at Mahakanadarawa WTP, except that an elevated tank is provided to supply water to the neighboring villages. Treated water is pumped to the elevated tank, which is located in the WTP site and also to the served areas through transmission pipelines.

The facilities in Wahalkada WTP are summarized in **Table 5.23**.

Table 5.23 Detail of Wahalkada WTP

Facility	Stage-1	Stage-2	Remarks
Receiving Well	W5.6 x L5.0m x H6.0m x 1 unit	-	*
Distribution Chamber	W2.5 x L2.0m x H5.0m x 2 units	-	*
Flocculator tank	7 stages x89.3m^3 x 4 units	7 stages x89.3m^3 x 4 units	
Sedimentation tank	W4.0m x L14.4m x H4.0m x 4units	W4.0m x L14.4m x H4.0m x 4unit	Plate settler
Rapid sand filter tank	W4.0m x L6.0m x 4units	W4.0m x L6.0m x 4units	
ACF sump	W10.0m x L14.0m x H3.0m x 1unit		future
ACF tank	W3.5m x L5.0m x 4units		future
Chlorine Mixing Chamber	W2.0m x L6.75m x H4.0m x 2units	-	*
Reservoir	W10.0m x L21.0m x H4.0m x 2units	-	*
Backwash water recycle tank	W5.0m x L15.0m x H4.0m x 2units	-	*
Thickener	Dia 12.5m x H4.0m x 1unit	Dia 12.5m x H4.0m x 1unit	
Drying bed	W15.0m x L25.0m x H1.0m x 4units	W15.0m x L25.0m x H1.0m x 2units	
Lagoon	W12.0m x 25.0m x 1.5m x 1unit	-	*
Administration Bldg.	W12.0m x L25m x 2 stories	-	*
Chemical house	W11.5m x L12.0m	-	*
Chlorine House including neutralization facilities	W12.0m x L14.0m	-	*
Pump House	W8.0m x L35.0m	-	*
Blower House	W7.3m x L13.5m		*
Generator House	W5.0m x L9.5m	-	*
Ware House	W10.0m x L17.0m	-	*

*The capacity of the facilities constructed in Stage-1 includes the whole capacity required for the Project up to Stage-2.

5.3 Transmission and Distribution System

5.3.1 Description of Project Area

The project area is comprised of six DSDs, which are further divided into 194 GNDs covering an area of about 2,863 km^2. The six DSDs are Padaviya, Kebithigollewa, Medawachchiya, Rambewa, Horowpothana and Kahatagasdigiliya. The population in the project area is estimated to be 204,700 in 2012, which indicates a low population density at less than 1 person/ha on the average.

There are several main roads of route A and B in the project area as shown in **Figure 5.22**. There are four Route A roads and seven Route B roads. The core areas (urban center) are formed with multiple DSDs at six locations as shown in **Figure 5.22**. These core areas are located at the intersection or intersections of the above-mentioned main roads as the development centers of the project area, including Bogahawewa in Padaviya DSD, Kebithigollewa in Kebithigollewa DSD, Medawachchiya in Medawachchiya DSD, Rambewa in Rambewa DSD, Horowpothana in Horowpothana DSD and Kahatagasdigiliya in Kahatagasdigiliya DSD. Villages are sparsely located along the main roads or inland from such roads in each GND. The project area is covered in forests, paddy lands, artificial lakes (tanks) and other vacant lands. The villages are located, in general, beside or near the tank (reservoir) and paddy fields. The road network is also limited in these areas.

Ground elevations in the project area vary widely from +30m up to +150m. The local topography is not necessarily flat, but sometimes fluctuates considerably within GNDs.

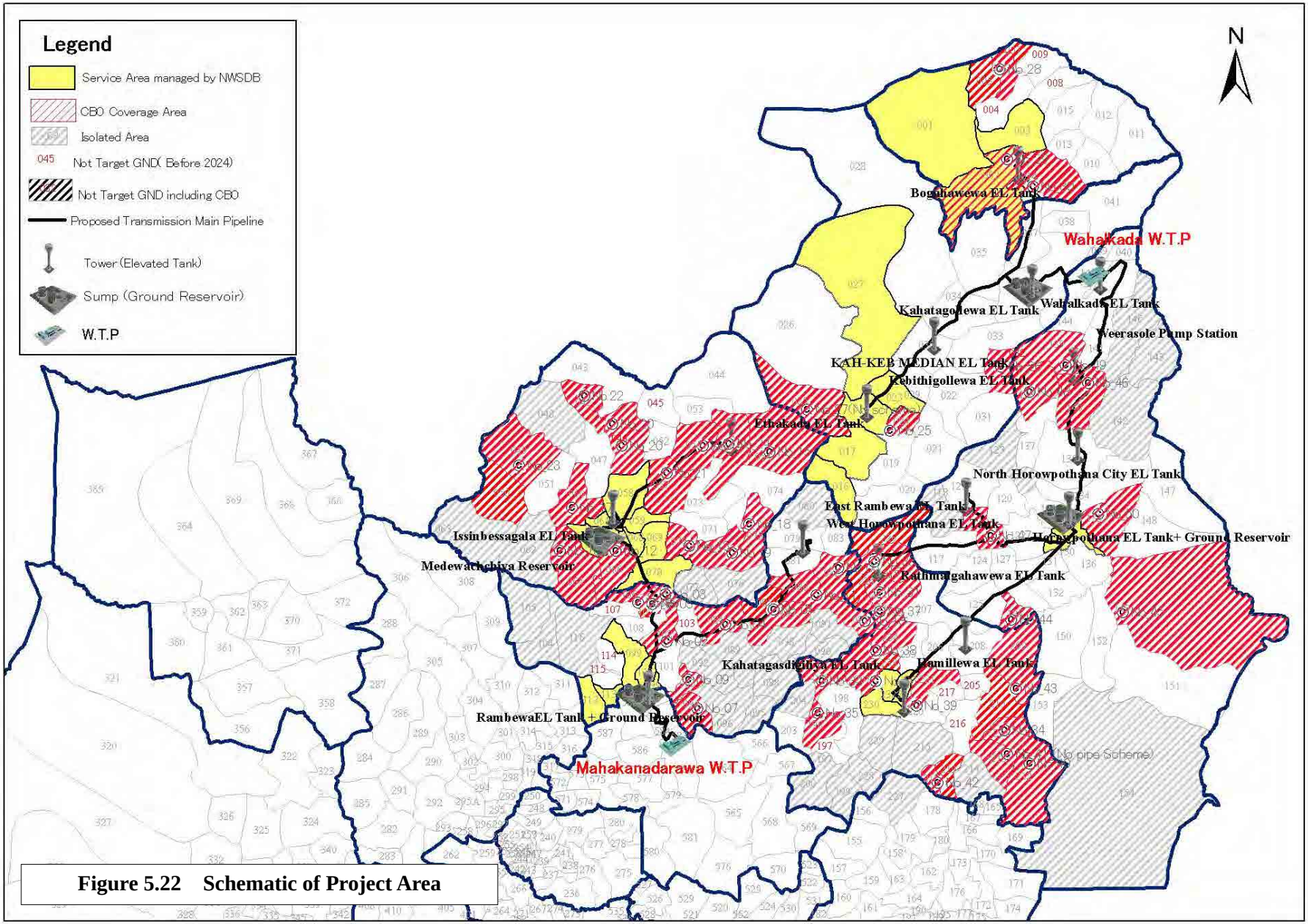


Figure 5.22 Schematic of Project Area

5.3.2 Planning Concept of the System

The system plan for transmission and distribution was made based on the water demand for the target year of 2034, and the dimensions of the major facilities such as transmission mains, distribution mains, ground reservoirs, elevated tanks, etc. were determined based on the requirement for the year 2034. The dimensions of minor facilities such as distribution sub-system were determined for the year of 2024 for the project implementation.

(1) Transmission System

There are six NWSDB's systems and 50 existing community water supply systems (CBO and CWSSP) in the project area. The NWSDB systems, covering 25 GNDs, are located in the core area(s). Generally, each CBO covers a part of a GND. Some CBOs, however, cover multiple GNDs or two to three GNDs. New water supply systems for GNDs other than the existing CBOs will be constructed under this project. However some of the GNDs will not have piped supply systems, but will be supplied from an indirect system to which water will be transferred by water tankers (Bowsers). All the existing CBOs receive treated water at their elevated tanks except for three (3) CBOs as mentioned in **Section 4.2.5**. They area CBO 20 (GND 46), CBO26 (GND 32) and CBO 47 (GND 119)

The number of GNDs presently supplied by NWSDB, existing CBO or new system established under the present project is summarized as follows:

Table 5.24 Summery of GNDs in Project Area

DSD	GNDs currently supplied by NWSDB	GNDs currently supplied by CBOs	GNDs supplied by new water supply systems		GNDs receiving bowser delivery water supply	
			Year 2024	Year 2034	Year 2024	Year 2034
Padaviya [1)]	3	4	5	8	4	1
Kebithigollewa	5	2	17	17	1	1
Medawachchiya	8	13	8	9	6	5
Rambewa	4	12	6	10	16	12
Horowpothana	2	6	21	21	8	8
Kahatagasdigiliya	3	18	7	11	12	8
Total	25	55	64	76	47	35

Note [1)]: GND 2 of Padaviya DSD is supplied from both NWSDB and existing CBO (29)

Figure 5.24 shows such GNDs supplied by the existing piped system, new system and indirect supply.

Two water sources are selected for the present integrated water supply system in the northern and southern parts of the project area, namely Wahalkada Wewa and Mahakanadarawa Wewa

respectively, from where raw water is conveyed, after treatment, to the entire project area through two transmission systems.

The transmission system from the Mahakanadarawa Wewa is named as the Mahakanadarawa System, which will cover DSDs of Medawachchiya and Rambewa. The Wahalkada system from Wahalkada Wewa transmits treated water to the DSDs of Padaviya, Kebithigollewa, Horowpothana and Kahatagasdigiliya.

From the demand projection for the year of 2034, the transmission capacity for the Mahakanadarawa and Wahalkada systems is determined as 17,300 m^3/day and 26,900 m^3/day respectively.

Each transmission system is composed of a transmission main system and a sub-main system. The main system is formed to cover the entire supply zone from the respective water treatment plant and the sub-system supplements the main system to convey bulk water to the elevated tanks, which are placed at strategic locations to distribute water to the new system of GNDs and transmit bulk water to the existing CBOs.

The transmission main system is composed of transmission mains and service centers where a pumping station and an elevated tank are provided. In addition, booster pump stations are provided at strategic locations. The transmission main route of each system is, in general, selected to run along the main roads mentioned above, from the water treatment plant and between service centers. Elevated tanks are provided at key locations to distribute treated water directly to the new distribution systems of GNDs. On the other hand, the existing systems will receive bulk water from the transmission system at the elevated tanks.

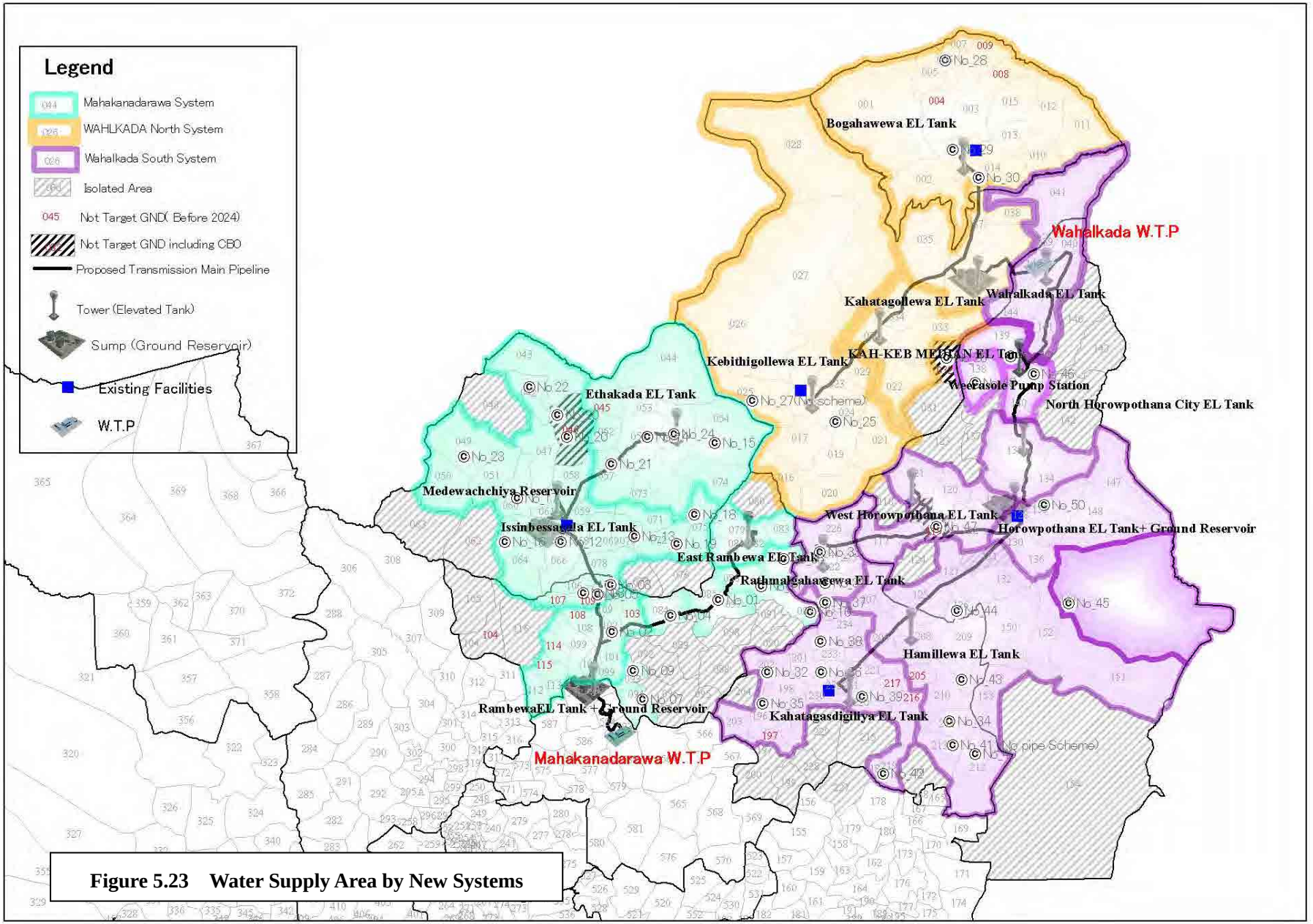


Figure 5.23 Water Supply Area by New Systems

Fifteen elevated tanks, four in the Mahakanadarawa system and 11 in the Wahalkada system, are strategically positioned to cover the entire service area. **Table 5.25** shows the area covered by each elevated tank.

Table 5.25 Covering Area of Elevated Tanks

Transmission System	Elevated Tank	Covering area (ha)
Mahakanadarawa System	I-1 ET (Rambewa)	6,387
	I-2 ET (Issinbassagala)	22,333
	I-3 ET (Ethakada)	13,269
	I-4 ET (East Rambewa)	2,590
Wahalkada System	II-1 ET (Wahalkada)	8,545
	II-2 ET (Kahatagollewa)	7,979
	II-3 ET (Bogahawewa)	24,252
	II-4 ET (KAH-KEB Median)	6,839
	II-5 ET (Kebithigollewa)	37,952
	II-6 ET (North Horowpothana)	4,408
	II-7 ET (Horowpothana)	8,522
	II-8 ET (West Horowpothana)	5,782
	II-9 ET (Rathmalgahawewa)	5,571
	II-10 ET (Hamillewa)	26,695
	II-11 ET (Kahatagasdigiliya)	12,244

It is noted that transmission to some of the CBOs, which are remotely located from the transmission main at high ground elevation, will need to be boosted to the level of their respective elevated tanks as shown in **Figure 5.26** for the Mahakanadarawa system and **Figure 5.27** for the Wahalkada system.

(2) Distribution System

There are two systems of distribution, one is the system for the existing CBO systems operated independently by individual CBOs, and the other is the new system for GNDs operated under NWSDB.

The existing CBO's system will receive bulk water from the transmission system operated by NWSDB, and distribute water through the existing distribution network. The new system of the GND will be directly distributed from the elevated tank constructed under the project, and the entire system will be operated by NWSDB. The service area of the existing system under NWSDB will receive bulk water also from the transmission system at the elevated tank and distribute water to its distribution network. In accordance due to the increase in demand, the existing service area will be reduced to meet the capacity of the existing distribution system including the existing elevated tank. The remaining area after reduction of its service area will be covered by the new distribution system constructed under this project.

The CBO is assumed to continue to operate and manage the existing system only. On the other hand, the expansion of service area of CBO due to demand increase is assumed to be handled as

NWSDB considers appropriate.

5.3.3 Design Criteria

(1) Selection of Pipe Materials

Pipe materials to be applied for transmission and distribution pipelines are examined in accordance with the characteristics of pipe materials, locations where they will be installed, and economy of construction.

The range of sizes for transmission main, sub-main and distribution network will be as follows:

Transmission Main:	ND 250mm to 450mm
Transmission Sub-main:	ND 100mm to 250mm
Distribution Main:	ND 100mm to 400mm
Distribution Sub-system (network):	ND 50mm to 200mm

Among pipe materials prevailing, the following are considered as applicable for piping work for the above pipelines:

DCIP or DIP:	Ductile cast Iron Pipe
SP:	Steel Pipe
PE:	Polyethylene Pipe
PVC:	Un-plasticized Polyvinyl Chloride Pipe

The conditions of the installation sites and pressure conditions vary widely depending on functions and range of pipelines, as mentioned. But in general, these conditions are classified as shown in **Table 5.26**.

Table 5.26 Condition of Pipeline

Pipeline	Site Conditions	Pressure Conditions
Transmission Main	Underground piping installed alone main road, thus traffic load is to be duly considered	High pressure of 10 bar or less [1)]
Transmission Sub-main / Distribution main	Underground piping installed along the public road with possible surface loading by traffic	The pressure is less than 10 bar
Distribution Network	Underground piping installed within the village at rural area, thus traffic load is limited	Low pressure of less than 2 bar

1) The pressure of some section of transmission main will exceed 10 bar caused by water hammer, where pipes with rated pressure of 16 bar will be used.

The major factor in the selection of pipe materials is its cost. **Table 5.27** shows the unit price of DIP and PE for comparison, in accordance with cost quotation.

Table 5.27 Unit Price of Pipe Materials

(Unit: Rs/m)

ND (mm)	DIP	PE
450	20,457	15,689
400	17,228	12,856
350	13,913	10,022
300	11,207	7,932
250	9,308	4,919
200	7,240	3,918
150	5,434	2,043

The general features of pipe materials and the evaluation on the application of each pipe material are summarized in **Table 5.28**.

Table 5.28 Evaluation of Pipe Materials

Description	DIP	SP	PE	PVC
Safety against external Load				
Underground piping	◎	◎	△	△
As structure member	○	◎	×	×
Safety against internal pressure	◎	◎	○	○
Roughness on internal surface	○	○	◎	◎
Water tightness of joint	○	◎	◎	○
Adaptability against soft/poor soil	○	○	○	○
Workability for installation	○	△	△	◎
Transportation and handling	○	△	△	△
Corrosion resistance	△	×	○	○
Resistance against acid water	×	×	◎	◎
Applicable Size	80～2600	50-2400	20-1600	20-600

Where, ◎: excellent, ○: good enough, △: tolerable, ×: not recommended

From the above evaluation on pipe materials, the recommended pipe materials are summarized as follows:

Transmission Main: PE considering importance as main facility for transmission system, low roughness of internal surface, which reduces friction loss for transmission and economy for applied range of pipe sizes, in comparison with DIP and SP. It is noted, however, that care shall be taken for pipe installation, especially in rocky soil conditions and where there are traffic loads. Sand bed and backfill up to above the crown of the pipe shall be provided.

Transmission Sub-main/ Distribution Main: PE for the same reasons as above.

Distribution Sub-system: PVC considering the small size of pipelines, limited external loads and economy of construction.

Special construction: SP or DIP will be used for crossing works such as major roads, river crossings by pipe bridges and inverted siphon depending on the site conditions and method of crossings.

(2) Transmission Hydraulics

Key Ground Elevation:

Transmission mains are planned between the water treatment plant and the service centers by pumping. The ground elevations at such sites for the construction of the major facilities are important to determine the size of the transmission main and the dimensions of the pump facilities. Based on the topographical and line surveys, the key ground elevations are determined as shown in **Table 5.29**.

Table 5.29 Key Ground Elevation of Transmission System

Transmission System	Pump Station / Main Elevated Tank	Ground Elevation (m)
Mahakanadarawa System	Water Treatment Plant I (Mahakanadarawa WTP)	+ 91.0
	Pump Station I-1 PS / Elevated Tank I-1 ET (Rambewa)	+ 89.5
	Pump Station I-2 PS (Medawachchiya)	+ 100.0
	Elevated Tank I-2 ET (Issinbassagala)	+ 113.0
	Elevated Tank I-3 ET (Ethakada)	+ 121.0
	Elevated Tank I-4 East Rambewa	+ 112.0
Wahalkada System	Water Treatment Plant II, Elevated Tank II-1 ET (Wahalkada WTP)	+ 61.0
	Pump Station II-1 PS / Elevated Tank II-2 ET (Kahatagollewa)	+ 68.0
	Elevated Tank II-3 ET (Bogahawewa)	+ 66.0
	Elevated Tank II-4 (KAH-KEB Median)	+ 94.5
	Pump Station II-2 PS, Elevated Tank II-5 ET (Kebithigollewa)	+ 122.0
	Pump Station II-3 PS (Weerasole)	+ 57.0
	Elevated Tank II-6 (North Horowpothana)	+ 86.0
	Pump Station II-4 PS / Elevated Tank II-7 ET (Horowpothana)	+ 73.5
	Elevated Tank II-8 ET (West Horowpothana)	+ 116.0
	Elevated Tank II-9 ET (Rathmalgahawewa)	+ 122.0
	Elevated Tank II-10 ET (Hamillewa)	+ 101.7
	Pump Station II-5 PS / Elevated Tank II-11 (Kahatagasdigiliya)	+ 146.0

Water Levels

Water levels of above major facilities are set as follows:

Water Treatment Plant: Clear water reservoir: HWL/LWL: as determined by preliminary design by WTP

Ground Reservoir and Pump Sump: HWL: 2 meter above ground elevation
LWL : 2 meter below ground elevation

Elevated Tank: HWL: 25 meters above ground elevation
LWL: 21 meters above ground elevation

Hydraulic Analysis

The Hazen-William Formula is used for friction loss analysis of pipelines, where the friction loss coefficient (C-Value) is applied assuming that pipe materials will be either PE or PVC as follows:

Transmission Pipeline: 130
Distribution Main: 130
Distribution Sub-system: 120

The transmission hydraulics shall be re-checked during the detailed design stage for the Stage-1 and Stage-2 flow.

Pressure Condition

For safe operation of the transmission system, the hydraulic profile of the pipeline should be such that the pressure is positive at any point along the pipeline route.

Surge along Pipelines

Pipelines shall be designed for any operating condition, including pressure surge at time of sudden pump stops due to power failure. In such cases, negative pressure may occur along the pipeline. The negative pressure, however, shall be not less than -5 m or approximately at any points along the pipeline.

(3) Dimensions of Ground Reservoirs and Main Elevated Tanks

Dimensions of ground reservoir at pump station and elevated tank will be determined using the following retention times:

Ground Reservoir:	2 hours
Elevated Tank:	8 hours

The height of elevated tanks is planned such that the low water level is 21 m above ground elevation, as stated above.

(4) Distribution Mains and Distribution Sub-system of GND

Distribution system will be composed of distribution main and sub-system. The pipe material used for distribution mains, which will transfer distribution water to each GND with a tree type system in general, will be PE taking its importance into account. On the other hand, the pipe material used for the distribution sub-system (networks) in the GNDs will be PVC, taking into account the smaller diameter of the pipes, length of the pipelines, limited external loads and low cost.

Pressure at the receiving point of bulk water is set at 15 meters using following hydraulic conditions:

Pressure at the tapping point:	10 meters
Head loss of distribution sub-system:	3 meters

The peak factor for water distribution is taken as 2 times of the maximum day demand.

(5) Installation of Valves

The transmission and distribution mains will be provided with valves at the following locations:

Main Valve: at branches and the place right after along the pipeline, major crossings of main roads, downstream of blow-offs, upstream of air valves, every 2 – 3 km interval and other places as required.

Blow-off: at concave points of pipeline profile near river and drains which are available.

Air Valve: at convex points of pipeline profile

(6) Earth Cover of Pipeline

The earth cover of pipeline is set at, in general, the following depths:

Transmission main and Distribution Primary Mains: 1.2 meters

Distribution network (Secondary & Tertiary): 1.0 meters

Bedding of pipes will be provided with sand or appropriate soil with a minimum of 10 cm thickness. Similar soil materials will be used for backfilling up to 10 cm above the pipe crown.

5.3.4 Mahakanadarawa System

A schematic flow diagram of the Mahakanadarawa System is shown on **Figure 5.24**.

The Mahakanadarawa system for transmission main is composed of four (4) sections as follows:

Section 1: from Mahakanadarawa WTP to Rambewa Service Center (Pump station/Elevated tank) along local road

Section 2: From Rambewa Pump station to Medawachchiya Pump station along Route A9 and A14 at the end span

Section 3: From Medawachchiya Pump station to Issinbassagala Elevated tank along bypass between Routes A9 and A14

Section 4: From Medawachchiya Pump station to Ethakada Elevated tank along Route B211

(1) Section 1

The treated water is transferred through a ND 450mm transmission main to the distribution reservoir of Rambewa service center, where a pump station (I-1PS) and an elevated tank (I-1ET) will be provided. The pipe length is approximately 7.1 km. The elevated tank at Rambewa will cover a new system serving twelve (12) GNDs by direct distribution and one CBO to its elevated tank.

Two surge tanks (one way tank) are planned to be located right after WTP and before the Service Center to guard against surging caused by sudden stop of pump operation.

(2) Section 2

Treated water will be further transferred through a ND 450 ~ 400 mm transmission main to the ground reservoir (I-2PS) at the service center of Medawachchiya. The pipe length is approximately 15.8 km (ND450mm at 3.2 km and ND400mm at 12.6 km). On the way to Medawachchiya pump station from Rambewa, a branch for a transmission sub-main is installed at approximately 3.2 km from Rambewa service center (point “a”) to convey bulk water to eight existing CBOs and one elevated tank (East Rambewa, I-4 ET) for direct distribution to the new

systems in three GNDs.

Another branch (point "b") at about 3.8 km downstream from Point "a" will be provided to transmit bulk water to three existing CBOs.

After Point "b", the transmission main runs approximately 8.8 km up to the ground reservoir at Medawachchiya pump station (II-2 PS).

I. MAHAKANADAWARA TRANSMISSION SYSTEM FLOW DIAGLAM

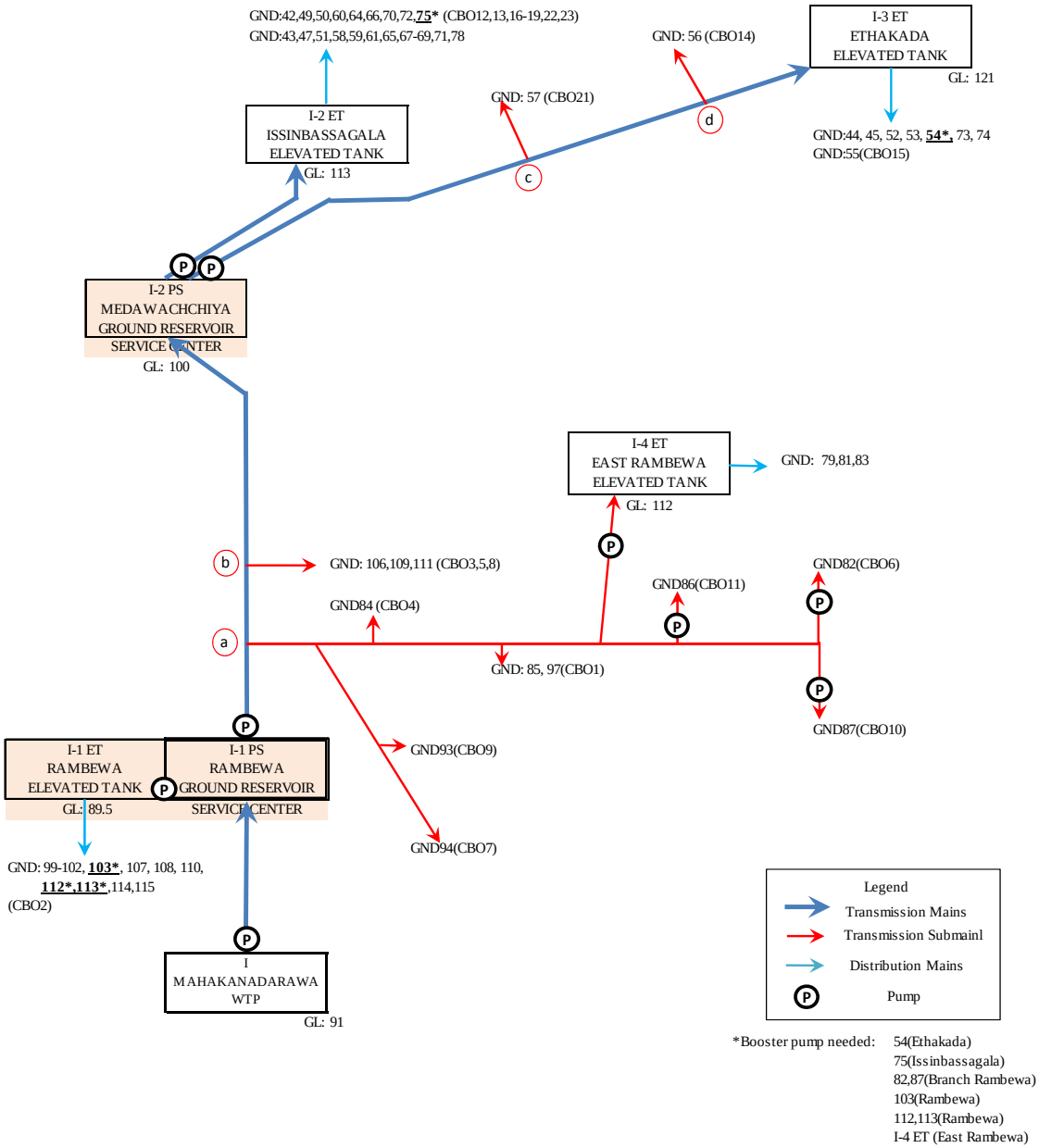


Figure 5.24 Schematic Flow Diagram of the Mahakanadarawa System

(3) Section 3

From Medawachchiya pump station where water is pumped up to the elevated tank at

Issinbassagala (I-2ET). The size of main is ND 350mm, with a length of approximately 3.1 km. The Issinbassagala elevated tank transfers bulk water to the existing elevated tank of NWSDB which cover eight GNDs, nine existing CBOs and direct distribution to new systems in four GNDs.

Due to the limited capacity of the existing distribution system of NWSDB, the present service area will be reduced, due to the increase in demand, and replaced by a new distribution system from the new elevated tank.

(4) Section 4

The Medawachchiya pump station also transfers water through a ND 250 to 300 mm transmission main to the elevated tank at Ethakada (II-3ET). The pipe length is approximately 14.4 km. The Ethakada elevated tank will cover two existing CBO and new systems in six GNDs. At 7.1 km and 11.3 km from the pump station, two branches (at point "c" and "d") will be provided to transmit bulk water to one existing CBO each.

Table 5.30 summarizes the existing system (NWSDB and CBOs) and new system for GNDs to be fed from transmission mains and covered by respective new elevated tanks by the Mahakanadarawa transmission system.

Table 5.30 Existing and New Systems Covered by New Elevated Tank

Elevated Tank	NWSDB System	CBO System	New System
I-1 ET (Rambewa)	-	-	99, 100, 101,102, 103, 107, 108, 110, 112, 113, 114, 115
I-2 ET (Issinbassagala)	51, 58, 59, 61, 65, 67, 68, 69, 78	42, 49, 60, 64, 66, 70, 72, 75	43, 47, 71
I-3 ET (Ethakada)	-	54, 55	44, 45, 52, 53, 73, 74
I-4 ET (East Rambewa)	-	-	79, 81, 83
Transmission mains	-	46, 57, 55, 75, 82, 84, 85, 86, 87, 93, 94, 97, 102, 106, 109, 111	-

Note [1)]: There are four GNDs presently supplied from existing water supply source which is however located outside of the project area. The supply condition of these GNDs are poor at present due to remote from the supply source, therefore they are included in the present system planned.

(5) Transmission Sub-main

As mentioned above, the transmission sub-mains are planned at four branches of transmission main to convey water to a new elevated tank at East Rambewa and the existing CBOs. A total length of transmission sub-main is estimated at about 46.2 km which size is ranging from 250mm to 100mm in diameters.

To determine size of transmission main and sub-main of Mahakanadarawa system, hydraulic

analysis has been carried out. The results of above hydraulic analysis is presented in **Appendix 5.3 (a)** and **5.3 (b)** for transmission main and sub-main respectively.

5.3.5 Wahalkada System

The Wahalkada System is further divided into two sub-systems to cover northern part and Southern part of its service area. The former is named as Wahalkada Sub-system IIA and the latter as Wahalkada Sub-system IIB.

A schematic flow diagram of the Wahalkada System is shown in **Figure 5.25**.

To determine the size of transmission main and sub-main of Wahalkada system, hydraulic analysis has been carried out. The results of above hydraulic analysis are presented in Appendix 5.3.1-a and 5.3.1-b also for transmission main and sub-main respectively.

II. WAHALKADA TRANSMISSION SYSTEM FLOW DIAGLAM

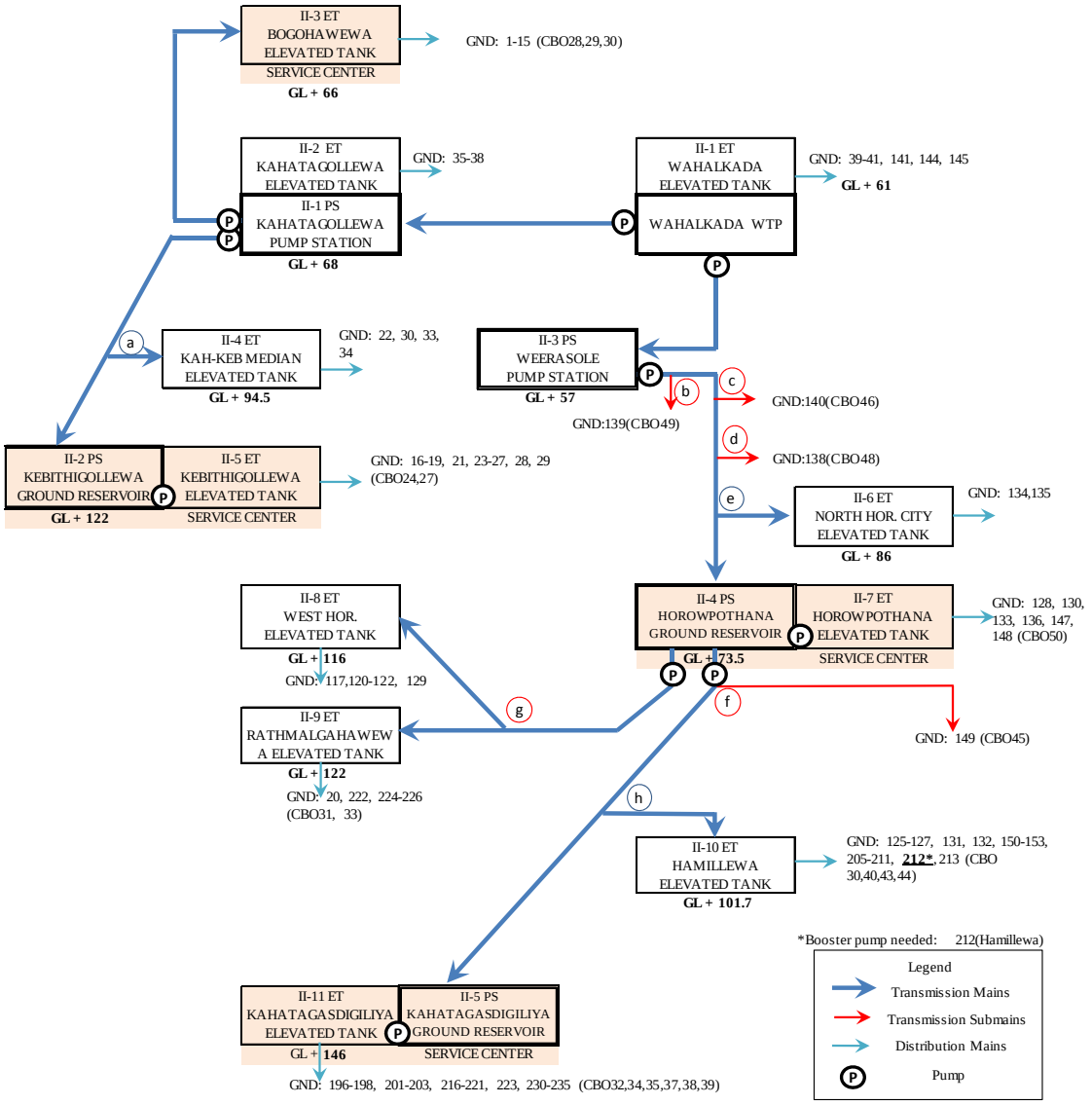


Figure 5.25 Schematic Flow Diagram of the Wahalkada System

(1) Wahalkada Sub-system IIA

Wahalkada Sub-system IIA conveys treated water (about 11,600 m^3/day as maximum day demand) to two service centers at Bogahawewa and Kebithigollewa. Wahalkada elevated tank (II-1 ET), which is located within the water treatment plant premises, distributes bulk water to five GNDs located in the area surrounding the water treatment plant by gravity.

The Wahalkada transmission sub-system IIA is composed of three sections as follows:

Section 1: from Wahalkada WTP to Kahatagollewa pump station along local road

Section 2: from Kahatagollewa pump station to Bogahawewa elevated tank along Route B 211

Section 3: from Kahatagollewa pump station to Kebithigollewa pump station along Route B 211

1) Section 1

Treated water is conveyed to the Kahatagollewa pump station (II-1 PS) from Wahalkada WTP through a transmission main of ND 400mm with a length of approximately 7.8 km. Transmitted water is lifted to an elevated tank (II-2 ET) in the same premises as the pump station, from where water is distributed to new systems in four (4) GNDs.

2) Section 2

The Kahatagollewa pump station transfers water to Bogahawewa Elevated tank (II-3 ET) at the service center in DSD Padaviya through a 12.0 km long approximately transmission main of ND 350 mm diameter. The elevated tank covers the entire service area of Padaviya, based on the topographical conditions. Although the majority of the service areas are located remotely from the tank, the ground elevation of these areas is more than 20 meters lower than ground level of the elevated tank. The tank will transmit bulk water to the existing system of NWSDB and CBOs. The remaining service areas will be supplied directly by gravity flow from the elevated tank.

3) Section 3

Water transmitted to the Kahatagollewa pump station is further boosted to Kebithigollewa service centers (II-2 PS and II-5 ET) in DSD Kebithigollewa through 20.1 km of ND 350mm transmission main, installed along Route B 211. The elevated tank is provided beside Kebithigollewa pump station to distribute water to new systems in five GNDs, two existing CBOs and five and the existing system under NWSDB, which covers five GNDs.

A branch (at Point “a”), at approximately 10.1 km downstream of Kahatagollewa pump station, is provided to feed bulk water to an elevated tank (II-3 ET). The elevated tank covers new systems in four GNDs.

Table 5.31 summarizes the existing system (NWSDB and CBOs) and new system for GNDs to be fed from transmission mains and distributed by respective new elevated tanks by Wahalkada

transmission system II A.

Table 5.31 Existing and New Systems Covered by New Elevated Tank

Elevated Tank	NWSDB System	CBO System	New System
II-1 ET (Wahalkada)	-	-	39, 40, 41, 141, 144, 145
II-2 ET (Kahatagollewa)	-	-	35, 36, 37, 38
II-3 ET (Bogahawewa)	1, 2, 3	5, 6, 7, 14	4, 8, 9, 10, 11, 12, 13, 15
II-4 ET (KAH-KEB Median)	-	-	22, 30, 33, 34
II-5 (Kebithigollewa)	16, 17, 18, 23, 27	24, 25	19, 21, 26, 28, 29
Transmission Mains	-	32	-

Note [1)]: GND 2 is covered by both NWSDB and CBO systems

(2) Wahalkada Sub-system IIB

About 15,200 m3/day of treated water from Wahalkada water treatment plant is conveyed to the area under Wahalkada Sub-system IIB of two service centers at Horowpothana and Kahatagasdigiliya.

The Wahalkada Sub-system IIB is composed of three sections as follows:

Section 1: from Wahalkada WTP to Horowpothana pump station along local road

Section 2: from Horowpothana pump station to Kahatagasdigiliya pump station along Route A12

Section 3: from Horowpothana pump station to Rathmalgahawewa elevated tank along Route B282

1) Section 1

The first section is between the Wahalkada water treatment plant (WTP II) and Horowpothana service center (II-4PS / II-7ET), where water transmitted from the water treatment plant is boosted at Weerasole (II-3PS) up to the Horowpothana service center. Due to the long distance between the water treatment plant and Horowpothana, (approximately 30km in length), a booster pump station is provided at Weerasole. Also the specific topographical features along the main route between Weerasole and Horowpothana are taken into account. There are two high points at about 7.4 km from Weerasole and 1.5 km before Horowpothana. The transmission main installed in this section is ND 450 mm in diameter and approximately 15.5 km long and runs along a local road. No main road is available in this area.

Four branches, after Weerasole pump station, are provided along this section. The first branch (point “b”) feeds one existing CBO at about 0.5 km from the pump station, and the second branch (point “c”) conveys water to one existing CBO also at about 1 km downstream from point “b”. The third branch (point “d”) feeds water to one existing CBO at about 4.0 km downstream of branch “c”. The forth branch feeds water to a new elevated tank (II-6 ET: North Horowpothana) at about 8.0 km upstream of Horowpothana service center. The elevated tank covers two new systems in GNDs.

It is noted that transmitted water is planned to receive at higher elevation (9 m high from ground elevation at Horowpothana Pump Station) due to the specific pipeline profile between Weerasole and Horowpothana as mentioned. The hydraulic gradient shall be above the pipeline with ample safety. Transmission main installed at a high point is located only 1.5 km upstream of Horowpothana pump station. Also this is effective to reduce the negative effect caused by surges by sudden stops of pump operation caused by power failure.

2) Section 2

Water received at Horowpothana service center is further pumped in two directions to Kahatagasdigiliya and Rathmalgahawewa elevated tank.

Transmitted water to Horowpothana Service center is lifted to the elevated tank (II-7 ET) located at this service center covers one existing CBO, two GNDs supplied by NWSDB at present and new systems for three GNDs.

Section 2 of transmission main is the route between Horowpothana service and Kahatagasdigiliya service centers along Route A 12. The length of the transmission main in this section is approximately 22.4 km with a diameter of ND 450 mm.

On the way to Kahatagasdigiliya service center, two branches are provided at points “f” and “h”. At the first branch (approximately 0.6 km from Horowpothana pump station), bulk water is fed to one existing CBO. The second branch, at 9.3 km upstream of Kahatagasdigiliya, transmit water to Hamillewa elevated tank (II-10 ET), which covers five existing CBOs and new systems for13 GNDs.

Kahatagasdigiliya elevated tank (II-11 ET), after receiving water lifted from the pump station, transmit bulk water to three (3) GNDs of the existing NWSDB system and nine existing CBOs by gravity. Also it distributes water directly to new systems of seven GNDs.

3) Section 3

Horowpothana pump station transfers water to Rathmalgahawewa elevated tank (II-9 ET) through ND 300 in diameters for approx. 19.2 km. At about 8.4km from Horowpothana pump station (branch g), a branch is provided to feed water to the West Horowpothana elevated tank (II-8) which feeds water to new system of five GNDs.

Table 5.32 summarizes the existing system (NWSDB and CBOs) and new system for GNDs to be covered by respective new elevate tanks by the Mahakanadarawa transmission system.

Table 5.32 Existing and New Systems Covered by New Elevated Tank

Elevated Tank	NWSDB System	CBO System	New System
II-6 North Horowpothana City	-	-	134,135
II-7 Horowpothana	128, 130	133	136, 147, 148
II-8 West Horowpothana	-	-	117,120,121,122,129
II-9 Rathmalgahawewa	-	222, 224, 225, 226	20
II-10 Hamillewa	-	126,209, 210, 211, 212, 213	125, 127, 131, 132, 150, 151, 152, 153, 205, 206, 207, 208
II-11 Kahatagasdigiliya	230, 231, 232	196, 201, 202, 218, 219,	197, 198, 203, 216, 217,

		221, 223, 233, 234	220, 235
Transmission Mains	-	119, 138, 139, 140, 149	-

(3) Transmission Sub-main

Transmission sub-mains are planned from branches of transmission mains to convey water to four new elevated reservoirs (II-4 ET, II-6 ET, II-8 ET and II-10 ET) and the existing CBOs. A total length of transmission sub-main is estimated at about 22 km composing of 0.2 km and 21.8 km in Sub-section A and B respectively, which pipe size is ranging from 250mm to 100mm in diameters.

5.3.6 Distribution System

(1) Method of Estimate

Distribution system, as mentioned earlier, is composed of distribution main and distribution sub-system. **Figure 5.26** illustrates definitive plan of the distribution system.

As shown on **Figure 5.26**, distribution main conveys water from the elevated tank directly to the GND's distribution sub-system which distributes water to each customer directly. On the other hand, the main feeds water to the existing elevated tank of CBO, from where distribution sub-system distributes water to each customer. In both cases, a water meter will be installed at the inlet of either distribution sub-system of new system of GND or existing elevated tank of CBO.

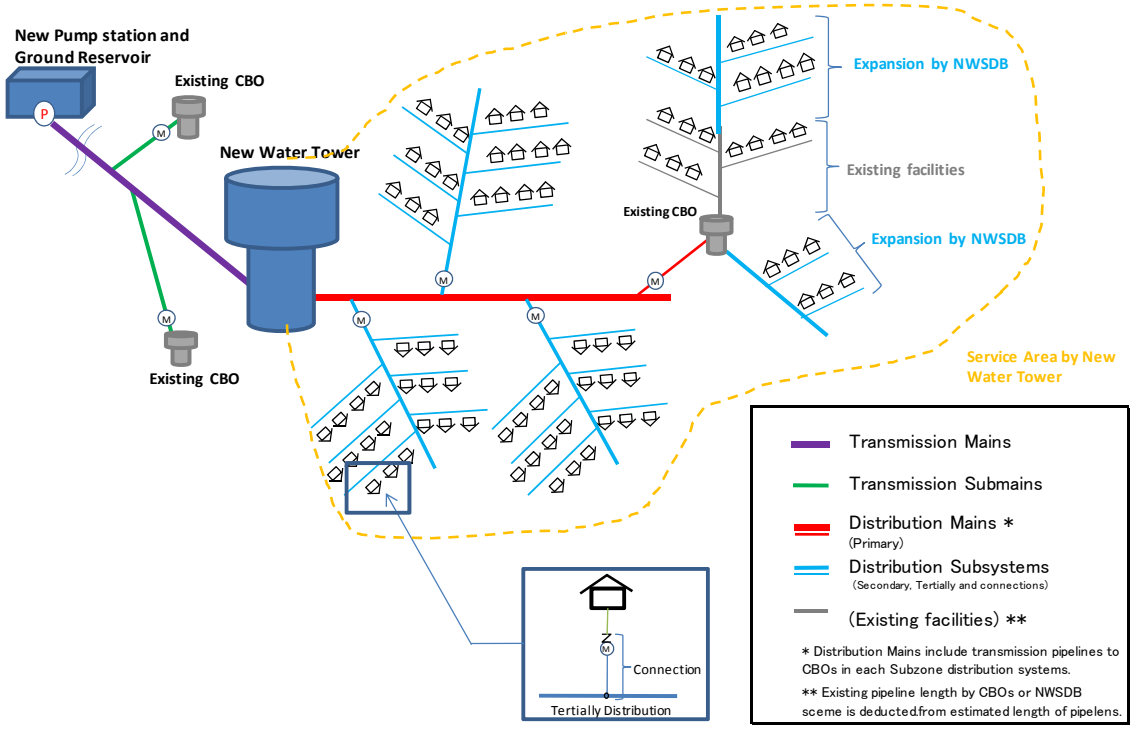


Fig. 5.26 Definitive Diagram of Distribution Systems

1) Distribution Trunk Main

The preliminary design of distribution main is carried out using Google map to obtain distance and ground elevation for analysis of sizing of distribution main for the purpose of cost estimate.

Appendix 5.3 (b) presents general layout of the distribution main for each subzone (11 subzones from elevated tanks) and hydraulic analysis

2) Distribution Sub-system (Refer to **Appendix 5.3 (c)**)

The study on distribution sub-system is carried out mainly for cost estimate purpose based on the following procedures:

- Firstly, select three networks (small, medium and large systems) designed by the existing CBO system. The system capacities of the above systems are 100m3/day as small system, 150m3/day as medium system and 300m3/day as large system.
- Secondly, determine the scale of the distribution systems of 150m3/day for small system, 300m3/day for medium system and 600m3/day for large system as day average demand in 2034.
- Then, by enlarging existing system in length and node discharge in proportion to demand difference, the network model was established. Using the above network model, network analysis was carried out to obtain size and pipeline length.
- Finally, unit length of each size of distribution pipe per service connection was analyzed to obtain pipeline length by size for respective size of network.
- Using above unit length, pipeline length of each size were estimated by GND.

(2) Pipeline length

1) Distribution Main

The sizing of distribution main was determined peak hour demand of year 2034 requirement for new system of GND and day maximum demand of year 2034 for the existing CBO.

Based on the hydraulic analysis of the distribution main, length of each size of pipeline was obtained as presented in **Table 5.34**.

2) Distribution Sub-system

Using unit length to service connection, the pipeline length for each size was estimated for Phase I (year 2024) based on the following considerations:

- Pipeline lengths of 100mm or larger were estimated for year 2034 requirement
- Pipeline lengths of 50mm and 75mm were estimated for year 2024 requirement corresponding to the construction period.

The results of pipeline length for Stage-1 requirement are summarized in **Table 5.34** also. It should be noted that the length in the table is for a year 2024 requirement which corresponds to the project implementation period.

The number of service connections required for the project implementation is also shown in **Table 5.33**.

Table 5.33 Additional Quantities of Service Connections

Items	Mahakanadarawa		Wahalkada		Total
	NWSDB	CBO	NWSDB	CBO	
Service Connection by 2018 (Nos.)	1,647	1,279	2,940	1,529	7,395
Service Connection (2019-2024) (Nos.)	1,134	1,474	1,361	1,580	5,549
Total by 2024 (Nos.)	2,781	2,753	4,301	3,109	12,944

5.3.7 Major Facilities of Transmission and Distribution System

(1) General

Major facilities presented in this sub-section are for civil structures, buildings, and pipelines excluding mechanical and electrical equipment which are described in Sub-sections 5.4 and 5.5 respectively.

The major facilities include transmission mains and sub-mains, ground reservoirs and sumps for pump stations, elevated tanks for distribution, operation buildings and distribution mains. The service center will be provided with a ground reservoir, pump station, operation building and other miscellaneous facilities. Elevated tanks will be placed at strategic locations where a caretaker/operator quarter will be provided.

(2) Ground Reservoir

The retention time of ground reservoirs is taken at two hours for transmission flow as mentioned previously. The ground reservoir, which is a reinforced concrete structure, is divided into two compartments for maintenance. The reservoir is equipped with an inlet and outlet valve installed in each compartment. In addition, a drain pipe with valve and overflow pipe is installed in each compartment.

(3) Pump Station

The pump station, which is comprised of a pump room and electrical/control room, is provided adjacent to the reservoir. The transmission pumps are installed in the pump room and electrical and control equipment are housed in the electrical room, adjacent to the pump room. The pump station is a single story, reinforced concrete structures.

(4) Elevated Tank

The elevated tank having eight hours' retention time is circular in shape, constructed of reinforced concrete, as shown on the standard drawings. The height at low water level is set as 21 m above ground elevation with water depth of 6-7 meters depending on its volume capacity. The elevated tank is supported by a cylinder-shaped concrete structure in which access to the tank and pipe gallery will be provided.

(5) AE/OIC Office

The AE/OIC Office is composed of an AE/OIC office, a customer counter, a zonal laboratory, night duty room, washrooms and an entrance hall. The purpose of the zonal laboratory is water quality testing in transmission and distribution system and therefore it is assumed to be equipped only with testing facilities for residual chlorine, turbidity and pH.

(6) Chlorination House

The chlorination house, equipped with liquid chlorine dosage equipment, is provided at every ground reservoir or elevated tank sites. The house is composed of a chlorine storage room, a chlorination room (chlorine ejector), a booster pump room, chlorine bath for chlorine neutralization and eye shower.

(7) Generator House

Beside the pump station, a generator house is provided for emergency use in case of power supply failure. The generator house will be a single story reinforced concrete structure with an oil storage tank outside.

(8) Staff and Caretaker/Operators' Quarters

Operator/Caretaker's quarters will be constructed at each Ground Reservoir or Elevated Tank sites. In addition, staff quarters will be constructed in the premises of six service centers at Rambewa, Medawachchiya, Bogahawewa, Kebithigollewa, Horowpothana and Kahatagasdigiliya. The quarters are assumed to be of a size suitable for one operator with his family.

(9) Area Engineer's Office with SCADA system/ Costumer Counter

An Area Engineer's Offices with SCADA system will be constructed for each DS division in six service centers at Rambewa, Medawachchiya, Bogahawewa, Kebithigollewa, Horowpothana and Kahatagasdigiliya. The building is combined with the customer service counter for the payment of the bill in each DS division. The Area Engineer's Office with SCADA system/ Customer Counter will be a single story reinforced concrete structure.

(10) Workshop

A workshop is provided for the storages pipes, customer meters and repairing materials and also

space for the maintenance activity. It will be placed at strategic places in service centers such as Medawachchiya, Kebithigollewa and Horowpothana. Workshops will be single story reinforced concrete structures.

(11) Transmission and Distribution Mains

As mentioned previously, the transmission pipeline systems are composed of transmission mains and sub-mains. The transmission mains form a grid system between the water treatment plant, service centers and elevated tanks. Transmission sub-mains will be branched from the transmission mains to the elevated tanks located at strategic locations to cover respective GNDs for distribution.

The distribution system is composed of distribution main and sub-system as mentioned previously. The distribution main is installed between the elevated tanks to the respective GND at their receiving points, from where the distribution sub-system (network) will be installed to distribute water to the respective consumers.

The summary of major facilities of transmission and distribution system is presented in **Tables 5.34 to 5.36** and **Figure 5.27** below:

Table 5.34 Summery of Pipelines of Transmission and Distribution System

Items/ Length of Pipelines (km)	Nominal Diameter (mm)										**Total**
	50	75	100	150	200	250	300	350	400	450	
I. Mahakanadarawa System											
1) Transmission Mains	-	-	-	-	-	7.6	7.5	3.3	13.1	10.8	**42.3**
2) Transmission Sub-mains	-	-	23.0	5.9	21.6	0.3	-	-	-	-	**50.8**
3) Distribution Mains	-	-	7.0	55.5	41.2	26.1	4.3	5.6	1.7	-	**141.4**
4)-1 Distribution Sub-System (NWSDB scheme)	80.2	25.6	59.7	31.3	4.8	-	-	-	-	-	**201.6**
4)-2 Distribution Sub-System (Existing CBO scheme)	130.6	113.8	49.1	18.8	2.8	-	-	-	-	-	**315.1**
Subtotal*	**210.8**	**139.4**	**138.8**	**111.5**	**70.4**	**34.0**	**11.8**	**8.9**	**14.8**	**10.8**	**751.2**
II. Wahalkada System											
1) Transmission Mains	-	-	-	-	-	-	20.2	33.7	20.8	42.6	**117.3**
2) Transmission Sub-mains	-	-	18.6	0.1	5.0	0.6	-	-	-	-	**24.3**
3) Distribution Mains	-	-	46.0	138.0	72.9	43.7	11.7	9.8	4.6	-	**326.7**
4)-1 Distribution Sub-System (NWSDB scheme)	148.5	63.2	127.2	32.8	6.7	-	-	-	-	-	**378.4**
4)-2 Distribution Sub-System (Existing CBO scheme)	102.7	75.7	48.3	23.4	4.5	-	-	-	-	-	**254.6**
Subtotal*	**251.2**	**138.9**	**240.1**	**194.3**	**89.1**	**44.3**	**31.9**	**43.5**	**25.4**	**42.6**	**1101.3**
Total	**462.0**	**278.3**	**378.9**	**305.8**	**159.5**	**78.3**	**43.7**	**52.4**	**40.2**	**53.4**	**1852.5**

Note [1]: length of transmission main in the above table includes additional 5% of estimated length that will be allowed when latent site conditions are considered.

[2]: lengths of transmission sub-main and distribution main in the above table include additional 10% of estimated length that will be allowed since the estimate is based on Google map which is considered as not accurate enough.

[3]: length of distribution sub-system in the above table includes additional 10% of estimated length that will be allowed since the estimate is based on the plot type design based on network model which is considered not accurate enough

[1]~[3]: HDPE, **[4]-[1]~[2]:** PVC

* Subtotal of each items:

1) Transmission Mains: **159.6 km**, 2) Transmission Sub-mains: **75.1 km**, 3) Distribution Mains: **468.1 km**

4) Distribution Sub-System (NWSDB scheme): **580.0 km**, (Existing CBO scheme): **569.7 km**

Table 5.35 Summery of the Facilities to Be Constructed

System	Site	Elevated Tank	Ground Reservoir	Pump House	Operational Complex *1	Chlorinator Building	Generator	Workshops	Quarters for Staff	Quarters for Operator	Surge Tank (100m3)
Mahakanadarawa	Rambewa	1,250m3	1,500m3	✓	✓	✓	✓		✓	✓	
	Medawachchiya		1,000m3	✓	✓*2 *3	✓	✓	✓	✓	✓	
	Issinbassagala	2,000m3				✓				✓	
	Ethakada	750m3				✓				✓	
	East Rambewa	250m3				✓				✓	
	Mahakanadarawa ~Rambewa										✓✓
Wahalkada South	Wahalkada	500m3				✓				✓	
	Kahatagollewa	250m3	1,000m3	✓		✓	✓			✓	
	Bogahawewa	2,000m3			✓	✓			✓	✓	
	KAH-KEB Median	250m3				✓				✓	
	Kebithigollewa	750m3	500m3	✓	✓*3	✓	✓	✓	✓	✓	
Wahalkada North	Weerasole		1,500m3	✓		✓	✓			✓	
	North Horowpothana	250m3				✓				✓	✓
	Horowpothana	500m3	1,000m3	✓	✓*3	✓	✓	✓	✓	✓	
	West Horowpothana	750m3				✓				✓	
	Rathmalgahawewa	500m3				✓				✓	
	Hamillewa	1,250m3				✓				✓	
	Kahatagasdigilliya	1,500m3	500m3	✓	✓	✓	✓		✓	✓	
Total		**15**	**7**	**7**	**6**	**17**	**7**	**3**	**6**	**17**	**3**
Symbol											

*1 Lab., OICs Office, Customer Counter, Room for Crews

*2 Satelite Office is to be included

*2 OIC Office should be replaced to Area Engineers Office

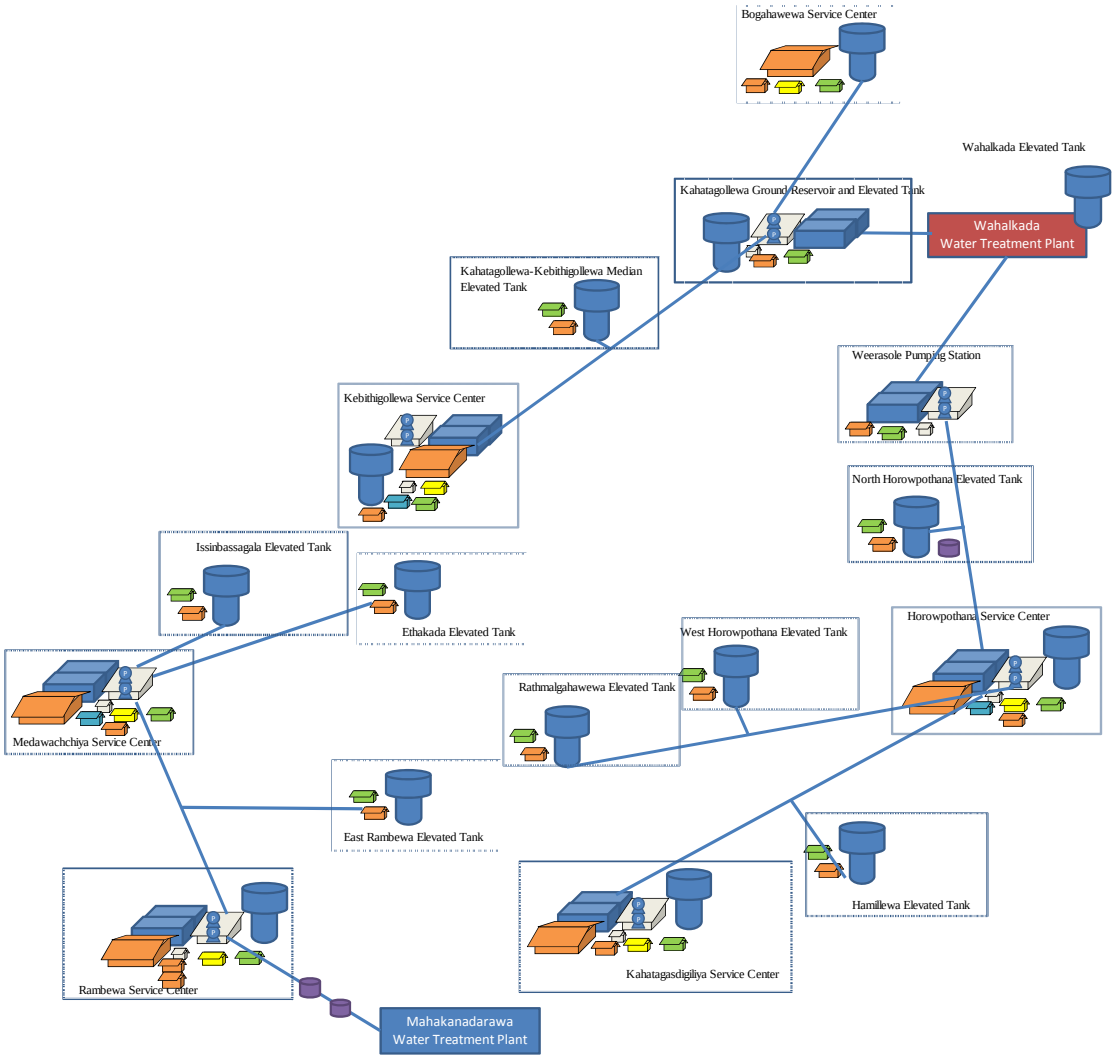


Figure 5.27 Summary Diagram of the Facilities to be Constructed

Table 5.36 Major Facilities of Transmission and Distribution System

DS Division	Land Location	Facilities to be constructed
Rambewa	Rambewa *	Elevated Tank (1,250m3) Ground Reservoir (1,500m3) Pump House / Power Control Unit Generator Operational complex — Zonal Lab Operational complex — OIC Sub-office with SCADA monitor Operational complex — Customer Counter Operational complex — Room for crews Chlorinator Building Staff Quarters Caretaker/Operator Quarters Guard House Parking/Bowser Station
	East Rambewa	Elevated Tank (250m3) Chlorinator Building Caretaker/Operator Qts
	Surge Tank A	One Way Surge Tank (100m3)
	Surge Tank B	One Way Surge Tank (100m3)
Medawachchiya	Medawachchiya *	Ground Reservoir (1,000m3) Pump House / Power Control Unit Generator Operational complex - Zonal Lab Operational complex - Area Eng. office with SCADA monitor Operational complex - Customer Counter Operational complex - Room for crews Chlorinator Building Workshop Staff Quarters Caretaker/Operator Quarters Guard House Parking/Bowser Station
	Issinbassagala	Elevated Tank (2,000m3) Chlorinator building Caretaker/Operator Qts
	Ethakada	Elevated Tank (750m3) Chlorinator Building Caretaker/Operator Qts
Horowpothana	Wahalkada	Elevated Tank (500m3)
	Weerasole	Ground Reservoir (1,500m3) Chlorinator Building Generator Caretaker/Operator Qts Parking/Bowser Station
	Horowpothana *	Elevated Tank (500m3) Ground Reservoir (1,000m3) Pump House / Power Control Unit Generator Operational complex -Zonal Lab Operational complex -BCustomer Counter

DS Division	Land Location	Facilities to be constructed
		Operational complex — Room for crews Chlorinator Building Workshop Staff Quarters Caretaker/Operator Quarters Guard House Parking/Bowser Station
	North Horowpothana City	Elevated Tank (250m3) Chlorinator Building Caretaker/Operator Qts One Way Surge Tank Parking/Bowser Station
	West Horowpothana	Elevated Tank (750m3) Chlorinator Building (100m2) x1 Caretaker/Operator Qts (100m2) x1
	Hamillewa	Elevated Tank (1,250m3) Chlorinator Building Caretaker/Operator Qts
Kahatagasdigiliya	Kahatagasdigiliya *	Elevated Tank (1,500m3) Ground Reservoir (500m3) Pump House / Power Control Unit Generator OIC Sub-office with SCADA monitor / Customer Counter Operational complex - Zonal Lab Operational complex - OIC Sub-office with SCADA monitor Operational complex - Customer Counter Operational complex - Room for crews Chlorinator Building Staff Quarters Caretaker/Operator Quarters Guard House Parking/Bowser Station
	Rathmalgahawewa	Elevated Tank (500m3) Chlorinator Building Caretaker/Operator Qts
Kebithigollewa	Kebithigollewa *	Elevated Tank (750m3) Ground Reservoir (500m3) Pump House / Power Control Unit Generator Operational complex - Zonal Lab Operational complex - Area Eng. office with SCADA monitor Operational complex - Customer Counter Operational complex - Room for crews Workshop Chlorinator Building Staff Quarters Caretaker/Operator Quarters Guard House Parking/Bowser Station
	KEB-KAH Median	Elevated Tank (250m3) Chlorinator Building

DS Division	Land Location	Facilities to be constructed
		Caretaker/Operator Quarters
	Kahatagollewa	Ground Reservoir (1,000m3)) Elevated Tank (250m3) Chlorinator Building Caretaker/Operator Quarters
Padaviya	Bogahawewa *	Elevated Tank (2,000m3) Operational complex - Zonal Lab Operational complex - OIC Sub-office with SCADA monitor Operational complex - Customer Counter Operational complex - Room for crews Chlorinator Building Staff Quarters Caretaker/Operator Quarters Guard House Parking/Bowser Station

* Service Center

5.4 Mechanical Equipment

5.4.1 Design Criteria of Pumping Stations

Design of equipment and the planning of pumping stations are based on criteria issued by NWSDB as shown below, and from the survey results of the existing pump stations.

(1) Design Manual D5, Mechanical, Electrical and Instrumentation Aspects of Water Supply Design March 1989
(2) Procurement of Supply and Install Mechanical & Electrical Equipment and Accessories for Water Supply Scheme
(3) NWSDB/SBD/S&I/Water Pump: Specifications for Horizontal Shaft Driven Double Suction Pumping Sets and Accessories
(4) NWSDB/SBD/S&I/Water Pump: Specifications for End Suction Vertical Delivery Back Pull out Centrifugal Pumping Sets and Accessories

5.4.2 Planning of Pump Station

The pump stations particularly take the following points into consideration:
(1) Energy conservation
Design systems to minimize use of energy and provide better energy efficiency, such that the pumps are effectively operated and save electric power.
(2) Operation
The facilities in pumping stations should allow easy operation and maintenance.

(3) Water intake

It is considered as the plan under which the required water for the city can be certainly taken through one year from an irrigation canal and a measure of discharging the sand/silt deposit on intake waterways.

(4) Water Hammer

Water hammer analysis is conducted such that water can be transmitted safely.

5.4.3 Intake Facility

Water taken from an irrigation canal is conveyed to the pump suction pit by an open channel. In the pump suction pit, it is necessary to lower the bottom from the level of irrigation canal in order to keep air from going into a pump, thus sand/silt is deposited in the pump suction pit. Therefore, a facility which discharges the sand/silt from the pump pit to a sand sedimentation pond is planned. After discharging periodically to the pond by pump, the clear supernatant liquid is returned to the irrigation canal, and the sand/silt which is deposited is removed manually by workers.

The intake facility includes the following:

(1) Gate equipment which is installed at the intake point for stopping water at drainage work

(2) Submersible drainage pump with a beating impeller, which exhausts the sand/silt

(3) Gantry crane for lifting and moving a submersible drainage pump on the pump suction pit

(4) Sand sedimentation pond in which water and sand/silt are separated

The requirement for grit removal equipment shall be studied and determined during the detailed design stage based on the status of silt deposition in raw water confirmed.

5.4.4 Pump

The pump floor elevation shall be set so as not to have the damage at the time of flood based on the study during the detailed design stage.

Control method of transmission systems shall be studied and determined during the detailed design stage.

(1) Operation system of pump

1) Control of intake pump

Intake pump stations are built in or near the site of the water treatment plant, and operation is performed from the administration building of the plant. Since the change in water supply demand from when operation will start in 2018 to the target year of 2034, or roughly in the range of 25% (of the 2034 demand) to 100%, the pumps need to operate efficiently,

corresponding to the change in demand. Therefore, an operating system that the pump speed is adjusted according to the change in water demand, which is more effective than operation method of pump number and valve control, is adopted. Speed control (VVVF system) equipment is equipped in each pump panel, and the pump speed is determined according to the required amount of water from the administration building of the water treatment plant.

2) Control of transmitting pump with a motor rating of 15kW or more

Although the number control of pumps is carried out at the existing pump station, looking at the water level of the transmitted tank, the power loss becomes large. Therefore, speed control which can smoothly supply water of the required amount to suit the demand is adopted.

Operation of pumps is carried out using a system which adjusts the speed manually, based on the water level signal from the water tank, which is the same method as is used for existing pumps. A water level meter is installed in each water tank and the SCADA system sends the water level signal to the pump station as discussed in Clause 5.5.

3) Control of transmitting pump with a motor rating of 11kW or less.

For the pump with motor rating such as 11kW or less, the number control of pumps by discharge water levels is selected for that the energy-conservation advantage is small.

(2) The number of pumps

It is desirable to select a number pumps (4) because the water demand will increase from 25% (of 2034 demand) in 2018 to 100% in 2034. However, since the speed control system is used, it is possible to reduce the number of pumps. Therefore, the number of pumps is decided as shown in **Table 5.37.**

All essential pump systems include one standby pump/motor set to provide.

Table 5.37 Number of Pump Installed

Application	To be installed in initial stage		To be installed in future stage	Reason for selection
	Duty pump	Standby pump		
Transmission pumps	One (1) set	One (1) set	One (1) set	
Intake pumps	Two (2) sets	One (1) set	One (1) set	Intake pumps are required to have higher flow controllability.

(3) Type of pump and materials

The horizontal pump, which has easier maintenance than a vertical pump, is selected. For that purpose, the pump stations and water tanks are separated from each other.

The pump speed is selected as 1500 min^{-1} from the standard pump range because of higher efficiency compared to high-speed pumps operating at 3000 min^{-1}.

The materials of the main parts of a pump are as follows, taking into consideration the possibility of corrosion by chlorine.

1) Pump shaft : Stainless Steel
2) Impeller : Stainless Steel Casting
3) Casing : Cast Iron
4) Shaft Sleeve : Stainless Steel

5.4.5 Electric Motor

(1) Type of electric motor

The electric motor is directly coupled with the pump, and the specification of the motor is according to the requirements of "NWSDB/SBD/S&I/Water Pump".

1) Type of motor : Squirrel cage induction motor, indoor
2) Starting method : Variable speed drive for 15kW or more
: Soft start for 11kW or less
3) Voltage : 400V ±6%
4) Frequency : 50Hz
5) Insulation : F-class
6) Temperature rise : B-class
7) Enclosure : IP55
8) Speed : 4-pole

5.4.6 Selection of Pump

(1) Water transmission routes

The water transmission routes in Mahakanadarawa area are shown as **Figure 5.28** and the water transmission routes in Wahalkada are as shown in **Figure 5.29** and **Figure 5.30.** Pump stations will be constructed at intake places, near ground reservoirs and in the treatment plants.

Table 5.38 Pump Station and Pump No. in the Mahakanadarawa Area

Pump station	Pump No.
The Mahakanadarawa	Pa, Pb
The Rambewa	Pc, Pd
The Medawachiya	Pe, Pf

Table 5.39 Pump Station and Pump No. in the Wahalkada Area

Pump station	Pump No.
The Wahalkada	Pg, Ph, Pi, Po
The Kahatagollewa	Pj, Pk, Pl
The Kebithigollewa	Pm
The Weerasole	Pp
The Horowpohana	Pq, Pr, Ps
The Kahatagasdigiliya	Pt

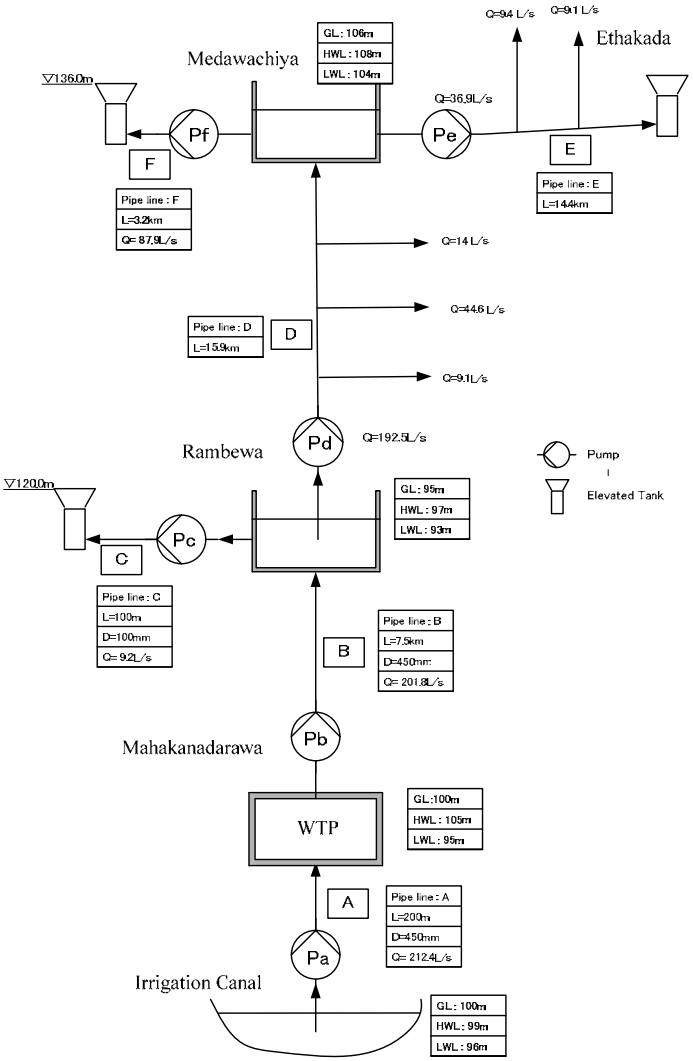


Figure 5.28 Water Transmission Flow for Mahakanadarawa

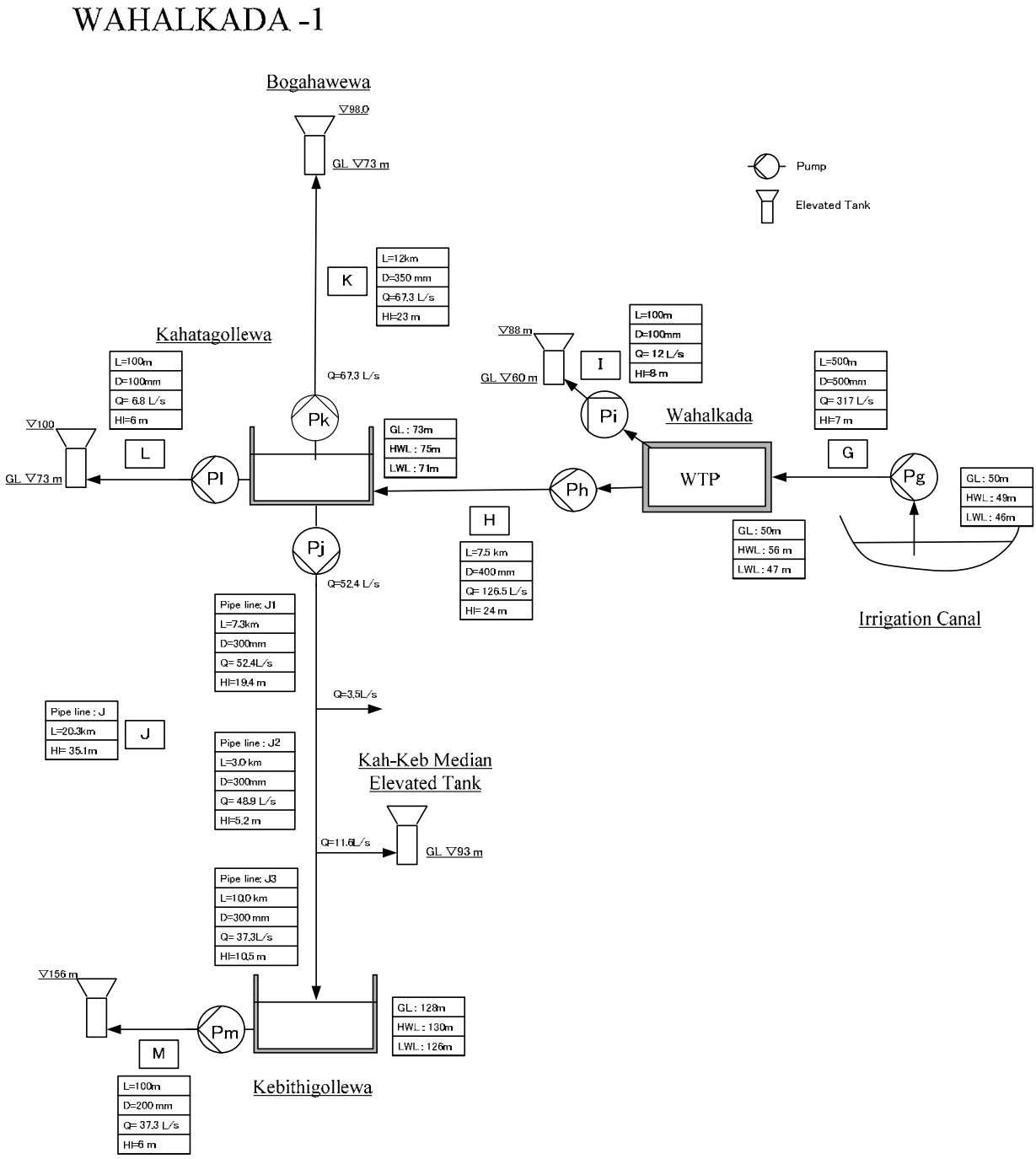


Figure 5.29 Water Transmission Flow for Wahalkada Area-1

WAHALKADA -2

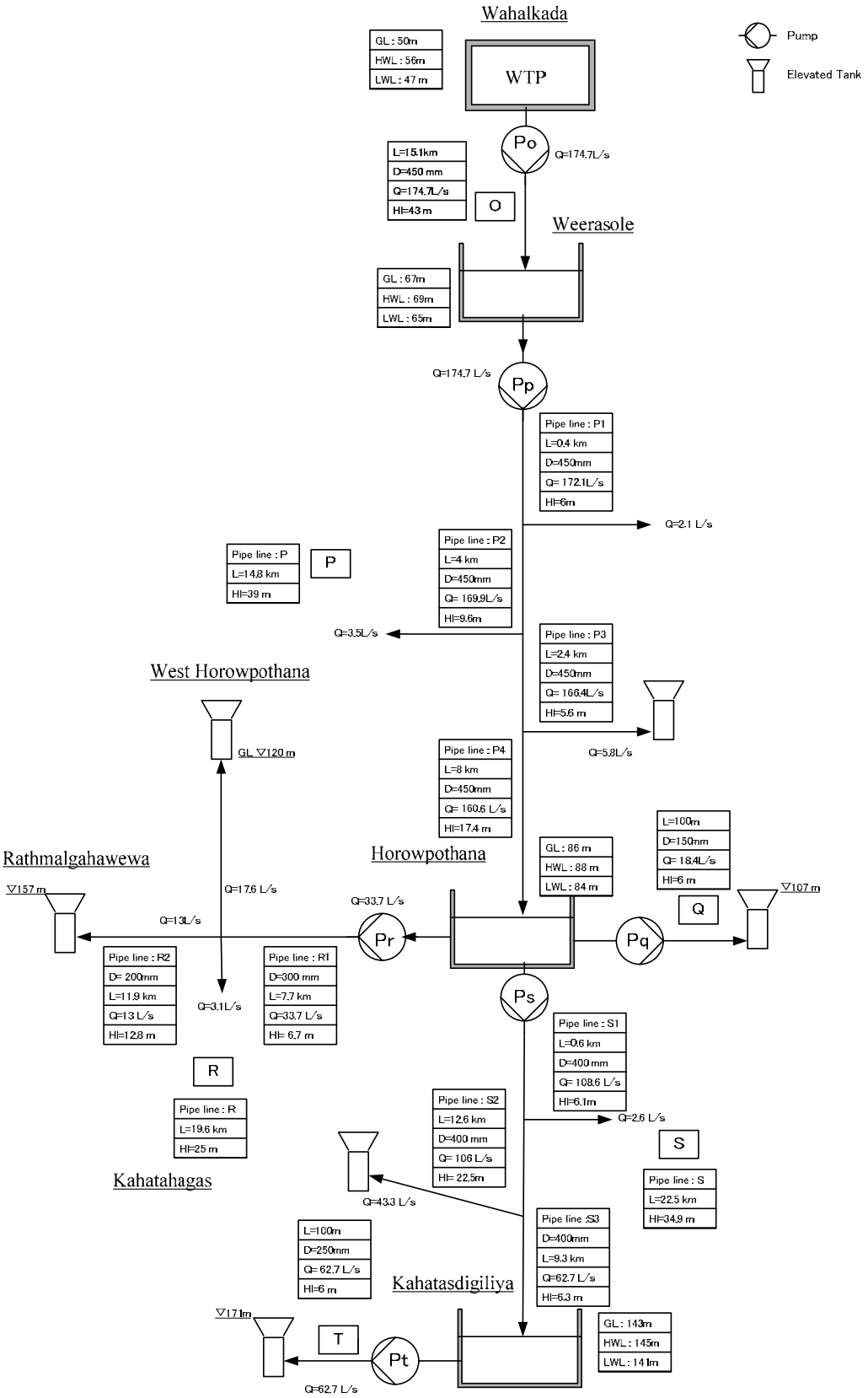


Figure 5.30 Water Transmission Flow for Wahalkada Area-2

(2) Calculation of total head

The amount of water supply, friction loss and total pump head of each transmission pipeline are shown in **Tables 5.40 to 5.42**.

Table 5.40 Calculation of Total Head for Mahakanadarawa

Item		Unit	Pa	Pb	Pc	Pd	Pe	Pf
Total flow	QT	m3/s	0.212	0.202	0.030	0.172	0.037	0.088
Suction level	Hs	M	96	97	93	93	104	104
Discharge level	Hd	M	106	97	123	108	151	139
Actual head	Ha	M	10	0	30	15	47	35
Length of pipe	L	M	200	7,500	100	15,900	14,400	3,200
Pipe diameter	D	M	0.45	0.45	0.15	0.45	0.25	0.35
Velocity	Dv	m/s	1.336	1.269	1.704	1.079	0.752	0.914
Friction loss	Hl1	M	1	25	2	40	39	8
Other loss	Hl2	M	5	5	5	5	5	5
Total loss	HL	M	6	30	7	45	44	13
Total head	H	M	16	30	37	60	91	48

Table 5.41 Calculation of Total Head for Wahalkada-1

Item		Unit	Pg	Ph	Pi	Pj	Pk	Pl	Pm
Total flow	QT	m^3/s	0.317	0.1265	0.012	0.0524	0.0673	0.0068	0.0373
Suction level	Hs	M	46	47	47	71	71	71	126
Discharge level	Hd	M	56	75	88	130	98	100	156
Actual head	Ha	M	10	28	41	59	27	29	30
Length of pipe	L	M	500	7,500	100	20,300	12,000	100	100
Pipe diameter	D	M	0.5	0.4	0.1	300	0.35	0.1	0.2
Velocity	Dv	m/s	1.615	1.007	1.529	-	0.700	0.866	1.188
Friction loss	Hl1	M	2	19	3	30	18	1	1
Other loss	Hl2	M	5	5	5	5	5	5	5
Total loss	HL	M	7	24	8	35	23	6	6
Total head	H	M	18	52	49	95	50	35	36

Table 5.42 Calculation of Total Head for Wahalkada-2

Item		Unit	Po	Pp	Pq	Pr	Ps	Pt
Total flow	QT	m^3/s	0.1747	0.1747	0.018	0.034	0.1086	0.0627
Suction level	Hs	M	47	65	84	84	84	141
Discharge level	Hd	m	69	88	107	157	145	171
Actual head	Ha	m	22	23	23	73	61	30
Length of pipe	L	m	15,100	14,800	100	19,600	22,500	100
Pipe diameter	D	m	0.45	450	0.15	300/200	400	0.25
Velocity	Dv	m/s	1.099	-	1.042	-	-	1.278
Friction loss	Hl1	m	38	34	1	20	30	1
Other loss	Hl2	m	5	5	5	5	5	5
Total loss	HL	m	43	39	6	25	35	6
Total head	H	m	66	62	29	98	96	36

(3) Specification of pump

It is necessary to plan selection of a pump so that cavitation does not occur at operating points. Therefore, it is desirable to select a pump so that the pump capacity is located at smaller capacity than the pump design capacity. The specifications of pumps are shown in **Tables 5.43 to 5.45**.

Table 5.43 Specification of Pump for Mahakanadarawa

Item		Unit	Pa	Pb	Pc	Pd	Pe	Pf
Type of pump			DV	DV	MC	DV	MC	ES
Diameter	D	mm	200	200	100	200	100	150
Number of Pump Duty + spare(1)			3	2	2	2	2	2
Pump capacity	QP	M^3/min	4.25	6.05	0.90	5.15	1.11	2.64
Total head	H	m	16	30	37	60	91	48
Pump speed	N	min^{-1}	1475	1475	1475	1475	1475	1475
Motor output	kW	kW	15	45	11	90	30	37

DV: Double suction volute pump
MC: Multi-stage centrifugal pump
ES : End suction volute pump

Table 5.44 Specification of Pump for Wahalkada-1

Item		Unit	Pg	Ph	Pi	Pj	Pk	Pl	Pm
Type of pump			DV	DV	MC	MC	ES	MC	ES
Pump diameter	D	mm	250	200	65	125	125	65	125
Number of pump Duty + spare(1)			3	2	2	2	2	2	2
Pump capacity	QP	m^3/min	6.34	3.80	0.36	1.57	2.02	0.20	1.12
Total head	H	m	18	52	49	95	50	35	36
Pump speed	N	min^{-1}	1475	1475	1475	1475	1475	1475	1475
Motor output	kW	kW	30	55	5.5	45	30	3.7	15

Table 5.45 Specification of Pump for Wahalkada-2

Item		Unit	Po	Pp	Pq	Pr	Ps	Pt
Type of pump			DV	DV	MC	MC	MC	ES
Pump diameter	D	mm	250	250	80	100	150	125
Number of pump Duty + spare(1)			2	2	2	2	2	2
Pump capacity	QP	m^3/min	5.24	5.24	0.55	1.01	3.26	1.88
Total head	H	m	66	62	29	98	96	36
Pump speed	N	min^{-1}	1475	1475	1475	1475	1475	1475
Motor output	kW	kW	90	90	5.5	30	75	22

(4) Spare parts

Spare parts are equipped at each pump as follows, according to “NWSDN/SBD/S&I/Water Pump: Specification, October-Version 2”.

a. Impeller	: 1 set
b. Shaft sleeves	: 2 sets
c. Pump bearings	: 2 sets
d. Motor bearings	: 1 set
e. Impeller neck rings	: 1 set
f. Casing wear rings	: 1 set
g. Coupling bushes	: 1 set
h. Gland	: 1 set
i. Gland packing	: 1 set
j. All gaskets, seals and packings	: 2 sets
k. Stuffing box gland with nuts & bolts	: 1 set

5.4.7 Other Equipment

The following equipment is installed in each pump station.

(1) Overhead traveling crane
All motions of traverse, travel and lifting are manually operated.
(2) Flow control valve
One flow control valve is installed at each transmission pipe.
(3) Valves for suction and discharge of pump
Since pumps are installed in a position lower than the low water level of suction tank, a sluice valve is equipped at the pump suction side, and a check valve and a motor operated valve in the pump discharge side.
(4) Indoor piping
The indoor piping is made from Mild Steel, with flanges of ISO PN16.
(5) Drain pumps in pump room
One drain pump with one standby is provided.

5.4.8 Measures against Water Hammer

(1) Water hammer measure system
The general features of the different surge protection measures are shown in **Table 5.46**.

Table 5.46 Comparison of Measure System

Measure system	General feature
One-way Surge tank system	Although it is a simple method, the installation space is needed on the pipeline, and in order that the setting position may be left distantly from the pump station. There is a fault that maintenance management is difficult.
Surge vessel system	It is not suitable for the pipeline form such as passing the mountain, flat and going-down slope. It is expensive, and it is not easy to maintain because this system consists of many equipment and instruments. In case of bladder accumulator type, the selection which meets actual requirements such as size, gas volume and pressure is difficult.
Flywheel method	Maintenance management is very easy and reliable, and it is economical. The effect is almost the same as surge vessel system.
Air valve	When negative pressure arises in pipeline by down surge, it is the simplest system that puts air in a pipe and relieves negative pressure. However, if a pump is again started in the condition where air remains in pipe, there is a danger of air hammer generating. The reliability of the functional maintenance is very low.

It is judged from the above table that the flywheel method is the most appropriate system and this is adopted. The main reasons for this are easy maintenance management and cost saving.

However, if negative pressure cannot be prevented by using the flywheel system only, in cases such as pipelines passing over a mountain, the one-way surge tank is installed at the high point of the pipeline.

(2) Pipelines to be analyzed

It is expected that the dangerous negative pressure (below -5m) for the transmission pipelines sending water to the elevated tanks does not occur, because the water level in elevated tanks is 20m to 25m higher than pipeline level. Therefore, the calculations of surge analysis are conducted for the pipelines from pump stations to ground reservoirs. The water transmission flows are shown in **Figures 5.30 to 5.32**, and the pipelines analyzed are listed as follows.

Mahakanadarawa Area ：B and D pipelines
Wahalkada Area-1 ：H and J pipelines
Wahalkada Area-2 :O, P and S pipeline

(3) Result of water hammer analysis

The negative pressure which result from the down surge makes higher than dangerous negative pressure -5m in consideration of calculation or a survey error. The results of surge analysis and measure for preventing the dangerous pressure are shown in **Tables 5.47 to 5.49**.

Table 5.47 Measure Method for the Mahakanadarawa Area

Pipe No.	From	To	Pipe length (m)	Dia. (mm)	Flow (L/s)	Result of analysis and measure
B	WTP	Rambewa	7,500	450	202	Dangerous negative pressure occurs. Since there is a high ground point in the middle of pipeline, it is necessary to install a one-way surge tank. Measure with a one-way surge tank and with flywheel GD^2 50kgm^2
D	Rambewa	Medawachiya	15,900	450, 400	172	Dangerous negative pressure occurs. Measure with flywheel GD^2 100kgm^2

WTP: Water treatment plant

The analysis of water hammer is attached in APPENDIX

Table 5.48 Measure Method for the Mahakanadarawa Area-1

Pipe No.	From	To	Pipe length (m)	Dia. (mm)	Flow (L/s)	Result of analysis and measure
H	WTP	Kahatagollewa	7,500	450	127	Dangerous negative pressure occurs. Measure with flywheel GD^2 150kgm^2
J	Kahatagollewa	Kebithigollewa	20,300	450, 400	52.4	No dangerous negative pressure

Table 5.49 Measure Method for the Wahalkada Area-2

Pipe No.	From	To	Pipe length (m)	Dia. (mm)	Flow (L/s)	Result and measure
O	WTP	Weerasole	15,100	450	175	Dangerous negative pressure occurs. Measure with flywheel GD^2 150kgm^2
P	Weerasole	Horowpothana	14,800	450	175	Dangerous negative pressure occurs. Since there are high ground points in the middle of pipeline, it is necessary to install a one-way surge tank. Measure with one surge tank and flywheels GD^2 200kgm^2
S	Horowpothana	Kahatagasdigiliya	22,500	400	109	Dangerous negative pressure occurs. Measure with flywheel GD^2 100kgm^2

(4) The proposed systems

The proposed systems consist of the following equipment.

1) Flywheel method

A flywheel is equipped between a pump and an electric motor as shown in **Figure 5.31.**

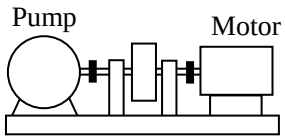


Figure 5.31 Flywheel

2) One-way Surge Tank

Composition of one-way surge is shown in **Figure 5.32**. The tank is installed 3 m above ground.

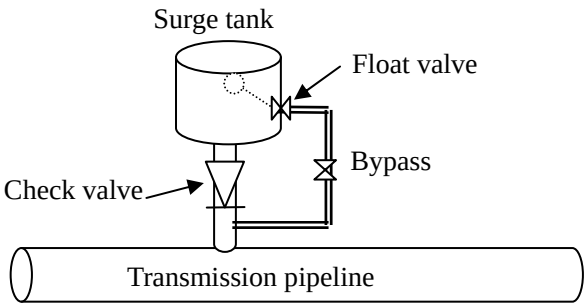


Figure 5.32 One-way Surge Tank

5.5 Electrical Equipment

5.5.1 Electricity Power Supply

(1) Incoming Facilities

In Democratic Socialist Republic of Sri Lanka, electricity power generating, transmission, and distribution are managed by Ceylon Electricity Board (here in after: CEB). No grid-station of CEB is furnished in North Central of Anuradhapura area, and 33 kV power transmission lines are supplied by over head lines from Anuradhapura grid-stations.

The power distribution to water supply facilities will be classified into the categories mentioned below by CEB. In these categories, Low voltage means three-phase four lines 50Hz 440/230V while Medium voltage means three-phase three lines 50Hz 11/33kV. In this project, 33kV will be applied.

Category I-1: This category shall apply to the consumers who require 400/230 nominal voltage at individual incoming point and whose power demand is less than or equal to 42kVA. If there is an existing transformer supplied by CEB close to the incoming point (within 400m), the consumer will not have to bear the installation cost. But if not, the consumer will be required to install a new transformer and bear a half of installation cost.

Category I-2: This category shall apply to the consumers who require 400/230 nominal

voltage at individual incoming point and whose power demand exceeds 42kVA. In case the power demand exceeds 42kVA and up to 63kVA, incoming medium voltage line and power transformer shall be installed by CEB and fifty percent of the installation cost shall be owned by consumer. In case the power demand exceeds 63kVA, full of those costs shall be borne by consumer. Concerning metering, over 42kVA up to 1MVA, kilo watt-hour will be measured at the secondary side of transformer by CEB metering device, and exceeding 1MVA, primary side of transformer will be measured by it. No upper limitation is set for this contract demand.

Category I-3: This category shall apply to the consumers who require 11/33kV at individual incoming point. In this case, power receiving facility shall be constructed by the customer and power receiving capacity will have no limitation except for the lower side limitation, 1 MVA.

However, the construction cost of power receiving facility will be expensive because the power distribution voltage applied in the North Central area is 33kV. So it is not suggested to apply this category I-3 even if the power rate is lower than Category I-2 by 0.2 rupees per kilo watt-hour., except for the facility including high-voltage motors.

Elevated tanks and GND Transmission pump stations, which have no main power loads other than Chlorination booster pumps, will be applied General Purpose (GP-1). Other facilities such as water treatment plants and ground water reservoirs will be applied Category I-1 or Category I-2 mentioned above. However, after the site survey, there is not existing transformer near the low demand ground reservoirs; Kahatagasdigiliya and it is better to install the transformer for own use not to infect the voltage fluctuation to surrounding consumers. So, all facilities except for elevated tank sites; Ishinbassakgala, Etakada, Bogahawewa, Kah-Keb Medium, North Hor.Cith, West Hor., Rathmalgahawewa and Hamillewa, and GND Transmission Pump sites will be applied Category I-2.
In the case of Category I-2, housing for the power measurement panel will be installed and owned by customer based on the CEB standard drawings.

According to the comments of CEB, there is no actual example of double power incoming system so there is no choice but to install single power incoming system for all medium voltage receiving facilities.

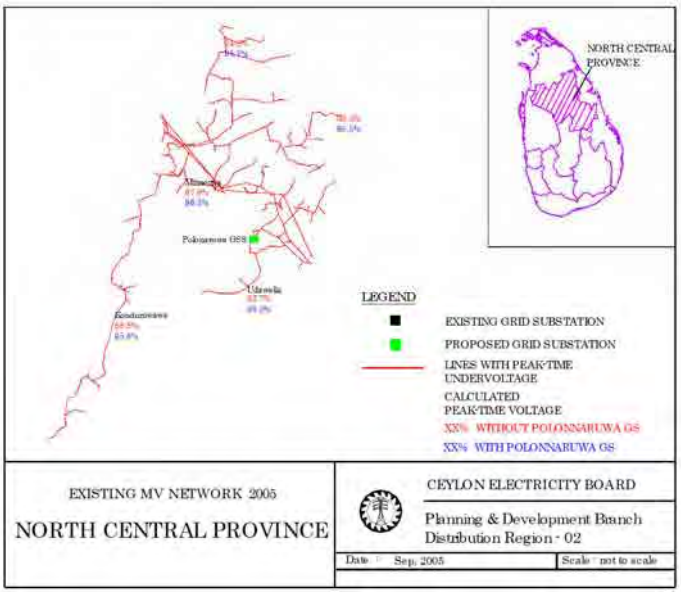
Electricity rate discount based on power factor correction is not set up in the tariff. On the other hand, demand rate will be discounted corresponding to the power factor correction since the rate is determined by kVA. On this design, static capacitor for power factor correction will not be applied because of using VSD (Variable Speed Driver) for all transmission pumps, while it is

described to install static capacitor to the loads whose capacity is more than 25kW to improve the power factor from 85% to 95% on the Specifications for Horizontal Shaft Driven Double Suction Pumping Sets and Accessories (here in after: NWSDB Specifications).

The installation cost for 33kV medium voltage distribution line is 2.4MRs per 1km, and this cost is increasing year by year as reported by CEB.

(2) Reliability of electricity power source

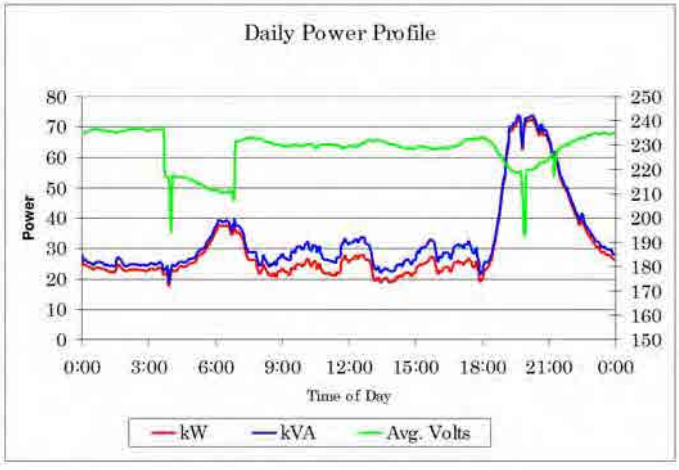
The study team investigated about blackout continuation time, voltage fluctuation and frequency fluctuation etc. to check the reliability of electricity power source to CEB. But there was no answer from the CEB in the study period. From the annual report of CEB in 2009, it is reported that: One of the key tasks the planning area was improving the reliability of supply provided to its customers. In this respect, many actions were taken to improve operation of Distribution Control Centers, Automation of Distribution network operations. During the year, the average failure rate of MV network of the region was 5.7 per 100 line km. per month. The same for LV network was 14.9 per 100 line km. per month. The corresponding figures for the previous year (2008) were 5.8 and 16.7 respectively. The main causes of the failures were vegetation, brunches from distance, burning of jumpers and aging of components.



Source: "Rural Electrification and Network Expansion Strategy", ADB Sept.2006"

Figure 5.33 Peak Time Under Voltage Area

On the other hand, from the Final Phase 2 Report of Rural Electrification and Network Expansion Strategy ADB in September 2006, the data logging survey was undertaken with the support of CEB, in five villages in representative areas throughout Sri Lanka. From this report, from four o'clock to seven o'clock in the morning, seven percent of voltage drop was come up and from seven o'clock to nine o'clock in the



Source: "Rural Electrification and Network Expansion Strategy", ADB Sept.2006"

Figure 5.34 Daily Power Profile in Anuradhapura

evening, about four percent of voltage drop was came up. (See **Figure 5.34**)

The voltage drop brings on the excess current to the motor and it involves the risk of motor burn out. A voltage monitor should be installed in the main low voltage panel secondary side of main transformer to prevent the excess current, under voltage, phase failure and phase reverse in the NWSDB standard specifications.
By this protection, it is very high to trip the main molded circuit breaker of main low voltage panel and a long blackout is comparatively expected. On this report, fuel tank capacity is decided to bear 24hours power interruption.

(3) Power demand and rates
Proposed facilities will be applied for the category I-1 and I-2 for Industry Use except for elevated tanks and GND transmission pump stations.
For the elevated tanks and GND transmission pump stations, the category for General Purpose Use will be applied.
An electricity tariff of the category I-1 and I-2 is calculated as shown **Table 5.50** and **Table 5.51**. General Purpose Use is calculated as shown **Table 5.52**.

Table 5.50 Rate for Category I-1

Time Zone		Rs/kWh	FAC	Fixed Charge
All Time	00:00～24:00	10.5	15%	240 (Rs/Month)

FAC: Fuel Adjustment Charge in 2012

Table 5.51 Rate for Category I-2

Time Zone		Rs/kWh	FAC	Fixed Charge	Demand Charge
Peak	05:30～18:30	13.6	15%	3000 (Rs/ Month)	850 (Rs/ kVA) (Rs/Max. Demand/ Month)
Off Peak	18:30～22:30	7.35	15%		
Day	22:30～05:30	10.45	15%		

FAC: Fuel Adjustment Charge in 2012

Table 5.52 Rate for Category GP-1

Time Zone		Rs/kWh	FAC	Fixed Charge
All Time	00:00~24:00	19.50	25%	240 (Rs/ Month)

FAC: Fuel Adjustment Charge in 2012

From the above Tables, assumption of power demand and rates for the facilities of water supply

systems are approximately estimated as shown **Table 5.53** in case Rapid Sand Filter with Activated Carbon Filter which could be installed in near future for the water treatment plant.

Table 5.53 Power Demand and Rate

Location	2024 Demand (kW)	2034 Demand (kW)	2024 Rate per year (Rs)	2034 Rate per year (Rs)
Mahakanadarawa WTP & Intake	120.9	215.2	15,448,056	27,468,669
Rambewa Ground Water Reservoir	48.5	187.4	6,222,516	23,917,776
Medawachchiya Ground water Reservoir	33.3	126.2	4,272,421	16,117,398
Wahalkada Water Intake	39.2	84.2	5,033,340	21,393,105
Wahalkada WTP	202.8	378.5	25,879,342	48,281,659
Kahatagollewa Ground Water Reservoir	72.3	147.2	9,245,672	18,802,665
Kebithgollewa Ground Water Reservoir	16.6	32.6	2,149,750	4,186,388
Weerasole Ground Water Reservoir	84.1	167.6	10,753,108	21,393,105
Horowpothana Ground Water Reservoir	100.1	204.5	12,790,256	26,098,313
Kahatagasdigiliya Ground Water Reservoir	13.0	45.2	1,690,904	5,792,348
Sub-total for Category I-2			93,485,365	213,451,426
Each Elevated Tanks (8 locations)	8*3.6	8*6.1	3,033,856	5,118,264
Each GND Transmission Pump (7 locations)	7*2.8	7*4.4	2,057,727	3,284,687
Sub-total for Category GP-1			5,091,583	8,402,951
Total			98,576,948	221,854,377

FAC of Category GP-1 is assumed 25%.

Unit Power Rates at 2024 and 2034 for Makahanadarawa and Wahalkada area are assumed as **Table 5.54** respectively in case Rapid Sand Filter with Activated Carbon Filter is installed for the water treatment plant.

Table 5.54 Unit Power Rates in case of Rapid Sand Filter with Activated Carbon Filter

Year	Location	Makahanadarawa	Wahalkada	Total
2024	Water Supply (m^3/year)	3,248,500	4,927,500	8,176,000
	Electricity Rate (Rs/year)	28,844,455	69,732,493	98,575,948
	Unit Power Rate (Rs/m^3)	8.88	14.15	12.06
2034	Water Supply (m^3/year)	6,533,500	10,001,000	16,534,500
	Electricity Rate (Rs/year)	72,238,638	149,615,739	221,854,377
	Unit Power Rate (Rs/m^3)	11.06	14.96	13.42

(4) Power transformer

Transformer Capacity will be calculated by the formula as shown below.

Transformer Capacity (kVA) = Total Loads (kW) *(β*α)/ (η*φ)

Here, φ: Total power factor

η: Total efficiency

β: Demand factor

α: Safety factor

In this formula, spare motor capacity will not be included in the Total Loads.

Capacity of transformers for each facility considering the assumed power demand is shown below. The list for elevated tanks is omitted herein as low-voltage power will be supplied to them.

Table 5.55 Transformer Capacity

Location	2024 Required Capacity(kVA)	2034 Required Capacity (kVA)	Transformer Capacity (kVA)
Mahakanadarawa WTP & Intake	400	630	630
Rambewa Ground Water Reservoir	160	400	400
Medawachchiya Ground water Reservoir	100	250	250
Wahalkada Water Intake	160	160	160
Wahalkada Water Treatment Plant	630	800	800
Kahatagollewa Ground Water Reservoir	160	250	250
Kebithgollewa Ground Water Reservoir	63	63	63
Weerasole Ground Reservoir	160	250	250
Horowpothana Ground Water Reservoir	160	400	400
Kahatagasdigiliya Ground Water Reservoir	63	100	100

Rapid Sand Filter will be applied for each Water Treatment Plant.

Construction of this project is planned to be completed in 2018. The target year of 1st phase is 2024 while the ultimate target year is 2034. It means that only six years will have passed in 2024 since the proposed facilities start service. In addition, the installation cost of transformers shall be borne by NWSDB although the transformers will be installed by CEB. Considering that enhancement will be required six years later than start of the service, it is reasonable the capacity of transformers installed will cover the ultimate phase power demand from the beginning.

5.5.2 Power Generator

Actual record of the CEB grid-stations power failure for this area is not informed in this study period. But, electricity power reliability at the North Central Area is low, as described as¥¥in section 5.6.1(2). Diesel engine generator for the emergency is indispensable to supply water steadily as

during times of blackout time. The continuing time of power failure is expected to be a long time. So, the storage volume of fuel tank will be designed for twenty-four hours use so as to be able to fill the gap when the fuel storage comes low. The fuel tank will be basically installed outside.

Considering the high frequency of power failure and request from NWSDB, installation of stand-by generator will be imperative.

According to environmental recommendation from the Central Environmental Authority for the Water Purification Plant at Wahalkada Proposed by the National Water Supply and Drainage Board, noise regulation of proposed area requires less than 45 dB at night at the boundary of the proposed site and surrounding area. In principle, enclosed sound attenuated type stand-by generators can be planned to comply with the regulation.

As a most commonly used type, diesel generator will be applied for this project.

No generators will be installed at the facility only for an elevated tank. Standby power supply for instrumentation and monitoring equipment at the elevated tanks, such as level meters and wireless communication devices for SCADA, will be backed up by UPS for approximately 30 minutes.

Capacity of generators installed for each facility considering the assumed power demand will be shown as **Table 5.56**.

As same as transformer, these generators will also cover the ultimate phase power demand from the beginning.

Table 5.56 Generator Capacity

Location	2024 Required Capacity(kVA)	2034 Required Capacity (kVA)	Generator Capacity (kVA)
Mahakanadarawa WTP & Intake	200	300	300
Rambewa Ground Water Reservoir	200	300	300
Medawachchiya Ground water Reservoir	150	250	250
Wahalkada Water Intake	100	150	150
Wahalkada Water Treatment Plant	375	625	625
Kahatagollewa Ground Water Reservoir	150	250	250
Kebithgollewa Ground Water Reservoir	50	75	75
Weerasole Ground Reservoir	150	300	300
Horowpothana Ground Water Reservoir	200	375	375
Kahatagasdigiliya Ground Water Reservoir	75	75	75

5.5.3 Low Voltage Facilities

As for motor starters, standards requirement is mentioned in detail in the specification of NWSDB
This proposal will comply with the specification as follow.

(1) Motor Control Centre（ MCC）
MCC will be composed following items.

1) Panel enclosures
2) Bus-bars with MCCB's (Distribution section)
3) Supply incoming section
4) Small power distribution section
5) Motor starting sections
6) Automatic controllers & indicators
7) Cabling

Enclosures shall be of sheet metal construction using 1.5 mm. thick steel sheets with corrosion resistant coat while enclosures shall be protected to IP 55. Maximum operating height of the enclosure shall not exceed 2000 mm.
Incoming section will be required following item.

1) One 4 pole molded case circuit breaker of adequate capacity with thermal magnetic overload and earth fault trip
2) One ammeter with selector switch for monitoring phase currents
3) One power factor meter
4) One voltmeter with selector switch for monitoring phase to neutral and phase to phase voltages
5) One supply voltage monitor with the following features and interlocked with all motor starters
   (a) Phase failure protection
   (b) Supply voltage imbalance (adjustable)
   (c) Under and over voltage (adjustable)
   (d) Phase reversal
6) Lamp indicator to indicate operating condition of supply voltage monitor
7) Incoming terminals
8) Surge suppression device (surge arrestors)
9) Duty selector switch with interlocking arrangements
10) One of three phases four pole MCCB of 30A. The capacity of MCCB shall be incorporated in the panel board for an auxiliary power supply.

Motor starters shall comply with BS 587 (Specification Motor starters and controllers) or

equivalent. Starter shall be adequately rated for the required number of starts per hour and in any case not less than 6 starts per hour. Contactors incorporated in motor starter shall conform to BS 775 (Specification. Motor starters and controllers) and BS 5424 (Specification for control-gear for voltages up to and including 1000 V A.C. and 1200 V D.C. Additional requirements for contactors subject to certification) or equivalent. If the method of starting is Auto Transformer, then over heating protection for the Auto Transformer coils shall be provided.

Motor starter panel to be provided shall consist of the following basic elements. Motor Starter section will be required following item.

1) One 3 pole MCCB with adequate rated capacity and thermal magnetic overload trip to serve as the feeder for the starter.
2) One three phase adjustable thermal overload
3) For three phase ammeter to rated phase current and ammeter shall be marked according to the phase designations, like R- phase etc.
4) Indicator lamps to indicate following:
   (a) Pump running
   (b) Pump tripped (overload)
   (c) Pump stopped
   (d) Pump tripped (low water level)
5) Hours run meter
6) Adequate set of control relays, timers etc. necessary for operation.
7) 2 pole – MCB for control supply.
8) Thermal protector relay connected to thermal sensors, mounted in the Motor windings.
9) Power factor correction capacitors to correct the power factor to 0.95 lagging for motors of 25 kW and above.
10) Auto transformers (if applicable)

For automatic controllers and interlocks, the following shall be required.

1) Automatic cut –off of the pumps when the well level in the sump is below the minimum level.
2) Control relays, transducers, cables etc. necessary for realizing above shall be provided.

MCCB and MC shall be required to comply with IEC regulations.

5.5.4 Instrumentation Facilities

Flow meters, level meters and pressure meters will be installed in this project to monitor the quantitative parameters. As for qualitative parameters, there are turbidity, pH, temperature, chlorine ion concentration, color, conductivity and alkalinity of raw water, chlorine ion

concentration at the discharge of filter, turbidity and residual chlorine of the effluent required to be monitored in general. Considering the lifetime of automatic measuring instrument, which is generally short, and difficulty of troubleshooting at site, water quality as mentioned above will be manually analyzed in a water testing laboratory by means of drawing sampling water from each section.

Surge arrester will be installed to both transmitter and receiver to prevent from lightning surge since it frequently thunders in Sri Lanka.

There are four types of typical flow meters, electromagnetic type, inserting electromagnetic type, venturi(orifice) with differential pressure transmitter type, and ultrasonic type. Accuracy of inserting electromagnetic type and ultrasonic type is about ±2%, and this accuracy could be even much worse depending on the fixing. In addition, electromagnetic type is quite expensive and difficult to be maintained when it is in trouble.

On the other hand, a type of flow meter with differential pressure transmitter is easy to be replaced when it has trouble. Although this type of flow meter causes some pressure loss at the measuring part, there are ones which cause less pressure loss than Venturi's such as Dall tube type.

For these reasons, Dall tube type flow meter with differential pressure transmitter will be proposed for this project.

As for level meters, there are differential pressure type, submersible type, float type, capacitance type, ultra sonic type, and so on. In principle, differential pressure type will be proposed unless there is any interference to fixing condition since differential pressure type is accurate enough and relatively reasonable among them. In addition, submersible type will be proposed if the measuring and fixing from the upper side of water is required because it has no moving parts and relatively does not require the strict accuracy of fixing.

5.5.5 Monitor and Control Facilities

(1) Central monitoring and control system

SCADA (Supervisory Control And Data Acquisition) will be installed as the most proven central monitoring system in Sri Lanka.

The water supply system proposed in this project comprises Makahanadarawa network and Wahalkada network. The SCADA will be designed to cover each network systematically which will contain a water treatment plant, transmission and distribution pipelines.

Two LCD monitoring devices and two printers for logging and alarming compose central

monitoring system. The two LCD devices shall be configured as dual redundant system, one primary and the other hot-standby, so that the standby one can take over the primary one in case of the failure occurred in the primary one without interruption to the plant operation.

(2) Water transmission and distribution system monitoring

There are three communication network systems which have been more installed recently because of their inexpensiveness than existing telemeter system as a remote monitoring communication system. The first one is wireless communication system using UHF, the second one is VPN communication system combining the technology of the existing telephone line (ADSL) and the internet. And the third one is GPRS communication system utilizing the packet communication of the GSM network.

The GPRS system is relatively reasonable to use and applied worldwide. Considering the fact that existing elevated tanks in Anuradhapura area also utilize it, GPRS system will be proposed in this project.

The study team conformed to the supplier who has the experience to install GRPS system in Kandy project, the transmission condition of GRPS in North Central area.

NWSDB specification mentioned automatic control should not be installed when utilizing GPRS system. According to the specification, the engineers for monitoring will need to stay at site on 24 hours basis and manually operate pumps monitoring the water level of elevated tank.

To make the operation easier, LCD device to monitor water level of each elevated tank will be installed at the ground reservoir which has pumps to transmit the water to two or more elevated tanks or ground reservoir. The LCD device has the function to alarm operators by making a phone call to or mailing to.

At the elevated tanks, a float type valve will be installed to avoid overflow. To prevent the pumps from continuously operating when the float valve is closed, the pumps will be automatically stopped with an interlock by detecting the combination signals of non-flow from a flow meter and transmission high pressure from a pressure switch. Obviously, an interlock will be also required to stop the pumps when the water level is below the minimum level.

(3) Control for water transmission and distribution

For example, from WTP clear water reservoir to distribution reservoirs communication will be applied as follows;

At the ultimate stage, there will be four pumps (including one standby) installed for the transmission from clear water reservoir to distribution reservoir.

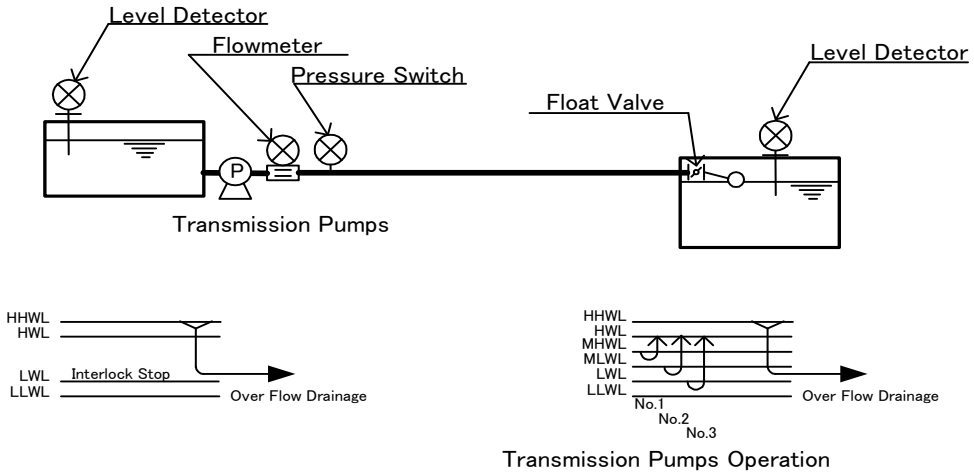


Figure 5.35 Transmission Pump Operation Diagram

Operators will normally select the number of pumps to be operated according to the water level of distribution reservoir. The signals of water level will be transmitted from a PLC of distribution reservoir to one of WTP through the GPRS packet communication system.

In case of communication failure, inflow of the distribution reservoir will be shut out by floating valve set at HHWL over flow level.

5.6 Outline of Proposed Water Supply System

5.6.1 Mahakanadarawa Integrated Water Supply System

The following table summarizes the facilities in the Mahakanadarawa Integrated Water Supply System.

Table 5.57 Mahakanadarawa Integrated Water Supply System

I. Mahakanadarawa		
Intake Facilities/Water Treatment Plant		
Location/Facilities		Fascilities to be constructed
Mahakanadarawa	Intake Facilities	Intake Gate Screen Intake Pump (4.25m3/min x 15m x 15kW) x (3+1)
	WTP	Production: 9,400 m3/d Receiving Well Roughing Filter Slow Sand Filter/Ecological Filter Clear Water Reservoir Transmission Pump (6.05m3/min x 32m x 45kW) x (2+1) Sludge Lagoon
Transmission/Distribution Facilities		

DS Division	Land Location (Extent)	Fascilities to be constructed
Rambewa	Rambewa * (1.5AC)	Elevated Tank (1,250m3) Ground Reservoir (1,500m3) Pump house / power control unit (120m2) x1 Generator (30m2) x1 Area Engineers office with SCADA system / Customer Counter (125m2) x1 Operational complex (100m2) x1 — Zonal Lab (RCl, Turbidity, pH) Chlorinator Building Room for crews Staff Quarters (100m2) x1 Caretaker/Operator Quarters (100m2) x1 Parking
	East Rambewa (1AC)	Elevated Tank (250m3) Chlorinator Building (100m2) x1 Caretaker/Operator Qts (100m2) x1
	Surge Tank A	One Way Surge Tank (100m3)
	Surge Tank B	One Way Surge Tank (100m3)
Medawachchiya	Medawachchiya * (2AC)	Ground Reservoir (1,000m3) Pump House / Power Control Unit (100m2) Generator (30m2) x1 Area Engineers office with SCADA system / Customer Counter (125m2) x1 Operational complex (100m2) x1 — Zonal Lab (RCl, Turbidity, pH) Chlorinator Building Room for crews Workshop (170m2) x1
		Staff Quarters (100m2) x1 Caretaker/Operator Quarters (100m2) x1 Parking
	Issinbassagala (1AC)	Elevated Tank (2,000m3) Chlorinator Building (100m2) x1 Caretaker/Operator Qts (100m2) x1
	Ethakada (1AC)	Elevated Tank (750m3) Chlorinator Building (100m2) x1 Caretaker/Operator Qts (100m2) x1

5.6.2 Wahalkada Integrated Water Supply System

The Following table summarizes the facilities in the Wahalkada Integrated Water Supply System.

Table 5.58 Wahalkada Integrated Water Supply System

II. Wahalkada		
Intake Facilities/Water Treatment Plant		
Location/Facilities		Fascilities to be constructed
Wahalkada	Intake Facilities	Intake Gate Screen Intake Pump (6.56m3/min x 22m x 30kW) x (3+1)

	WTP	Production: 14,400 m3/d Receiving Well Roughing Filter Slow Sand Filter/Ecological Filter Clear Water Reservoir Transmission Pump (0.29m3/min x 41m x 5.5kW) x (1+1) Transmission Pump (5.22m3/min x 62m x 90kW) x (2+1) Transmission Pump (3.97m3/min x 51m x 55kW) x (2+1) Sludge Lagoon Elevated Tank (500m3)
Transmission/Distribution Facilities		
DS Division	Land Location (Extent)	Fascilities to be constructed
Horowpothana	Weerasole (1AC)	Ground Reservoir (1,500m3) Generator (30m2) x1 Caretaker/Operator Qts (100m2) x1
	Horowpothana * (0.5AC)	Elevated Tank (500m3) Ground Reservoir (1,000m3) Pump house / power control unit (120m2) Generator (40m2) x1 Operational complex (100m2) x1 — Zonal Lab (RCl, Turbidity, pH) Chlorinator Building Room for crews Workshop (170m2) x1 Staff Quarters (100m2) x1 Caretaker/Operator Quarters (100m2) x1 Area Engineers office with SCADA system / Customer Counter Parking
	North Horowpothana City	Elevated Tank (250m3) Chlorinator Building (100m2) x1 Caretaker/Operator Qts (100m2) x1 One Way Surge Tank (100m3)
	West Horowpothana	Elevated Tank (750m3) Chlorinator building (100m2) x1 Caretaker/Operator Qts (100m2) x1
	Hamillewa	Elevated Tank (1,250m3) Chlorinator Building (100m2) x1 Caretaker/Operator Qts (100m2) x1
Kahatagasdigiliya	Kahatagasdigiliya * (1AC)	Elevated Tank (1,500m3) Ground Reservoir (500m3) Pump House / Power Control Unit (100m2) Generator (30m2) x1 Area Engineers office with SCADA system / Customer Counter Operational complex (100m2) x1 — Zonal lab (RCl, Turbidity, pH)
Kahatagasdigiliya	Kahatagasdigiliya * (1AC)	Chlorinator Building Room for crews Staff Quarters (100m2) x1 Caretaker/Operator Quarters (100m2) x1
	Rathmalgahawewa (1AC)	Elevated Tank (500m3) Chlorinator Building (100m2) x1 Caretaker/Operator Qts (100m2) x1
Kebithigollewa	Kebithigollewa * (1AC)	Elevated Tank (750m3) Ground Reservoir (500m3)

		Pump House / Power Control Unit (120m2) Generator (20m2) x1 Operational complex (100m2) x1 — Zonal Lab (RCl, Turbidity, pH) Chlorinator building Room for crews Workshop (170m2) x1 Staff Quarters (100m2) x1 Caretaker/Operator Quarters (100m2) x1 Area Engineers office with SCADA system / Customer Counter Parking
	KEB-KAH Median	Elevated Tank (250m3) Chlorinator Building x1 Caretaker/Operator Quarters x1
	Kahatagollewa (1AC)	Ground Reservoir (1,000m3) Elevated Tank (250m3) Chlorinator Building x1 Caretaker/Operator Quarters x1
Padaviya	Bogahawewa * (2AC)	Elevated Tank (2,000m3) Ground Reservoir (500m3) Pump House / Power Control Unit (100m2) Generator (20m2) x1 Area Engineers office with SCADA system / Customer Counter Operational complex (100m2) x1 — Zonal Lab (RCl, Turbidity, pH) Chlorinator Building Room for crews Staff Quarters (100m2) x1 Caretaker/Operator Quarters (100m2) x1 Parking

5.7 Water Supply System for Isolated Areas

The Project is to integrate the existing small-scale water supply systems into two large-scale ones. The following priority of factors is considered to select service areas of two pipe borne water supply systems.

1st GNDs with an existing water supply system
2nd GNDs where the facilities of a proposed water supply system are included
3rd GNDs covering a urban centre including its surrounding GNDs
4th GNDs along with main roads designated

As the result of analysis, the remaining areas are categorized as isolated areas. The population is 53,500 for isolated areas, 225,000 for non-isolated areas and 278,500 in total for the target year of 2034, respectively.

Details of the isolated areas are listed in the following table.

Table 5.59 Isolated Area

G.N. Division number and name	Area (ha)	Total population (2001)	No. of HHs	Population (2024)	Water Demand (2024)	Population (2034)	Water Demand (2024)
I. Mahananadarawa System							
Medawachchiya D.S.Division							
45 - Paranahalmillewa	902.05	1,067	303	1,404	14	1,582	16
48 - Anekattiya	2,290.82	796	199	1,047	10	1,180	12
63 - Thammenne Elawaka	2,533.44	1,368	360	1,800	18	2,028	20
62 - Puleliya	2,208.39	1,321	354	1,738	17	1,958	20
77 - Lindawewa	852.35	610	188	803	8	904	9
76 - Karambankulama	1,256.39	734	211	966	10	1,088	11
Sub-total	**10,043.44**	**5,896**	**1,615**	**7,758**	**78**	**8,740**	**87**
Rambewa D.S.Division							
105 - Kolibendawewa	1,725.96	1,032	255	1,268	13	1,387	14
104 - Medagama	1,146.29	988	245	1,214	12	1,328	13
116 - Kadurugasdamana	1,969.33	1,081	301	1,328	13	1,453	15
107 - Siyambalagaswewa	449.88	525	149	691	7	778	8
103 - Diviyaudabendawewa	629.29	681	208	896	9	1,009	10
80 - Ambagahawewa	1,299.20	555	157	730	7	823	8
91 - Konakumbukwewa	743.92	637	188	783	8	856	9
89 - Kallanchiya	1,232.46	768	194	944	9	1,032	10
92 - Gonewa	1,123.47	977	238	1,285	13	1,448	14
114 - Mahawewa	748.03	957	260	1,176	12	1,286	13
115 - Pandukabhayapura	116.20	650	186	799	8	874	9
98 - Kapiriggama	923.89	443	115	583	6	657	7
90 - Peenagama	677.59	668	199	821	8	898	9
88 - Meemalwewa	1,189.00	462	118	568	6	621	6
95 - Rotawewa	609.34	560	149	737	7	830	8
96 - Kudagama	1,397.79	604	157	742	7	812	8
Sub-total	**15,981.64**	**11,588**	**3,119**	**14,565**	**146**	**16,092**	**161**
Total	**26,025.08**	**17,484**	**4,734**	**22,323**	**223**	**24,832**	**248**
II. Wahalkada System							
Padaviya D.S.Division							
9 - Abhayapura	895.77	1,599	417	1,965	20	2,149	21
8 - Maithreepura	934.85	1,292	316	1,700	17	1,915	19
4 - Track B	1,038.58	1,754	471	2,308	23	2,600	26
15 - Balayawewa	1,298.12	864	224	1,137	11	1,281	13
Sub-total	**4,167.32**	**5,509**	**1,428**	**7,110**	**71**	**7,945**	**79**
Kebithigollewa D.S.Division							
31 - Bandaraulpatha	1,569.03	501	133	616	6	673	7
Sub-total	**1,569.03**	**501**	**133**	**616**	**6**	**673**	**7**
Horowpothana D.S.Division							
146 - Maradanmaduwa	2,141.24	602	168	740	7	809	8
143 - Wagollakada	1,591.62	589	136	724	7	792	8
142 - Dutuwewa	2,937.95	905	229	1,191	12	1,342	13
137 - Thawalanhalmillewa	1,051.22	381	101	468	5	512	5
123 - Thimbiriettawala	1,725.58	776	152	1,021	10	1,150	12
118 - Rasnaka Wewa	966.23	500	143	658	7	741	7
124 - Gammahegewewa	1,117.69	602	178	792	8	892	9
154 - Dematawewa	19,145.36	488	133	600	6	656	7
Sub-total	**30,676.89**	**4,843**	**1,240**	**6,194**	**62**	**6,894**	**69**
Kahatagasdigiliya D.S.Division							
205 - Sampathgama	426.29	1,056	259	1,389	14	1,565	16
217 - Thallattewa	488.06	766	206	1,008	10	1,135	11
204 - Samadhigama	655.37	617	159	812	8	915	9
216 - Konwewa	926.61	1,056	251	1,298	13	1,419	14
214 - Tikkampothana	1,168.82	310	84	381	4	417	4
215 - Divulwewa	1,845.45	889	216	1,092	11	1,195	12
229 - Diganhalmillawewa	1,247.62	923	249	1,214	12	1,368	14
227 - Kelenikawewa	1,244.46	828	192	1,017	10	1,113	11
228 - Nelugollakada	625.83	572	152	753	8	848	8
197 - Ellawewa	442.83	763	200	1,004	10	1,131	11
200 - Nekutunu Wewa	1,378.26	817	230	1,075	11	1,211	12
199 - Kanadara-Rathmale	825.68	601	162	739	7	808	8
Sub-total	**11,275.28**	**9,198**	**2,360**	**11,782**	**118**	**13,125**	**131**
Total	**47,688.52**	**20,051**	**5,161**	**25,702**	**257**	**28,637**	**286**
Grand Total	**73,713.60**	**37,535**	**9,895**	**48,025**	**480**	**53,469**	**535**

Figure 5.38 shows the concept of water supply system in the isolated area.

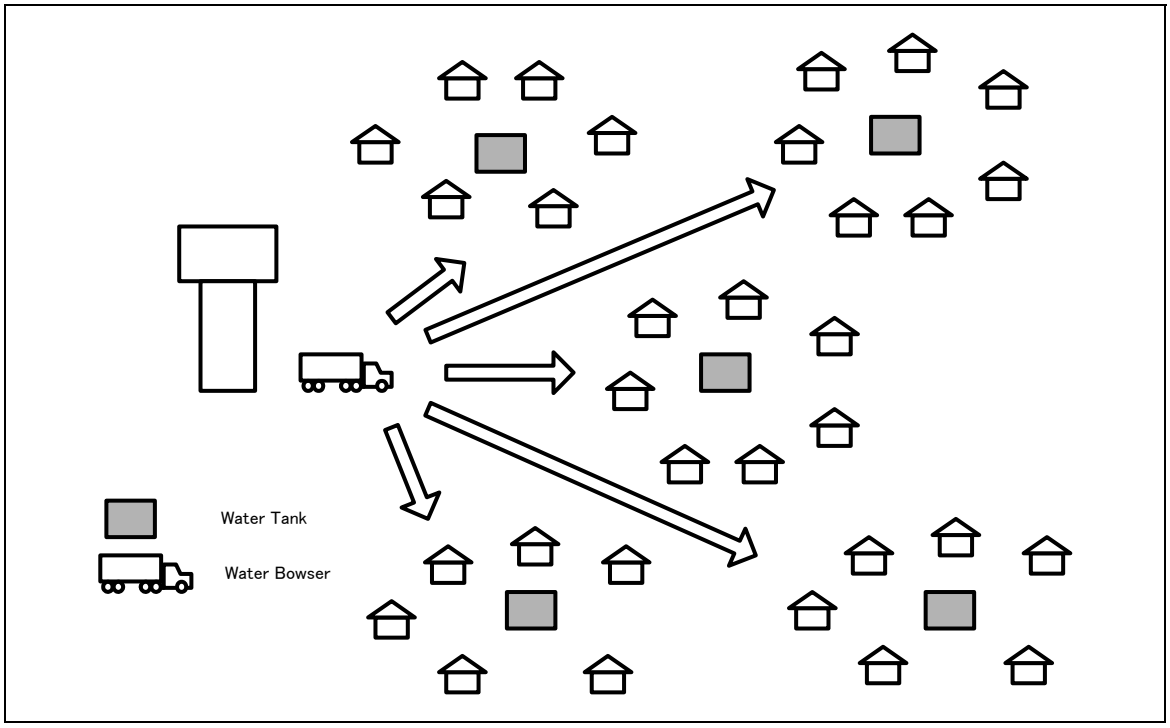


Figure 5.36 Water Supply System in Isolated Area

The water supply system in the isolated areas consists of water tanks (capacity 5 m^3) and water bowsers (capacity 5 m^3) and 10 Lpcd of water will be provided to each population. The numbers of water tanks and water bowsers are calculated as follows.

population x 10 Lpcd = water demand

water demand / 5 m^3 = number of water tank

number of water tank / 6 locations/day = number of water bowser

Example of Madewachchiya Station for 45 - Paranahalmillewa.

(45 - Paranahalmillewa)

1,582 x 10 Lpcd = 15,820 Lpd = 15.8 m^3/d => 16 m^3/d

16 m^3 / 5 m^3 = 3.3 tanks => 4 tanks

(Madewachchiya Station)

This station serves water to 15 water tanks.

15 tanks / 6 locations/day = 2.5 water bowser => 3 water bowsers

The calculation results are shown in **Table 5.59**. Totally, 107 water tanks and 20 water bowsers are required for the water supply for the isolated areas.

Table 5.60 Water Tanks and Bowsers in Isolated Areas

Station	G.N. Division number and name	Water Demand (2024)	Water Tank ($5m^3$)	Water Bowser ($5m^3$)
I. Mahananadarawa System				
Madewachchiya	45 - Paranahalmillewa	16	3	3
	48 - Anekattiya	12	2	
	63 - Thammenne Elawaka	20	4	
	62 - Puleliya	20	4	
	80 - Ambagahawewa	8	2	
Sub-total		**76**	**15**	**3**
Rembewa	77 - Lindawewa	9	2	6
	76 - Karambankulama	11	2	
	105 - Kolibendawewa	14	3	
	104 - Medagama	13	3	
	116 - Kadurugasdamana	15	3	
	107 - Siyambalagaswewa	8	2	
	103 - Diviyaudabendawewa	10	2	
	91 - Konakumbukwewa	9	2	
	89 - Kallanchiya	10	2	
	92 - Gonewa	14	3	
	114 - Mahawewa	13	3	
	115 - Pandukabhayapura	9	2	
	98 - Kapiriggama	7	1	
	90 - Peenagama	9	2	
	88 - Meemalwewa	6	1	
	95 - Rotawewa	8	2	
	96 - Kudagama	8	2	
Sub-total		**173**	**35**	**6**
Total		**248**	**50**	**9**
II. Wahalkada System				
Bogohawewa	9 - Abhayapura	22	4	3
	8 - Maithreepura	19	4	
	4 - Track B	26	5	
	15 - Balayawewa	13	3	
Sub-total		**80**	**16**	**3**
Weelasol	146 - Maradanmaduwa	8	2	1
	143 - Wagollakada	8	2	
	142 - Dutuwewa	13	3	
Sub-total		**29**	**6**	**1**
West Horowpothana	31 - Bandaraulpatha	7	1	2
	137 - Thawalanhalmillewa	5	1	
	123 - Thimbiriettawala	12	2	
	118 - Rasnaka Wewa	7	1	
	124 - Gammahegewewa	9	2	
Sub-total		**40**	**8**	**2**
Kahatasdigiliya	154 - Dematawewa	7	1	5
	205 - Sampathgama	16	3	
	217 - Thallattewa	11	2	
	204 - Samadhigama	9	2	
	216 - Konwewa	14	3	
	215 - Divulwewa	12	2	
	214 - Tikkampothana	4	1	
	229 - Diganhalmillawewa	14	3	
	227 - Kelenikawewa	11	2	
	228 - Nelugollakada	8	2	
	197 - Ellawewa	11	2	
	200 - Nekutunu Wewa	12	2	
	199 - Kanadara-Rathmale	8	2	
Sub-total		**138**	**28**	**5**
Total		**287**	**57**	**11**
Grand Total		**535**	**107**	**20**

5.8 Strategic Plan (Staged Development Plan)

5.8.1 Necessity of Priority and Staged Development

The proposed Water Supply System will require a large amount of capital investment and many years to complete. In general, such large projects become feasible for implementation if they are implemented through several construction stages with appropriate development steps or prioritized implementation.

The development priority is also utilized in selecting a priority project in the later chapter. Further, the priority is needed for investment decision by financial or investment institutions. Projects are typically composed of several components and usually higher priority components or the components that create higher profit are implemented first. For the above reasons a development priority for the Water Supply System is considered by preparing a number of alternative project packages.

5.8.2 Proposed Project Components

Many project components have been proposed in the previous chapter. The water supply facilities consist of the following facilities:

1) Intake facilities
2) Water treatment plants
3) Water transmission pump facilities
4) Water transmission pipelines
5) Ground reservoirs (sumps)/elevated tanks
6) Water distribution piping networks

However, it is essential for a new water supply system to be developed in one stage from the water sources (intake facilities) to houses (water distribution piping networks/house connections). Therefore “facility-base development”, cannot be applied, and for example only intake facilities and water treatment plants will be constructed in the first stage.

5.8.3 Comparison of Staging

Figure 5.37 simplifies the schematic flow diagram of **Figure 5.24** and **Figure 5.25** to facilitate the understanding of an overall system composition which is divided into two water supply systems, namely (1) Mahakanadarawa System and (2) Wahalkada System. In the Wahalkada System, two water transmission pipelines directs to the north (Bogahawewa) and west (Kebhitigollewa), and the south (Horowpothana), respectively from the Wahalkada Water Treatment Plant.

Applicable staged development options are “water demand-base development” and “district-base development”. The following figures show the concepts of the two staged development options.

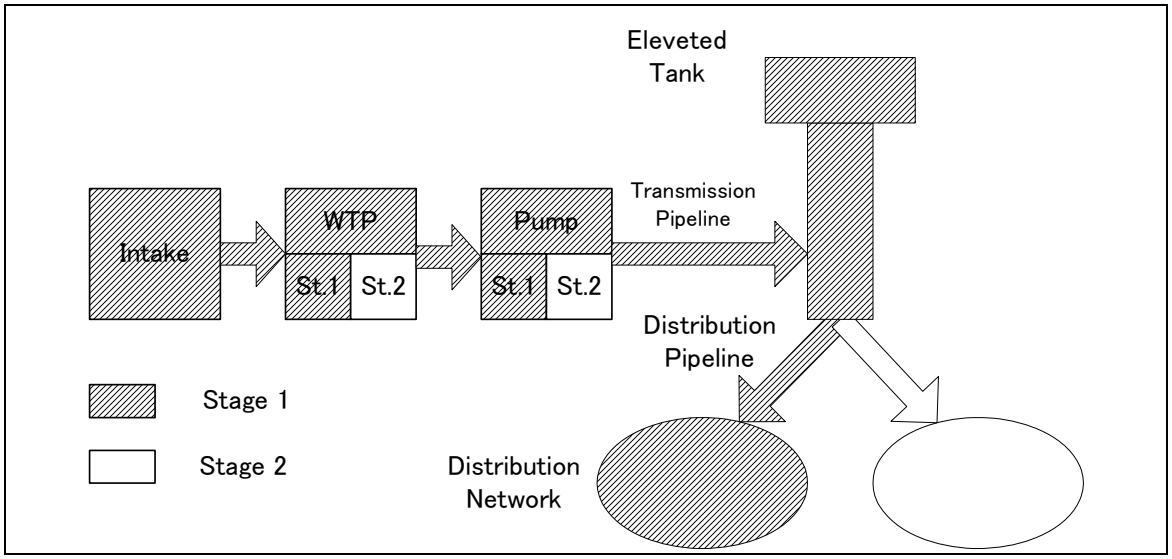


Figure 5.37 Water Demand-base Development

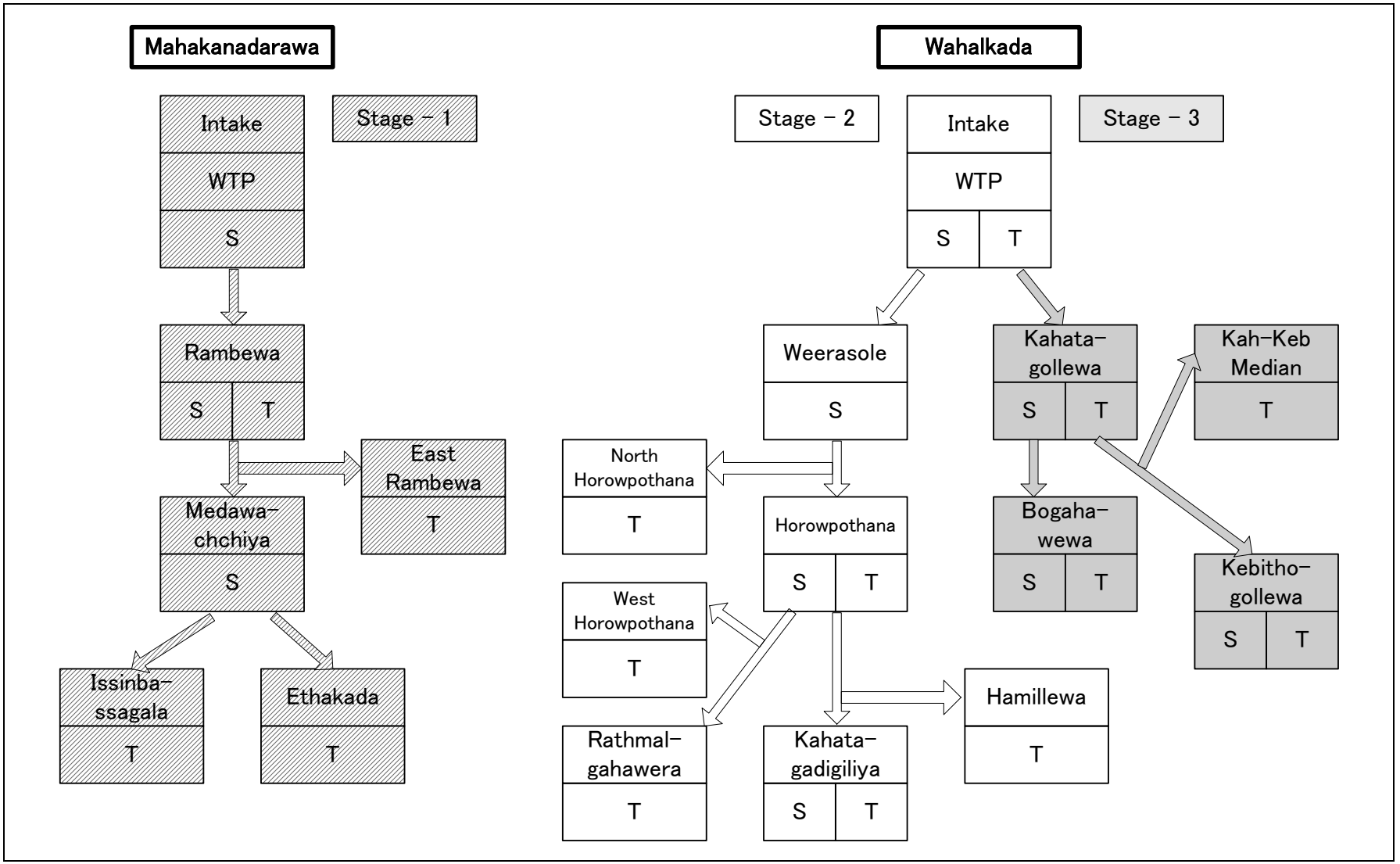


Figure 5.38 District-base Development

These two types of staged development are able to compare in the following table.

Table 5.61 Comparison of Development

Item	Water demand-base development	District-base development
Stage (Production)	1-1. Water demand on 2024 Mahakanadarawa 9,400 m^3/d	1. Mahakanadarawa Mahakanadarawa 18,800 m^3/d
	1-1. Water demand on 2024 Wahaklkada 14,400 m^3/d	2. Wahalkada – I Wahalkada 16,500 m^3/d
	1-1. Water demand on 2034 Mahakanadarawa 9,400 m^3/d Wahalkada 14,400 m3/d	3. Wahalkada – II Wahalkada 13,500 m^3/d
Cost (Estimate)	Stage 1 – 70 % Stage 2 – 30 %	Stage 1 – 40 % Stage 2 – 35 % Stage 3 – 25 %
Advantage	➢ All study areas are developed from the first stage.	➢ Investment can be minimized in the first stage.
Disadvantage	➢ Large investment is required from the first stage.	➢ Only limited area will be improved in the earlier stage.

Since many people in the study area are suffering a bad quality of water from their own water sources or the CBO water supply systems, it is recommended to apply “Water demand-base development” in order to supply safe and good-quality water for as many people as possible from the first stage.

CHAPTER 6

MANAGEMENT, OPERATION AND MAINTENANCE OF PROPOSED WATER SUPPLY SYSTEM

CHAPTER 6 MANAGEMENT, OPERATION AND MAINTENANCE OF PROPOSED WATER SUPPLY SYSTEM

This section provides a brief background of NWSDB as an institution and examines its current organization structure, with focus on the organization and operating structure of the NWSDB Regional Support Centre (North Central), which stands to benefit from the implementation of this Project. It assesses the capacity of the RSC and proposes capacity building / training and development programmes to enhance organisational skills and improve individual or staff competencies to manage, operate and maintain the new facilities / system thereby transforming organizational and individual potentials into actuality. It also assesses the organizations concerned in project implementation; then defines, describes and delineates the sharing of roles and responsibilities among these organizations to mitigate managerial, financial and technical problems may arise in the case of the project's implementation.

The sound operation and maintenance of the facilities after its completion entails an organization that is ready, capable, and skilled in performing the required works. Thus, after an examination of the current O&M organisation, this section proposes a strengthened O&M organization so that proper and rapid response can be attained when operating and maintaining mechanical and electrical equipment at the water treatment plants and pumping stations, when detecting and repairing leaks in the water transmission and distribution pipelines, and when ensuring compliance to Sri Lankan water quality standards.

Finally, the section also examines the modes by which water supply services can be distributed to the RSC service area, which also consists of community-based water supply organisations or CBOs. It proposes strategies and approaches in the provision of water supply services to the CBOs, which includes the categorization of CBOs based on their willingness to connect, conditions for connecting, and the technical suitability of the CBO water supply system for bulk connection. In terms of the tariff system of the CBOs, there are varied tariff structures and charges. The examination of these tariff systems will keep the RSC apprised of the average monthly household water bill on a per CBO basis as it embarks on its awareness campaign to get the CBOs to connect to its new distribution facilities.

6.1 Project Implementation Organization

The National Water Supply and Drainage Board (NWSDB), together with the Urban and Municipal Councils and Pradeshiya Sabhas, are legally mandated to provide safe water and sanitation in the entire Sri Lanka. The NWSDB, which is under the Ministry of Water Supply and Drainage (MWSD), is the primary agency responsible for water supply and sanitation. It

core competence lies in planning and developing; designing and constructing; managing, operating and maintaining larger urban water supply schemes; and of late, supporting the development of rural schemes in areas declared under the NWSDB Act.

The organizational set-up and the institutional capacity of NWSDB have been the subject of both analysis and recommendation, mostly as a component of project studies funded and/or assisted by multilateral and bilateral development and aid cooperation agencies. These projects were aimed at improving and expanding water supply infrastructure and services while strengthening the institution's capacity for service delivery by focusing on either one or more of the following: water utilities' management and managerial effectiveness, financial management and viability, technical competence and operational efficiency, human resource management and development, project management and implementation capacity, and regional operations and decentralization.

6.1.1 NWSDB Organization

The existing organisation structure of NWSDB has evolved from a number of internal and external institutional development initiatives. It is also as a result of operating under a more comprehensive framework of sector reforms and policies since it was established in 1974, in addition to the amendments to its original charter in 1992, which has given NWSDB stronger policy enforcement powers.

The latest organization structure of NWSDB is shown in **Appendix 6.1 (a).** However, this organization structure is currently undergoing revision, with the approval, in 2011, of the *NWSDB Approved Cadre (Category-wise and Salary Code)*. The revision process includes a series of discussions with the 37 trade unions within NWSDB. The new and updated organization structure will be only issued after completion of the revision process, and when the attendant *Scheme of Recruitment and Promotion* is drafted and eventually approved.[1]

The NWSDB Approved Cadre provides for 246 categories and designations spread over 15 Board Grades. It calls for a total manpower complement of 10,119 personnel. As of 01 July 2012, the actual number of personnel stood at 9,193, or 926 less than the approved number allowed in the cadre.

[1] Interview with Mrs. Chandra Siriyani Weerasinghe, Assistant General Manager for Human Resource Management, NWSDB, 04 July 2012.

To enable to fulfil its mission and vision, as well as the seven-point goals stated in its Corporate Plan (2012-2016), NWSDB is organized along both functional and geographical lines. Functionally, the NWSDB has the following major offices: (i) Policy and Planning, (ii) Water Supply Projects, (iii) Sewerage, (iv) Corporate Services, (v) Personnel and Administration (vi) Commercial (vii) Finance, and (viii) Internal Audit. Geographically, NWSDB has three regional offices under which 14 regional support centres have been organized, and are fully operational. These are the Western Regional Office which takes charge of four regional support centres; the Southern / Eastern Regional Office, under which are five regional support centres, and the Northern / Central Regional Office, which has five regional support centres under it. These functional and geographic organisational dimensions are carried over to the organization structure of the regional support centres where the smallest operational unit is the water supply scheme.

(1) The Regional Support Centres

The Regional Support Centres (RSC), headed by a Deputy General Manager or an Assistant General Manager, were established to provide necessary assistance and support to the daily operations of the water supply and sewerage systems. The RSCs also manage projects aimed at expanding water supply and sanitation services to villages and towns within their jurisdiction.

The RSC is where the functions of water supply / water utility are performed such as: water utility management; technical (engineering) services such as sector planning, water supply planning and development, design and construction; water supply operations and maintenance of facilities; commercial operations including major customer service activities such as billing and collection and the maintenance of customer accounts; financial operations such as general accounting, budgeting and financial reporting, and the consolidation of all operating and financial reports; and administrative operations such as human resource management and other administrative support services.

(2) The District Offices

The District Office, headed by a district engineer, oversees the operation and maintenance of the water supply schemes (WSS), and coordinates the planning and development of the different WSS together with the RSC. The District Office provides supervision over the officers-in-charge of the WSS, and is staffed by administrative and technical personnel. It consolidates reports from the different WSS, prepares cost estimates for minor works, and gives inputs to proposed capital works.

(3) The Water Supply Schemes

The Water Supply Schemes are headed by an officer-in charge (OIC). Being the smallest operating unit of NWSDB, the WSS is a microcosm of the RSC, performing production, treatment, distribution of water, as well as undertaking repairs, small extensions, and minor

rehabilitation. It also undertakes commercial tasks such as meter reading, distribution of pre-addressed water bills during reading time, processing of application for new service connections, reconnections and disconnections; and administrative tasks such as monitoring and reporting of employee attendance / leaves and inventory management. The WSS coordinates closely with its customer base attending to customer inquiries and complaints, as well as supports the technical requirements of CBOs around its area of operation.

6.1.2 NWSDB Regional Support Centre (North Central)

The NWSDB RSC(N/C) is one of 14 RSCs under the NWSDB, and is one of five under the Northern / Central Regional Office) Zone. It is headed by a deputy general manager, and supported by an assistant general manager, and is composed of five operating units/sections, namely: (i) Development Section, (ii) Operations Section, (iii) Commercial and Financial Section, (iv) Human Resources Section, and (v) IT Section. The current organization structure of NWSDB RSC(N/C) is presented in **Appendix 6.1(b)**; while the total number of personnel distributed by Section / Unit is shown in **Table 6.1**.

Table 6.1 Current Number of NWSDB RSC(N/C) Personnel according to Section / Unit

Office / Section	Sub-section / Unit	Sub-Total per Unit	Total per Section
DEPUTY GENERAL MANAGER			**4**
Deputy General Manager		1	
DGM Staff		3	
DEVELOPMENT			**66**
Assistant General Manager		1	
	1) Mechanical / Electrical	1	
	2) Planning and Design	16	
	3) Sector Planning	5	
	4) Construction	13	
	5) Ground Water	30	
FINANCE AND COMMERCIAL			**3**
Chief Accountant		1	
	1) Finance	2	
HUMAN RESOURCES			**10**
Manager, Support Services		1	
	1) Support Services	9	
INFORMATION TECHNOLOGY			**2**
	1) Information Technology	2	
OPERATIONS			**307**
Manager, O&M		1	
Assistant Manager, O&M		1	
	1) Operation & Maintenance	18	
	2) Regional Workshop	17	
	3) District Engineering		
	a) Anuradhapura District	173	
	b) Polonnaruwa District	69	
	4) Commercial		
	a) Accounting	10	
	b) Customer Service	15	
	5) Laboratory	3	
	GRAND TOTAL		**392**

Source: HR Section, as of 15 September 2012.

(1) Functions of the Sections in the N/C RSC Structure

There is no formal functional chart that describes, delineates and defines the broad and specific responsibilities of the sections organised under the North Central RSC. This impacts the efficient and effective management and operation of the RSC, since accountability and responsibility cannot be fully pinpointed. This is exacerbated by the fact that certain core utility functions and sub-functions are still centralised in the Head Office, although other functions have already been decentralised. Examples of functions centralised in the Head Office are human resource management, particularly recruitment, selection and placement (including transfers), promotions, training and development (for Grades 7 and up), and HR records' maintenance. The same is true with financial management and accounting, business planning, asset management, and capital budgeting. Decentralised functions are those pertaining to operation and maintenance, sector planning and development, and construction for small local projects, and billing and collection. The following are the functions being performed by the Sections:

1) The Development Section

The Development Section is headed by the Assistant General Manager, who is concurrently the second-in-command in the RSC. The Section undertakes sector planning activities, such as the preparation of pre-feasibility studies for new schemes, studies of small-scale water supply projects as requested by the external sector, and data collection, research and maintenance of the water supply database. It also performs general planning and design work, such as the preparation of proposals and initial estimates for service improvements; preparation of tender and construction documents; design of treatment works for GOSL funded projects; procurement activities and procurement planning for capital budget projects; rehabilitation of existing treatment plants based on O&M requirements; design and rehabilitation for NRW reduction works; and the study of pipeline extensions and pipeline shifting works. It also undertakes construction management for water supply schemes' projects of the RSC. The groundwater unit under this Section undertakes and/or supervises well development and drilling activities.

2) The Operations Section

The Operations Section is headed by the O&M Manager, who is also the concurrent head of its O&M Unit. The Section is in charge of production and treatment of water, and its distribution to its consumers. It ensures that the water supplied to its consumers complies with the Sri Lankan national standards for drinking water, is adequate for the growing population, and the water service reliable. It provides consumer services, such as: (i) connecting new consumers to the system; (ii) implementing the disconnection / reconnection policies of the NWSDB; (iii) responding to consumer requests and complaints with dispatch; and (iv) billing and collection. It operates and maintains all water supply facilities and

equipment efficiently and effectively and in accordance with NWSDB standards through the water supply schemes. It also promotes the establishment of, and provides assistance to, rural water supply organisations, such as the CBOs, to ensure availability of safe water (and sanitation) in areas not reached by NWSDB's services.

3) The Commercial and Finance Section

The Commercial and Financial Section is headed by the Chief Accountant. The Section prepares the annual operating and capital budget requirements of the RSC, and supports the accounting and finance requirements of the Head Office, where financial management is centralised. In addition, it coordinates with the Commercial Unit under the Operations Section in terms of achieving billing targets and collection efficiency ratios set by the Head Office.

4) The Human Resource Section

The Human Resources Section is headed by the Manager, Human Resources. This Section prepares the annual personnel requirement (HR plan) and staffing actions for the RSC for submission to, and approval by the Head Office. It performs tasks delegated to it by the Head Office, where human resource management and development functions are centralised. It coordinates / conducts training for those in Board Grades 7 and lower. It also provides support services, such as supplies management, to the RSC.

5) The IT Section

This Section takes charge of maintaining the following: (i) all information technology (IT) and electronic equipment; (ii) all servers of the North Central RSC, all radio communications units (frequency bands); and the SCADA system. It administers the RSC's call centre operations, which is the customer care unit with a 24-hour online service. It also implements the IT modules of the RSC such as human resources, financial, commercial, attendance, and inventory management modules / systems.

(2) The Approved Cadre for North Central RSC

The *2011 NWSDB Approved Cadre* provides for 441 personnel for the North Central RSC. However, this July 2012, an additional complement of 44 O&M personnel was approved by the Department of Management Services, Ministry of Finance, bringing to 485 the total number of personnel in the North Central RSC approved cadre, spread along 65 categories / designations covering 11 Board Grades as shown in **Appendix 6.1(c). Table 6.2** shows the Approved Cadre distributed according to sections in the NC RSC.

Table 6.2 Approved Cadre Distributed according to Sections in the NWSDB RSC(N/C)

Board Grade	Categories Designation	DGM	SECTIONS				
			DEV'T	O&M	COMM & FIN	HR	IT
2	Deputy General Manager	1					
3	Assistant General Manager		1				
4	Manager (Operation and Maintenance)			1			
	Chief Engineer (Civil)		3				
	Chief Engineer (Mechanical)		1				
	Manager (Ground Water)		1				
	Manager (Human Resources)					1	
	Chief Accountant				1		
	Chief Sociologist		1				
7	Hydrogeologist /Geologist		2				
	Engineer (Civil) / District Engineer		10	3			
	Engineer (Electrical)			2			
	Engineer (Mechanical)			2			
	Computer Hardware Engineer (IT)						1
	Chemist			2			
	Asset Management Officer				1		
	Commercial Officer (Opns / Investigation)			2			
	Accountant			1	1		
	Cost Accountant				1		
	Sociologist		1				
	Quantity Surveyor		1				
8	Human Resource Officer					1	
	Supply Officer					1	
	Personnel Assistant Secretary	1					
	Assistant Engineer		2	20			
	System Administrator						1
9	Engineering Assistant (Civil)		10	19			
	Engineering Assistant (Mechanical)		1	7			
	Engineering Assistant (Electrical)		1	3			
	Draughtsman		2				
	Management Assistant Supra (Audit)			1			
	Management Assistant Supra (Accounts) [Accounts Asst]			2			
	Management Assistant Supra (Accounts Commercial) [Acct Asst Commercial]			1			
	Management Assistant (Costing)				2		
	Consumer Relations Assistant			1			
	Management Assistant Supra (HR)[Staff Asst]			1			
	Laboratory Assistant			2			
	Computer System Operator			1			
	Driller		8				
10	Management Assistant (Accounts Clerk)			7	2		
	Computer Hardware Technician						1
11	Management Assistant (Human Resources) [General Clerk]		3	12		3	
	Management Assistant (Consumer Relations)[Consumer Relations Clerk]			4			
12	Management Assistant (Cash & Funds) Cashier			2			
	Plant Operation Technician			9			
	Management Assistant (Data Entry Operator)			4			
	Management Assistant (Word Proc English)		1	1			
	Management Assistant (Word Proc Sinhala)					1	
	Management Assistant (Store Keeping) [Store Keeper]		1	6			
	Laboratory Attendant			2			
	Meter Reading Inspector			1			
	Management Assistant (Receptionist)			1			

Board Grade	Categories Designation	DGM	SECTIONS				
			DEV'T	O&M	COMM & FIN	HR	IT
13	Meter Reader			31			
	Driver	1	8	24			
	Labour Supervisor		2	10			
	Mechanic			3			
	Electrician			4			
	Plant Operator Mechanic			44			
	Carpenter			1			
	Circuit Bungalow Keeper			3			
	Mason			2			
	Pipe Fitter			31			
	Cook			1			
15	Caretaker			3			
	Labourer	1	20	100	1	4	1
	TOTAL	**4**	**80**	**377**	**9**	**11**	**4**

(3) The Proposed Cadre to Support the Project (2018)

There is an approval process that has to be followed should the NC RSC request for additional / new cadre. Considering that this Project will entail the development and construction of new facilities, having the right number and right qualifications of the additional staff to manage, operate and maintain the new facilities will be an essential part of successful project implementation. **Figure 6.1** provides the process in requesting for additional cadre for the RSC.

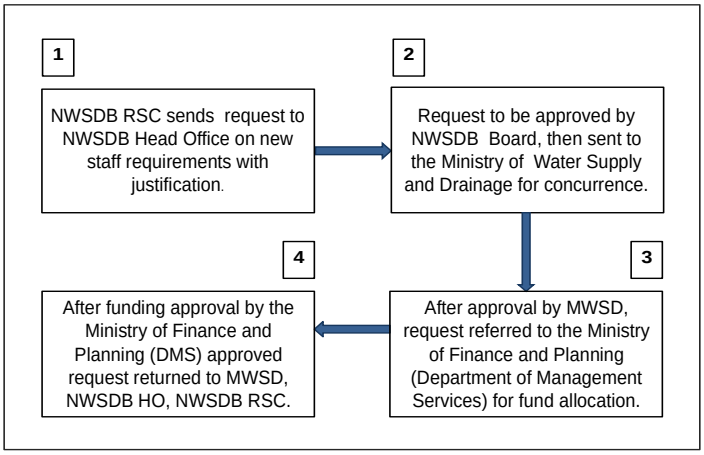


Figure 6.1 Process of Approval for New Staff/Cadre

Once the request for new staff / cadre is approved, then the NWSDB will commence recruitment based on the *Scheme for Recruitment and Promotion*, either recruiting internally, adhering, however, to the internal allotment criteria, or externally, where the required position is advertised. In any case, the qualification and experience criteria for each position, plus the officially recognized recruitment process(es) will have to be strictly complied with. The proposed cadre is shown in **Table 6.3**.

Table 6.3 Proposed Cadre for NWSDB RSC(N/C) for 2018 by Board Grades

Board Grade	Categories / Designation	Approved Cadre (2012)	Proposed New Cadre (2018)
2	Deputy General Manager	1	0
3	Assistant General Manager	1	0
4	Manager (Operation & Maintenance)	1	0
	Chief Engineer (Civil)	3	0
	Chief Engineer (Mechanical)	1	0
	Manager (Ground Water)	1	0
	Manager (Human Resources)	1	0
	Manager (IT)	None	1
	Manager (Training)	None	1
	Chief Accountant	1	0
	Chief Sociologist	1	0
5	Senior Human Resource Officer	None	1
6	Training Officer	None	2
7	Hydrogeologist / Geologist	2	0
	Engineer (Civil) / District Engineer	13	1
	Engineer (Electrical)	2	0
	Engineer (Mechanical)	2	0
	Computer Hardware Engineer (IT)	1	0
	Chemist	2	0
	Asset Management Officer	1	0
	Commercial Officer (Operations / Investigation)	2	0
	Accountant	2	0
	Cost Accountant	1	0
	Sociologist	1	0
	Quantity Surveyor	1	0
8	Human Resource Officer	1	0
	Supplies Officer	1	0
	Personnel Assistant / Secretary	1	0
	Assistant Engineer	22	0
	System Administrator	1	1
9	Engineer Assistant (Civil)	29	0
	Engineer Assistant (Mechanical)	8	1
	Engineer Assistant (Electrical)	4	1
	Engineer Assistant (O&M) (WTP)	0	3
	Draughtsman	2	0
	Management Assistant Supra (Audit)	1	0
	Management Assistant Supra (Accounts)(Accounts Asst.)	2	0
	Management Assistant Supra (Accounts Comm) (Account Asst Comm)	1	0
	Management Assistant (Costing)	2	0
	Consumer Relation Assistant	1	1
	Management Assistant Supra (Human Res) (Staff Asst)	1	1
	Laboratory Assistant	2	1
	Computer System Operator	1	0
	Driller	8	0
10	Management Assistant (Accounts Clerk)	9	0
	Computer Hardware Technician	1	0
11	Management Assistant (Human Resource) (General Clerk)	18	0
	Management Assistant (Consumer Relation)(Consumer Relation Clerk)	4	0
12	Management Assistant (Cash and Funds) Cashier	2	0
	Plant Operation Technician	9	6
	Management Assistant (Data Entry Operator)	4	0
	Management Assistant (Word Processing English)	2	1
	Management Assistant (Word Processing Sinhala)	1	1
	Management Assistant (Store Keeping) (Store Keeper)	7	0
	Laboratory Attendant	2	1
	Meter Reading Inspector	1	0
	Management Assistant (Receptionist)	1	0

Board Grade	Categories / Designation	Approved Cadre (2012)	Proposed New Cadre (2018)
13	Meter Reader	31	1
	Driver	33	4
	Labour Supervisor	12	0
	Mechanic	3	0
	Electrician	4	2
	Plant Operation Mechanic	44	6
	Carpenter	1	0
	Circuit Bungalow Keeper	3	0
	Mason	2	0
	Pipe Fitter	31	8
	Cook	1	0
15	Caretaker	3	9
	Labourer	127	9
	TOTAL	**485**	**63**

As shown in the Table above, 63 new personnel will have to be recruited. It is recommended that the recruitment process start at least a year before the expected completion of construction, or on 2017, so that there is ample time for the entire recruitment, selection and placement (RSP) processes. The details of the staff distribution for the 63 personnel are further explained later into this Chapter.

(4) The NWSDB RSC(N/C) Organisational Structure with Proposed New Units for 2018

The organisational structure of NWSDB RSC(N/C) will, for all intents and purposes, remain the same. However, because of the Project, certain necessary additions to the structure are proposed. This is in line with strengthening the O&M organisation, to ensure appropriate and sustainable, efficient and effective operation and maintenance of the new facilities and also that the consumers – whether the CBOs or the directly-served households – are provided with the reliable 24-hour service, adequate and safe water supply.

The organisation structure showing the proposed new units is shown in **Figure 6.2.** However, the details relating to the proposed Area Engineer's Office are explained in "**Section 6.2: The Operation and Maintenance Organisation"**; while the details to support the Training Unit / Centre are in "**Section 6.1.4: Capacity Development of the Implementation Organisation"** in particular, "2) Setting up a Training Unit and a Regional Training Centre".

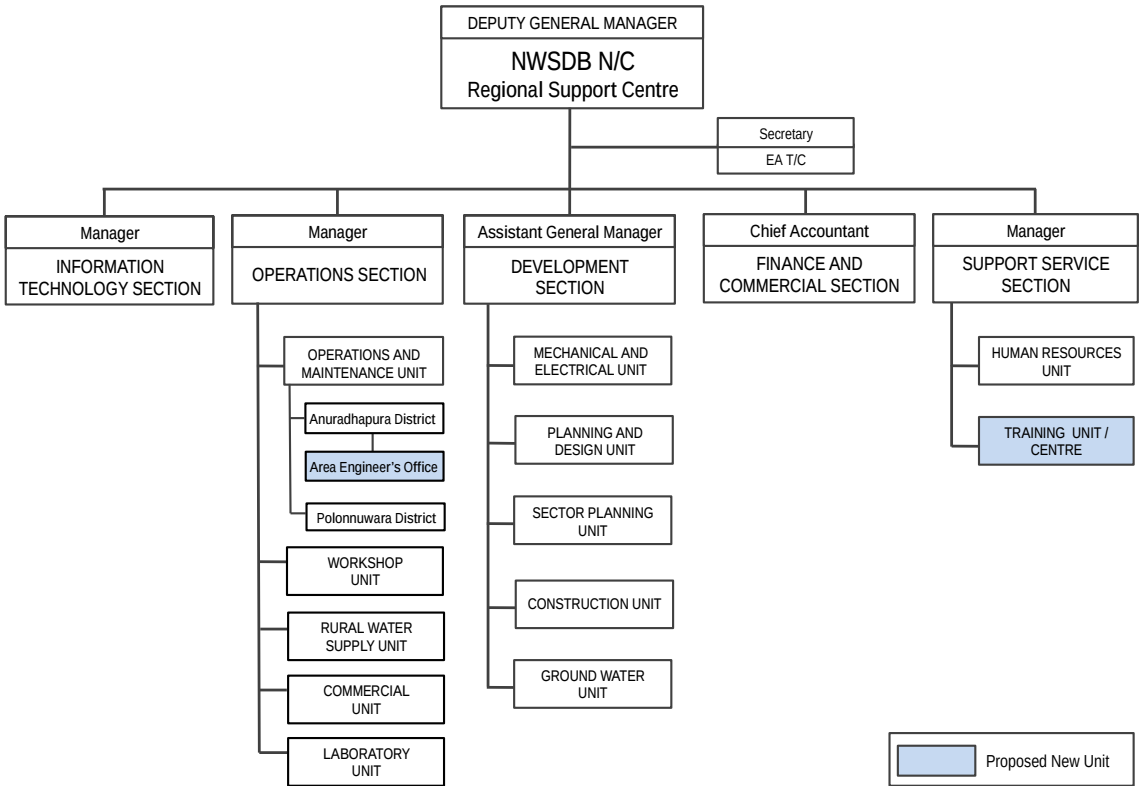


Figure 6.2 Proposed New Units for NWSDB North Central RSC

6.1.3 Project Implementation Arrangements

Ensuring the successful implementation of the Anuradhapura North Integrated Water Supply Project necessitates setting up a rational project implementation system that would take into consideration the requirements of, and the agreements between, the proposed lender, in this case the Government of Japan (GOJ) and the borrower, the Government of Sri Lanka (GOSL).

This section addresses setting up the project implementation system, which requires identifying the key institutions / stakeholders that have varying interests and involvements in project's implementation, setting up project organizations to support smooth project implementation and successful project completion, then defining and/or clarifying the roles and responsibilities of the project organizations within the set framework.

(1) Key Stakeholders

The key stakeholder institutions with interest in the project's implementation are the Central Environment Authority, the Department of Irrigation, the Department of Wildlife Conservation, the Department of Health, the Land Commissioner's General Department, the Department of Archaeology, and the Forestry Department. In addition, there are the local government authorities and the CBOs.

1) Central Environment Authority

The CEA is the government agency under the Ministry of Environment and Natural Resources. It is responsible for ensuring compliance to the Environmental Impact Assessment (EIA) procedure for projects under the National Environment Act. The EIA is a major planning tool aimed at identifying likely effects of a particular project on the environment, and finding ways to reduce unacceptable impacts so that the project is shaped to suit the local environment. It is a mandatory requirement for the establishment of sustainable development projects in Sri Lanka, which this Project is identified.

2) The Irrigation Department

The Irrigation Department is under the Ministry of Irrigation and Water Resource Management. It is the principal government organization responsible for the regulation and control of inland waters. This Project intends to tap water from the irrigation systems / facilities / tanks of the Irrigation Department and transmit this to the proposed water treatment plants before distribution to the six project areas. The rules and regulations imposed by the Department of Irrigation must be complied with, which makes this department a key stakeholder where close coordination must be established and maintained.

3) The Department of Wildlife Conservation

Under the purview of the Ministry of Environment and Natural Resources, the Department of Wildlife Conservation has a unique mandate of protecting, conserving and preserving Sri Lanka’s ecosystem, its wildlife and nature, its forests, its fauna and flora, and its rich biological resources, including their habitats. The interest of this Department is in ensuring that the Project adheres to the National Wildlife Policy of Sri Lanka, the Fauna and Flora Protection Ordinance, and the regulations supporting the Network of Wildlife Protected Areas (WLPAs).

4) The Department of Health Services

The Department of Health Services is responsible for the providing effective health services to the people of Sri Lanka, where environmental health measures, such as supply of safe and adequate water and sanitation, play a key role. Thus, the Department has special concern over the successful implementation of the Project, as it will improve the quality of water being supplied to the project area, which is known to have high levels of fluoride concentration in its groundwater. The aim is to reduce incidences of fluorosis that causes abnormality in teeth and bones, as well as prevent the rapid increase in chronic kidney diseases, which the Sri Lankan government suspects is due to the high fluoride content in drinking water.

5) The Department of Archaeology

The Department of Archaeology is the apex institution and chief regulatory body for the protection, conservation and management of Sri Lanka's archaeological heritage. Since the Project area has very close proximity to the ruins of Buddhism in Anuradhapura, which has been designated as a world cultural heritage by UNESCO, there exists the possibility of important archaeological finds, meriting the inclusion of this Department as a key Project stakeholder.

6) The Land Commissioner's General Department

One of the mandates of the Ministry of Land and Land Development is the allocation of lands for development projects. The lands where the water facilities are to be built have been identified as government land. This makes the Ministry, particularly the Land Commissioner's General Department, as an important stakeholder in the project.

7) The Forestry Department

The Forestry Department is government agency under the Ministry of Environment and Natural Resources whose mandate is to sustainably manage, conserve and develop the forest and tree resources of Sri Lanka while contributing to national prosperity and economy of the country and its people. It implements the Forest Ordinance, an important legislation for managing state owned forests. The Forestry Department is an important stakeholder because it owns the land where the proposed WTP will be constructed in Wahalkada. In addition, the Forestry Department ensures that development Projects adhere to these other laws / ordinances / policies – the National Heritage and Wilderness Area Act, the Fauna and Flora Protection Ordinance, the National Environmental (Protection) Act, the Soil Conservation Act, the Felling of Trees (Control) Act, and the Land Legislation (Land Development Ordinance, Crown Land Ordinance, Land Settlement Ordinance).

8) The Local Authorities

Local Authorities is the collective nomenclature for local government bodies, which are divided into four different groups – provincial councils, municipal councils, urban councils and the divisional councils or the *pradeshiya sabha*. Laws require local authorities to carry out regulatory and administrative functions, promote public health, and provide physical structures and specific services, such as roads, drains, water supply and sanitation, housing, waste collection, markets, public parks and recreational facilities. The implementation of the Project will have the local authorities as stakeholders, not only because their immediate constituents will stand to benefit from it, but also because the project will be constructed within its areas.

The role of the local authorities under the *National Policy on Water* is to (i) undertake planning, design and implementation of small and medium rural water supply schemes; (ii) undertake the operation and maintenance of small and medium scale water schemes, (iii) ensure quality and standards of services, (iv) develop and build partnerships for operations and maintenance activities for the enhancement of service delivery, (v) facilitate the CBOs in implementing and managing the water supply systems and provide them with necessary technical assistance, and (vi) ensure environmental harmony in all development activities and the sustainability of the sub-sector through cost recovery.

9) Community Based Organisations (CBOs)

Community-based organisations have been known to be very active in the supplying water and sanitation to the Sri Lankan countryside / villages. There are 50 registered CBOs presently operating in project area, and their interest in the successful implementation of the project is the additional supply of safe water for its own (and new) consumers. These CBOs can also plan on expanding their own distribution system as a consequence, thus improving service coverage, adequacy and water quality.

The *National Policy on Water* has listed the responsibilities of the community as water "user" by promoting the formation of CBOs to implement and manage community water supply schemes. CBOs are also tasked to coordinate, participate, and/or contribute in sector development activities during planning, design and construction stages of a project, contribute towards the preservation, protection and conservation of water resources, and recognize the value of the service and contribute towards cost recovery to sustain service.

(2) The General Implementation Framework for the Project

The aim of the *National Policy on Water* is setting a direction for all stakeholders in the drinking water sector so that the broader goals and objectives established by the Government are achieved. In this manner, not only are issues related to quality and quantity aspects resolved, but also the commitment of the service providers and the users for the sustainable utilisation of drinking water is promoted.

In implementing this Project, there is a need to put in place, as well as situate the roles of, institutions and stakeholders involved in a project implementation framework. This framework, indicated in **Figure 6.3**, shall define and govern the general and specific interactions among the project organisations.

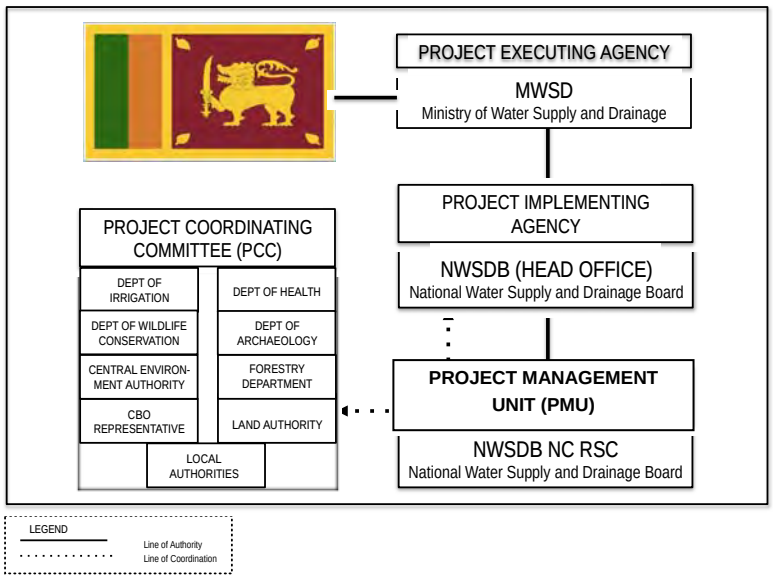


FIGURE 6.3 General Project Implementation Framework

The figure shows that a *line of authority* (represented by a solid line) exists between the Government of Sri Lanka (GOSL) and the Ministry of Drainage and Water Supply (MWSD), which will be the Project Executing Agency. The Ministry is under the supervision and authority of the Government and among its responsibilities are formulating national policies and programmes, and laws and regulations on water supply, sanitation and drainage

A *line of authority* also links the MWSD and the National Water Supply and Drainage Board (NWSDB), which will be the Project Implementation Agency. The NWSDB is the only organisation under the purview of MWSD, which in turn, is responsible for facilitating and guiding the NWSDB in implementing programs and projects in accordance with national priorities.

The North Central RSC is one of the operating arms of NWSDB. As such, the Head Office has direct authority, control and supervision over the N/C RSC even if technical functions, such as planning and development as well as operation and maintenance have been decentralized to the RSC. The N/C RSC will house the Project Management and Coordination (PMCU) with personnel coming primarily from NWSDB HO Unit. A *line of authority* symbolizes the relationship between the NWSDB HO and NWSDB RSC(N/C).

The project stakeholders will be organised into the Project Coordination Committee (PCC). This will enable their varied interests to be addressed by NWSDB during project implementation. The coordinative relationship between the PCC and the NWSDB (through the NWSDB RSC(N/C)) is described by *line of coordination* (represented by a dotted line).

It should be noted that project implementation and management shall generally be spelled out in and governed by the Loan Agreement to be signed between GOSL and GOJ. It will include adherence to the Contract particulars that specify the mutual rights and obligations of each party, which emphasize abiding by all relevant GOSL laws. It will also provide for setting up and supporting a project organisation (Project Management and Coordination Unit) for the duration of implementation, and strengthening this unit as a primary consideration in the project implementation process.

(3) Roles and Responsibilities of the Project Organisations

Each of the project organisations enumerated in the general implementation framework has responsibilities to discharge, as summarised in **Table 6.4**.

Table 6.4 Roles and Responsibilities of Project Organisations

PROJECT ORGANISATION	INSTITUTION	MAIN ROLE	RESPONSIBILITY
Project Executing Agency	Ministry of Water Supply and Drainage	Oversight	General
			Procurement
			Disbursement
Project Implementation Agency	National Water Supply and Drainage board	Technical Supervision and Monitoring	Procurement
			Disbursement
			Monitoring
Project Management and Coordination Unit	NWSDB	Project Management, Field Supervision, Monitoring and Coordination	General
			Project Management
	NWSDB North Central	Coordination	Coordination of Implementation Issues
Project Coordination Committee	Key Stakeholders	Coordination	Coordination of Implementation Issues

1) Project Executing Agency

The project executing agency will be the MWSD, whose mission is “to facilitate stakeholders to serve the nation by providing safe drinking water and adequate sanitation facilities, ensuring protection of water sources and environmental equality in the drinking water supply sector”. Pursuant to this mission, the MWSD is granted legislative, policy, regulatory and coordinative powers and functions to achieve the water supply goals contained in the “Mahinda Chinta” development plan, and the development objectives of the Millennium Development Goals. Inherent in the exercise of its mandate and its powers is oversight, which refers to the crucial role of monitoring and reviewing actions taken by agencies of government under its purview.

(a) General Role of MWSD as Executing Agency

The general role of MWSD is oversight, which will be in holding the NWSDB accountable for implementing the project in compliance with the terms and conditions

set forth in the Loan Agreement to be signed between GOSL and GOJ as well as in conformance to Government's laws, rules and regulations. Note that the implementation of this project will be undertaken by the NWSDB, which is the only agency under the MWSD. Thus, oversight is designed to facilitate project implementation and expedite problem-solving as one link, or is a part of the multi-level performance-based expenditure management system within the national framework for monitoring and evaluating public sector projects of the GOSL.

The MWSD has the Planning and Monitoring Division to perform its oversight role. This division is responsible for planning, monitoring and reviewing the progress of foreign and locally funded development projects implemented by the NWSDB. The general mechanisms for the executing agency to maintain effective oversight are:

- Establish a monitoring and evaluation system that would track the progress of the Project against the technical and financial plan.
- Formulate and/or recommend on policy issues referred to it because of legal or other conflicts that may impede the smooth implementation of the Project.
- Identify and set-up mechanisms for systematic and coordinated delivery of services by tapping other Ministries and/or Agencies to augment and support the process of project implementation, such as land acquisition.
- Identify the priority list of projects, and include in the yearly budget call, all related facilities required for the Project, but not covered under the loan proceeds, but is a part of GOSL's responsibility under the Loan Agreement.
- Make recommendations on investments related to the Project and include these in the priority investment program of the GOSL.
- Ensure the timely release of counterpart (local) funds, if needed, for the Project to the appropriate Ministry.
- Report to the Government on the over-all progress of the Project, if required.
- Call regular meetings (quarterly) for the duration of the Project, and special meetings should the need arise.

(b) Procurement and Disbursement Responsibilities of MWSD

Generally, the employment of consultants and procurement of all goods and services financed out of the proceeds of the loan are made in accordance with JICA's guidelines for procurement. Because of the size and nature of the project, it is expected that the civil works contracts will be awarded on the basis of international competitive bidding. There is a domestic contracting industry in GOSL, and sub-project surveys, investigations, and designs carried out with JICA funding can be undertaken by prequalified local contractors (private sector companies, institutes, and universities) selected by NWSDB, but confirmed by MWSD, on the basis of local competitive

bidding using procedures acceptable to JICA. Procurement of materials and equipment is also expected through local bidding for the reason mentioned above.

The extent of involvement in procurement responsibilities will depend on the final terms and conditions of the Loan Agreement. These responsibilities are as follows:

- If required, MWSD will assist the NWSDB by providing an expert staff in NWSDB's Evaluation Committee to select and employ the Consultants for the Project, based on the *Guidelines for the Selection and Procurement of Consultants for JICA ODA Loans*.
- MWSD will confirm the action/decision of the NWSDB Board of Directors in negotiating with, awarding and signing the contract with the winning Consultant, where the signatory to the contract will be either be the General Manager of the NWSDB, or the Chairman of the NWSDB's Board of Directors, or both.
- If required, MWSD will assist the NWSDB by providing an expert staff in NWSDB's Evaluation Committee to select and procure civil works Contractors, based on the *Guidelines for Procurement under JICA ODA Loans.*
- MWSD will confirm the action/decision of the NWSDB's Board of Directors on the selection and procurement of the civil works contractors, as well as on the procurement of goods and other services, based on the *Guidelines for Procurement under JICA ODA Loans*, where the signatory to the contract will be either be the General Manager of NWSDB, or the Chairman of the Board of Directors, or both.

It should be noted that the MWSB has a Procurement Division, which functions to facilitate and/or expedite the procurement process relevant to water supply and sewerage projects implemented with local and foreign funds, both at Ministry and Cabinet procurement levels.

In addition, the executing agency also has responsibilities in disbursement. Since disbursement of JICA funds follow the principle of payment against invoice and other evidences, together with the certification of completed work, GOSL shall advance the funds to start the Project activities, and then claim reimbursement from JICA every time a certain portion of the work is completed. The responsibilities of GOSL in disbursement are specified in the Loan Agreement, and GOSL will abide by the disbursement procedures such as *Commitment Procedures*, the *Reimbursement Procedure*, and *Transfer Procedures*.

2) Project Implementing Agency

The Project Implementing Agency is the NWSDB, which will exercise monitoring and technical supervision over the project. While JICA has a built-in monitoring system of ODA projects, NWSDB has developed its own monitoring system that tracks the progress of the project against the technical and financial plan. This function is performed under the office of the Additional General Manager for the Water Supply Projects.

(a) Monitoring Role of NWSDB as the Project Implementing Agency

The objective of monitoring is to achieve efficient and effective project implementation as it keeps an eye on the progress of implementation and provides relevant and timely feedback to project managers and implementers. Feedback is necessary to provide project management the basis for improving operational plans, taking appropriate corrective actions or measures in case of shortfalls, and therefore, putting the implementation back on track. Technical monitoring shall include scope, time or schedule, quality, and performance monitoring; while financial monitoring shall include cost (budget), procurement, and disbursements monitoring.

Normally specified in the Loan Agreement would be the submission of *Quarterly Reports* to JICA until the completion of the project; as well as the *Project Completion Report* not later than six months after the completion of the project, using specified official forms and details of the report. All these reports will be prepared by PMCU, with the assistance of the Consultants, and when submitted to JICA will bear the final approval and signature of the duly authorized official.

On its own end, MWSD may require NWSDB to submit regular monitoring reports on project implementation activities, and of the work of the Consultants. The content and regularity of monitoring may be designed jointly by NWSDB and MWSD.

Therefore, the first level project monitoring is actual field monitoring, which will be performed by the Project Management and Coordination Unit, to be created at the Office of the Additional General Manager for Water Supply. The second-level monitoring will be done by NWSDB in its role as the Implementing Agency, NWSDB. The third level monitoring is the oversight level to be performed by the MWSD.

These levels of monitoring will surely facilitate project implementation because problems not sufficiently addressed on the first level, can be re-identified or resolved if it recurs on the second level and so forth, thereby integrating monitoring into a feedback loop that ends up into the next planning period. Either the NWSDB management or MWSD can require PMCU to submit regular (weekly, or every two weeks, or monthly,

depending on the requirement) monitoring reports, specifying items that need to be reported. Monthly face-to-face meetings can be initiated to deal with those problems that may not have been adequately addressed.

(b) Procurement and Disbursement Responsibilities of NWSDB

Generally, the responsibilities of the Project Implementing Agency in procurement and disbursement are contained in the Loan Agreement. These are:

- Selection and employment, negotiation, awarding and signing the contract with the winning Consultant based on the *Guidelines for the Selection and Procurement of Consultants for JICA ODA Loans*, where the signatory to the contract will be either be the NWSDB General Manager or the Chairman of the NWSDB Board, or both.
- With the assistance of the Consultant, performing the prequalification of tender, tender calling, tender evaluation, and contract negotiation for the civil works contractors, as well as on the procurement of goods and other services, based on the *Guidelines for Procurement under JICA ODA Loans*, where the signatory to the contract will be either be NWSDB General Manager or the Chairman of the NWSDB Board, or both.
- Undertaking project compliance to covenants stipulated in the Loan Agreement.

As discussed earlier, disbursement of JICA funds follow the principle of payment against invoice and other evidences, together with the certification of completed work. All responsibilities in disbursements are again specified in the loan agreement and in the JICA disbursement procedures. PMCU, with the assistance of the project consultant's team shall carry out the final review and approval of all documents submitted to it by the contractors and suppliers and submit the same to the Additional General Manager / General Manager, who will affix his signature prior to its transmittal to JICA.

3) Project Management and Coordination Unit

The Project Management and Coordination Unit will be established at the Office of the Additional General Manager for Water Supply Projects. A Project Director (PD) shall be appointed / assigned to head the Unit, and he/she shall be selected from the technical and professional ranks of NWSDB.

Although the physical location of the PMCU will be in at the NWSDB North Central RSC where the facilities will be constructed, the PMCU will retain its direct authority and supervisory link with the Office of Water Supply Projects in the Head Office.

(a) General Role of PMCU

The PMCU shall be tasked with managing the day-to-day activities of the project at the field level. Providing day-to-day supervision over the management of the project means addressing technical skills like scheduling, cost estimating, and risk management; and also encompasses other disciplines such as scope definition, procurement management, financial management, asset management, human resource management, environmental and social considerations, and communications.

The NWSDB is quite familiar with managing projects of this scale funded from foreign bilateral or multilateral sources. The experiences obtained have contributed not only to their well-developed project management skills, but also to their knowledge of international loan procedures and working with Project Consultants.

(b) Project Management and Coordination Responsibilities of the PMCU

While it shall be working very closely with the Project Consultants, the PMCU's tasks relate to the application of project management concepts, tools and techniques. This addresses the full range of activities from the beginning (initiating) to the end (closure) of a project, and the management of multiple sub-activities within the project. PMCU shall be involved in the entire cycle of the project as reflected in the whole range of services to be provided by the Consultant.

- Provide day-to-day supervision and management over the project.
- Review billing and expenditure statements. Prepare request for loan availment according to GOSL and JICA disbursement procedures.
- Prepare and submit comprehensive work and financial plans (WFP) for the approval of the NWSDB General Manager, through the Additional GM for Water Supply Projects and submit the same to MWSD for monitoring purposes.
- Undertake project management within the approved work plans and report the progress of the project to NWSDB Management, and if required, to MWSD.
- Initiate coordination with the PCC (as project stakeholders) concerning project implementation bottlenecks that would be within these stakeholders' ability to resolve.
- Prepare and submit to NWSDB Management and/or MWSD annual progress reports for information of the Government.
- Prepare and submit project completion reports, conduct closing workshop and prepare project acceptance certificate.
- After the completion of the project, NWSDB will have the option of retaining the PCMU staff and place them in vacant technical posts, if warranted.

(c) Proposed Staff Requirement for the PMCU

The proposed staff requirement for the PMCU is for 10 members, as shown in **Table 6.5**. It is recommended that the Project Director be appointed solely for this project given the scope and scale and project completion time, which is approximately four years. Other personnel needed for the PMCU should also come from the current roster of NWSDB Head Office or N/C RSC to effect synergies and opportunity for training and development. Others that cannot be filled from the existing ranks shall be hired on a contractual basis for the duration of the project. Recruitment and selection, however, will follow the government regulations and processes on hiring. It will also be based on the NWSDB's *Scheme of Recruitment and Promotions*, which describes the academic and professional qualifications, as well as the experience requirements for the positions.

Table 6.5 Proposed Staff Requirement for the PMCU

	PMCU Position	Category in Approved Cadre	Proposed Number
Engineering/Technical Staff			
1	Project Director	Project Director	1
2	Project Manager	Chief Engineer	1
3	Project Engineer	Engineer (Civil)	2
4	Project Engineering Assistant	Engineering Assistant	3
Administrative Staff			
5	Project Accountant	Accountant	1
6	Administrative Assistant	Management Assistant (Data Entry Operator)	1
7	Driver	Driver	1
		Total	**10**

(d) Job Tasks of PMCU Staff

Each member of the PMCU will discharge his/her responsibilities in keeping with objectives of the Project. As such, the main and specific job description / tasks for each member of the PMCU are described and defined in **Table 6.6**.

Table 6.6 Main and Specific Job Tasks of PMCU Staff

Job Title	Main	Specific
Project Director (PD)	On **the operating level**, will ensure that objectives / targets of Project are achieved efficiently and effectively and according to schedules, plans and procedures agreed upon by JICA and the GOSL. On **the monitoring level,** will attend the regular meetings to be called by NWSDB Management on the implementation of this ODA project and bring to its attention urgent issues for immediate resolution. On **the policy level,** the PD, as the PCC chair, will proactively coordinate and collaborate with the key stakeholders especially on matters that may need policy decisions and resolutions.	As **over-all in charge of project management and coordination activities**. • Responsible for reviewing all documents and communications going to the GM / Addl GM, for approval or endorsement to external offices. • Responsible for direction and guidance over PMCU staff. • Responsible for management and supervision of technical tasks, such as the review of detailed design, and construction management of the new facilities (treatment plants, distribution tanks and reservoirs, water transmission and distribution network).

Project Manager (PM)	Directly manages and supervises work for the project and work outputs of the PMCU staff.	• Reviews and confirms the scope of work of consultants for the approval of the Project Director; • Defines the roles and responsibilities of each PMCU team member and secure their respective commitments; • Defines the outputs, resource constraints, timelines and quality expectations for the submission of the outputs by each team member. • Develops the work and financial plans of the project for approval of the NWSDB Management through the PD and determines the resource and logistical constraints to complete the objectives of the project.
	Develops systems, policies/rules and procedures to manage and monitor the implementation of the project components.	• Monitoring benchmarks to evaluate the progress of the project; • Monitoring the progress of the Consultant and Contractors in terms of scope, time and budget using the appropriate software; • Database and monitoring system that will enable quick and accurate online downloading of information on the progress of the project; • Development and implementation of standards, guidelines and regulations
	Ensures the timeliness and quality of outputs of the Consultants, contractors and suppliers.	• Reviews all reports of the Consultant and recommends the appropriate action, where necessary; • Recommends to the PD the dispatch of people for field visits, coordination and inspection; • Reviews post-field reports and identifies issues with the necessary recommendations for submission to PD; • Reviews and recommends invoices, including certification of work completion/acceptance of Consultant and contractors/suppliers for billing purposes;
	Manages and monitors all pertinent activities, like work flow and records management; administrative coordination and financial transactions.	
	Reviews and manages the monitoring plan for the natural and social environment, and other social considerations;	
	Provides regular progress and performance evaluation reports and to the NWSDB Management, MWSD, GOSL and JICA through the PD.	
Project Engineer (PE)	*Reports directly to the PM:* Responsible for the field-level implementation and management by providing direction for the effective and efficient field implementation of the different components of the project, while also monitoring the performance of the contractor and the field experts of the Consultant;	• Assists the PM in his responsibility for the management and supervision of technical studies to be undertaken; • Directly oversees and supervises the implementation of field-level activities, particularly in civil works construction; • Certifies the completion of work and payments of suppliers; • Develops and undertakes planning activities, such as but not limited to, the work (technical) and financial plans for submission to and approval of NWSDB Management and undertake the implementation of the approved work plan;

		• Monitors project activities and accomplishments, using the designed monitoring system; • Prepares supporting reports on the progress of the project for NWSDB, MWSD, the Government, and the JICA; • Reviews monitoring report of consultants and contractor's work and submits this to through the PMCU's chain of command.
Project Engineering Assistant (PEA)	*Reports directly to the PE:* Responsible for efficient and effective support and assistance to the Project Engineers field-level implementation and management.	• Validates the progress of implementation of each activity in the work plan; • Assists in monitoring the activities and accomplishments of the project; • Assists in preparing regular supporting reports for various users; • Facilitates the preparation of the work (technical) and financial plan; • Reports and/or find solutions to problems encountered in the field. • Assists in monitoring the performance of the contractor and the field experts of the Consultant; • Prepares regular field inspection reports; • Reports any deviations and problems to the PE.
Draftsman	Provides drafting services and supports other technical requirements of the Project, as necessitated by the PD and PM.	
Project Accountant PA)	*Reports directly to the PD* Performs project accounting and financial functions such as disbursements and cash management.	• Prepares the financial portion of the WFP; • Keeps all project accounts up-to-date while assists in maintaining project book of accounts; • Ensures timely preparation of report of disbursements and periodic accounting reports of the Project; • Processes vouchers and documents for disbursement of project funds.
Administrative Assistant (AA)	*Reports directly to the PD* Performs administration work such as records keeping, office management, and support services.	• Develops, maintains and manages the Project's HR system, records system, project office documents and communications system, as well as physical facilities and supplies; • Coordinates and processes procurement of goods and services for the PMCU; • Processes request for payments from suppliers and reviews compliance with GOSL and JICA procedures; • Prepares request for payment for suppliers, contractors and consultants.
Driver	Drivers shall be maintained under the Administrative Assistant under the office of the PD.	• Ensures the safe transport of passengers and goods within the project sites; • Performs regular maintenance works on the vehicles assigned to them.

(e) Proposed PMCU Organisation Chart

The organisation chart of the PMCU is shown in **Figure 6.4**. The chart indicates not only the number of personnel for the Unit, but also clearly specifies the authority, responsibility and communication (reporting) lines.

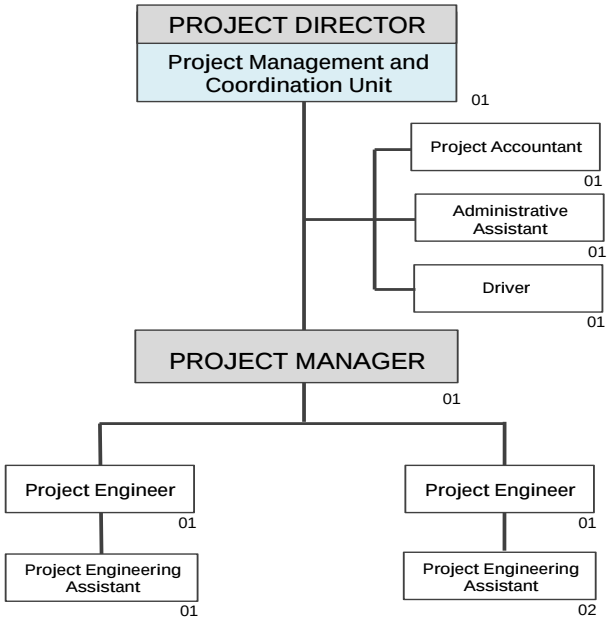


Figure 6.4 Proposed Organisation Chart of PMCU

4) Project Coordination Committee

The PCC shall be composed of the key stakeholder organizations, which have varied and, sometimes, differing interests in the Project, stemming from the stakeholders' specific mandates and legal responsibilities. It is the aim of the PCC to ensure that all these interests converge, and that conflicts are resolved for the smooth implementation of the project. The following guidelines are recommended:

(1) Membership to the PCC

- The stakeholder organizations will nominate their official representative and alternate representative to the PCC in writing addressed to the General Manager, NWSDB – Attention: Additional General Manager for Water Supply Projects.
- As much as possible, the official representative and alternate representative shall be those officials assigned to the regional or provincial offices of the Ministries or Departments concerned in Anuradhapura, who have decision making authority(ies).
- In like manner, the quad-level local authorities will also nominate in writing their representative and alternate representative to the PCC.
- The CBOs will meet for the purpose of selecting (or electing) their representative and alternate representative to the PCC, such that there will be six CBO representatives, one from each of the six study areas.

(2) Role of NWSDB RSC in the PCC

- The PCC chair will be the DGM of the North Central RSC, with the Project Director acting as co-chair.
- For purposes of coordination, quarterly meetings will be held to apprise the PCC members of the progress of the project, and to discuss and find solutions to issues raised.
- Special meetings can be called should the need arise.
- The N/C RSC will provide secretariat services to the Committee, and will also be the official depository of the PCC minutes of the meetings.
- Meeting rules will be deliberated upon by the Committee in an organisational meeting called for that purpose.

6.1.4 Capacity Development of the Implementation Organisation

This section provides the capacity building / training and development approaches for the NWSDB North Central RSC given the requirements, results and impacts brought about by the Project. The objectives of capacity building and development are, therefore, twofold. First is to enhance the capacity / ability of the NC RSC, as an institution, to perform the activities related to the operation and maintenance of the newly constructed facilities. Second is to enhance the existing skills of key staff, as well as identified group(s) of personnel with the competencies required to manage, operate and maintain the new facilities / system thereby transforming organizational and individual potentials into actuality.

(1) The Current Training Organisation

Training and development is a centralised function, with the Manpower Development and Training Office being the dedicated unit primarily tasked to plan, develop, and implement the training requirements through a Staff Training Plan that “includes continuous training, hands-on experience utilizing new technologies and management techniques” conducted either internally or externally.

1) Head Office

In-house training programmes are broadly categorised into (i) technical courses; (ii) non-technical courses, (iii) computer training courses; and (iv) training courses for select external institutions. All these training are conducted by the trainers of the NWSDB in its Training Centre located in Colombo City. For 2012, 154 training courses were programmed to be conducted by the Centre totalling 15,000 training hours. See **Appendix 6.1(d)** for the list of technical training programmes (2012); **Appendix 6.1(e)** for the list of non-technical training programmes (2012); **Appendix 6.1(f)** for the list of computer training courses (2012); and **Appendix 6.1(g)** for training courses conducted for external institutions (2012).

In-country (external) training programmes are categorised into (i) graduate and postgraduate degree courses (doctorate, master's and post graduate diploma courses) offered by government-recognized universities and educational institutions of higher learning, (ii) diploma courses offered by reputable and government-recognised institutes; and (iii) short specialised courses, certificate courses, and advanced courses offered by reputable institutes, government-recognised universities, and engineering organisations. See **Appendix 6.1(h)** for the list of graduate and postgraduate degree programmes (2012); **Appendix 6.1(i)** for the list of diploma programmes (2012); and **Appendix 6.1(j)** for the list of short, certificate and advanced courses (2012).

In addition to in-house and in-country training, NWSDB key personnel also receive overseas training, usually part of the capacity building phase of foreign-assisted projects. For 2012, 75 staff members have been programmed to receive various types of training overseas.

Table 6.7 gives the targets for all training to be conducted by the NWSDB Training Centre from 2012 to 2016.

Table 6.7 Training Targets of NWSDB (2012-2016)

Description	Unit of Measurement	2012	2013	2014	2015	2016
In-house Training	No. of Programs	150	150	160	160	160
In-Country (External) Training	No. of Persons	240	240	250	250	250
Overseas Training	No. of Persons	75	75	80	80	80

Source: NWSDB Corporate Plan 2012-2016, p 27.

(2) North Central RSC

Training of RSC staff is conducted by the NWSDB Training Division and the RSC. **Table 6.8** provides the trainings received by a range of staff categories, such as engineers, engineering assistants, cashiers and drivers. The total number participants who received training are 40 in 2010 and 293 in 2011, which translates into a total of 112 and 436 training days for 2010 and 2011, respectively.

Table 6.8 Training Received by NC RSC Staff for 2010 and 2011

	Title of Training	Conducted By	Target Group	Duration (No. of Days)	No. of Participants	Total Training Days
	Year 2010					
1.	Industrial Training for Engineers	RSC	Engineers	18	10	180
2.	Office Procedure for Cashiers	RSC	Cashiers	2	2	4
3.	Training for Drivers	RSC	Drivers	1	28	28
	Year 2011					
1.	Flow Measurement Control	Training Division, NWSDB HO	Engineering Assistant	1	33	33
2.	Traffic Laws (Sinhala)	RSC	Drivers	1	24	24
3.	Maintenance of Gas Chlorine	NWSDB HO	Engineering Assistants	3	33	99
4.	Water Treatment Process	NWSDB HO	Engineering Assistants	2	40	80
5.	O&M Aerometers and Sedimentation Tank	NWSDB HO	Engineering Assistants	2	33	66
6.	Surge Analysis for Engineers	NWSDB HO	Engineers	5	1	5
7.	Geographic Information System	RSC	Engineering Assistants	1	12	12
8.	Water CAD Application	RSC	Engineering Assistants	1	12	12
9.	MS Word 2007	RSC	Engineers / EAs	1	5	5
10.	Field Visit to Dowatenne Power Plant	Ceylon Electricity Board	Mixed	1	50	50
11.	Attitude Development and Time Management	RSC	Mixed	1	50	50

Source: HR Office, NWSDB RSC(N/C), July 2012.

Except for one training which lasted for 18 days, the duration of training(s) was from one to five days. This has given rise to the request from the RSC that training be localized in the regional centre, to save both on travel time and accommodation, and to maximize the training benefit to cover other staff who may not have been included due to costs.

This view was shared by NWSDB (Addl GM for Corporate Services and Asst GM for Manpower Development and Training). The Head Office conducts a total of 15,000 training days per annum, and therefore sees the necessity of strengthening the regional centres to enable them to conduct their own training. This would necessitate having a training facility equipped with basic training equipment to cater to the area, the training of trainers, and the development of training modules and courses on a wide variety of subject matters. Linkage with other training institutions must also be developed.

(2) Enhancing Organisational Capacity in Training and Development

While training is also conducted at the regional support centre levels, much of the training is still done centrally at the NWSDB Training Centre in Colombo. There is a need to greatly enhance the organisational capacity of NWSDB RSC(N/C) in the area of training and

development by: (i) the development and implementation of a North Central RSC Training Plan; (ii) setting up a regional-level training unit / centre to implement the training plan; and (iii) staffing the regional training unit / centre.

1) The Development and Implementation of a *North Central RSC Training Plan*

While the Head Office integrates the training requirements of all regional support centres, as well as prepares and implements the country-wide training and development plan, it can allow for even greater participation of the RSC by decentralising the development and implementation of the regional-level training plan, which can be done by the NC RSC through these recommended steps:

- Undertaking a training needs analysis (TNA) for the entire RSC starting with each organisational section/unit/office, then for each category in the cadre, and ending with each staff/personnel;
- Linking the TNA to performance management (as part of the entire human resources management model) and to the result of the performance evaluation done on each staff member;
- Preparing a five-year "North Central RSC Training Plan" which (i) answers the unique training needs of the RSC, (ii) is aligned with the comprehensive strategic human resource development plan of the Head Office, and (iii) identifies resource requirements for its sustained implementation;
- Implementing the NC RSC Training Plan on an annual basis, together with the NWSDB Training Centre at the Head Office;
- Reviewing, updating and evaluating the NC RSC Training Plan yearly to incorporate emerging capacity development and training needs and to improve on programme content and delivery.

2) Setting up a Training Unit / Regional Training Centre

The issue of where training should be conducted has been brought up in support of localising training on a regional basis in order to achieve training efficiency and effectiveness. Training efficiency redounds to savings on travel time, which could be better spent on the actual training itself; savings both on travel and accommodation costs; and fully maximising the training effort and costs by being able to cover staff who may otherwise have been left out due to cost constraints if training was conducted in Colombo. Training effectiveness comes from being able to use local cases and experiences as "lessons learned" tools; having longer on-the-job training as compared to if training was not in the jobholder's area; and having ample time to demonstrate competencies learned for skills-based training programmes.

The idea of setting up regional training unit / centre is not new considering the number of training programmes conducted and the number of participants being trained by the Training Centre in Colombo. As for the North Central RSC, the Head Office sees the necessity of strengthening the regional support centre to enable it to conduct most of its own training, as well as for the RSCs nearby. To accomplish this, the NC RSC must have the following basic components:

(a) Basic components in establishing a training unit or centre

- *Training infrastructure, training facilities and spaces,* which are the "hard component" of establishing a training unit or centre. These are: (i) a conference room for large-style lectures; (ii) seminar rooms(s) for multi-purpose, small sized instructions; (iii) workshop space(s) for hands-on practical training; (iv) administrative support space(s) for trainers' offices and general storage areas; and (v) user support spaces to be used for the library or reading room, dining or snack room, and rest rooms.
- *Training and communications equipment,* which are the support components of establishing a training unit or centre as it reinforces face-to-face training and web-based lectures and training programmes. These are: (i) computer(s) and networks; (ii) audio-visual and still camera and video equipment; (iii) basic O&M training equipment to support practical or hands-on training on water supply O&M, such as for leak detection and repair, water meter connection and disconnection and repair, and so forth; (iv) other training aids.
- *Training programmes and courses and its materials, manuals and* modules, which are *the soft component* of establishing a training unit / centre. Many of these have been developed by the NWSDB Training Centre, and can be revised and/or updated. New materials and modules to replace out-dated or obsolete materials, or to support new training courses can be developed by outsourcing training and content experts. All programmes and courses will specify: (i) the knowledge, behavioural, attitudinal and skills *objectives*; (ii) the training *content* or the knowledge and skills to be learned, which may be presented in manual, video and/or training module formats; and (iii) the training *methodology(ies)* appropriate to the training objectives, suitable to the level of the participant-learner, and applicable to the type of knowledge, skill or competencies to be developed.

(b) Establishing the *Training Unit* (Intermediate Measure)

During the detailed design and construction phases of the project, the NWSDB RSC(N/C) can allocate, from its existing inventory of buildings and facilities, the physical location and structure to house the Training Unit. Training equipment can be subcontracted on demand basis, while current training materials and modules can be updated based on users'

and participants' feedback. However, all these still need financial resources, if the NC RSC were to provide the superior level of training services. It can, therefore, source the required funds from NWSDB, or from development assistance.

(c) Establishing the *Regional Training Centre* (2018)

Training infrastructure and facilities for the regional training centre is proposed by 2018. The same is true with furnishing the centre with necessary equipment for lecture-type and practical training, including equipment to support web-based training. The latter will allow connection with the NWSDB Training Centre in Colombo, to enable NC RSC to have access to distinguished lecturers not available in the region.

The fund support / financial resources for the hard component, the support component and the soft component (as discussed earlier in this section) can either come from NWSDB funds or be the subject of new development assistance, or a mix of both. What is important is that training and development activities are demand driven, based on actual and local training needs, and answer NC RSC's management and O&M requirements.

3) Staffing the Training Unit (Intermediate) and the Regional Training Centre (2018)

As of August 2012, the Human Resources Section, headed by the Manager, has a total of 10 personnel as shown in **Table 6.9.** However, the HR section staff is concerned with recurring administrative and personnel work, such as the preparation of the annual and project-related personnel requirements and staffing actions for submission to the Head Office. It also provides support services to the RSC in the area of supplies management.

Table 6.9 Human Resources Section Staff, 2012

	Post / Category / Designation	Board Grade	No. in Approved Cadre
1	Manager, Human Resources	4	1
2	Human Resource Officer	7	1
3	Supply Officer	7	1
4	Management Assistant (Clerical HR)	9	3
5	Labour	15	4
		Total	**10**

It must be noted that the extent of decentralisation of HR functions to the RSCs is still on-going at the NWSDB. It would take time for HR functions to be fully devolved. This is true in the area of training where the RSC, at present, is made to coordinate training with the Head Office, and conducts certain training programmes, but only for those in Board Grades 7 and lower.

Thus, to operationalize and regionalise training and development activities, the NC RSC needs to provide a minimum number of qualified and cadre-approved staff for the proposed training unit. With the establishment of and eventual staffing of the training unit, capacity

enhancement of RSC staff and O&M personnel can be addressed based on the current and future demands of the organisation. Considering the RSC will be looking forward to the improvement of its water facilities / system, it is imperative that its human resources be made ready to take on the actual management as well as operation and maintenance of the new facilities.

1) Staffing for Training Unit

The proposed training unit will be made a part of the Human Resource Section, and will function under the leadership of the Manager, Human Resources, where logically, training and development is a vibrant part of the human resources management cycle. The training unit will become the core of the future regional training centre, growing and developing experience and expertise in planning and implementing training programmes / courses. As shown in **Table 6.10**, by 2017-18, three staff members would have been hired to start up the operations of the training unit. Its priority activity will be the preparation, development and implementation of a five-year *North Central RSC Training Plan* (as described earlier). **Figure 6.5** shows the organisation structure for the training unit.

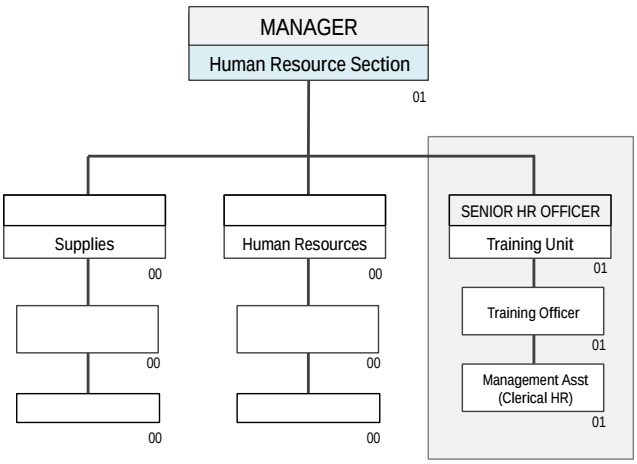


Figure 6.5 Proposed Organisation Structure of the Training Unit (Intermediate)

2) Staffing for the Regional Training Centre (2018)

The Training Unit will be spun off into a full-fledged Regional Training Centre (RTC) attached to (and not under) the Human Resources Section, thereby enabling the NC RSC to take advantage of economies of scope and scale, as well as the learning curve. During this time, the North Central RSC will see an increase in: (i) the number of programmes and courses offered; (ii) the number of participants to its training programmes; and (iii) the frequency of training. The projected increase in training activities will result from extending training to the neighbouring RSCs (North, Central and North Western) and from the completion of construction of the water supply facilities. It will also take on the added

function of providing training services in the areas of small water utility management and O&M to the personnel of the 50 CBOs operating in the area, the number of which would likely go up in the future due to increased water supply from the NC RSC.

Table 6.10 Staffing for Training Unit and Regional Training Centre

	Post / Designation	Board Grade	Proposed Number of Staff		Total 2018
			Training Unit	Training Centre	
1	Manager, Training	4	-	1	1
2	Senior Human Resource Officer	5	1	-	1
3	Training Officer	6	1	1	2
4	Management Assistant (Clerical HR)	9	1	-	1
5	Management Assistant (Sinhala)	12	-	1	1
6	Management Assistant (English)	12	-	1	1
		Total	**03**	**4**	**7**

The Regional Training Centre is proposed to be headed by a Manager, Training, and shall be assisted by three additional staff members, thus bringing to seven the total staff complement for the RTC (including those from the former Training Unit). Subject matter experts will be insourced from NWSDB Head Office, or outsourced from industry and/or the academe depending on the training course(s) to be conducted. **Figure 6.6** presents the proposed organisation structure for the Regional Training Centre.

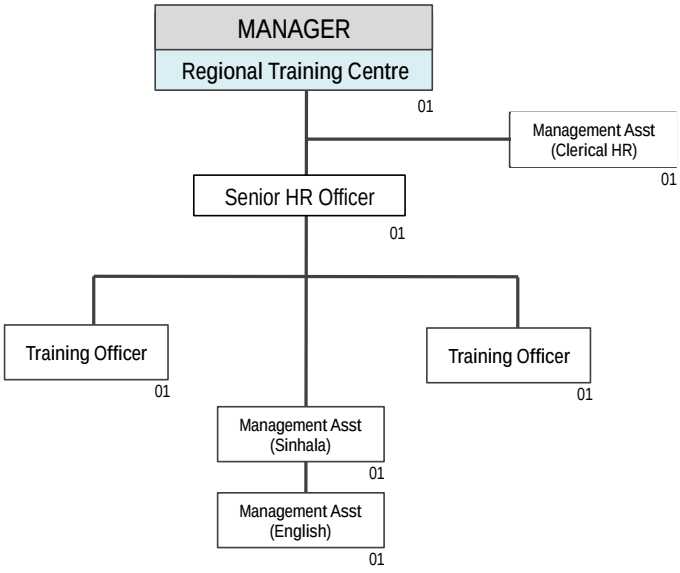


Figure 6.6 Proposed Organisation Structure of the Regional Training Centre (2018)

(4) Enhancing Staff Capacity through Training and Development

Establishing and operationalizing the training unit / centre are the first important steps in developing the capacity of the implementation organisation, or the NC RSC. Next comes the other half of the equation – developing and enhancing the capacity of the staff through the implementation of the training plan. Training and development activities for the key staff, as

well as identified group(s) of personnel tasked to manage, operate and maintain the new facilities / system will have to be rationally and systematically performed.

1) General and Specific Approaches

The general approach to enhancing staff capacity is to acknowledge that all personnel will require various types of training in the short and medium term. This becomes even more important given both the educational attainment and training profiles of the O&M staff. Thus, training should not be designed as a sporadic separate activity, but rather address specific current and emerging needs of the North Central RSC.

This approach provides for training that will cover (i) the entire organization; (ii) the sections and units based on their specific functional roles and responsibilities, and (iii) individual skills training, based on job function and position held. The latter, however, will require a more in-depth training needs assessment, subjecting each candidate to more detailed review of his qualifications and aptitude, to ensure the matching of proposed training with job requirements and individual capacity. Until this is done, there is little room for training to be successful.

Three specific approaches to training will be utilized to enhance the staff capacity of NC RSC. The first will be the traditional approach where the training staff designs the objectives, contents, techniques, and evaluation for the participants, with the training staff providing the intervention to skills development. The second is the experiential approach where the trainer provides learning experiences, thus making the learner an active partner in the training process. This approach emphasizes real job situations or can simulate conditions in which the trainee(s) currently operates or will eventually operate. Thus, the trainers and the trainees jointly determine the training objectives and other elements of training with the trainers primarily serving as facilitators, catalysts, or resource persons. The third approach is the competency-based or performance-based approach where the emphasis is given to the trainees' acquiring a specific observable skill for a task, and then attaining the skill by demonstrating it with a given level of competency or proficiency. This approach is mostly task or skill centred and is applicable for on-the-job training.

(a) Developing a Core of Trainers

It becomes imperative for the NC RSC to begin identifying who, from its own ranks, will make up the core of technical trainers (apart from the training staff to be hired) to conduct training using the experiential and competency-based approaches. This core of technical trainers should possess relevant experience, proven skills and considerable knowledge on a particular technical area. It is proposed that this core of technical trainers be given an

extensive "trainers training" course to develop proper skills directed at making them effective instructors / trainers in their recognised field(s) of expertise.

(b) Language of Instruction

The language(s) of instruction for training will be bi-lingual – English and Sinhala – although the balance we would best left to the discretion of the trainer. What is important is that the language used must promote full understanding of the training and retention of what has been learned. Thus, training materials, modules and hand-outs should also be bi-lingual (English and Sinhala).

(c) Developing a Knowledge Base

A knowledge base is best described as a centralized repository for information. The NC RSC has accumulated and will continue to accumulate much information through its experience in operating and maintaining water supply facilities. These various types of experiences, if systematically collected, organized and retrieved, can be of significant use internally towards improving WSS' operations and enhancing training. It will also be of value externally, that is, in assisting the CBOs and the water supply units of the local authorities to improve water supply services. A well-organized knowledge base will save NC RSC resources, and will increase organisational and staff capacity on water supply management, operation and maintenance.

2) Levels of Training for North Central RSC

There should be a series of *organization-wide* training designed and developed for all NC RSC staff members to provide them with the big picture or macro perspective of the RSC. Topics suggested are NWSDB Vision-Mission-Objectives-Strategies; NWSDB RSC(N/C) policies, organisation structure, broad and specific functions (sections and units); overview of NC RSC water supply facilities, its operations and maintenance; and personnel rules and regulations. This type of training is usually taken for granted, but is actually necessary as key personnel of the RSC are routinely re-assigned to another area after serving in one RSC for a period of time. The training is also seen to promote organisational pride and an understanding of how one's job affects and relates to another person's.

Training should also be designed and conducted by *functional area* of the organization, or by specific section and/or unit. This micro perspective will ensure that the staff of each section recognises the contribution of their own section(s) to the NC RSC's total effort / success. Focus should not only be by section functions and responsibilities, but also on the importance of coordination and linkages between and among sections and units, if only to highlight unity of effort and cohesion as ingredients to efficiency and productivity.

Training will also be done by the *individual (staff) level.* It is proposed that the training for selected / identified employees commences only after a more detailed training needs assessment. Individual training must be matched with the proposed trainee's qualifications, the job presently held, and the skills needed for the job-holder to perform at the minimum acceptable standards of the particular job. This requires three things: (i) the evaluation of all jobs / positions in the organization; (ii) the development of job qualification standards; and (iii) having job or position descriptions for each job family. With these requirements, training investments will be well spent.

The NWSDB has the critical inputs to ensure that staff-level training can more easily be designed, developed and customised by the proposed Training Unit. It has written job descriptions for all categories / designations in the Approved Cadre.[2] In addition, it also has a performance evaluation system in place for executive and non-executive grades / categories.[3] All that is needed are for the human resources and/or training staff to translate these inputs into the *North Central RSC Training Plan,* which shall take into consideration the training needs analysis results.

3) Proposed Training Programme / Courses

The proposed training programmes / courses will be focused on ensuring the sound operation and maintenance of the newly constructed water production and water distribution facilities, including the transmission and distribution network, and all related mechanical, electrical, and water laboratory equipment and appurtenances. The training will be divided into in-country and overseas training and will cover the following areas: utility management, project management, operations and maintenance, water quality, human resources, and public information and education. Note that the in-country and overseas training will be included in a more comprehensive capacity development (soft component) sub-project, which is discussed further in this section.

(a) In-country Training

The proposed in-country training programme is divided into technical courses (Project Management, Water Treatment Plant Operations and Maintenance, Network Installation and Maintenance, Water Quality Monitoring); and non-technical courses (Human

[2] The job descriptions delineate the vertical reporting lines upward (superior[s]) and downward (subordinates[s]); the posting and grade level; the division and location; the purpose of job; and work environment and conditions. It also defines the key (critical and supportive) responsibilities; and identifies accountability, norms, authority and relationships.

[3] The performance evaluation system specifies the composition of evaluation panels for each category and spells out the evaluation procedure, such as guidelines, reasons for the evaluation, the criteria or measures of performance, and the evaluation period.

Resources Management [focus on Training and Development], Public Information, Education and Communication, and the Trainers Training), as presented in **Table 6.11**.

Table 6.11 Proposed In-Country Training Programme

	Title of Training	Proposed Participants	Duration
1.	Project Management	Total 10 participants • *Development Section*: 06 participants Preferably the Unit Heads of Mechanical / Electrical, Planning and Design, Sector Planning, Construction, and Groundwater Units • *O&M Section*: 04 participants Preferably the O&M Manager and Assistant Manager, District Engineers of Pollonuwara and Anuradhapura Districts	10 days
2.	Water Treatment Plant Operations and Maintenance	Total: 20 participants • *Optional*: O&M Manager and Assistant Manager • Heads of all WTPs in NC RSC, personnel of the new Mahakanadarawa and Wahalkada (WTP) WSS • Staff of the Proposed O&M Area Office • Head, Regional Laboratory • Head, Workshop Unit	20 days
3.	Water Distribution system Operation and Maintenance	Total: 25 participants • Engineering Assistants and Staff of the WSS of the Six Project Areas, Staff of the proposed O&M Satellite Office • Selected Engineering Assistants of NC RSC • Head, Workshop Unit	20 days
4.	Human Resources Management	Total: 12 participants • Heads of all Sections • Key Personnel of Human Resources Section • Staff of the proposed Training Unit	05 days
5.	Public Information, Education and Communication	Total: 12 participants • Head, Commercial Unit • Head, Rural Water Supply Unit • Key personnel of the Customer Service and RWS units • Engineering Assistants of the Six Project Areas and the proposed O&M Satellite Office	05 days
6.	Trainers Training	Total: 15 participants • Identified subject matter experts on technical training • Identified subject matter experts on non-technical (management) training	05 days
7.	Water Quality Monitoring	Total: maximum of 07 participants • Chemists • Laboratory Assistants • Laboratory Attendants	20 days

The coverage of the training courses is as follows:

- The Project Management Training Course

  The participants will learn the Project Management Framework as the basic structure for understanding the environment in which the Project operates enabling the implementers to manage the day-to-day activities of the North Anuradhapura Integrated Water Supply Project for its successful completion. By being taught the project management knowledge areas and processes, the various elements of the

project will be properly planned, coordinated, executed and controlled. Costs will be more carefully planned, budgeted and controlled; human resources be more effectively utilized and developed; work quality assured; information and communication on performance reported; risks minimized, and project procurement better planned and controlled.

The training will include such topics as: Introduction to the Modern Concept of Project Management and project management framework along with the nine knowledge areas including Integration, Time, Cost, Risk, Quality, Communication, Human Resource, Procurement and Scope Management. Starting from the Initiation process for a project, participants will be introduced to the detailed process of Planning, Execution, Control and Closing.

- The Public Information Education and Communication Training Course
  The participants will learn the Information, Education and Communication Framework and the different ways by which the North Central Regional Support Centre can convey its message(s) and policies across its various stakeholders. By doing so, the participants will be able to classify its messages, develop IEC strategies that would be appropriate for its various publics / audiences, and learn to use the most suitable media to deliver its message. The ultimate objective is getting the target audience not only to be aware of the NC RSC's important messages, but to have a deeper understanding of its meaning, and to act positively based on this understanding.

  The training will include topics such as the Introduction to Information Education and Communication Processes, Public Relations, Public Consultations, Media Relations, Advocacy, Public Awareness, Events Management, Communication Infrastructure, and Evaluation of Communications Programmes. Messages that can be used for the IEC programme(s) are: water conservation and the preservation of the environment; water, health and hygiene; water quality and water borne diseases (dental and skeletal fluorosis and chronic kidney diseases). Others topics can fall under customer services, such as the conduct of consumer surveys; water service coverage to the poor and disadvantaged; handling customer services and customer accounts, new connections, reconnections, disconnections and customer complaints.

- The Water Treatment Plant O&M Training Course
  The training is designed for the O&M staff of the two new water treatment plants / schemes to safely and effectively manage and maintain the intake, transmission and WTP facilities. While the training programme will include basic classroom

(theoretical) learning, it will provide numerous practical (job-site) learning opportunities and activities.

Training will cover the following topics: Types and quality of water sources; Structure of water source, materials, intake water volume, and allocation of water intake facility; Water theory of treatment process and hydraulic capacity; Stages of conventional water treatment; Structure, material and allocation of chemical facility; Raw water quality and annual fluctuation of water levels. On the operations side, topics will be: Operation methodology of raw water intake dependent on the required water demand; Operation the intake pumps dependent on the required water demand; Operation methodology for the water treatment process dependent on the required water demand and raw water quality; Methodology for investigation the process water qualities (iron, manganese, turbidity, color, pH and residual chlorine); Methodology and handling of the sludge treatment; Required daily and regular maintenance for water treatment plant; Preventive maintenance; Water quality control; Information, documentation and records keeping; Safety regulations; Workshop and stores; Vehicles and transport; O&M cost estimation; and Responsibilities of the WTP operators.

- Distribution System O&M Training Course

  The training is designed for the O&M staff at the water supply schemes to safely and effectively manage and maintain the distribution facilities and network of pipelines. While the training programme will include basic classroom (theoretical) learning, it will provide numerous practical (job-site) learning opportunities and activities.

  Training will cover the following topics: Theory of water distribution in a water supply system; NC RSC's distribution network system, diameter of pipe, pipe material and hydraulic capacity; NRW control, measurement and reduction program and methodology of investigation for leakage volume; Methodology of distributing the required water amount into each distribution block; Installation method of consumer flow meter; Operating the tools for installation of consumer flow meter / bulk meter; Mapping, records and reports. The practical aspects will include operating and maintaining water distribution systems, emphasizing role and duties of water distribution system operators, procedures for operating and maintaining water towers, components and characteristics of distribution system facilities, operating and maintaining distribution systems, maintaining water quality in the system, disinfecting new and repaired facilities as well as water delivered to consumers, and techniques for recognizing hazards and developing safe procedures and programs.

- Water Quality Monitoring Training Course

  The training is designed for water laboratory personnel and will include the following topics: Water quality monitoring principles and strategies – sampling methods samples protocol, sampling handling, special parameters quality assurance, safety and security, data management, interpretation and reporting; Water quality sampling and analysis – source water quality monitoring, tap water quality monitoring, demonstration of selected, basic measurements and methods including QA/QC techniques; and Laboratory certification. Practical aspects of the training will include laboratory management including equipment O&M, and planning regular water quality monitoring for the new WTPs.

- Human Resources Management Training Course

  The training provides an analysis of human resources' role in organizations, and identifies future trends and needs from preparing policies and procedures manuals to identifying the elements of effective performance management. Topics will cover the following: Changing role of HR in NWSDB; Functions and roles of HR within the organization; Human Resource Management Principles (recruitment, selection and placement, performance appraisal); Employment Process in government / civil service; Organisational and employee development; and Change management.

- Trainers' Training Course

  The training will allow the participants will discover new training methodologies in engaging the trainee-audience, and develop into a confident facilitator of learning, not just a mere presenter or lecturer. Topics will cover the following: Active adult learning by determining how team-building, on-the-job assessment and immediate learning involvement can occur at the earliest stages of a training program; Assessment, or distinguishing problems that can be addressed by training and devising questions for use in a training assessment; Objectives setting that focuses on outcomes and results rather that on topics and identifies objectives as affective, behavioural or cognitive; Implementing "active training" that chooses methods and formats appropriate to the objective and training audience; Facilitating and engaging the trainees through presentations, lectures, and experiential learning activities; and Feedback and evaluating techniques.

(b) Overseas Training

It is also proposed that overseas training be designed and conducted for the top

management team of the NWSDB (Head Office and NC RSC) on water utility management best practices. The 15-day training will consist of three-day visits to three water utilities[4] that have been recognized for management and operational excellence, such as the Phnom Penh Water Supply Authority (Cambodia)[5], Manila Water (Philippines)[6], and Hyderabad Metropolitan Water Supply and Sewerage Board (India)[7]. The training will also include another three-day visit to a water utility in Japan that has set an exemplary record in reducing non-revenue water.

The general approach for the overseas training will be similar to a twinning program, albeit in an abbreviated form. It will be an arrangement where NWSDB will be paired off with three water utilities with similar characteristics, but which had been able to gain considerable expertise in aspects of water utility performance. The idea is to match the stronger utility (expert) with the developing utility (recipient) to enable the latter to improve in any of the following areas: service coverage and delivery, financial sustainability, governance, NRW reduction, customer service improvement, development of a training center, tariffs and financial management, to name a few. Thus, the specific purpose of the training is to learn from the best practice of the expert water utility and to share this valuable expertise with NWSDB. The training will consist of lecture-type discussions with the general managers or administrators of the expert water utilities or water authorities, plus an observation-tour of relevant water supply facilities. See **Table 6.12** for the proposed overseas training.

Table 6.12 Proposed Overseas Training Programme

	Title of Training	Proposed Participants	Duration
1.	Overseas Training on Water Utility Management Best Practices	Total Participants: 07 *From NWSDB HO* – 03 participants *From the North Central RSC* – 04 participants (Deputy General Manager, Assistant General Manager, Chief Engineer, and Manager O&M)	15 days (including travel time)

[4] The choice of water utilities to be visited is tentative, and will be subject to the final choice of NWSDB and JICA.

[5] The *Asian Development Bank Water Prize (2004)* for overhauling Phnom Penh's water supply system and demonstrating leadership and innovation in project financing and governance; and the *Stockholm Water Industry Award (2010)* for contribution to sustainable water management.

[6] Four-time awardee of the *Corporate Governance Asia Recognition Award*, the latest being in 2010 for its continuing commitment to the development of corporate governance in the region; and the *Finance Asia: Asia's Best Companies (2011)*, for the mid-cap category, the 2nd best in Asia for *Corporate Social Responsibility*, and the 3rd for *Corporate Governance*.

[7] The *National Urban Water Awards (2010)* from the Government of India in the financial reforms category for its "Online Mobile Bill Generation and Collection Improvement through Process Reengineering".

4) The Capacity Development (Soft Component) Sub-Project

Capacity development is an effective countermeasure to address the O&M issues earlier identified such as the existing quality of human resources, the operations system and operating procedures; the corrective and preventive maintenance system, and the need for appropriate technology in training and development. In this connection, the capacity development (soft component) sub-project will integrate the following activities: (i) the aforementioned in-country and overseas training courses, (ii) the conduct of a training needs analysis, (iii) the development of the five-year NWSDB RSC(N/C) Training Plan, (iv) the development of course modules, and (v) the issuance of written O&M manuals. This would require financial resources, which can come from either the NWSDB Head Office or accessed from overseas development assistance. **Table 6.13** shows the summary of activities and outputs for the sub-project.

Table 6.13 Capacity Development Sub-Project Activities and Outputs

	Activities	Outputs
1.	Conceptualize, develop and conduct the in-country technical and non-technical training courses	• Conduct of four technical training courses: o Project Management o Water Treatment Plant O&M o Water Distribution System O&M o Water Quality Monitoring • Conduct of three non technical training courses: o Human Resources Management (focus on Training and Development) o Public Information, Education and Communication o Trainers Training
2.	Develop the five-year Training and Development Plan for the NC RSC, which will require the completion of a Training Needs Assessment as baseline information	• Training Needs Assessment Report • Five-Year Training and Development Plan
3.	Develop course modules and training materials for the seven training courses	• Course modules and training materials for the four technical training courses • Course modules and training materials for the three non-technical training courses
4.	Develop the WTP Operation and Maintenance Manual, the O&M Water Distribution System Operation and Maintenance Manual, and the Water Quality Monitoring Manual subsequent to the conduct of the three training courses under the same topic/area	• WTP Operation and Maintenance Manual • O&M Water Distribution System Operation and Maintenance Manual • Water Quality Monitoring Procedural Manual
5.	Design and conduct an overseas training programme for NWSDB Head Office and NWSDB RSC(N/C) top management	• Conduct of Overseas Training on Water Utility Best Practices

6.2 Operation and Maintenance Organization

The water supply schemes currently operating in the project area will also operate and maintain the newly constructed facilities such as: (i) elevated water towers, (ii) groundwater reservoirs; (iii) equipment and appurtenances such as pumps, generators, surge tanks, and power control units; (iv) workshops, chlorinator buildings, operational complexes (with zonal labs); (v) the

primary, secondary and tertiary distribution lines; and (vi) grounds and buildings. There is a need therefore to expand the organisation of these water supply schemes.

In addition, two new water supply schemes will have to be organised to operate and maintain the following new facilities: (i) the intake structure / facility and equipment; (ii) the raw water conveyance pipelines; (iii) the water treatment plant facilities, equipment and appurtenances; (iv) the transmission mains; and (v) the transmission sub-mains that link the WTP to the different elevated water towers.

Considering that the service area (formerly project area) is geographically extensive, and its service population widely dispersed, there is a need to establish an O&M satellite office (Area Engineering Office) to provide for another layer of organisational support to the water supply schemes, adhering to the organisational principles of span of control and coordination.

The need for additional O&M staff before the end of the construction period (2018) is to ensure the smooth transition from pre-operations to the full operations of the newly constructed distribution facilities and networks. In this connection, the following guidelines are proposed:

- Strategic recruitment shall be observed so that efficient utilisation of and synergy among O&M staff can be achieved. In any case, hiring of new personnel will strictly follow the Sri Lankan government's recruitment and selection process(es).
- The number of new staff will be kept to a minimum since existing personnel shall also be utilised for O&M of the new facilities, with focus on further maximising their productivity through (re)training.
- Recruitment will also take into consideration keeping a low staff productivity index (SPI) or number of staff to number of connections ratio without prejudice to efficient service to the customers.
- The present number of outsourced / contractual personnel (caretakers, labourers and meter readers) shall be retained through 2018, as they are already serving the current operational requirements of their respective WSS.
- Outsourcing as a strategy will continue to be utilised, especially for the following services (posts) – meter reading services (meter readers), new connections services (labourers), leak detection and repair services (pipefitters and labourers), and security guards. However, the recruitment schedule for these posts will be phased, and will be dependent on the solid projections of the number of new connections / customers to be generated as a result of this water supply improvement project.
- As far as practicable, outsourcing for the labour grades will be from the trained personnel of CBOs or farmers' organisations within the area, to provide jobs, and to keep good relations within the community.

- The additional labour grades required by the end of the construction period are: (i) Pump Operator Mechanics, to operate and maintain pumps, generators, and other electro-mechanical equipment; (ii) Pipefitters, to operate the workshops, service new connections, and repair pipe leaks; (iii) Caretakers, to maintain of newly constructed facilities, buildings and ground; (iv) Drivers, primarily to drive service crews as well as water delivery vehicles to non-piped (isolated) areas; and (v) Labourers, to assist service crews, to assist in maintenance and security services of buildings and grounds.

6.2.1 Additional O&M Staff/Cadre for the Existing WSS in the Project Area

There are four water supply schemes presently operating in the project area. However, Rambewa will need to be organised into a new water supply scheme to manage the newly constructed facilities that will be operational by 2018. Meantime, the other three existing WSS shall be expanded to enable it to take on the added O&M responsibilities given the new facilities. **Table 6.14** provides the water supply schemes and its area(s) of coverage.

Table 6.14 The Water Supply Schemes and Coverage

WSS	Name of Water Supply Schemes	Status	Coverage (Facilities in Project Area)
1	Rambewa Water Supply Scheme	New	Rambewa
2	Khatagasdigiliya Water Supply Scheme	Existing	Kahatagasdigiliya and Horowpothana
3	Kebithigollewa Water Supply Scheme	Existing	Kebithigollewa and Padaviya
4	Medawachchiya Water Supply Scheme	Existing	Medawachchiya

(1) New O&M Cadre for Rambewa Water Supply Scheme

Rambewa will have its share of water supply facilities that will necessitate organising the Rambewa WSS. It will be headed by an Engineering Assistant (OIC) and supported by six O&M staff as shown in **Table 6.15.**

Table 6.15 O&M Staff for New Rambewa WSS

Post (Category)	Board Grade	New Staff / Cadre		Total By 2018
		Outsourced Contractual	New	
Engineering Assistant (O&M)	9	-	1	1
Pump Operator Mechanic	13	-	1	1
Pipefitter	13	-	2	2
Caretaker	15	-	1	1
Labourer	15	-	1	1
Total		**0**	**6**	**6**

(2) O&M Staff for the Kahatagasdigiliya Water Supply Scheme (includes Horowpothana)

The current area of coverage of Kahatagasdigiliya WSS includes Horowpothana. This set-up will be continued even with the construction of new facilities in Horowpothana (including North and West Horowpothana, Weerasole, Hamiwela and Wahalkada) and in Kahatagasdigiliya (including Rathmalgahawewa). However, by the end of the construction period, nine additional

personnel will be required to operate and maintain the new facilities in both Kahatagasdigiliya and Horowpothana bringing to 18 the total number of O&M staff, as shown in **Table 6.16**.

Table 6.16 O&M Staff for Katahagasdigiliya WSS (includes Horowpothana)

Post (Category)	Board Grade	Current Staff (2012)			Additional Staff		Total By 2018
		Outsourced Contractual	Approved Posts		Outsourced Contractual	New	
			Vacant	Filled			
Engineering Assistant (O&M)	9	-	-	1	-	-	1
Pump Operator Mechanic	13	-	-	1	-	2	3
Pipefitter	13	-	-	1	-	2	3
Driver	13	-	-	-	-	1	1
Caretaker	15	2 1/		-	-	2	4
Labourer	15	3	-	1	-	2	6
Total		**5**	**0**	**04**	**0**	**9**	**18**

1/ The two caretaker posts are the only posts currently assigned to Horowpothana.

(3) O&M Staff for the Kebithigollewa Water Supply Scheme (includes Padaviya)

The existing area of operations of Kebithigollewa WSS includes Padaviya. This will not change even with the construction of new facilities in Kebithigollewa (including KEB-KAH Median and Kahatagollewa) and in Padaviya (including Bogahawewa). However, an additional eight staff are required to operate and maintain the newly constructed facilities, in addition to the current number of 16 staff, as shown in **Table 6.17**.

Table 6.17 O&M Staff for Kebithigollewa WSS (includes Padaviya)

Post (Category)	Board Grade	Current Staff (2012)			Additional Staff		Total (By 2018)
		Outsourced Contractual	Approved Posts		Outsourced Contractual	New	
			Vacant	Filled			
Engineering Assistant / OIC (O&M)	9	-	-	1	-	-	1
Pump Operator Mechanic	13	-	-	6 1/	-	1	7
Pipefitter	13	-	-	1	-	2	3
Driver	13	-	-	-	-	1	1
Caretaker	15	1 2/		-	-	2	3
Labourer	15	3	-	4 3/	-	2	9
Total		**4**	**0**	**12**	**0**	**8**	**24**

1/ Three pump operator mechanics are assigned to Padaviya, while the other three are assigned to Kebithigollewa.
2/ Caretaker post is assigned to Padaviya.
3/ Two labourer posts are assigned to Padaviya and two to Kebithigollewa.

(4) O&M Staff for the Medawachchiya Water Supply Scheme

Medawachchiya is the only WSS that does not cover any other GND in its area of operations. Aside from Medawachchiya, facilities will also be constructed in Issinbassagala and Ethakada, which will require six additional staff, as presented in **Table 6.18**.

Table 6.18 O&M Staff for Medawachchiya WSS

Post (Category)	Board Grade	Current Staff (2012)			Additional Staff		Total By 2018
		Outsourced Contractual	Approved Posts		Outsourced Contractual	New	
			Vacant	Filled			
Engineering Assistant / OIC (O&M)	9	-	-	1	-	-	1
Pump Operator Mechanic	13	1	-	2	-	1	4
Meter Reader	13	-	-	1	-	-	1
Pipefitter	13	-	-	1	-	1	2
Driver	13	-	-	-	-	1	1
Caretaker	15	-	-	-		2	2
Labourer	15	1	-	1	-	1	3
	Total	**02**	**0**	**06**	**0**	**6**	**14**

6.2.2 New O&M Cadre for the Mahakandarawa and Wahalkada Water Supply Schemes

Two new water supply schemes will be organised to operate and maintain the Mahakanadarawa and Wahalkada water treatment plants before the end of the construction period. This is necessary to have ample lead time in order to train the new O&M cadre for the pre-operation and start-up operational phases of the WTP.

(1) The Mahakanadarawa Water Supply Scheme

The proposed O&M cadre for the Mahakanadarawa Water Supply Scheme will be headed by an officer-in-charge (water treatment plant) / engineering assistant. He/She will be supported by plant technicians working on an eight-hour shift, as well as an electrician, pump operator technician, laboratory attendant, caretaker and labourer. In addition, a pipefitter is required, as the workshop intended for the Rambewa area will be constructed in the Mahakanadarawa WTP site. The personnel requirement for this scheme is shown in **Table 6.19**. Should additional personnel in the labour grades be required, these can be outsourced or hired on a contractual basis, whenever the need arises. See **Figure 6.7** for the proposed organisation structure of the Mahakanadarawa Water Supply Scheme.

Table 6.19 New O&M Cadre for the Mahakanadarawa WSS

Post (Category)	Board Grade	New Staff / Cadre		Total By 2018
		Outsourced Contractual	New	
Engineering Assistant / Officer-in-Charge (WTP)	9	-	1	1
Plant Technician	12	-	3	3
Pump Operator Mechanic	13	-	1	1
Electrician	13	-	1	1
Lab Attendant	13	-	1	1
Pipefitter	13	-	1	1
Caretaker	15	-	1	1
Labourer	15	-	1	1
	Total	**0**	**10**	**10**

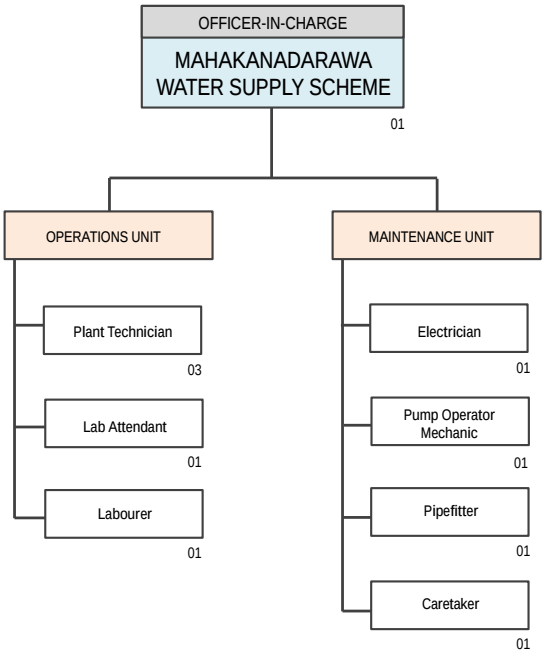


Figure 6.7 Proposed Organisation Structure of the Mahakanadarawa WSS

(2) The Wahalkada Water Supply Scheme

The Wahalkada Water Supply Scheme has a larger production capacity than Mahakanadarawa. It will be headed by an officer-in-charge (water treatment plant) / engineering assistant. He/She will be supported by plant technicians working on an eight-hour shift, as well as an electrician, pump operator mechanic, laboratory attendant, caretaker and labourer, as shown in **Table 6.20**. Should additional personnel in the labour grades be required, these can be outsourced or hired on a contractual basis, whenever the need arises. See **Figure 6.8** for the organisation structure of the Wahalkada Water Supply Scheme.

Table 6.20 New O&M Cadre for the Wahalkada WSS

Post (Category)	Board Grade	New Staff / Cadre		Total By 2018
		Outsourced Contractual	New	
Engineering Assistant / Officer-in-Charge (WTP)	9	-	1	1
Plant Technician	12	-	3	3
Pump Operator Mechanic	13	-	1	1
Electrician	13		1	1
Lab Attendant	13	-	1	1
Caretaker	15	-	1	1
Labourer	15	-	2	2
	Total	**0**	**10**	**10**

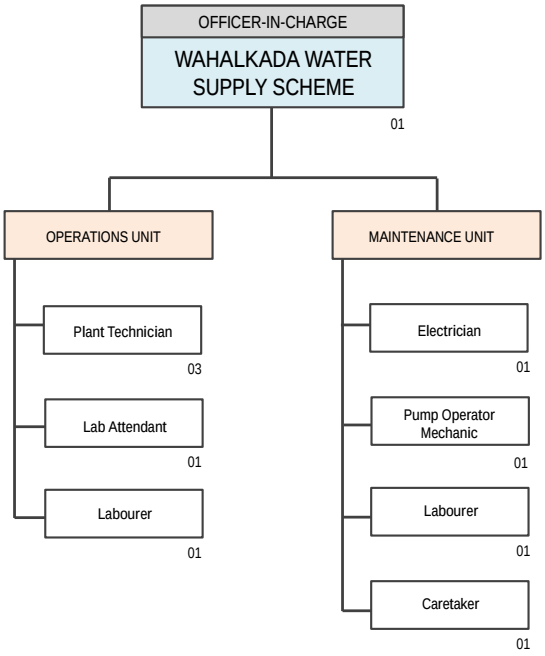


Figure 6.8 Proposed Organisation Structure of the Wahalkada WSS

6.2.3 Proposed O&M Area (Satellite) Office for the WSS in the Project Area

In 2018, with the completion of the Project, NWSDB RSC(N/C) will be faced with the following scenario – providing water supply to a service area (formerly project area) that is geographically extensive, and whose service population is widely dispersed. It will also see its existing water supply schemes take on additional managerial and operational responsibilities as a consequence of having new facilities, but whose physical location is far from the regional centre's operational resources. Given these impacts, and adhering to the organisational principles of span of control and coordination, there is a need to provide another layer of organisational support to the water supply schemes – the establishment of an O&M satellite office.

(1) Functions of the O&M Area (Satellite) Office

It is proposed that the O&M satellite office be organised in Medawachchiya, this place being the most developed among the GNDs, and situated at the crossroads of the project areas/WSS. The satellite office will have the following functions: (i) to *deliver quick response to O&M and technical issues* that need immediate resolution and which were inadequately dealt with by the water supply schemes; (ii) to *provide closer consumer service support services* considering the increased number of new customers to be generated by the completion of the project, (iii) to *spearhead the public information, education and communication (IEC) programme* on the importance of water to health; (iv) to *assist the WSS in delivering potable water* to the remote

villages not covered by the piped system, but which is required due to water quality health concerns.

(2) Manning of the O&M Area (Satellite) Office

The satellite office will not duplicate neither the functions nor the personnel of the water supply schemes, but rather, will provide the required level of intermediary and supplementary assistance and support to finding solutions to the water supply schemes' technical issues and consumer concerns. It will assist the personnel of the WSS to be ready, capable, and skilled in performing the required works, and in maintaining and repairing mechanical and electrical equipment at the water treatment plants and pumping stations, as well as the water transmission and distribution pipelines, and in being able to make the public aware of the health benefits of connecting to the water system that supplies water that complies with national standards. **Table 6.21** presents the proposed manning for the O&M satellite office, which will be organised upon the completion of construction of the water facilities in 2018.

Table 6.21 Proposed Manning of O&M Area (Satellite) Office

Post (Category)	Board Grade	New Staff / Cadre		Total By 2018
		Outsourced Contractual	New	
Area Engineer (Civil)	7	-	1	1
Mechanical Engineer	8		1	1
Electrical Engineer	8		1	1
Engineering Assistant (Mechanical)	9	-	1	1
Engineering Assistant (Electrical)	9		1	1
Consumer Relations Assistant	9	-	1	1
Electricians	13		2	2
Mechanics	13		2	2
Labourers	15		2	2
Driver 1/	13	-	1	1
Total		**0**	**13**	**13**

1/ The number of drivers will depend on the number of water delivery tankers / water lorries, and the vehicles for service crews. Personnel for this post can also be outsourced.

(3) Structure of the O&M Area (Satellite) Office

As a new unit / office, the O&M Area Office, headed by the Area Engineer, will be under the Operations Section, specifically directly under the Anuradhapura District, headed by the District Engineer. Thus, the Area Engineer will fall under the direct supervision and authority of the District Engineer. The proposed organisation structure of the O&M Area Office is presented in **Figure 6.9**.

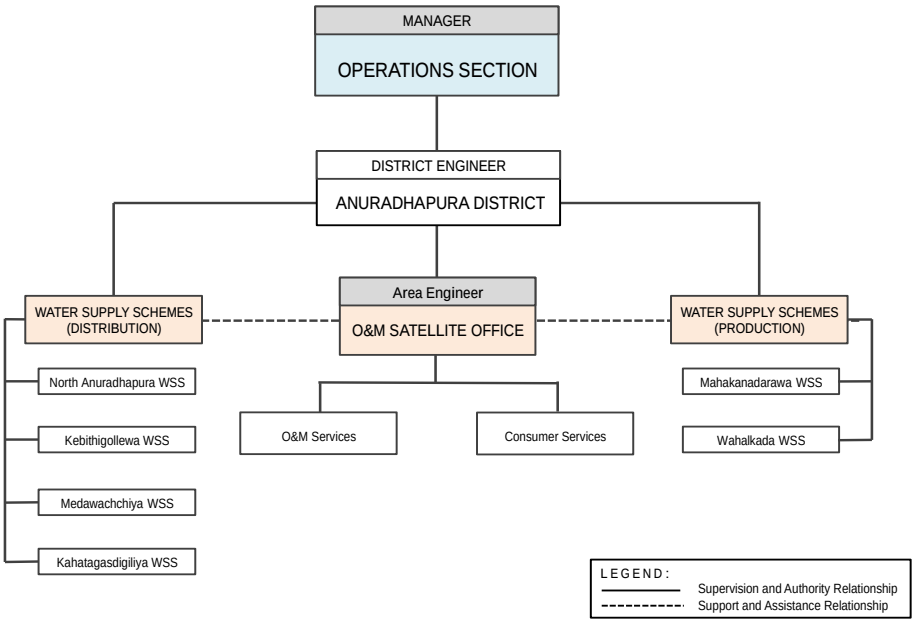


Figure 6.9 Organisational Structure of O&M Area (Satellite) Office

As shown in the organisation structure, the water supply schemes – Rambewa, Kebithigollewa, Medawachchiya, Kebithigollewa, Mahakanadarawa and Wahalkada – will remain under the direct supervision and authority of the Anuradhapura District. The solid line represents the authority or vertical relationship between the O&M Satellite Office and the Anuradhapura District up to the O&M Section level.

However, as earlier explained, the O&M Area (Satellite) Office will provide intermediary and supplementary assistance and support to the water supply schemes' technical issues and consumer concerns, and actively assist the WSS personnel in ensuring the efficient operation and maintenance of the production and distribution facilities, equipment, buildings; and in safeguarding health through the supply of safe water. Thus, there is no supervision or authority relationship between the O&M Area Office and the water supply schemes, but the relationship will be horizontal, or one of technical assistance and support, which is represented by a dotted line.

6.2.4 Enhancing Other Sections / Units in Support of O&M

There are also other sections and units in the NC RSC that need to be enhanced to support the proper operation and maintenance of the new facilities. These are the regional laboratory, the rural water supply unit, the commercial unit, and the IT section.

(1) The Regional (Central) Laboratory

The regional (central) laboratory, which is responsible for water quality monitoring and control, will see increased work with the new Mahakanadarawa and Wahalkada WTPs and the expanded WSSs in the project area. In addition to the chemical, physical and biological indicators being tested, there is also a need to develop the ability to test for pesticides, heavy metals and algal toxicity in the water, especially that the project area is where CKD and dental fluorosis are most prevalent. This will require upgrading the laboratory equipment, and enhancing the skills of the laboratory personnel through training. (See equipment list in the water quality section write-up and section on capacity development for training).

With the upgraded regional (central) laboratory, the NC RSC is committed to work towards water quality laboratory accreditation with the Sri Lanka Accreditation Board, based on ISO/IEC 17025 to ensure the competence of the laboratory in generating reliable and technically valid test results. Having accreditation will enable the laboratory to more effectively monitor the drinking water quality of its service area, and other organisations that seek its services.

Therefore, it is recommended that the approved (but vacant) laboratory attendant post be filled up by 2018, in addition to having additional laboratory assistant and laboratory attendant's posts, as shown in **Table 6.22**.

Table 6.22 Laboratory Unit Staffing Plan

Post (Category)	Board Grade	Current Staff (2012)			Additional Staff		Total (By 2018)
		Outsourced Contractual	Approved Posts		Outsourced Contractual	New	
			Vacant	Filled			
Chemist	7	-	-	1	-	-	1
Laboratory Assistant	9	-	-	1	-	1	2
Laboratory Attendant	12	-	1	1	-	1	3
Total		**0**	**1**	**3**	**0**	**2**	**6**

(2) Rural Water Supply Unit

The RWS unit is subsumed in both the Anuradhapura and Pollonuwara District Engineering offices. The RWS in the Anuradhapura district engineering office will take a more active role in rallying the community-based organisations in the area in mutually supportive mechanisms. One is in the provision of technical assistance to the CBOs in such fields as water supply planning and design, operation and maintenance, finding suitable solutions to water quality and quantity issues, and also in enhancing the CBO's capacity to respond to disasters. Towards this end, CBOs request for the training of their personnel in such areas as pre-CBO formation, billing and collection, pump rehabilitation and maintenance, community leadership and cooperation, and community development and change. The NC RSC (through the RWS unit) delivers, on the average, three CBO training programmes per quarter, as well as provides advice on technical or collection problems.

The RWS unit will take a lead role in promoting CBO's inter-connection with the new distribution system in 2018 when additional water supply would be made available in the Project area, taking into consideration the categorization of CBOs discussed later in this Section.

The RWS unit will also spearhead a programme to generate public awareness on the health benefits derived from the Project. This would involve conceptualising, designing and implementing information, education and communication (IEC) programmes on the importance of having safe water and reliable water supply, and its positive effect on health and productivity. In other words, the pubic awareness programme will have messages for each target audience – for CBOs, for school children, and for households – and will also utilize the most suitable media such as face-to-face (village) meetings, print media (newspapers, leaflets, posters) and broadcast media (radio, TV). Right now, the Public Relations Office (NWSDB Head Office) has produced leaflets, posters, video, film and even radio campaigns that can be utilized for the awareness programme, but customized approaches should also be considered. (See the part on capacity development for proposed training on IEC / public awareness).

(3) The Commercial Unit (O&M Section)

The Commercial Office is specifically guided by the NWSDB Customer Charter covering the provision of new connections and re-connections, dealing with customer complaints on meter reading / issues, and response to customers, among others. With the completion of the Project, more consumers are expected to connect to the system, translating to an increased number of connections to be serviced, billed and collected from. Thus, mobility is important factor to consider also in responding quickly to customer issues, hence the need to procure vehicles. (See **Table 6.26** for the list of vehicles to support customer services).

However, even with the increased number of customers to be serviced, it is not recommended to open additional (cadre) posts for meter readers / bill collectors; but rather continue the current strategy of outsourcing meter reading and billing services. This would allow for greater efficiency because hiring would be based on the actual increase(s) in the number of consumers, in addition to the plan to fully automate billing and collection system, connected to through a POS system, and the use of remote operated water meters.

(5) IT Section

The soon-to be-constructed Mahakanadarawa and Wahalkada water treatment plants will use the SCADA system, thus fully automating the operational processes of these plants. This system will also include the water distribution process, necessitating that the sub-offices be connected with SCADA monitors to enable the officers-in-charge to check on the system within their respective water supply schemes. It is important that the IT staff be knowledgeable on the

software system concepts, application(s), and solutions as well as the hardware component(s). This will enable it to effectively respond to any eventual problems especially when the operations of the system will be turned over to the RSC from the vendor. Other projects that the IT section is now involved in are: the enhancement of customer services through the expanded use of the call centre service, and the improvement of billing efficiency with the use of a point-of-sales system.

However, the IT section should not only deploy appropriate technology for the RSC, but also provide and generate useful information for management decision making. As of this time, the Northern Central Zone has an IT Manager that services the requirements of the five regional support centres under the Zone, namely, the Central, North Western, North Central, Northern and Northern Central RSCs. The IT Section is currently composed of four posts – two posts which have been filled, and two posts which remain vacant. However, by 2018, with the number of IT activities in progress and/or in the pipeline, the vacant posts will need to be filled up by qualified IT personnel, in addition to two more recommended, as shown in **Table 6.23**.

Table 6.23 IT Section Staffing Plan

Post (Category)	Board Grade	Current Staff (2012)			Additional Staff		Total (By 2018)
		Outsourced Contractual	Approved Posts		Outsourced Contractual	New	
			Vacant	Filled			
IT Manager	4					1	1
Computer Hardware Engineer	7		1				1
System Administrator	8	-	-	1	-	1	2
Computer Hardware Technician	10	-	1	-	-	-	1
Labourer	15	-	-	1	-	-	1
Total		**0**	**2**	**2**	**0**	**2**	**6**

6.2.5 Supporting O&M through Equipment and Engineering Software

(1) Equipping the WSS, the O&M Area Office and the Regional Workshop

To enable the water supply schemes to accomplish its functions, it will have to be equipped with basic O&M equipment and vehicles. For cost efficiency, some basic maintenance equipment and vehicles for rapid response mobility will be co-located in the “Area Engineer’s” Office in Medawachchiya, but will be available for use by all the water supply schemes in the area. **Table 6.24** provides the requirement for the O&M equipment.

Table 6.24 Proposed O&M Equipment for WSS and O&M Area Office

Equipment	No. of Units	Distribution
Asphalt Cutters	4	Rambewa WSS, Kahatagasdigiliya WSS, Medawachwhiya WSS, Kebithigollewa WSS
Tapping Machines	4	Rambewa WSS, Kahatagasdigiliya WSS, Medawachwhiya WSS, Kebithigollewa WSS
Compactors	4	Rambewa WSS, Kahatagasdigiliya WSS, Medawachwhiya WSS, Kebithigollewa WSS
Vibrating Hammers	4	Rambewa WSS, Kahatagasdigiliya WSS, Medawachwhiya WSS, Kebithigollewa WSS
Portable Generators	6	Rambewa WSS, Kahatagasdigiliya WSS, Medawachwhiya WSS, Kebithigollewa WSS, Mahakanadarawa WSS, WahalkadaWSS

In addition to O&M equipment, there is also a need to support the equipment requirements of the regional workshop. While the water supply schemes have their own workshops for routine repair and maintenance activities, those that cannot be handled on the scheme level are handled by the regional workshop. **Table 6.25** contains the list of equipment for the regional workshop.

Table 6.25 Proposed Equipment for Regional Workshop

Equipment	No. of Units
Small Lift Hoist / Crane	1
Pump Test Bed / Machine	1

The water supply schemes need mobility to (i) enable its service crews to readily respond to repair and maintenance requirements of the water treatment plants, the transmission and distribution networks; (ii) respond to customer requests for service connections and other complaints; (iii) provide safe water to isolated villages or clusters of households. In this connection, basic vehicles are required, as shown in **Table 6.26**.

Table 6.26 Proposed Basic Vehicle(s) List for WSS and O&M Area Office

Vehicles	No. of Units	Distribution	Main Purpose
Crew Cab	4	• Rambewa WSS • Kahatagasdigiliya WSS • Medawachwhiya WSS • Kebithigollewa WSS	Use of service crews for: i) new connections, ii) leak detection and repair
Single Cabs	2	• Mahakanadarawa WSS • Wahalkada WSS	Use of service crews for O&M of water treatment facilities (intake, transmission and WTP equipment)
Double Cabs	4	O&M Area (satellite) Office	To service the water supply schemes in the area
Water Bowser	3	• O&M Area (satellite) Office (to service Rambewa, Kahatagasdigiliya and Medawachchiya WSS) • Kebithigollewa WSS • Mahakanadarawa WSS	To provide water to non-piped borne areas
Mini-Backhoe	2	• O&M Area (satellite) Office (for Medawachichiya, Kahatagasdigiliya, Rambewa) • Kebithigollewa (Padaviya)	For new service connections and leak repair
Motorcycles	7	One for each WSS, plus area office	Customer service

(2) Supporting Planning, Design and Operations

The project will also require the latest version of engineering software packages to assist planning and design activities, and to support proper analysis and operation of the water supply system. The software will come with vendor-arranged training for selected staff of the Development, O&M, and the IT sections. The list of proposed software packages is shown in **Table 6.27.**

Table 6.27 Proposed Engineering Software Packages

Name of Software	No. of Units
Small World Water Network Information System	1 with 5-user licence
ArcGIS	1 with 5-user licence
WaterCAD	1 with 5-user licence
Surge Analysis Software	1 with 5-user licence
Structural Design Software	1 with 5-user licence
Project Management Software	1 with 5-user licence

6.3 Mode of Water Supply Services

The provision of water supply services, particularly in the rural sector, recognizes not only the value of water as a finite and vulnerable resource, but also acknowledges "the need for institutional arrangement for the efficient management of facilities with community participation and the stakeholders."[8] Towards this end, a national policy framework was issued in 2001 that spelled out the principles of the policy; the scope of the sector, such as the definition of the rural area and the description on access to levels of water supply; the sector partners and their responsibilities and regulatory powers; and legislative support for the sector.

The principles of the rural water supply (RWS) policy emphasize that water has to be recognized as an economic good and that activities must promote participatory approaches among users, planners and policymakers. It also clarifies the collective privilege(s) and responsibility(ies) of the water users – that users should be encouraged to own and manage the facilities and assets and share the capital investment incurred in creating the facilities, but should bear the full responsibility of sustainable operation and maintenance of the facilities.

Water supply providers with regulatory functions in the sector are the national government, through the NWSDB, the provincial governments and the local authorities, while purely water service providers are the Community Based Organization (CBOs), Private Sector and NGOs.

[8] Ministry of Urban Development, Construction and Public Utilities. *National Policy for Rural Water Supply and Sanitation Sector*, July 2001.

6.3.1 Community Based Organisations

(1) Definition and Form of Organisation

The RWS Policy defines CBOs "as groups formed or rural community organisation capable for the provision and sustainable management of water supply and sanitation facilities to their membership." CBOs are must be registered to be recognized as authorized institutions to take part in the development of the sector. They can take on the form of either a trust, development society, NGO or as a company under the Companies' Act, and are given authority to raise funds, obtain loans, receive grants, develop services, levy tariffs and manage facilities. The CBOs are accountable to their beneficiary community.

(2) Functions of CBOs

The functions of the CBOs are actually subject to the regulations imposed and standards set by the Government, Provincial Council and the Local Authorities. Enumerated among its functions are:

- To assess the needs, the demand and the aspirations of the communities for water supply, sanitation facilities and services;
- Assess the technical feasibility and economic viability of different options for providing water supply and sanitation facilities;
- Arrange internal funding;
- Play the key role in planning, designing, preparing proposals, implementing and managing the facilities and assets;
- Ensure the participation of user community and other partners at all stages of the process;
- Manage the facilities and services in a sustainable manner and to the satisfaction of the user community; and
- Conserve the environment with emphasis on water sources and watershed areas.

6.3.2 CBO-Managed Water Supply Schemes in the Project Area

It is envisioned that with the completion of the Project, the population in the project area be provided with safe water, adequate and reliable water supply. However, this may be true with those areas presently serviced by the NWSDB RSC(N/C), and 50 CBOs now operating and providing water in the project area, should the latter be willing to be connected to the new system.

Based on the criteria for the inclusion of CBOs into the project's service area, three CBOs namely, (i) Tristar, (ii) Dirimathaya and (iii) Al Naja will be excluded for various reasons, as described in **Section 4.2.5**. **Table 6.28** shows the list of CBOs and status of inclusion /

exclusion in the Project.

Table 6.28 Status of CBOs Included/Excluded in the Project

NAME OF WSS	#	NAME OF GND	NAME OF CBO	Remarks
RAMBEWA	1	Kendewa (97)	Swashakthi	Operational
	2	Ikirigollawa (102)	Ikra	Operational
	3	Sangilikanadarawa (111)	Arunalu	Operational
	4	Thalgahawewa (84)	Samagi	Operational
	5	Wahamalgollawa (109)	Ekamuthu	Operational
	6	Wewalkatiya (82)	Rangiri	Operational
	7	Maha Kandadarawa Yaya 01 (94)	Nildiyadahara	Operational
	8	Katukaliyawa (106)	Eksath	Operational
	9	Maha Kandarawa Yaya 02 (93)	Mahasen	Operational
	10	Ihala Kolongaswewa (87),	Dimuthu	Operational
	11	Bala Hodawewa (86), Ihala Kolangaswewa (87)	Pragathi	Operational
MEDWACHCHIYA	12	Katuwela (66)	Jayashakthi	Operational
	13	Halambagaswewa (70)	Samagi	Operational
	14	Ataweeragollewa (56)	Samagi	Operational
	15	Hirallugama (54)	Ekamuthu	Operational
	16	Wiralmurippuwa (64)	Ran Arunalu	Operational
	17	Kadawathgama (60)	Isuru	Operational
	18	Unagaswewa (75)	Randiya Dahara	Operational
	19	Kirigalwewa (72	Nelum	Operational
	20	Maha Kumbugollawa (46)	Diriyamatha	Operational; Excluded
	21	Maha Dilvuwewa (57)	Gamunu	Operational
	22	Kidawarankulama (42)	Sisila Diyahara	Operational
	23	Periyakulama (49),Yakkawewa (50)	Diriya Shakthi	Operational
	24	Athakade (55)	Ridi Nadi	Operational
KEBITHIGOLLEWA	25	Ayyathigewewa (24)	Shakthi	Operational
	26	Muslim Ataweerawewa (22)	Al Naja	Not commissioned; Excluded
	27	Gonumariyawa (25)	None	No CBO
PADAVIYA	28	Parakramapura (06)	Parakum	Operational
	29	18 Kanuwa (02)	Suwasehana	Operational
	30	Bogahawewa (14)	Suwasetha	Operational
KAHATAGASDIGILIYA	31	Mahakumukwewa (222)	Wajira	Operational
	32	Moragahawela (202)	Pragathi	Operational
	33	Palispothana (224)	Jansetha	Operational
	34	Pandarallawa (210)	Sobasisila	Operational
	35	Ranpathwila (196)	Randiya	Operational
	36	Kokmaduwa (201)	Nilmini	CBO Not Functioning
	37	Gonamaruwewa (223)	Seneth	Operational
	38	Turukkuragama (234)	Eksath	Operational
	39	Mahawewa (221)	Praja Shakthi	Operational
	40	Meekumbukwewa (212)	Apsara	Operational
	41	Ambagahawewa (213)	Pinibindu	Operational, Not Piped
	42	Waligollewa (218)	Sham Sham	Operational
	43	Kumbukgollawa (209)	Ekamuthu	Operational
HOROWPOTHANA	44	Wadigawewa (126)	Praeepa	Operational
	45	Parangiwadiya (149)	Upul	Operational
	46	Kapugollewa (140)	Jalasavi	Operational
	47	Angunochchiya (119)	Tri Star	Operational; Excluded
	48	Alonolondawewa (138)	Al Hidra	Near Operational
	49	Weerasole (139)	Adhikwa	Near Operational
	50	Maradanadawala (133)	Hansajala	Operational

(1) CBO Staff in the Project Area

The management and operations of the CBOs are generally performed by two staff members –

one technical and the other non-technical. The technical staff is in charge of operating and maintaining the pump(s) and maintaining the water source area. The non-technical staff is in charge of reading meters, and billing and collection. Most of the CBO staff are volunteers, who are employed either as teachers, government officials or local businessmen. They are remunerated based on revenue.

The CBO staff has been trained, receiving their first training upon CBO formation, on technical matters such as O&M of the scheme, and on managerial matters such as financial management, billing and collection and so forth. In the course of the CBO's operations, they request / receive follow-up training from the NWSDB RSC(N/C). In cases where the training is inadequate for repairing a pump, for example, the CBO goes to the nearest NWSDB RSC(N/C) water supply scheme for assistance.

(2) Problems of the CBO-Managed Water Supply Schemes

The CBOs operating in the project area suffer from a myriad of technical and non-technical problems. Technical problems can be traced to the lack of proper operation and maintenance of pumps, valves and bulk meters; the lack of repair and maintenance of distribution lines resulting to low water pressure in the mains; water quality problems because of inexistent or inadequate chlorination facilities and poor quality (high fluoride content for some CBOs) water at source; and insufficiency of water especially during the dry season. Non-technical problems can be grouped into the lack of transparency in CBO operations; shortage of trained people to manage the CBO and to operate and maintain the system; and the absence of records and in many cases, of accounting records and of proper keeping practices, and increasing gaps between costs and revenues.[9]

(3) Suitability of CBOs for Incorporation into NWSDB RSC(N/C) or for Bulk Supply

Problems notwithstanding, the facilities of most of the CBOs surveyed were either in "good" or "structurally sound" condition, making them candidates for bulk supply. However, there are a number of minor and major technical and non-technical problems faced by the CBOs. Thus, the CBOs were further assessed according to being suitable for immediate inclusion for bulk supply; recommended for inclusion but will require improvements, or would require that stated problems be addressed or resolved as shown in **Table 6.29.**

Based on survey team's assessment, 36 out of 50 CBOs or 72 percent are suitable for connection to the new system; 11 CBOs or 22 percent are also suitable for connection to the bulk system, but technical and non-technical problems need to be resolved. On the other hand, three CBOs or

[9] This is the summation of the problems which have been listed on a per CBO basis (total - 50 CBOs) found in Table 3.3 of the Final Report: *Status Survey on the Existing Water Supply Schemes*, earlier mentioned in this section.

six percent have been excluded, as earlier explained. See **Appendix 6.3(a).** for the detailed assessment of the 50 CBOs.

Table 6.29 Summary of Assessment of CBOs on Suitability for Bulk Supply

	Recommended for Immediate Inclusion	Recommended (But Will Require Improvements)		Excluded
	Suitable for immediate inclusion	Requires improvements before inclusion	Stated problems must be first addressed	
Total CBOs	**36**	**6**	**5**	**3**

As for the issue on improvements required or problems to be addressed before the CBOs' inclusion for bulk water supply, the NWSDB RSC(N/C) can take some necessary actions to resolve the issues. These are indicated in **Table 6.30**.

Table 6.30 Proposed Actions by NWSDB RSC(N/C) on the CBOs with Issues

CBO #	Name of CBO	Improvements required / Problems addressed before inclusion	Proposed action(s) by NWSDB RSC(N/C)
6	Rangiri	CBO management needs improvement; lack of good financial management; poor O&M of facilities	• Reorganize the CBO • Retrain CBO staff in all aspects of CBO management and operations; • Provide basic O&M guidelines and accounting systems
21	Gamunu	NRW not recorded; Tapping pressure low; Maintenance level low; Replacement of small and undersized diameter pipes required	Make a more detailed assessment and feasibility of technical and financial requirements to replace pipelines and other improvements
22	Sisila Diyahara	Field tests show NRW at 46.32%; Replacement / repair of pipes required	Make a more detailed assessment and feasibility of technical and financial requirements to replace pipelines and other improvements
23	Diriya Shakthi	Field tests show NRW at 41.38%; Replacement / repair of pipes required	Make a more detailed assessment and feasibility of technical and financial requirements to replace pipelines and other improvements

CBO #	Name of CBO	Improvements required / Problems addressed before inclusion	Proposed action(s) by NWSDB RSC(N/C)
27	No CBO/Scheme	Scheme / CBO must be organized before connection to bulk supply	• Organize the CBO • Train CBO staff in all aspects of CBO management and operations • Provide basic O&M guidelines and accounting systems; or • Direct distribution by NC RSC
36	Nilmini	Scheme did not operate from 2006	• Re-organize the CBO • Retrain CBO staff in all aspects of CBO management and operations • Provide basic O&M guidelines and accounting systems • Make a more detailed assessment and feasibility of technical and financial requirements to re-start CBO such as a thorough systems check before initial operation of scheme to determine adverse effects on water tank and distribution system
37	Seneth	Complete overhaul of CBO management (run by one person) for unreliable records and lack of transparency	• Reorganize the CBO • Retrain CBO staff in all aspects of CBO management and operations; • Provide basic O&M guidelines and accounting systems to promote transparency
40	Apsara	Field test shows NRW at 33.96%; Replacement / repair of pipes required	Make a more detailed assessment and feasibility of technical and financial requirements to replace pipelines and other improvements
41	Pinibindu	A rainwater harvesting scheme of 60 households; CBO to be formed for pipe borne water supply; new distribution system to be built	• Organize the CBO • Train CBO staff in all aspects of CBO management and operations • Provide basic O&M guidelines and accounting systems • Or, direct distribution by NC RSC
42	Sham Sham	Water source failed after one year of operation (2008); damaged pump not replaced; status of tank and distribution system to be checked; pipe has numerous leaks and must be replaced; CBO must be revitalized	• Reorganize the CBO • Retrain CBO staff in all aspects of CBO management and operations • Provide basic O&M guidelines and accounting systems • Make a more detailed assessment and feasibility of technical and financial requirements to re-start CBO
44	Pradeepa	Lack of leadership direction in CBO	Reorganize the CBO; retrain CBO staff in all aspects of CBO management and operations; Provide basic O&M guidelines and accounting systems

(4) Willingness of the CBOs to be Incorporated / Connected to the New System

The technical suitability of the CBOs to be incorporated into the NWSDB is only part of the equation. The CBOs must indicate their willingness, and if there is any reluctance, the reasons should be known, so that NWSDB RSC(N/C) can be apprised and corrective measures undertaken. **Table 6.31** provides the summary of the CBO's responses.

Table 6.31 Willingness of CBOs to Connect to NWSDB Bulk System

CBO	Willingness to Connect			Condition(s) to Connect			No Condition Specified
	Yes	No	Undecided	24-Hour Water Supply	Better Quality Water	Retain O&M Authority	
1	✓			✓	✓	✓	
2	✓			✓	✓	✓	
3	✓			✓	✓	✓	
4	✓			✓	✓	✓	
5	✓			-	-	-	✓
6	No comment			-	-	-	
7	✓			✓	✓	✓	
8	✓			✓	-	✓	
9	✓			✓	-	✓	
10		✓		-	-	-	
11	✓			-	-	✓	
12	✓			✓	✓	✓	
13	✓			✓	✓	✓	
14	✓			✓	✓	✓	
15	✓			-	-	-	✓
16	✓			✓	✓	✓	
17	✓			✓	✓	✓	
18	✓			✓	✓	✓	
19	✓			-	-	-	✓
20	Excluded						
21	✓			✓	-	-	✓
22	✓			-	-	-	✓
23	✓			✓	✓	-	✓
24	✓			✓	✓	-	✓
25	✓			✓	✓	✓	
26	Excluded						
27	No CBO / No Scheme						
28	✓			-	-	-	✓
29	✓			✓	✓	✓	
30	✓			✓	✓	✓	
31	✓			-	-	-	✓
32	✓			✓	✓	✓	
33	✓			✓	-	✓	
34	✓			-	-	-	✓
35	✓			✓	✓	✓	
36	✓			✓	✓	✓	
37	✓			-	-	-	✓
38	✓			-	-	-	✓
39			✓	-	-	-	✓
40	✓						✓
41	Not a Piped System						
42	✓			-	-	-	✓
43	✓			-	-	✓	
44	✓			-	-	-	✓
45	✓			-	-	-	✓
46	✓			-	-	✓	
47	Excluded						
48	✓			-	-	✓	
49	✓			-	-	✓	
50	✓			-	-	-	✓
	42	**1**	**1**	**22**	**18**	**24**	**18**

Note: Information analysed from Summary Sheet No. 7 – Willingness to Connect to the New Bulk System Final Report, "Status Survey of the Existing Water Supply Schemes for the Preparatory Survey on Anuradhapura North Integrated Water Supply Project" by Ceywater Consultants, August 2012.

As can be gleaned from the **Table 6.31**, a resounding majority of 42 CBOs or 84 percent are willing to connect to the new distribution system. One CBO (two percent) said it was not willing to connect; one (two percent) was undecided; one (two percent) did not respond. On the other hand, one (two percent) does not have CBO/scheme, while one (two percent) is a rainwater harvesting scheme. Three CBOs (six percent) have been excluded from the study. However the final decision is made at the general meeting of the community, therefore, through an awareness campaign, such present stance of CBOs could be changed.

This willingness to connect to the new distribution system corroborates with the results of the social survey's willingness-to-pay in the sense that "100 percent of the CBO respondents expressed their willingness-to-pay if they get a better water supply through NWSDB RSC(N/C) where about 50 % of the CBO respondents expressed that they are willing to pay any reasonable amount upon receiving a quality water supply as they severely suffer due to absence of a proper water supply in the area."[10]

However, of the 42 CBOs willing to connect to the bulk system, 22 CBOs gave the condition that if connected to the new system, they want to retain the authority to operate and maintain the CBO. They also expect that water service to be available 24 hours per day, and that water distributed to be of better quality than what they are now producing. Eighteen CBOs, on the other hand, did not categorically specify retaining the authority for O&M as a requirement to connecting to the new system, but mentioned wanting assurance of 24-hour water service, in addition to having safe and potable water.

6.3.3 Approaches in Providing Water Supply Services to CBOs

There are several approaches in getting the CBOs to connect to the new system, given the information / data on technical suitability of the CBO systems, technical and non-technical issues to be resolved, the CBOs willingness to connect and conditions for connecting. As such it is proposed to rationally categorize the CBOs based on the information / data presented.

(1) Categorization of CBO Inter-Connection with NWSDB RSC(N/C)

It is proposed that the first category would be comprised of CBOs that have indicated their willingness to connect to the new system, without any conditions, and whose systems have been assessed as suitable for immediate bulk supply connection. There are 11 CBOs (22 percent) that fall under Category 1.

[10] Final Report. *Social Survey Conducted for the Feasibility Study of Anuradhapura North Integrated Water Supply Project* by Engineering Consultants (Pvt) Ltd., September 2012, p.24.

The second category would be the CBOs who are willing to connect, also without conditions, but whose systems need improvements or have issues to be resolved. These CBOs will be more accepting of being inter-connected to the system, since they are presently experiencing either unsatisfactory service, having water quality problems, or inadequate water supply. Six CBOs (12 percent) fall under Category 2.

The third category CBOs are those willing to connect, but with conditions, although their systems have been assessed as suitable for immediate connection. The water supply systems of the third category CBOs are generally still in good working condition, and can continue provide an acceptable level of service to the community. There are 24 CBOs (48 percent) that fall under Category 3.

The fourth category are CBOs that require major rehabilitation to precede an efficient inter-connection, because these are either non-functioning, not a pipe borne system, or have no CBO / no scheme organised. These also include water CBOs who are undecided or made no comment. Five CBOs (10 percent) fall under Category 4.

The fifth or last category is the CBOs that have been excluded from the project study and the CBO not willing connect. There are four CBOs (8 percent) that fall under Category 5. See **Table 6.32** for list of CBOs and their categorization, and **Appendix 6.3(b)** for the summary table on suitability, conditions, willingness to connect and categorisation.

Table 6.32 Categorisation of CBOs Based on Willingness to Connect, Conditions Set and Technical Suitability

CBO	CATEGORY 1 • Willing to connect • No conditions • Suitable for bulk supply	CATEGORY 2 • Willing to connect • No conditions • Requires improvements	CATEGORY 3 • Willing to connect • With conditions • Suitable for bulk supply	CATEGORY 4 • Willing to connect • Requires major rehabilitation • Undecided	CATEGORY5 • Not willing to connect • Excluded
1			o		
2			o		
3			o		
4			o		
5	❖				
6				•	
7			o		
8			o		
9			o		
10					▪
11			o		
12			o		
13			o		
14			o		
15	❖				
16			o		
17			o		
18			o		
19	❖				
20					▪
21		➢			
22		➢			
23		➢			
24	❖				
25			o		
26					▪
27				•	
28	❖				
29			o		
30			o		
31	❖				
32			o		
33			o		
34	❖				
35			o		
36				•	
37		➢			
38	❖				
39				•	
40	❖				
41				•	
42		➢			
43			o		
44		➢			
45	❖				
46			o		
47					▪
48			o		
49			o		
50	❖				
TOTAL	**11**	**6**	**24**	**5**	**4**

(2) Strategies in the Provision of Water Supply Services

It must be emphasized that CBOs are composed of beneficiary households. They were formed on the basis of consultation and participation, which has become an important factor in its success. Through this process, the various stakeholders' influence, share control and make decisions over development initiatives and resources that affect them. Thus, NWSDB RSC(N/C) must be able to provide water supply through the following strategies: (i) bulk distribution through the existing CBOs by encouraging them to connect to the new system; (ii) direct distribution, by constructing the required distribution lines to an expanded urban centre or new cluster of populations, or by takeover or turnover of CBO facilities, depending on the arrangement with the CBOs; and (iii) distribution by water tankers to isolated or far flung areas that are not reachable by the distribution system. See **Figure 6.10** below.

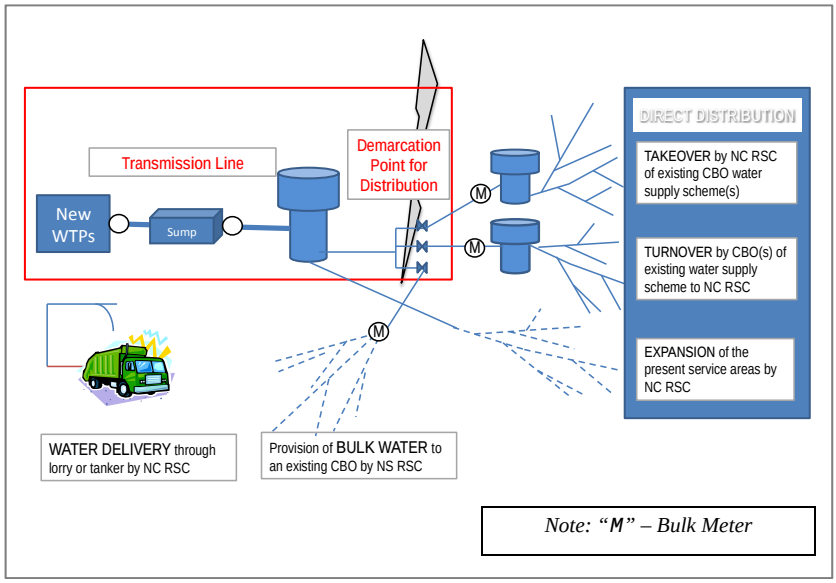


Figure 6.10 Provision of Water Supply Services

It is of utmost importance, therefore, that the NWSDB RSC(N/C) establish closer and deeper consultative mechanisms with the CBOs to determine how they want to be supplied with water from the new system, preferably using as a guide the CBO categorisation discussed earlier in this section. This demand-driven participatory approach would help resolve issues that could hinder inter-connection. See **Table 6.33** for a more detailed summary of the manner of supply service provision.

Table 6.33 Manner of Providing Water Supply Services

DISTRIBUTION METHOD	By Existing CBO	By Direct Distribution			By Water Tankers
OVERVIEW	Bulk supply to CBO by RSC	Turnover of CBO facilities to RSC(N/C)	Takeover of CBO facilities by RSC(N/C)	By NWSDB RSC(N/C)	By NWSDB RSC(N/C)
DESCRIPTION	CBO keeps its current organisational characteristics	CBO voluntarily turns over facilities for management by RSC	RSC employs compulsory take over of CBO facilities	RSC expands its existing urban service area(s)	Isolated house-hold clusters not part of CBO or RSC
DISTRIBUTION FACILITIES	• CBO to connect to RSC using bulk meter • CBO to provide rehabilitation to minor/damaged facilities • CBO to expand own distribution network	• RSC to provide rehabilitation to minor/damaged facilities • RSC to expand distribution network	• RSC to provide rehabilitation to minor/damaged facilities • RSC to expand distribution network	RSC to construct new distribution network(s)	Constructing distribution pipelines is not economically feasible
MANAGEMENT AUTHORITY	• CBO retains management authority	• Management authority is RSC	• Management authority is RSC	• Management authority is RSC	• Management authority is RSC
O&M RESPONSIBILITY	• CBO retains responsibility for O&M	• Responsibility for O&M to be decided between CBO and RSC(N/C)	• Responsibility for O&M to be decided between CBO and RSC(N/C)	• RSC retains responsibility for O&M	• RSC retains responsibility for O&M
TARIFF COLLECTION	• CBO retains responsibility for tariff collection	• Responsibility for tariff collection to be decided between CBO and RSC(N/C)	• Responsibility for tariff collection to be decided between CBO and RSC(N/C)	• RSC retains responsibility for tariff collection	• RSC is responsible for setting water charges

As can be gleaned from the above discussion, the CBOs will still retain water distribution rights over its service area. As such, NWSDB RSC(N/C) should vigorously continue to fulfil its mandate of providing technical assistance for such schemes that are operated and managed by the community. It has to strengthen and sustain training activities for the CBOs, capacitating them in operations and maintenance, financial management, billing and collection, records keeping, and governance. It has to re-establish the institutional basis and legal recognition of the CBOs by ensuring the presence of By-Laws, Rules of Business Conduct, preparation of Annual Reports. Finally, it has to put in place a database system of the CBOs that are supplied with water from RSC(N/C) as a monitoring tool of CBO technical and financial operations.

6.4 Water Tariff Systems

The CBO tariff system is prepared with the assistance of the CBO itself and the CBO project proponents. Usually, the system includes the following (i) replacement cost (ii) future rehabilitation cost (iii) capital investment (iv) O&M cost, including staff salary. All tariff systems have to be presented and accepted by the CBO in a general meeting called for the purpose, with a required minimum participation / presence of two-thirds of its membership.

(1) CBOs Tariff System

Domestic water tariff is available for 44 out of 50 CBO schemes in the Project area, while non-domestic water tariff is available for only 25 CBO schemes. The reason for this shortfall is that free water supply is provided to public institutions such as schools and temples.

Tariff charges vary from scheme to scheme. There is a basic monthly fee levied on each customer, with majority of CBOs (52 percent) charging within the range of Rs. 50-59, as shown in **Table 6.34**.

Table 6.34 Basic Monthly Fee Charged by CBOs in the Project Area

Basic Charge (in Rs.)	<49	50-59	60-69	70-79	80-89	90-99	100	150	No data
No. of CBOs	1	26	6	3	3	1	4	1	5
%	2	52	12	6	6	2	8	2	10

Note: Information sourced and analysed from *Annex 3 – Water Tariff Structure for each CBO*, "Status Survey of the Existing Water Supply Schemes for the Preparatory Survey on Anuradhapura North Integrated Water Supply Project" by Ceywater Consultants, August 2012.

As for the per unit consumption charges, the results of the Status Survey revealed that ADB-supported projects generally charge lower tariffs, which range from Rs. 15 to 20 per unit; while CWSSP schemes have higher tariff, varying from Rs. 21 to 27 per unit.

The CBOs in the Project area also impose a connection / re-connection charge on the customer equivalent to the costs incurred. Replacement of the water meter is also charged to the customer. **Table 6.35** shows the re-connection fees imposed.

Table 6.35 Reconnection Fee Charged by CBOs in the Project Area

Reconnection Fee (in Rs.)	250-499	500-749	750-999	1000	2000	3000	No charge	No data
No. of CBOs	3	16	5	5	3	1	2	15
%	6	32	10	10	6	2	4	30

Tariff structure also varies among CBOs. Although all CBOs have a basic charge per household connection, tariff is structured using a unit rate with a block progressive rate. Volumetric rate increases as the consumption increases. The Status Survey used a sample rate analysis for a sample household in each of the 50 CBOs with an average monthly consumption of 18 cubic meters. The formula used is: Base Charge + Consumption Tariff + Tax. The results of the sample rate analysis provide a good idea, for comparison purposes, on the average water

bill of a sample household in each CBO.

As shown in **Table 6.36**, sample households of 18 CBOs, or 36 percent, have water bills within the range of Rs. 300-399; the sample households of 13 CBOs, or 26 percent, have water bills within the range of Rs. 400-499.

Table 6.36 Sample Analysis of Monthly Water Bill of CBO Households

Sample Monthly Water Bill (in Rs.)	200-299	300-399	400-499	500-599	600-699	No data
No. of CBOs	9	18	13	3	1	6
%	18	36	26	6	2	12

This amount is similar to the one confirmed through the social survey conducted which found out that the average amount paid by CBO users come up to Rs. 346 per month, while the average amount paid by the consumer is Rs. 400 per month.

After the new water supply system will enter into operation, NWSDB will be responsible for management, operation and maintenance of new systems. If NWSDB will take over the existing CBO system based on the resolution at the general meeting of the community, the NWSDB's water tariff is imposed to the respective customers, while if the existing CBO will keep an independence from NWSDB, the NWSDB's bulk water supply rate will be imposed to the total water consumption of the CBO. For the new service area, since NWSDB has no intention to allow the new CBO establishment. NWSDB's water tariff will be applied to all the new customers. Takeover of the existing CBO facilities will be done in principle for nothing, since the materials required for the construction of facilities were originally provided by the Government for nothing.

In case of a bulk supply from NWSDB to existing CBOs, the bulk supply charge will be newly imposed, while the consumable expenditures such as electricity or diesel oil and chlorine will be cut from the present expenditures. The profit/loss is then estimated as indicated in **Table 6.37**, in which 17 CBOs (about 41%) out of 41CBOs will show a loss. Although the total payment of one community will be higher than the current one, the water supply by NWSDB still has advantages of (i) safe water supply to meet the Sri Lankan drinking water standards even for fluoride, (ii) stable water supply even in the dry season, (iii) proper chlorination of water, (iv) professional operation and maintenance for distribution facilities such as replacement of defective water meters, repair of leaks.

6.5 Cost Sharing

The connection work of transmission mains and sub-mains to the existing elevated tanks under

the CBOs water supply schemes will be done in the Project with no cost to existing CBOs.

In the new service area, distribution mains and sub-systems will be installed in the Project. For small-size distribution pipes (below 100 mm) NWSDB has a plan to provide materials and install them by the people's labour contribution based on the request of the community people under the NWSDB's supervision, which is also helpful to heighten the willingness to connect to a new system. In case of a new connection, NWSDB is responsible for the service pipe installation work from the branch of distribution pipes to a water meter, while an applicant for the remaining work from the meter outlet to the taps. The connection fee varies from Rs.4,000 to Rs.20,000 depending on the cost estimation. If there is a pavement road, the cost to break and reinstate the pavement is borne by an applicant who is required to pay such cost to the relevant authorities beforehand.

Table 6.37 Estimation of Revenue and Expenditure in Case of an Application of Bulk Supply Charge to Existing CBOs

DSD	GND	CBO	No. of Connections (Conn.)	Water Consumption (m3/month)	Bulk Supply Payment (Rs./year)	Revenue (Rs./year)	Present Expenditure at CBOs				Profit/Loss (Rs./year)
							Total (Rs./year)	Personnel (Rs./year)	Consumables (Rs./year)	Maintenance (Rs./year)	
Padaviya	Padaviya	Suwasehana	192	1,989	405,756	1,025,364	425,928	84,000	101,928	240,000	295,608
	Parakramapura	Parakum	576	9,307	1,898,628	2,045,400	618,380	348,000	192,780	77,600	-278,828
	Bogahawewa	Suwasetha	186	2,661	542,844	730,052	478,348	180,000	164,484	133,864	-126,656
Kebithigollewa	Ayyatigewewa	Shakthi	235	2,583	526,932	562,758	534,519	216,000	148,589	169,930	-350,104
Medawachchiya	Kidawarankulama	Sisila Diyadahara	190	1,762	359,448	535,060	373,612	156,000	207,612	10,000	9,612
	Maha Kumbugollewa	Diriyamatha	180	1,460	297,840	562,228	421,037	180,000	141,037	100,000	-15,612
	Periyakulama &Yakawewa	Diriyashakthi	138	1,365	278,460	490,000	362,432	132,000	207,432	23,000	56,540
	Hirulugama	Ekamuthu	173	1,953	398,412	394,796	358,672	198,000	120,672	40,000	-241,616
	Athakade	Ridinadi	121	938	191,352	446,472	224,569	120,000	72,480	32,089	103,031
	Ataweeragollewa	Samagi	110	1,266	258,264	434,792	289,904	96,000	183,904	10,000	70,528
	Maha Divulwewa	Gemunu	70	487	99,348	192,684	81,420	30,000	51,420	0	63,336
	Kadawathgama	Isuru	181	1,915	390,660	714,806	476,204	258,000	139,404	78,800	-12,654
	Viralmurippuwa	Ran Arulnalu	192	1,907	389,028	402,264	176,323	102,000	70,188	4,135	-92,899
	Katuwela	Jayashakthi	220	2,932	598,128	927,904	632,164	288,000	294,164	50,000	-8,224
	Helabagaswewa	Samagi	190	1,818	370,872	1,270,584	332,448	190,800	106,848	34,800	674,112
	Kirigalwewa	Nelum	139	660	134,640	286,620	159,624	72,000	87,624	0	79,980
	Unagasewewa	Randiya Dhahara	107	1,018	207,672	527,540	291,700	78,000	181,200	32,500	209,368
Rambewa	Wewelketia & Thamarahamillewa	Rangiri	120	797	162,588	341,832	192,492	96,000	96,492	0	83,244
	Talgahawewa	Samagi	135	973	198,492	432,168	260,950	162,000	71,440	27,510	44,166
	Balahodawewa	Pragithi	128	726	148,104	290,772	123,515	66,000	46,748	10,767	65,901
	Ihala Kolongasw.	Dimuthu	67	417	85,068	147,732	81,263	48,000	30,576	2,687	11,977
	Mahakanadarawa 2	Mahasen	153	1,336	272,544	319,376	266,966	120,000	134,016	12,950	-86,118
	Mahakanadarawa 1	Nildiyadahara	144	1,175	239,700	391,396	242,219	114,000	93,219	35,000	2,696
	Kedewa & Galkandegama	Swashakthi	154	949	193,596	441,276	199,605	120,000	64,968	14,637	113,043
	Ikirigollewa	Ikra	613	8,645	1,763,580	1,883,160	1,084,874	540,000	528,361	16,513	-436,933
	Katukeliyawa	Eksath	118	1,632	332,928	305,352	226,842	96,000	54,684	76,158	-199,734
	Wahamalgollewa 3	Ekamuthu	245	1,448	295,392	616,920	347,832	168,000	175,332	4,500	149,028
	Sangilikanadarawa	Arunalu	183	2,834	578,136	974,584	466,315	180,000	217,920	68,395	148,053
Horowpothana	Wadigawewa	Pradeepa	161	1,578	321,912	382,908	226,651	120,000	52,880	53,771	-112,775
	Maradankadawela	Hansajala	111	1,231	251,124	392,044	224,817		82,632	142,185	-1,265
	Kapugollewa	Jalasavi	157	1,107	225,828	331,324	224,859	94,000	82,882	47,977	-36,481
	Parangiyawadiya	Upul	195	1,691	344,964	613,428	224,501	132,000	69,701	22,800	113,664
Kahatagasdigiliya	Moragahawela	Pragathi	131	855	174,420	339,660	176,620	120,000	46,620	10,000	35,240
	Kubukgollewa	Ekamuthu	78	447	91,188	200,900	159,532	48,000	102,172	9,360	52,352
	Pandarellewa & Panwella	Sobasisila	178	2,254	459,816	510,720	242,664	120,000	122,664	0	-69,096
	Mee-Kumbukwewa	Apsara	101	492	100,368	290,592	192,548	96,000	94,548	2,000	92,224
	Mahawewa	Praja Shakthi	165	1,089	222,156	624,740	368,669	150,000	99,395	119,274	133,310
	Maha Kubukwewa	Vajira	135	1,233	251,532	431,496	290,632	198,000	70,632	22,000	-40,036
	Gonumeru Wewa	Senath	79	525	107,100	275,312	185,640	24,000	134,640	27,000	117,212
	Palippothana ~ Kirigallewa	Janasetha	189	1,952	398,208	615,476	249,024	120,000	117,024	12,000	85,268
	M. Kiribbewa & Kurukuragama	Eksath	100	930	189,720	214,800	196,116	96,000	100,116	0	-70,920

Note: Profit/Loss = Revenue - (Bulk Supply Payment + Personnel Expenditure + Maintenance Expenditure)

The water tariff for the bulk supply of water to CBOs is Rs.17 per cubic meter with no service charge.

CHAPTER 7

ENVIRONMENTAL AND SOCIAL CONSIDERATION

Chapter 7 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

7.1 Project Summary

7.1.1 Project Title

The Anuradhapura North Integrated Water Supply Project (ANIWSP).

7.1.2 Project Summary

The project is planned to provide safe drinking water in the northern part of Anuradhapura in Sri Lanka. The current main water source in this area is groundwater and it is usually supplied by small scale piped water supply systems or from individual wells. The groundwater in the area contains a high concentration of hardness and sometime contains a high concentration of fluoride. It is believed that the bad water quality brings about endemic diseases such as fluorosis and CKDs. For this reason, the NWSDB has decided to establish a water supply system in the area using an alternative water source from surface waters.

The planned project will provide a positive impact to the people in the area by improving their living standards. On the other hand, the project might have negative impacts on the natural environment and social conditions. Mahakanadarawa WTP was planned to extract water directly from the tank which is designated as Sanctuary, so this Project was considered as category B.

7.2 General Conditions for Environmental and Social Considerations of the Project Area

7.2.1 Land Use

The project area is a suburban and rural area, which is located in the northern part of Anuradhapura district. The largest land use of project area is covered forest, followed by covered scrub. Cultivated land is mainly paddy fields. The area occupied by tanks is relatively high and there are a large number of tanks, as the area is dry. Irrigation using water from tanks has been carried out since ancient times. **Figure 7.1** shows land use in the Project area.

There are main 35 tanks and 21 middle tanks, totally 56 tanks are under the Irrigation Department control. On the other hand, the relative smaller tanks are under the control of Agrarian services department of Ministry of Agriculture, and the number is 877. **Table 7.1** shows the number of tanks in the Project area. Additionally, there are many abandon tanks too.

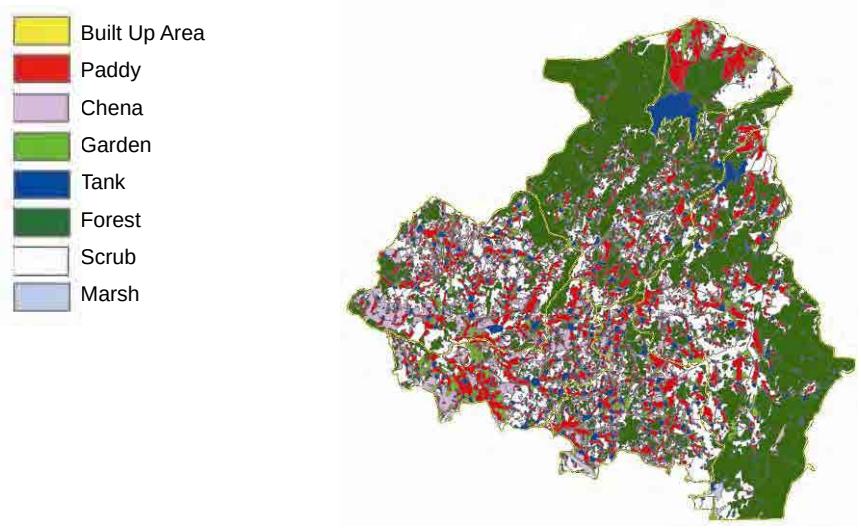


Figure 7.1 Land Use of the Project Area

Table 7.1 Tanks in the Project Area

DSD	Major/median irrigation tanks	Minor irrigation tanks
Padaviya	5	34
Kebithigollewa	11	204
Medawachchiya	-	-
Rambewa	10	181
Horowpothana	22	215
Kahatagasdigiliya	8	222

7.2.2 Ethnic Group

The ethnic composition of Sri Lanka is 76% Sinhalese, 15% Tamil and 9% Muslim. In Anuradhapura, the ratio of Sinhalese is higher than the national average at more than 90%.

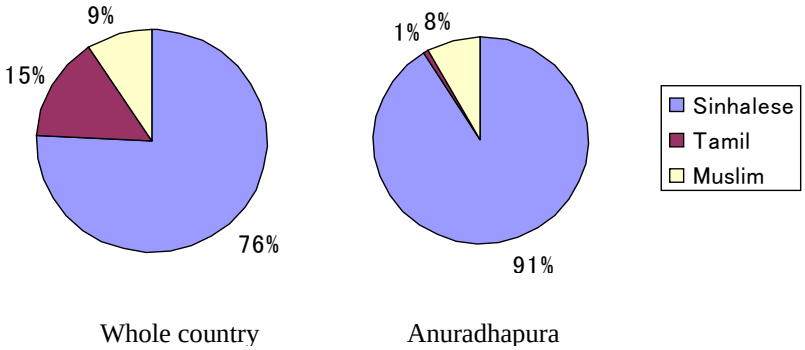


Figure 7.2 Ethnic Composition

There are indigenous people called **'Veddas'** in Sri Lanka, but there are none living in the project area. Tamil and Muslim are considered as minority in this area but they seem to live

together without conflict.

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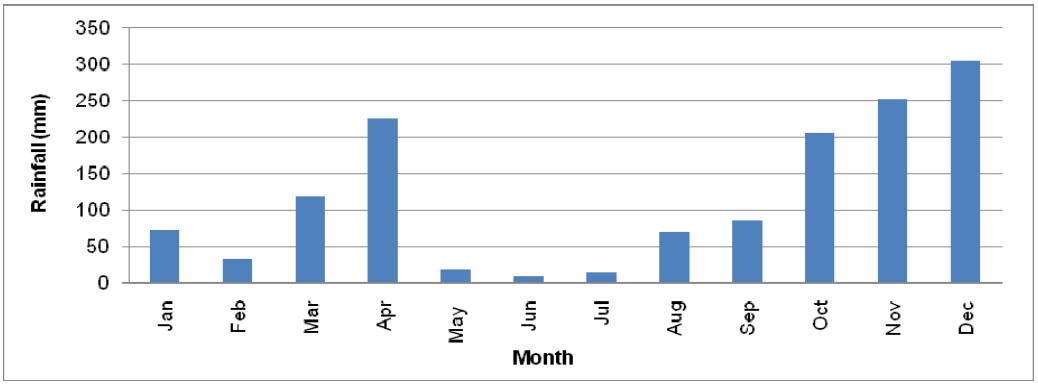
7.2.3 Environmental Condition in the Study Area

(1) Climate

The Anuradhapura District falls within the dry zone of Sri Lanka. According to the records of the Department of Meteorology, the average monthly temperature varies between a minimum of 24.0ºC and a maximum of 32.8ºC. The relative humidity ranges from 69% during the day to 90% at night. The area experiences rain as the result of the northeast monsoon and to a lesser degree from the southwest monsoon. The mean annual rainfall in the last 4 years is 1,401 mm. Peak rainfall occurs during the months of October to December, when about 75% of the total annual rainfall occurs. Scattered rains are experienced during March to April when the inter-monsoon rain is uncertain. The dry season in the region extends from May to July. **Figure 7.3** shows the rainfall pattern in the project area.



Source: Department of Meteorology

Figure 7.3 Monthly Average Rainfalls in Anuradhapura

(2) Air quality

No air quality measurements have been conducted recently in the study area. However the CEA carried out monitoring in Anuradhapura town, in 1999. The measured one hour average for all parameters was well below the National Ambient Air Quality Standards, including for Carbon Monoxide (CO), Sulphur Dioxide (SO_2), Oxides of Nitrogen (NO_x), Nitrogen Dioxide (NO_2) and Nitric Oxide (NO). With regard to the project area, where no highly polluting industries exist and the number of vehicles is much lower than in other areas, except the areas where main roads traverse, the ambient air quality is expected to be within the National Ambient Air Quality Standards.

Table 7.2 Ambient Air Quality Measurements in Anuradhapura, 1999

Parameter	Averaging time	Unit	Maximum permissible level	Japanese standard	Recorded level
Particulate Matter	1 hr	µg/m3	100*	100	32.4
Carbon Monoxide (CO)	1 hr	ppm	26.00	10	0.35
Sulphur Dioxide (SO_2)	1 hr	ppm	0.08	0.04	0.002
Nitrogen Dioxide(NO_2)	1 hr	ppm	0.13	0.04 ~ 0.06 or less	0.003

* For 24 hour average time as the National Environmental (Ambient Air Quality) Regulations, 1994 and its amended version in 2008 not specify Maximum permissible level for 1 hour average PM10.

Source: Environmental Atlas of Sri Lanka, Central Environmental Authority, 2005Source: *Environmental Atlas of Sri Lanka, Central Environmental Authority, 2005*

(3) Topography, Geology and Soil

The study area is a part of north-central Sri Lanka and the topography is generally flat and some undulating part, with elevations ranging from below 100m to about 200m in the highest parts. Ridges, escarpments valleys are significant in the area. The Kala Oya, Malwathu Oya, and Yan Oya are the major river basins in the district and there are many major tanks that hold water throughout the year; however the minor tanks suffer from water shortages during the dry period.

The geology of the area belongs to the Highland complex and is overlain by Quaternary and superficial deposits on the Precambrian strata. **Figure 7.4** describes the schematic geology and climate in Sri Lanka. The Highland complex is composed mainly of inter-banded metamorphosed sediments, occurring as crystalline metamorphic rocks, and occupies a broad belt running across the centre of the island in a S-W to N-E direction, east of the Anuradhapura District. A general geology map of the area is given in **Figure 7.5**.

The soil map of the area (**Figure 7.6**) shows that the surface geological strata is covered with three different types of soils classified according to agricultural suitability. They are

- Reddish brown Earths and Low Humic Gley soils;
- Red Yelloe Podzolic soils with dark B horizon and Red-Yellow Podzolic with prominent A1 horizon and;
- Alluvial soils of variable drainage and texture

Figure 7.4 Geology and Climate of Sri Lanka

Figure 7.5 General Geology of the Area

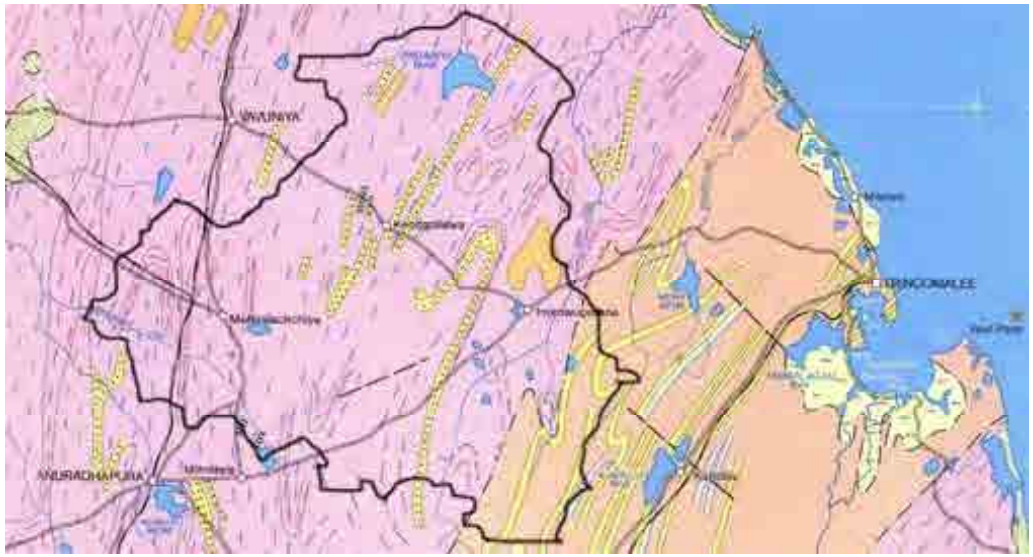
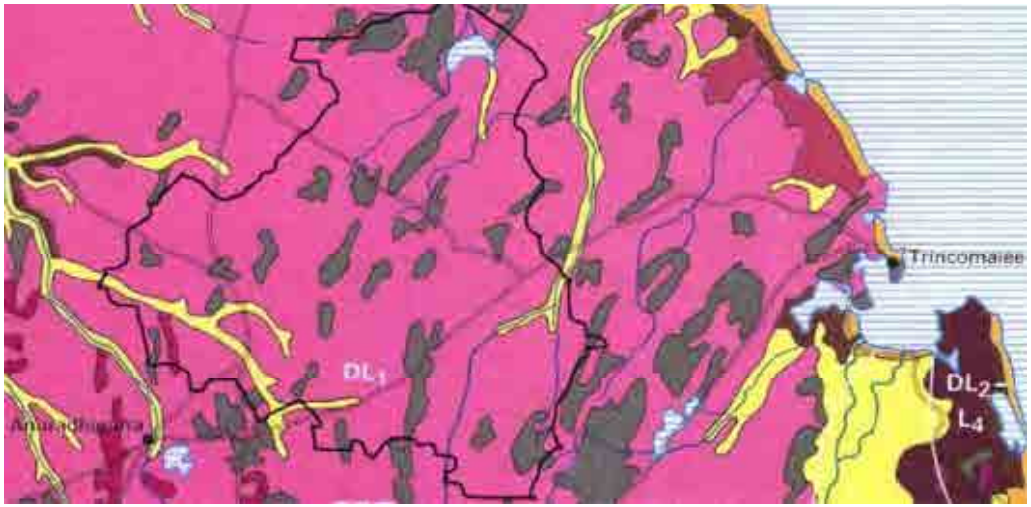


Figure 7.6 Soil Map of the Area



(4) Ecological Resources

The area in which the project is to be located belongs to the DL1 agro ecological zone and generally comprises of dry mixed evergreen forest types. DL1 stands for Dry Zone (Rainfall < 1,500 mm) and Low Country (0 - 300 MSL) category 1, which indicates rice soil type in Sri Lanka. The forests in the area are dominated by Manilkara hexandra (Sinhala - Palu), Chloroxylon sweitenia (Sinhala - Burutha), Drypetes sepiaria (Weera), Feronia limonia (Divul), Vitex altissima (Milla), Syzygium spp (Dan), Azadirachta indica (Kohomba) and Chukrasia tabularis (Hulan Hik).

There are several protected areas (**Table 7.3** and **Table 7.4**), and vegetation in such areas provides good feeding and resting places for wild fauna, especially birds, butterflies and other insect groups. In all the other places, the natural habitat of the project area has been subjected to various anthropogenic activities for many decades. The main habitat types found in the project area include reservoirs, paddy fields, home gardens and secondarily grown forest patches.

(5) Description of protected areas and designated areas in the study area

1) The Protected Area stipulated by CEA

The National Environmental Act No.47 of 1980 (hereinafter referred as to NEA) has provisions which allow the Central Environmental Authority CEA) to declare specific areas as Environmental Protection Areas through an order published in a Gazette. Once the CEA declares an area as an Environmental Protection area, any planning scheme or project stops in that area. However, up to date, only six such sites have been declared under the provision and none of them are situated within Anuradhapura District. The six declared Environmental Protection Areas are as follows.

- Muthurajawela Wetland
- Thalangama Tank
- Gregory Lake
- Knuckles Forest
- Maragala Mountain Range
- Walawwatta Wathurana Swamp Forest

On the other hand, an environmentally sensitive area which requires approval for development on the basis of EIA/IEE is defined in Gazettes (Extra-ordinary no.772/22 24th June 1993, 1104/22 6th November 1999 and 1108/1 29th November 1999). The following conditions could conflict with the project.

- Any reservation beyond the full supply level of a reservoir
- Within 100 meters from the boundaries of or within any area declared as a Sanctuary under the Fauna and Flora Protection Ordinance
- Within 100 meters from the high flood level contour of or within a public lake as

defined in the Crown Lands Ordinance.

2) The Protected Area stipulated by Forest department

Three types of protected areas are administered by the Forest Department as enforced by the Forest Ordinance of 1907 and its amendments namely Forest Reserve (FR), Proposed Reserve (PR) and National Heritage Wilderness Area (NHWA). The protected areas under the preview of the Forest Department which are located within the project areas are as follows.

Table 7.3 Protected Areas under Forest Ordinance

Protected Area	Category	Notification Date	Extent (ha)
Mihintale	FR	14.11.1924	3,308.2
Madawachchiya	PR	-	2,892.5
Issanbessawewa	FR	07.06.1901	441.9
Hinna	PR	-	1,021.8
Etakaduwa	PR	-	7,689.0
Wedakada	PR	-	5,180.0

FR - Forest Reserve; PR - Proposed Reserve; Source: National Conservation Review (NCR) Report Volume 1 (1997)

3) The Protected Area stipulated by Department of Wildlife Conservation

Fauna and Flora Protection Ordinance No. 2 of 1937 (and its amendments) constitutes Sanctuary and seven categories of National Reserves.

<National reserves>

- Strict Natural Reserve (SNR)
- National Park (NP)
- Nature Reserve (NR)
- Jungle Corridor
- Refuge
- Marine Reserve
- Buffer zone

<Sanctuary>

The protected areas under the preview of the Department of Wildlife Conservation which are located within the project areas are listed in **Table 7.4**. The Mahakanadarawa tank is one of the planned water sources for the project.

Table 7.4 Protected Areas under Flora and Fauna Ordinance

Protected Area	Category	Notification Date	Extent (ha)
Mahakanadarawa Wewa	Sanctuary	09.12.1966	1,679.7
Mihintale	Sanctuary	27.05.1938	999.6
Padawiya Tank	Sanctuary	21.06.1963	6,475.0

Source: National Conservation Review (NCR) Report Volume 1 (1997)

The level of protection of a Sanctuary is not as severe as that for National Reserves. A minor development action can be done with a permission of authority. According to the Fauna and Flora Protection Ordinance, the following activities are prohibited in a Sanctuary.

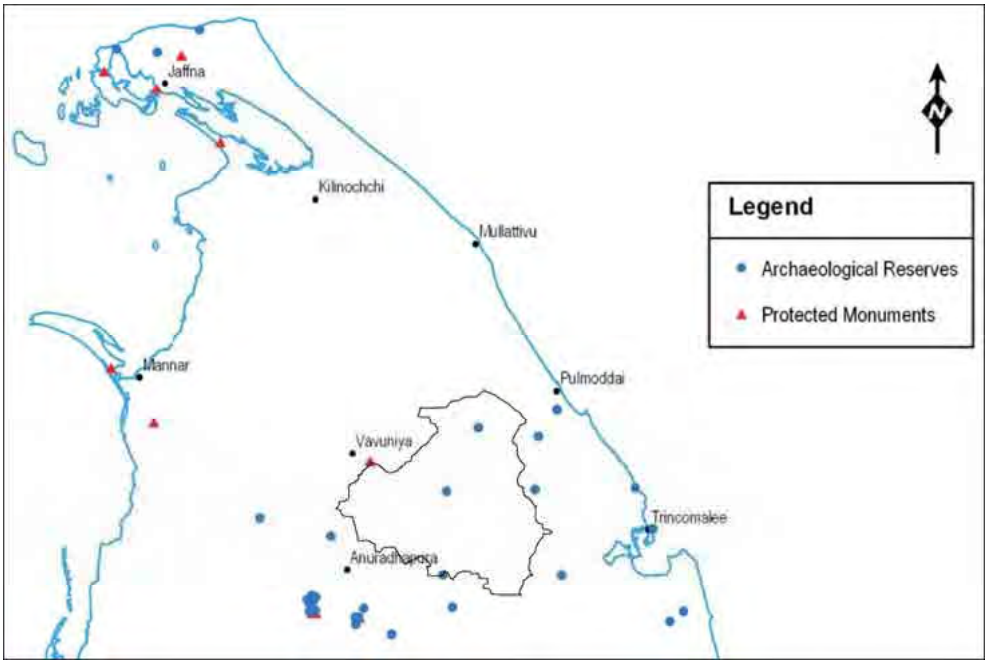
- Hunting, shooting, killing or taking any wild animal, taking or destroying egg of bird or reptile or nest of bird
- Carrying gun or explosive
- Fishing or taking aquatic animal or plant from water without permission
- Removing archaeological, pre-historic, historical, geological or other scientific interesting object, or any other object of mineral value without permission
- Firing a gun, doing any act to disturb wild animal, or interfere breeding place
- Constructing or using hide or ambushing for hunting, shooting, injuring wild animal, bird or reptile
- Setting, laying or spreading any pitfall, trap, snare or other instrument

The following are prohibited on any State Land within a Sanctuary.

- Damaging or destroying plant, taking, collecting or removing plant
- Clearing land for cultivation, mining or any other purpose
- Kindling or carrying fire
- Possessing or using any trap, explosive, or poisonous substance
- Making any fresh clearing
- Erecting building permanent or temporary without permission
- Constructing or using road

4) The Protected Area stipulated by Department of Archaeology

The archaeological sites of Sri Lanka can be separated into 3 major groups i.e. (1) proto-historic sites, (2) prehistoric sites and (3) archaeological reserves and protected monuments. Archaeological reserves and protected monuments located within the project area are shown in **Figure 7.7**. The planned construction sites are located outside of the protected sites.



Source: Environmental Atlas of Sri Lanka, Central Environmental Authority, 2005

Figure 7.7 Archaeological Reserves and Protected Monuments

5) The Protected Area stipulated by Irrigation department

Irrigation Department has set apart reservations for protection and safety of the structural components of all the schemes by Department Circular No. 10/1986. This will apply to all the schemes managed by the Irrigation Department within the project area.

6) The Declared Area of Urban Development

Under the law of Urban Development Authority (U.D.A.), certain urban areas are declared as a development area for the better Physical & Economic utilization of such areas. Mihintale Pradeshiya Saba and Medawachchiya Pradeshiya Saba have been declared as this type of area.

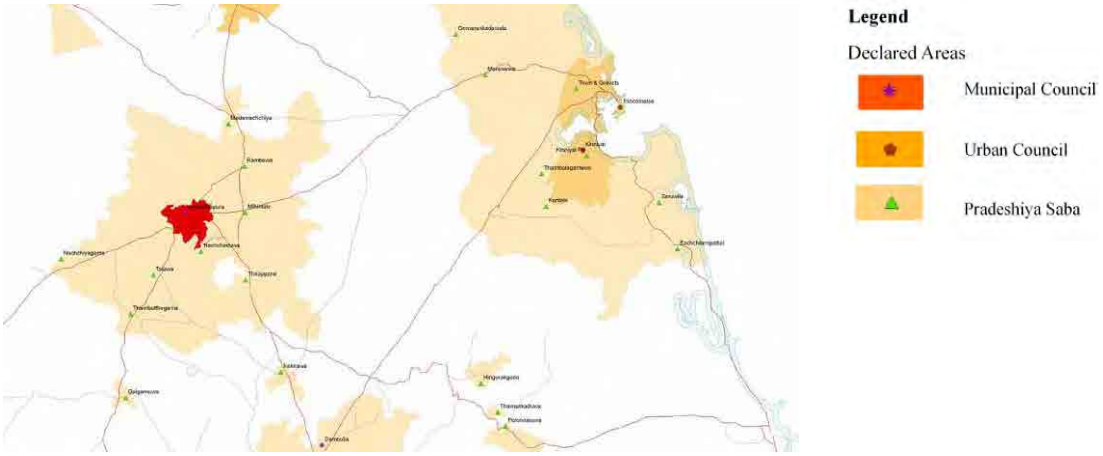


Figure 7.8 Areas Declared under Urban Development Authority Act

7.2.4 Social Conditions in the Study Area

The project service area consists of six DSDs namely; Padaviya, Kebithigollewa, Horowpathana, Kahatagasdigiliya, Medawashchiya and Rambewa. However, the Mahakanadarawa Tank which is one of the two water sources of the project is located within Mihintale DSD. The intake and Water Treatment Plant will be most likely located within Mihintale DSD, within the impact area of the project. Therefore for this study, Mihintale DSD was also taken into account.

The total population in the project area is 225,590, which is distributed over an area of 299,271 ha. The highest population is recorded in Madawachchiya whilst the lowest is in Kebithigollewa. The population density varies from 1.379 capita/ha highest in Rambewa to 0.386 in both Kebithigollewa and Horoupatana

Table 7.5 Population and Per Capita Land Used by Divisional Level – 2010

DSD	Population			Area (ha)	Population Density	Per capita land consumption (ha)
	Male	Female	Total			
Padaviya	11,940	11,597	23,537	23,119	1.018	0.98
Kebithigollewa	11,077	10,580	21,657	56,062	0.386	2.59
Medawachchiya	22,615	22,429	45,044	50,730	0.888	1.13
Rambewa	17,411	17,766	35,177	25,509	1.379	0.73
Kahatagasdigiliya	18,457	18,911	37,368	33,141	1.128	0.89
Horoupotana	16,536	16,457	32,993	85,487	0.386	2.59
Total 6 DSD	98,036	97,740	195,776	274,048	0.864	1.485
Mihintale	14,938	14,876	29,814	25,223	1.182	0.85

Source: Department of Census and Statistics

(1) Agriculture

Paddy cultivation is mainly carried out by making use of the irrigation systems in the area. The irrigation systems are categorized as Major and Minor. Rainfed farming is also a key source of harvesting paddy. A total of 46,749.9 ha is under paddy cultivation, of which 60% is by Minor irrigation, 26% by Major irrigation and 14% Rainfed.

Table 7.6 Cultivated Extent of Paddy by Divisional Level – 2010

(Extent in ha)

DSD	By Irrigation		Rainfed	Total
	Major	Minor		
Padaviya	2,762	1,082	996	4,841
Kebithigollewa	1,562	3,570	172	5,304
Medawachchiya	820	5,533	439	6,791
Rambewa	3,229	3,367	804	7,399
Kahatagasdigiliya	934	6,324	1,347	8,605
Horoupotana	2,614	5,988	2,322	10,924
Total 6 DSD	11,921	25,864	6,079	43,864
Mihintale	359	2,165	362	2,886

Source: Department of Census and Statistics of Sri Lanka

The main highland crops in the project area are Cashew, Arecant, Mango, Orange, Lime, Jack, Plantain and Papaw. In Mihinthale DSD, 787.7 ha is utilized for harvesting highland crops, while 178.4 ha is used in Horoupatana for this purpose.

Table 7.7 Highland Crop Statistics by Divisional Level – 2010

(Extent in ha)

DSD	Cashew	Arecant	Mango	Orange	Lime	Jack	Plantain	Papaw
Padaviya	75.9	4.8	35.7	32	38.2	74.5	107.2	20.2
Kebithigollewa	73.6	16.1	106.3	35	54.4	99.6	175.6	32.7
Medawachchiya	116.9	18.4	111.9	37.8	73.1	126.8	136.9	44.2
Rambewa	98.3	11.7	140	52.2	78.5	98.8	159	32.3
Kahatagasdigiliya	70.2	4.4	116.3	40.8	69.5	88.4	145.3	40.4
Horoupotana	16.4	0.5	42.3	17.4	21.9	29.4	41.6	8.9
Mihintale	246.3	0	127.4	53.1	95	114.4	125.7	25.8

Department of Census and Statistics of Sri Lanka

(2) Education

A total of 196 schools are established in the project beneficial area, and Mihinthale has only 18 schools in the DS. With respect to National Schools, only Madawachchiya DS has one school that comes under this category. All the other schools in the project area are of 1AB, Grade 1C, Grade 2C and Grade 3 categories.

Table 7.8 Classifications of Schools by Divisional Level 2010

DSD	National Schools	1AB Schools	Grade I C Schools	Grade 2 Schools	Grade 3 Schools	Total
Padaviya	0	1	5	9	5	20
Kebithigollewa	0	0	2	8	17	27
Medawachchiya	1	0	4	18	16	39
Rambewa	0	0	4	17	12	33
Kahatagasdigiliya	0	1	6	14	18	39
Horoupotana	0	0	3	16	19	38
Mihintale	0	0	4	10	4	18

Source: Department of Census and Statistics of Sri Lanka

(3) Healthcare

There are 14 hospitals in the project area. Most of the hospitals have less than 75 beds and 5 wards. Padaviya Hospital is recorded to have the highest number of beds and wards, 127 and 6 respectively.

Table 7.9 Information on Government Hospitals by Divisional Level – 2010

D.S. Division	Name of hospital	No of wards	No of beds	No of outdoor patients	No of indoor patients
Padviya	Padviya	6	127	83157	8504
	Samapath Nuwara	2	77	25486	4312
Kabithigollava	Kabithigollava	5	63	90122	6569
Madawachchiya	Madawachchiya	4	105	87016	10068
	Puneava	1	5	5149	0
Rabava	Rabava	3	46	25754	4136
	Kallanchiya	2	9	15709	1304
Kahatagasthigiliya	Kahatagasthigiliya	4	74	86331	7713
	Rathmalgahaweva	3	41	55472	2200
Horovipothana	Horovipothana	5	72	53746	4151
	Kapugollawa	2	28	21214	1858
	Wahalkada	1	11	11982	0
Mihinthale	Mihinthale	5	100	89040	4254
	Thammennava	3	32	38850	3369

Source: Department of Census and Statistics of Sri Lanka

7.2.5 Result of Social Survey in the Study Area

(1) Purpose

The scope of the social survey in the Project area, is to determine and record socioeconomic status of the beneficiary population, determine the present status of the safe drinking water availability, the status of sanitation and health, specially water borne diseases such as Renal failure and Fluorosis which are known to be the most abundant in the target project area. In addition, it was aimed to find the views of the target community on the benefits anticipated and capability to pay on the new water supply.

(2) Methodology

The survey was carried out in the Project coverage area which are of 190 Grama Niladhari Divisions (GNDs) in six DSDs; Horowpothana, Kahatagasdigiliya, Kebithigollewa, Medawachchiya, Rambewa and Padaviya.

The social survey was carried out through a questionnaire survey targeting a total sample of about 990 households and commercial places. The sample was selected in terms of three kinds of population, 1: Existing piped supply water users group (hereinafter referred to as ‘User group’), 2: Non-supplied group (‘Non-user group’), and 3: Commercial /public utilities group. The number of samples is shown in **Table 7.10**.

Table 7.10 The Number of Samples

DS Division	Existing piped water users		Non-supplied group	Commercial/ public utilities group
	CBO	NWSDB		
Padaviya	29	19	47	17
Kebithigollewa	9	27	55	17
Medawachchiya	79	40	98	16
Rambewa	94	10	87	17
Horowpothana	29	5	81	17
Kahatagasdigiliya	59	34	86	17
Total	**299**	**135**	**454**	**101**

The survey was done through a household questionnaire survey and formal discussions with respective Grama Niladhari according to a predefined format. As a part of the survey, informal discussions with target community and respective officers in DS office, collecting available secondary data was done in order to identify the ground situation of the study area and to identify the actual need of the proposed water supply project targeting Mahakandarawa and Wahalkada tanks.

(3) Overview of Social and Economic Conditions Highlighted by the Survey

1) Economic activities

The economy of the project area is predominantly centered on paddy cultivation. Census data revealed that land utilization of Anuradhapura district in 2008, is about 128,719.79 ha and 59,084.05 ha for paddy and chena cultivation respectively. **Table 7.11** describes the community involvement in the main occupation categories in the project area.

Table 7.11 Main Occupation Sectors in the Project Area

DSD	Agriculture sector	Government sector	Private sector
Padaviya	3,883	1,991	315
Kebithigollewa	4,818	2,424	698
Medawachchiya	10,018	2,071	2,286
Rambewa	9,405	3,159	2,132
Horowpothana	10,958	3,011	1,086
Kahatagasdigiliya	11,346	2,939	576

Source: Respective DSD profile – 2011 data

The above data reveals that majority of the families living in the project area are involved in agriculture sector, while considerable amount of other people engaged in government and private sectors. The farmers mostly engaged in paddy cultivation during “Maha” season (December – February) where they get lot of rain for cultivation. Rest of the period of the year, farmers cultivates Other Food Crops (OFCs) and practice “Chena” cultivation. Majority of the government employees are belongs to the defense sector. There are people who engaged in Freshwater fishing activities associated with the tank systems distributed in the

project area. Livestock sector is an important component of the farming system of the project area that generates additional income, employment opportunities and highly nutritious food. Majority of people in the area depend on dairy farming using chattels, goats etc.

In addition, there are small-scale businesspersons, engaging bakery, carpentry, brick industries and self-employments. The water businesses is popular due to the drinking water scarcity in the area and people sell bottled drinking water with no proper sealing for LKR 100/- (30 L) with the delivery service, obtained from natural springs found specially in Kebithigollewa area. There is less number of people working overseas employments.

2) Education

There is no significant difference between User group and Non-user group in education level. Most of people living in this area have a considerable level of education. The majority of about 50 % of the respondents have studied up to Ordinary level (O/L) while more than 40% of the respondents have Advance level (A/L) qualifications. **Figure 7.9** shows that nearly 2 % have the higher education qualifications.

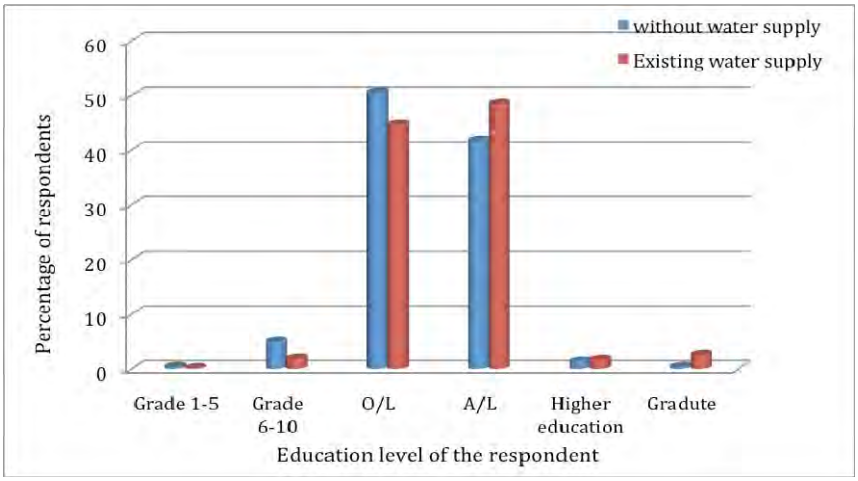


Figure 7.9 Educational Level of Respondent

3) Housing

The community living in the project area is a rural community where majority of the houses are permanent houses, while there are total of about 6,569 with no house for their shelter. The people without houses living in temporary places and they move around the area. The status of the housing in the project area is given in **Table 7.12**.

Table 7.12 Housing Condition

DSD	Permanent	Semi-permanent	Temporary	Without house
Padaviya	4,234	1,044	708	677
Kebithigollewa	5,098	662	320	997
Medawachchiya	8,853	3,428	1,205	1,310
Rambewa	7,311	2,287	455	1,100
Horowpothana	6,557	2,556	637	771
Kahatagasdigiliya	8,459	1,861	332	1,714
Total	**40,512**	**11,838**	**3,657**	**6,569**

Source: Respective DSD profile – 2011 data

4) Size of Family

The average number of family members in the study area is 4. There is no significant difference between User group and Non-user group.

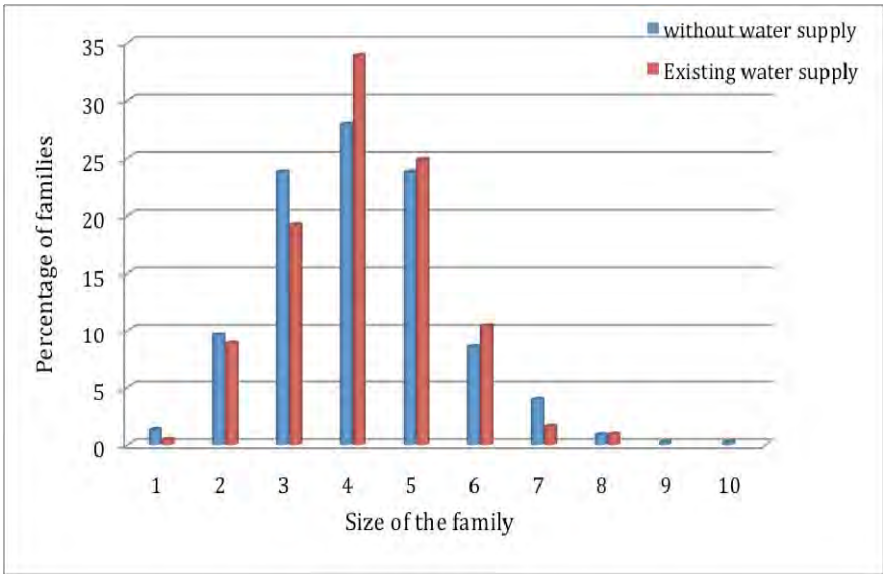


Figure 7.10 Size of Family

5) Income

Main income source for the people in this area is farming.

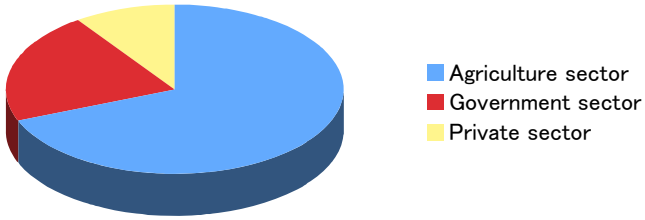


Figure 7.11 Main Occupation Sectors in the Project Area

Source: Respective DSD profile – 2011 data

Water supply area is located urban and suburban area usually, so the distribution pattern of Water user group is a bit different from Non user group.

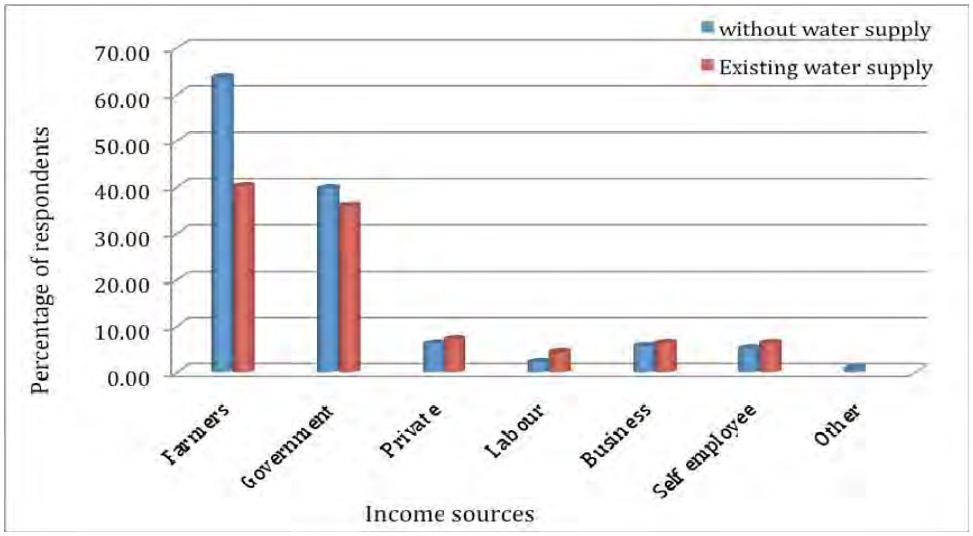


Figure 7.12 Income Sources

There is not found the big difference between User group and Non-user group in income level. The figure of income level is shown in **Table 7.13** and its distribution are shown in **Figure 7.13**.

Table 7.13 Income Level

(Unit: Rs.)

Group	Minimum	Mean	Medium	Maximum
Users	4,000	33,070	25,000	400,000
Non-users	1,600	37,270	25,000	405,000

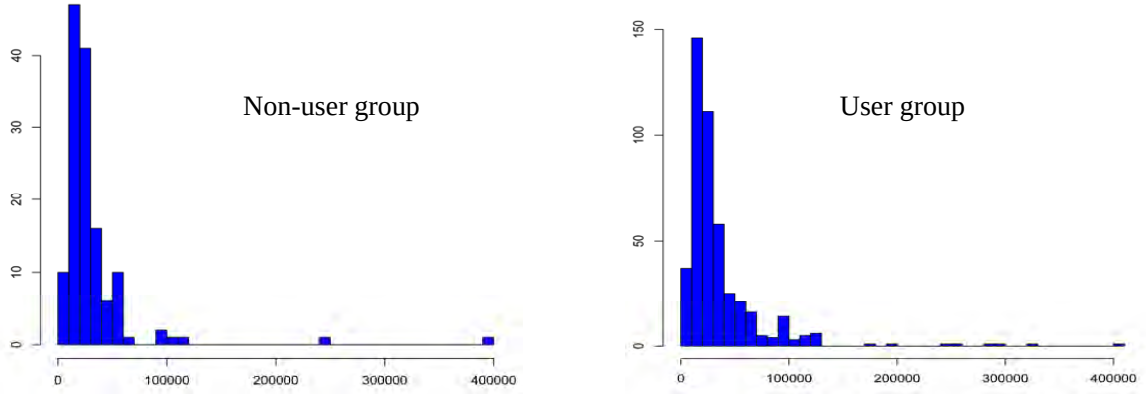


Figure 7.13 Distribution of Income

As stated in Central Bank Report of 2012, the poor household percentage in Anuradhapura district is 4.6 while this figure has been estimated as 7.0 % for whole country.

6) Water Source

The water source for drinking purpose of the User group is shown in Figure. The fact clearly shown in it is that nearly 35 % of the CBO water users depend on other water sources for drinking purpose even though they can use the piped water. 31% of CBO users don't satisfy the water quality, its figure is higher than the water user of NWSDB supply.

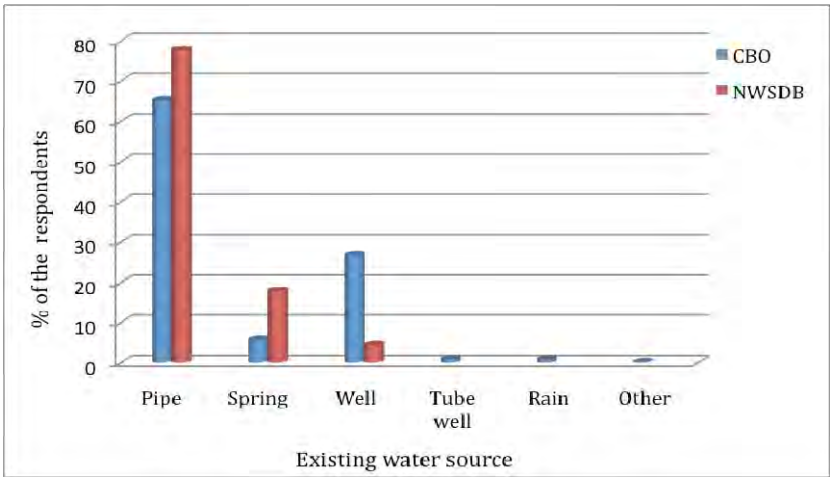


Figure 7.14 Drinking Water Source of the Existing Water User Respondents

Water sources for the Non-user group are shown in **Figure 7.15**.

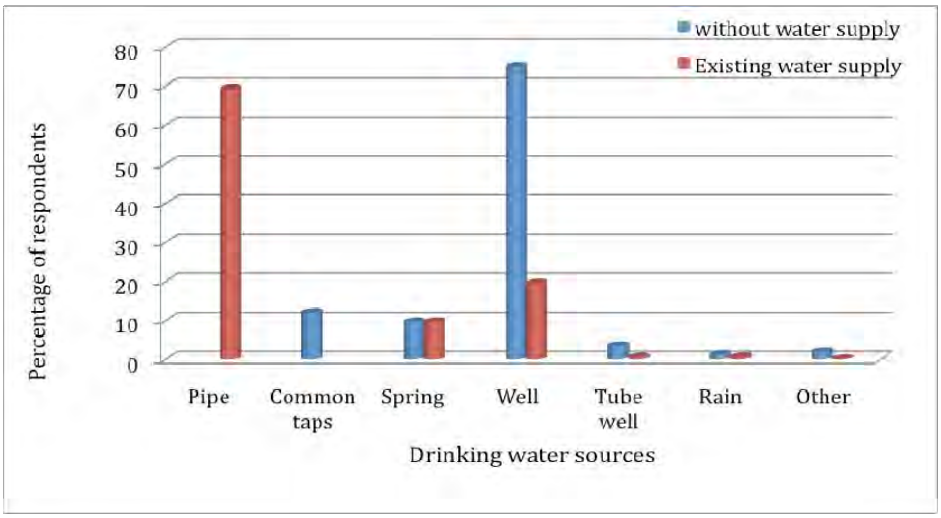


Figure 7.15 Drinking Water Source of Non-user Group

6) The problems of existing water supply

Figure 7.16 shows the problems identified by the users both of NWSDB and CBO. The tendency of answer is almost same in both users groups. The most frequent answer is the problem of water quantity and quality. It is notable that the more than 10% uses proclaimed that the cost for water was too high. About 20% of users NWSDB answered there was no issues and it is double of the CBO users.

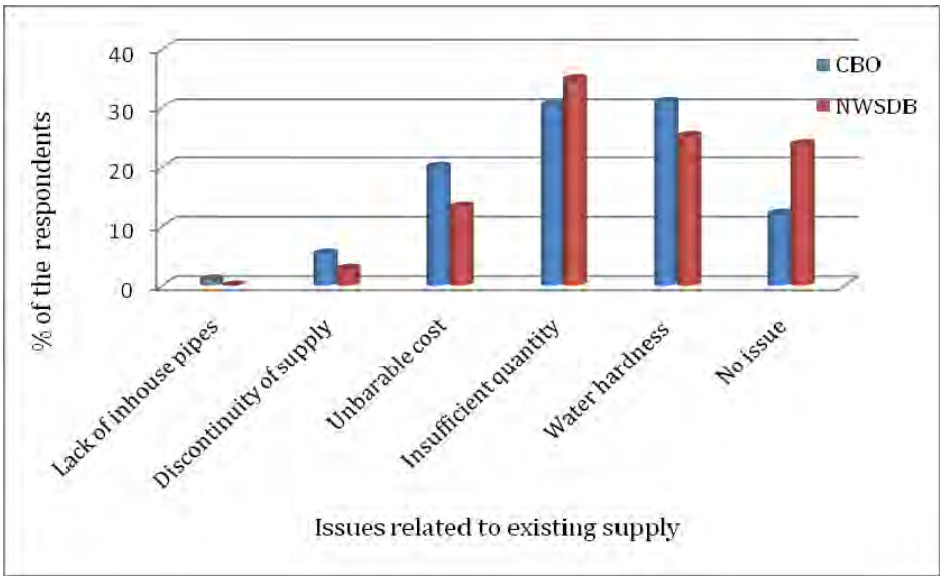


Figure 7.16 Problem of Supplied Water

7.3 Institutions and Organizations regarding Environmental and Social Consideration in Sri Lanka

The hierarchy of legislation in Sri Lanka is shown below.

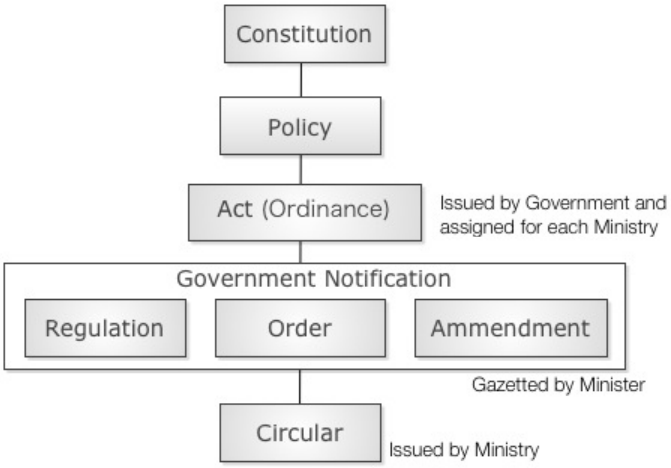


Figure 7.17 Hierarchy of Legislation in Sri Lanka

Under the constitution, Government enacts Policies and Acts. An Act is designated to each

Ministry, and more detailed regulations or amendments are stated as a Government Notification in a Gazette. Each ministry issues the circular as a ministerial decree for more practical use.

7.3.1 Policy of Environment Protection in Sri Lanka

The Constitution of Sri Lanka identifies "The duty of every person in Sri Lanka to protect nature and conserve its riches" Chapter VI, Art. 28 (f). To support this fundamental duty, the Government of Sri Lanka (GOSL) recognized the need for an explicit National Environmental Policy (NEP) to guide decision makers towards a more sustainable development pathway. The policy consists of a vision, objectives, principles, policy statements and strategies.

Vision: *"To achieve a healthy and pleasant environment sustaining nature for the well-being of the people and the economy"*

Objective: *"Protection and conservation of the integrity of the nation's environment and natural resources through ecologically sustainable development, with due recognition of the contribution of natural resources to economic development and to the quality of life"*

Policy Principles: *Decisions that involve the use, have impact on, or affect the status of natural resources and the environment will apply the following principles:*

- *Environmental and Natural Resource Management will apply an ecosystems approach.*
- *Natural resources will be managed so that it will be ecologically as well as socially sustainable.*
- *Partnerships will be promoted among central, sectoral, provincial, local, NGO, civil society and private sector agencies to encompass the needs of ecological integrity with economic vitality and social development.*
- *Environmental management will be devolved in concordance with constitutional provisions.*
- *The precautionary principle will duly apply to situations where the consequences of decisions are uncertain.*
- *Adequate attention will be paid towards ensuring environmental justice in all situations.*
- *Safe-minimum-standards will apply to essential environmental life-support functions and services in line with the requirements of ecologically sustainable development.*
- *In order to maximize environmental performance, management systems will be continuously revised so that they adapt to changing circumstances and realities.*
- *The benefits arising from the wise use of Sri Lanka's natural resources and the costs of their management will be shared equitably so as to benefit all segments of society.*
- *Polluter-pays principle will be applied to the benefit of industries and society.*
- *The extent of substitution of man-made capital for natural capital will be defined and*

will not exceed critical limits.

7.3.2 Major Environmental Policies in Sri Lanka

National Environment Policy – 2003 The policy aims to promote the sound management of Sri Lanka's environment balancing the needs for social and economic development and environment integrity. It also aims to manage the environment by linking together the activities, interests and perspectives of stakeholders and to assure environmental accountability.
National Forestry Policy – 1995 The policy was drawn up to provide clear directions for safeguarding the remaining natural forests of the country in order to conserve biodiversity, soil and water resources.
The National Policy on Wildlife Conservation – 2000 The policy renews the commitment of the government to conserve wildlife resources through promoting conservation, maintaining ecological processes and life sustaining systems, managing genetic diversity and ensuring sustainable utilization and sharing of equitable benefits arising from biodiversity. It emphasizes the need for effective protected area management with the participation of local communities.
National Air Quality Management Policy – 2000 The policy aims to maintain good air quality to reduce morbidity due to air pollution and in turn reduce national health expenditures.
National Watershed Management Policy – 2004 The policy aims to conserve, protect, rehabilitate, sustainably use and manage the watersheds while managing their environment characteristics with the involvement of people.
Cleaner Production Policy – 2004 The objective of this policy is to incorporate the cleaner production concept and practices into all development sectors of the country.
National Biosafety Policy – 2005 The policy on biosafety set the overall framework in which adequate safety measures will be developed and put into force to minimize possible risks to human health and the environment while extracting maximum benefits from any potential that modern bio technology may offer.
National Air Quality Management Policy – 2000 The purpose of this policy is to maintain good air quality to reduce morbidity due to air pollution and in turn reduce national health expenditures.
National Policy on Wetlands – 2005 The policy seeks to give effect to National Environment Policy and other relevant national policies, while respecting national commitments towards relevant international conventions, protocols, treaties and agreements to which Sri Lanka is a party.
National Policy on Sand as a Resource for the Construction Industry – 2006 The policy statement reflects Sri Lanka's constitutional, international and national obligations, including the Mines and Minerals Act No. 33 of 1992, the National Environmental Act of 1980, the Coast Conservation Act of 1981 and other relevant legislation, regulations and policy statements. It defines the commitment of Government, in partnership with the people, to effectively manage the construction-sand resource for the benefit of present and future generations.
National Policy on Elephant Conservation – 2006 The policy was developed to ensure the long-term survival of the elephant in the wild in Sri Lanka through the

mitigation of the human-elephant confect.
National Policy on Solid Waste Management – 2007 The policy has been prepared to ensure integrated, economically feasible and environmentally sound solid waste management practices for the country at national, provincial and Local Authority level. The main objectives of the policy are (a) to ensure environmental accountability and social responsibility of all waste generators, waste managers and service providers (b) to actively involve individuals and all institutions in integrated and environmentally sound solid waste management practices (c) to maximize resource recovery with a view to minimize the amount of waste for disposal and (d) to minimize adverse environmental impacts due to waste disposal to ensure health and well being of the people and on ecosystems.

7.3.3 Overview of Legal System regarding Environment and Social Consideration

(1) National Environmental Act

The most important and vital governmental organization for environmental protection in Sri Lanka is the Central Environmental Authority (hereinafter referred to as CEA). The CEA was established as an implementing agency in 1981 under the National Environmental Act No. 47 of 1980. Subsequently, the Ministry of Environment was established in December 2001 and this has overall responsibility for the affairs of the CEA, with the objective of integrating environmental considerations in the development process of the country. The CEA was given wider regulatory powers under the National Environment (Amendment) Acts No:56 of 1988 and No:53 of 2000.

The National Environmental Act orders the establishment of a Council which consists of the members of senior officers from related organization as a consulting body.

The authorities given to the CEA with the consultation of the Council are as follows.

- Land use management
- Natural resource management and conservation
- Management policy for fisheries and aquatic resources
- Management policy for wildlife
- .Management policy for forestry
- Management policy on soil conservation

The National Environmental Act is the highest level environmental legal basis in Sri Lanka, and there are enacted regulations under the Act regarding environmental issues such as EIA, natural resource management, waste management, environment protection, environmental qualities.

1) Prescribed Project and EIA/IEE procedure

The prescribed projects which are requested to implement EIA/IEE are defined and listed in

the Gazette no 772/22 of 24th June, 1993 and 859/14 of 23rd February 1995. Only large-scale development projects that are likely to have significant impacts on the environment are listed as prescribed projects. There are two categories.

1. By type and the magnitude
   In case of Water Supply Project, the conditions are;
   - All ground water extraction projects of capacity exceeding 1/2 million cubic meters per day.
   - Construction of water treatment plans of capacity exceeding 1/2 million cubic meters

2. By location (e.g. if projects are located wholly of partially within environmentally sensitive areas such as forest and wildlife reserves, stream or lake reservation, archaeological reserve, declared erodible areas etc.

CEA prepared guidelines for implementing EIA named 'Guidance for Implementing the Environmental Impact Assessment (EIA) Process', and it was separated into two parts; No.1 for 'A General Guide for Project Approving Agencies (PAA)' and No.2 for 'A General Guide for Conducting Environmental Scoping'. A project proponent can follow the guideline to implement the project with the proper consideration of the environment.

'Guidance for Implementing the EIA Process No.2' defines the primary technical topics commonly addressed in an EIA as follows.

- Water Resources
- Pollution issues
- Soils and Land Use
- Forests
- Wildlife and Biological Diversity
- Socio-Cultural and Economic Conditions

The National Environmental Act (NEA) was amended by Act No. 56 of 1988 to include a provision relating to EIA Regulations contained in Part IV C of the statute entitled "Approval of Projects". This section was further amended by Act No. 53 of 2000. The Central Environmental Authority is the agency charged with the responsibility of implementing the above provisions of the NEA. Depending on the significance of the anticipated impacts, there are two levels in the EIA process. If the environmental impacts of the project are not very significant then the project proponent may be asked to do an Initial Environmental Examination (IEE), which is a relatively short and simple study. However, if the potential impacts appear to be more significant, the project proponent will be requested to do an EIA

which is a more detailed and comprehensive study of environmental impacts. EIA reports must be kept open for public comments for 30 working days. IEE reports have been exempted from this requirement.

The National Environmental Act stipulates that approval for all prescribed projects must be granted by a Project Approving Agency (PAA). At present, 23 Government Agencies have been designated as PAAs. A single Project Approving Agency is established as responsible for administrating the EIA process for a project. When there is more than one PAA is involved the appropriate PAA is decided by the CEA. It is important to note that a state agency which is a project proponent cannot function as a PAA for that project. Project Approving Agencies are listed in the Gazette Extra Ordinary No.859/14 of 23rd February 1995 and Gazette Extra Ordinary, No.1373/6 of 29th December 2004.

The best time for a project proponent to submit the preliminary information on the proposed project is as soon as the project concept is finalized and the location of the project is decided. When a prescribed project is referred to CEA through the Basic Information Questionnaire (BIQ) form, the CEA will designate a suitable PAA. Then the PAA will carry out scoping and Terms of Reference (TOR) for the EIA/IEE will be issued to the project proponent. On receipt of an EIA report, the PAA will appoint a Technical Evaluation Committee (TEC) to evaluate the EIA report and make its recommendations. The expected duration of the project approval is shown in **Table 7.14**.

Table 7.14 Summary of Procedure for Obtaining Environmental Clearance from CEA

Legislation	Regulatory Authority	Summary of the procedure	Time scale
National Environmental Act No.47 of 1980 and amended Act No. 56 of 1988; Government Gazette Notifications No. 772/22 of 24th June1993, No. 859/14 of 23rdFebruary 1995, No.1104/22 of 5th November 1999 and No.1108/1 of 29th November 1999	CEA	1. Submit Preliminary information to CEA (BIQ submission)	During feasibility stage
		2. Designate PAA by CEA	
		3. Scoping; Issue of Terms of Reference for EIA/IEE by PAA	36 Days
		4. Conduct the IEE/EIA study and submit the report to PAA	About 60 to 90 Days
		5. Check for adequacy by PAA	14 days
		6. Open for public comments (only for EIA)	30 Days
		7. Review by TEC appointed by to CEA	36 Days
		8. Issuance of approval by PAA / CEA	

Figure 7.18 shows the schematic diagram of EIA/IEE approval procedure.

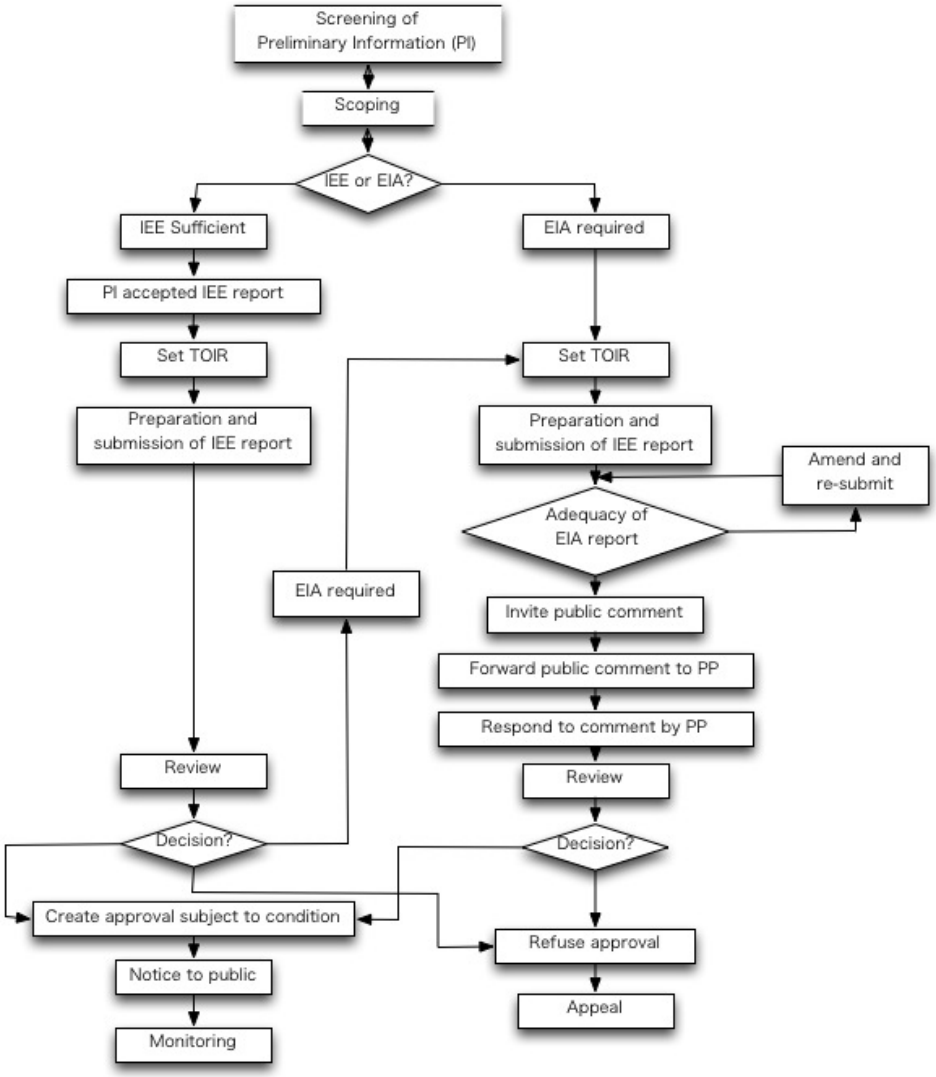


Figure 7.18 Environmental Impact Assessment Procedure

2) Environmental Recommendation

The any projects to establish industrial activities, which are not subject to EIA are advised to obtain environmental recommendation from the CEA for the proposed sites. The purpose of environmental recommendation is to minimize the environmental impact. The potential of the environmental impact of a proposed project is evaluated with respect to the zoning plans of relevant local Authorities surrounding land use, land availability for buffer zones, and the capacity of the area to receive additional pollution load and waste disposal requirements. The document contains the conditions, and the project should take mitigation measures to satisfy the conditions.

3) Environmental Protection License (EPL)

The potential polluting activities are requested to obtain Environmental Protection License

(EPL) under the section 23.A of NEA. The prescribed activities for which a license is required are listed in the Gazette Notification No 1533/16 dated 25.01.2008. Water treatment plants having a treatment capacity of 10,000 or more cubic meters per day is stated as the prescribed activity in part A. The license for a project is issued by Provincial Offices or District Offices of the CEA, and it has maximum one year validity. The project proponent has to renew the license.

(2) Fauna and Flora Act

EIA provisions are also included in the Fauna and Flora (Amended) Act No. 49 of 1993. According to this Act, prior written approval from the Director of Wildlife is necessary for any development activity of any description whatsoever proposed to be established within one mile (1.6km) from the boundary of any National Reserve. Under this enactment, it mandates that such projects should undergo the EIA process in terms of the National Environmental Act.

There are no National Reserves in the project area.

(3) Antiquity Act

An Archaeological Impact Assessment (AIA) should essentially be carried out in respect of a proposed development project to be carried out in every land the extent of which exceeds 0.25ha in accordance with Section 47 read with Section 43(b) of the Antiquities (Amendment) Act No. 24 of 1998 and published in the gazette No. 1152/14 dated 04.10.2000. The purpose of the AIA is to examine whether there are or are not antiquities in the land where the development project is proposed to be carried out, and if there are antiquities in the land, to find the impact of the proposed project on the antiquities and to report alternative measures to be taken. The prescribed projects which are requested to carry out AIA are defined in the above Act.

On receipt of the Employer’s completed application to the departments a copy of such application will be sent to the Regional Office of the Archaeological Department and a preliminary observation report on the place will be obtained. If there are no antiquities in the land according to the recommendation and observation report of the Regional Assistant Director, the said land will be released for the project concerned. If the preliminary observation report has proposed to carry out an AIA, steps will be taken to conduct the survey. The Archaeological Department will call for quotations from the agencies which have registered in the department for conducting the AIA surveys and a competent agency for conducting the AIA will be selected by the Apex Body headed by the Director General of Archaeology. The project developer shall bear the cost of conducting the AIA through the department and the agency shall submit the report within a time period maximum of six weeks. The Director General of Archaeology will make available his decision to the Project concerned after obtaining the recommendations from the Minister in charge of the subject. The summary of procedure for obtaining approval from

Archaeological Department is given in **Table 7.15**.

Table 7.15 Summary of Procedure for Obtaining Archaeological Department Approval

Legislation	Regulatory Authority	Summary of the procedure	Time scale
Under Section 47 read with Section 43(b) of Antiquities (Amendment) Act No. 24 of 1998; Gazette Notification No. 1152/14 dated 04.10.2000	Department of Archaeology Sri Lanka	1. Submit application to the Department	During feasibility stage
		2. Conduct a Preliminary Observation by Regional Office and submit the report to the Department	About 30 days
		3. (i) If there are no antiquities according to the recommendation and observation report, land will be released for the project.	
		(ii) If the preliminary observation report has proposed to carry out an archaeological impact assessment survey, steps will be taken to conduct the survey.	About 30 days
		4. Call for quotations for AIA from registered agencies by the Department and award the survey	
		5. Conduct the AIA survey by the selected agency and submit the report to the Department	42 days
		6. Submit AIA report to Minister in charge for approval	About 30 days
		7. Issuance of permit by the Department	

7.3.4 Applicability for the Project

The regulations specify activities for which environmental assessment is mandatory, and those that could occur by water supply projects are as follows:

- Groundwater extraction projects of capacity exceeding 500,000 cubic meters per day;
- Construction of water treatment plants of capacity exceeding 500,000 cubic meters per day;
- Involuntary resettlement exceeding 100 families
- Projects located in sensitive areas such as:
  1) Any erodible area declared under the Soil Conservation Act (1951, 1953)
  2) Any Flood Area declared under the Flood Protection Ordinance (1924, 1955) and any Flood Protection Area declared under the Sri Lanka Land Reclamation and Development Corporation Act (1968, 1982)
  3) Any reservation beyond the Full Supply Level of a reservoir
  4) Any archaeological reserve, ancient or protected monument as defined or declared under the Antiquities Ordinance (1965)

5) Any area declared under the Botanic Gardens Ordinance (1928, 1973)
6) Areas within, or less than 100m from the boundaries of any area declared under the National Heritage and Wilderness Act (1988): the Forest Ordinance
7) Areas within, or less than 100m from the boundaries of any area declared as a Sanctuary under the Fauna and Flora Protection Ordinance (1937)
8) Areas within, or less than 100m from the high flood level contour of a public lake as defined by the Crown Lands Ordinance (1947, 1949, 1956) including those declared under Section 71 of the Ordinance
9) Areas 60m or less from the bank of a public stream as defined in the Crown Lands Ordinance, with a width of more than 25m at any point.

The capacity of the water treatment plant of ANIWSP is planned. The agreed extraction capacity with Irrigation Department is shown in **Table 7.16**. The amount is well below the criteria of 500,000m^3/d, as stated above.

Table 7.16 Extraction Capacity Agreed with Irrigation Department

	Short term (until 2016)	Long term (until 2034)
Mahakanadarawa	6,800 m^3/d	18,800 m^3/d
Wahalkada	10,500 m^3/d	28,800 m^3/d

The number of families for resettlement is only one, which is well below the criteria of 100 families. In the pre-FS study, the water would be taken from the tank directory. The construction or establishing permanent structure conflicts with the conditions 3), 7) and 8) described above. The project changed the plan, and the water intake is decided to locate outside of the tank and place a certain distance from the tank to prevent any kind of impact to the surrounding environment of the water. The identification of the actual location of the protected area was difficult and confused because the protected area is under the control of many authorities. In order to clarify the problem, the NWSDB sent the letters to relevant authority and obtained the clearance. The clearances for each tank are listed in **Table 7.17**.

Table 7.17 Clearance for Tanks

Submitted to		→	Received from	
Item	Date		Obtaining Permission	Date
Request of approval for (old) Mahakanadarawa WTP	14/12/2011	CEA	Clearance for (old) Mahakanadarawa WTP (NCPO/AD/07/487/2012)	23/02/2012
Request of approval for Wahalkada WTP	13/01/2012	CEA	Clearance for Wahalkada WTP (NCPO/AD/07/499/2012)	23/02/2012
Request of Archeology Impact Assessment	22/09/2011	Dept. of Archeology	Clearance for Wahalkada WTP	04/10/2011
Request of approval for (New)	17/07/2012	CEA	Clearance for (New)	15/08/2012

Submitted to		→	Received from	
Item	Date		Obtaining Permission	Date
Mahakanadarawa WTP			Mahakanadarawa WTP (NCPO/AD/07/487/2012)	
Request of Archeology Impact Assessment	22/11/2011	Dept. of Archeology	Clearance for (New) Mahakanadarawa WTP and Intake (NCPO/AD/07/487/2012)	06/07/2012
Request for the Approval of proposed Anuradhapura North Integrated Water Supply Project	24/7/2012	Dept. of Wildlife conservation	Clearance for (New) Mahakanadarawaw WTP and intake (WL/06/028/460)	02/08/2012

On the other hand, the production capacity is more than 10,000 m^3/day so that the NWSDB has to obtain the EPL three months before starting operation

9.3.5 Requirements, Permissions and Standards

Requirements and permissions required for Project implementation are given below;

Table 7.18 Summary of Environmental Compliance Requirements for the Project Activities

	Project activity	Applicable Legislation	Statutory Requirement	Authorizing Body
1	Groundwater extraction projects of capacity exceeding 500,000 cubic meters per day	National Environment Act (NEA)	Environmental Clearance (EC)	Central Environment Authority (CEA)
2	Water treatment plant exceeding 500,000 cubic meters per day	NEA	EC	CEA
3	All activities in sensitive areas	NEA	EC	CEA
4	**All activities that require site clearance**	**Municipal Councils Ordinance No. 29 of 1947, the Urban Councils Ordinance No. 61 of 1939 and the Pradeshiya Sabha Act No. 15 of 1987 as amended**	**Clearance**	**Municipal Councils, Urban Councils and Pradeshiya Sabhas**
5	**All activities that require cutting of trees**	**Felling of Trees (Control) Act No 9 of 1951**	**Tree-cutting Permit**	**Forest Department**
6	All s activities within a 1 mile (1.6 km) radius of a national reserve	Section 14 of Fauna and Flora Protection (Amendment) Act, No. 22 of 2009	Clearance	Department of Wildlife Conservation
7	**All activities in close proximity of a reserve forest**	**Forests Ordinance No. 16 of 1907 as amended**	**Clearance**	**Forest Department**
8	All s activities in and around fishery	Fisheries and Aquatic	Clearance	Director of Fisheries

	Project activity	Applicable Legislation	Statutory Requirement	Authorizing Body
	reserves	Resources Act No. 2 of 1996		and Aquatic Resources
9	**All activities in proximity of archaeological reserves**	**Antiquities Ordinance No. 9 of 1940 as amended**	**Clearance**	**Department of Archaeology**
10	**All activities in and around irrigation development**	**Irrigation Development Act**	**Clearance**	**Director, Irrigation Department**
11	**All activities in and around declared urban development areas**	**Urban Development Authority Act No. 41 1978 and No. 4 of 1982**	**Clearance**	**Regional Director UDA**
12	**Water treatment plants having a treatment capacity of 10,000 or more cubic meters per day.**	**Gazette Notification No 1533/16 dated 25.01.2008**	**Environmental Protection License**	**CEA**

The hatched requirements are applicable to the ANIWSP.

The specific regulations and standards regarding environment and social consideration which will be applied to the Project are listed in **Table 7.19**.

Table 7.19 Summary of Basis of Regulations and Standards

Air Quality (discharge and ambient)	Discharge: No standard Ambient: The National Environmental (Ambient Air Quality) Regulations, 1994, published in Gazette Extraordinary, No. 850/4 of December, 1994 amended No. 1562/22 - Friday, August 15, 2008
Water Quality (discharge and ambient)	Discharge: National Environmental (Protection and Quality) Regulations, No. 1 of 2008 - Schedule I Ambient: Proposed standard
Drinking Water Quality	Sri Lanka Standards for potable water – SLS 614: 1983
Wastes (domestic and water treatment operation)	As specified in Environmental Protection License
Noise and Vibration	Noise: National Environmental (Noise Control) Regulations No.1 1996 Vibration: Proposed standards
Forest	Forest Ordinance No. 16 of 1907 (as amended) and the Rules and Regulations under the Ordinance
Wildlife	Fauna and Flora Protection Ordinance No. 2 of 1937 (as amended by Act Nos. 49 of 1993, 12 of 2005) and the Regulations under the Ordinance
Landscape	UDA Act No. 41 1978 and No. 4 of 1982
Heritage (Archeology)	Antiquities Ordinance No. 9 of 1940 as amended
Involuntary Resettlement	National Involuntary Resettlement Action Plan; Land Acquisition Act No.09 of 1950 (As Amended)
Protection of minority	The Constitution of Sri Lanka, 1978 as amended
Land expropriation and compensation	National Involuntary Resettlement Action Plan; Land Acquisition Act No.09 of 1950 (As Amended)
Safety of Labor	Factories Ordinance

7.4 Scoping Result and Research TOR

The scoping was done with the basis of the requirements of both Sri Lankan law and the JICA guidelines. The items cover all those in the check list attached in the JICA guideline in accordance with the condition stated in the CEA clearance, and also to follow the CEA guidance.

The CEA specifies the procedure on how to determine the significant impacts in the 'Guidance for Implementing the EIA Process'. It says that significant impacts should be determined based on considerations of both context and intensity, and the impacts should be evaluated in terms of following items.

1. Impacts that may be considered both beneficial and adverse.
2. The degree of effect on public health or safety
3. The degree of effect on unique characteristics of a geographic area; religious or cultural resources, archeological resources, nature reserves, wetlands, scenic areas, ecologically crucial areas, environmentally sensitive areas
4. The degree of impact on the environmental and social conditions, which is highly controversial
5. The degree of possible effect on the environment, highly uncertain or unique of unknown risks
6. The degree of effect for the future as a precedent.
7. The case of the total effect cannot be ignorable even they are insignificant individually.
8. The degree of effect for the right of future generation.

The scoping result is shown in **Table 7.20** and the research TOR is shown in **Table 9.21**.

Table 7.20 Scoping Result

	Item	Impact	Description
Pollution control (Construction stage)	Air	B (-)	Vehicles for construction generate exhaust gas and dust.
	Water quality	B (-)	There is possibility that turbid water will be generated by the construction work.
	Waste	B (-)	The construction work will generate surplus soil and waste.
	Noise and vibration	B (-)	Heavy equipment and trucks for construction will increase noise and vibration.
	Subsidence	D (0)	Groundwater level lowering work is not used.
Pollution control (operation stage)	Air	B (-)	There is possibility of spill from chlorine storage installation or chlorine dosing facility.
	Water quality	B (-)	Wastewater generated by the plant can contaminate the environment. Water quality of tank will not be changed because the facilities is located downstream, and amount of water use is not changed significantly.

	Item	Impact	Description
	Waste	B (-)	Sludge by the treatment process could contaminate the environment.
	Noise and vibration	B (-)	The operation of facility generates noise and vibration.
	Subsidence	D (0)	There is no possibility the plant will cause the subsidence because of no use of groundwater.
	Protected area	B (-)	The project site is not inside the protected area, but in the vicinity.
	Ecosystem (construction stage)	B (-)	Trees inside and around the site will be cut and it decreases the habitat of living things. Heavy equipment and vehicles generates noise and vibration, and this could worsen the living environment of living things.
	Ecosystem (Operation stage)	B (-)	There is no groundwater extraction and the water use amount is not changed much, so groundwater recharge is not affected significantly. The permanent discharge from the tank is only irrigation canal so the natural condition of river is not considerable. On the other hand, if the water will be taken from the canal for drinking water treatment, it results to secure the base flow discharge.
Social environment	Resettlement	B (-)	A few families are required to move.
	Living and livelihood	B (-)	Acquisition of cultivation land is suspected。(Decision of site is required) In case, the farmers benefit will be decreased. It is a project to convert the use of water from irrigation to drinking. The users of irrigation water (farmer) will decrease the benefit. Water tariff will increase when CBO receive water from NWSDB.
	Heritage	C	Department of archeology issued the letter of clearance. Newly added sites require additional Clearance.
	Landscape	D (0)	The project will not develop any large-scale structure which can change the local landscape.
	Ethnic group	D (0)	In the Project site, there are no indigenous people. The main ethnic group is Sinhalese.
	Labor environment	C	Labor environment will be secured under the relevant regulations.
Others	Effect by construction	B (-)	Estimation of migration of labor power is necessary. Traffic jam will be avoided.
	Monitoring	B (-)	Monitoring plan should be established.

＊Evaluation A（- - -or - -）: medium scale or large scale effect is expected

B(-)：effect is low

C：effect is unclear

D(0): no effect or improving direction

Table 7.21 Research TOR

Items	Survey items	Method
EIA and	(1) Monitoring of progress of obtaining	(1) Collection of information of required

Items	Survey items	Method
Environmental Permits	permissions	permissions. Hearing, Holding stakeholder meeting and obtain the written document.
Explanation to the Local Stakeholders	(1) Plan of awareness program (2) Activities of Regional project coordination committee	(1) It must be included in MOU (2) Meeting minute of regional project committee
Examination of Alternatives	(1) Water sources (2) Location of WTP and other facilities (3) Construction method	(1) Study mitigation measures to minimize adverse effect to environment and existing beneficiary (2)Minimizing land acquisition and resettlement, maximize the benefit (3) Study of construction method and route to minimize the adverse effect on environment and traffic.
Air	(1) Environmental standards(Sri Lanka, Japan, WHO, etc) (2) Current condition of Air pollution (3) Location of premise, school, hospital near the Project site (4)Effect of construction	(1) Literature survey (2) Literature survey (3) Field survey and hearing (4) Study of construction type, procedure, period, location, using equipment, transportation road
Water quality	(1) Water quality of water source (2) Current condition of water use (3) Suitability for drinking purpose	(1) Literature survey, hearing (2) Field survey and hearing (3) Field survey and pilot treatment
Waste	(1) Management of construction waste (2) Management of sludge	(1) Hearing of relevant organization, Case research (2) Hearing of relevant organization, Case research
Noise and vibration	(1) Environmental standards(Sri Lanka, Japan, WHO, etc) (2) Distance from source to the premises, school, hospital. (3) Effect of construction	(1) Literature survey (2) Literature survey, hearing (3) Study of construction type, procedure, period, location, using equipment, transportation road, simulation
Protected area	(1) Find the boundary of protected area (2) Confirmation of the positional relation between project site and protected area	(1) Hearing from relevant authority, obtaining written document such as meeting minute. (2) Hearing from relevant authority, monitoring the progress of obtaining permission
Ecosystem	(1) Inhabitation of endangered species (2) Study of the Project site	(1) Literature survey, hearing, site survey (2) Site survey
Land acquisition, resettlement	Magnitude of land acquisition, and resettlement In case of the land acquisition and resettlement is required, relocation plan is prepared.	Literature survey, hearing, site survey Making a relocation plan on the basis of Sri Lankan Act JICA guideline, Operational Policy 4.12 of WB.

Items	Survey items	Method
Living and Livelihood	(1) Sentiment of resident for changing water system (2) Change of livelihood, in case of land acquisition (3) Sentiment of resident for the possibility to increase the water tariff.	(1) (3) Socioeconomic survey (2) Hearing to the villagers
Heritage	(1) Possibility of important heritage existence in the Project area (2) Procedure for the case of excavated remains during construction	(1) Hearing with archeology department (2) Literature survey and hearing
Ethnic group, indigenous group	Condition of ethnic group, indigenous group in the Project site.	Hearing to the relevant authority and site survey
Labor environment	Sri Lankan regulation regarding labor environment and safety Safety measures for labors	Literature survey, hearing, case survey Planning of countermeasures and training regarding labor safety
Social infrastructure, service	Road condition of the Project site and vicinity	Projection of the traffic jam during construction
Monitoring	Adequacy of monitoring plan	Evaluation of monitoring plan

7.5 Result of Study

7.5.1 Examination of Alternatives

(1) Location of water intake and treatment plant

Originally, the location of the treatment plant was planned to be very near to a protected area and water would be taken from the tank directly. It means that the intake point will be within an environmentally sensitive area, so the original location was supposed to have an adverse effect on the natural environment. The intake point and location of the treatment plant were shifted in accordance with the suggestion of the Irrigation Department, and these facilities are now located outside of the protected area. An adverse effect on the environment is considered ignorable for the issues regarding location. However, still there is possibility to generate an adverse effect on the environment especially in construction period.

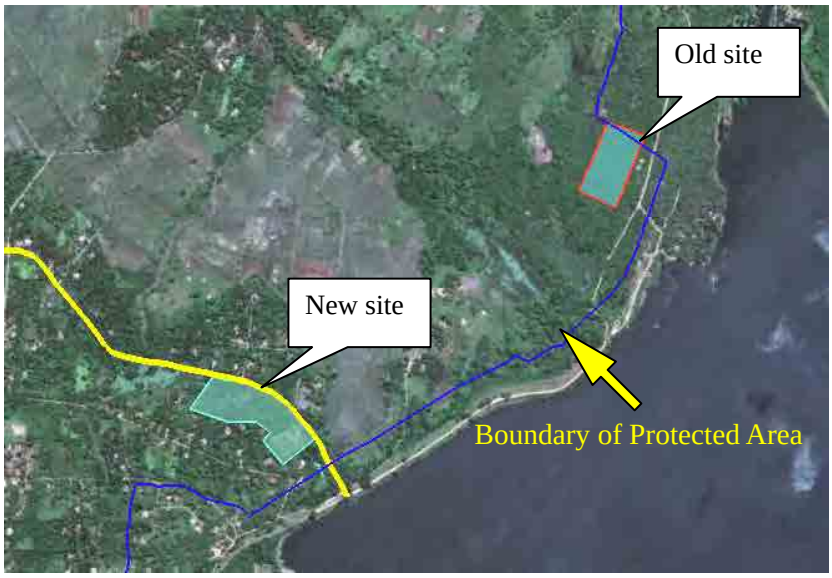


Figure 7.19 Mahakanadarawa Site Examination

In case of planned water treatment plan site of Wahalkada, three or four illegal occupants were recognized in the site. The Project decided to shift the site to prevent the any involuntary resettlement of irrespective titles.

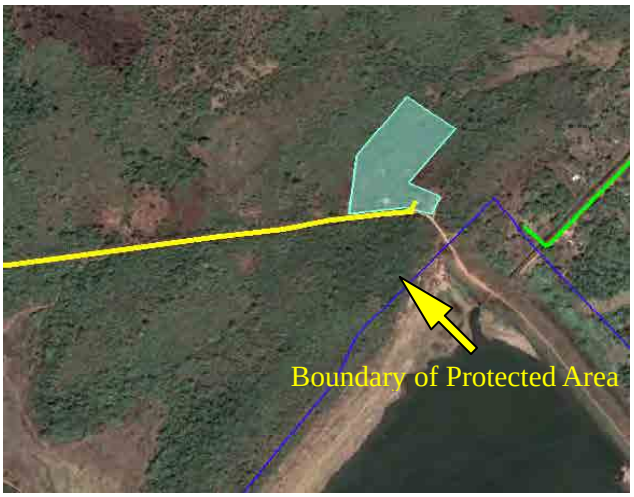


Figure 7.20 Wahalkada Site Examination

(2) Method of water intake

The methods of water intake are compared in **Chapter 5**. The study team examined and compared the method and tried to find the most environmentally friendly way. The comparison among four types of method is shown in **Table 7.22**.

Table 7.22 Comparison of Intake Method

	Method	Technical description	Evaluation of Impact
1	Intake well	This method is commonly used in lakes and reservoirs. Selection of intake depth is possible. Foundation should be stable.	The establishment of permanent construction inside the environmentally sensitive area results in serious effect.
2	Pontoon	This method uses floating body and the pump and electrical panels are installed on it. It needs wire anchors. The location of the intake can be moved. This method is not suitable if the water level varies significantly. Installation is not difficult and the cost is economical.	This method can reduce the adverse effect to compare to the method 1. But there is possibility that the floating movable body disturbs the habitat.
3	Inclined rail	A rail is installed on the incline of the bank, and the pump position is moved to suit the water level. Installation is not difficult and the cost is economical.	The adverse effect is lesser than method 1. But still it needs the construction work on the bund.
4	Canal Intake	Water is taken from the existing irrigation canal, which is operated by the Irrigation Department. The existing irrigation intake well takes water from the basement sill; therefore water quality has the characteristics of lake bottom water.	The intake does not affect directory the reservoir. The environmental impact is ignorable. The result of water quality monitoring reveals that the water quality does not differ significantly in depth.

Technically, the intake well method was considered the best procedure, but the environmental adverse effect seemed significant. On the other hand, the Irrigation Department raised the question to the construction work on the bund which was established many centuries ago. And Irrigation Department has a water right of full use of tank water and thought the difficulty of controlling extracted water quantity if the water was directly extracted from the tank. Alternatively, the idea of canal intake was examined. It seemed the best way from the viewpoint of protection of the environment surrounding the tank and irrigation reserve. The Project selected the canal intake procedure finally.

(3) Treatment procedure

The study team compared the water treatment procedure between the rapid sand filter method and slow sand filter method. The technical discussion is written in **Chapter 5**.

Here the result of comparison from the viewpoint of environmental and social considerations is tabled.

Table 7.23 Comparison of Treatment Procedure

	Item	Rapid sand filter (RSF)	Slow sand filter (SSF)	Evaluation
1	Area	Smaller area	Larger area	The area of land clearing is lesser in RSF and magnitude of the environmental impact will be smaller
2	Chemicals	Coagulant, pH adjuster, etc.	Not required	The use of chemical increase cost and waste.
3	Production of	Sludge amount is larger and	Sludge amount is almost	Smaller amount of sludge

	Item	Rapid sand filter (RSF)	Slow sand filter (SSF)	Evaluation
	sludge	sludge treatment procedure requires more energy	half of RSF	production save the energy and space for dumping
4	Quality of treated water	RSF is effective for removal of turbid. And it can reduce the color.	Result of experiment clealy shows that SSF cannot remove turbidity and color sufficiently.	The treated water by SSF is not suitable for drinking and domestic purpose of use due to high turbidity and color.

Slow sand filter method was considered environmental friendly and the Project was going to apply this procedure. But the result of practical experiment showed that SSF was not suitable for the raw water of this Project. Most essential requirement for the water supply is to secure the safe water supply. If the treated water contains unacceptable turbidity, it suggests the other materials are remaining in water. Due to the difficulty of treatment, the RSF procedure was selected with the consideration of principle of water supply and human's need,

(4) Configuration of facilities and buildings

Configuration of faculties and buildings are considered for reducing the potential impact to the surroundings. The noise and vibration generating facilities are located in the middle in the site as much as possible..

7.6 Evaluation of Impact

7.6.1 Air Quality

The expected causes of air pollution are exhaust gas by vehicles and heavy machineries and chlorine gas of leakage from chlorine gas storage place and chlorine injection facility.

(1) Exhaust gas

The regulation of exhaust gas was established under NEA as National Environmental (Air Emission, Fuel and Vehicle Importation Standards) Regulation in Gazette1137/35 23rd June 2000 in Sri Lanka.

Table 7.24 Discharge Standards for Petrol Vehicles

Type of Vehicle	Pollution Standard		Remarks
	Carbon Monoxide (CO (%vol)	Hydrocarbon HC (ppm v/v)	
Petrol wo/cc	a. > 5 years 3.0 < 5 years	1200	Low idling
Petrol w/cc	2	400	Low idling

Where:
wo/cc - Without catalytic converter
w/cc - with catalytic converter
. >5 years - vehicles more that 5 years old from the year of manufacture (used / unused)
< 5 years - vehicles less than 5 years old from the year of manufacture

Table 7.25 Discharge Standards for Diesel Vehicles

Type of Vehicle	Smoke Capacity% (k factor m-1)	
	Idle	Load
Diesel – Tare less than 1728 Kg Including three wheelers	65 (2.44)	75 (3.22)
Diesel – Tare more than 1728 kg	65 (2.44)	75 (3.22)

Table 7.26 Ambient Air Quality Standards

	Pollutant	Averaging Time*	Maximum Permissible Level		
			μgm^{-3}	ppm	
1	Particulate Matter - Aerodynamic diameter is less than 10 µm in size (PM_{10})	Annual	50	—	Hi-volume sampling and Gravimtric or Beta Attenuation Hi-volume sampling and Gravimtric or Beta Attenuation
		24 hrs.	100	—	
2	Particulate Matter - Aerodynamic diameter is less than 2.5 µm in size ($PM_{2.5}$)	Annual	25	—	
		24 hrs.	50	—	
3	Nitrogen Dioxide (NO_2)	24 hrs.	100	0.05	Colorimetric using saltzman Method or equivalent Gas phase chemiluminescence
		8 hrs.	150	0.08	
		1hr.	250	0.13	
4	Sulphur Dixoxide (SO_2)	24 hrs.	80	0.03	Pararosaniliene Method or equivalent Pulse Flourescent
		8 hrs.	120	0.05	
		1hrs.	200	0.08	
5	Ozone (O_3)	1 hr.	200	0.1	Chemiluminescence Method or equivalent Ultraviolet photometric
6	Carbon Monoxide (CO)	8 hrs.	10,000	9	Non-Dispersive Infrared Spectroscopy”
		1 hr	30,000	26	
		Anytime	58,000	50	

The proper use of vehicle and machinery with sufficient maintenance achieves that the exhaust gas will meet the standards. The management of vehicle and machinery is obligation of the contractor and it is mentioned in the contract document.

(2) Chlorine

The Project uses chlorine for disinfection purpose and its source is chlorine gas. Chlorine gas has distinct and irritating odor and is hazardous for health. It is harmful if inhaled, and it causes respiratory tract burns, skin burns, and eye burns. It is physical hazards that containers may rupture or explode if exposed to heat. The gas dissolves quickly to water and generate hydrochloric acid which is harmful and corrosive and reacts with metals violently. For these reasons, the spill and leakage have to be prevented under severe controlling in order to secure workers’ health and protect the surrounding environment. The chlorine gas is heavier than air, its specific gravity is 2.5, and accordingly the evaporated gas runs down and stays. The gas is

liquidized and kept in the cylinder. For the operation, gas is vaporized and introduced to the chlorinator, and dissolved into water to make chlorine water for disinfection. Consequently, the potential spill or leakage zone is from the chlorine storage house to chlorinator. Additionally, the minor potential is at the injection point of chlorine.

According to the design of the WTP facility, an automatic neutralization facility is attached to the storage room for the countermeasure to spill or leakage. The spilled or leaked chlorine gas will be collected and introduced to the scrubber and absorbed in liquid. It will be treated by neutralization facility safely. The gas leak detectors are placed at appropriate positions. Once the concentration of chlorine gas reaches certain level, the neutralization system will start working automatically. This system is able to lower the potential hazardous risk of chlorine gas exceedingly.

There are no specific regulatory criteria for the chlorine gas concentration in terms of occupational safety or environmental protection in Sri Lanka. But the standards provided by United States Department of Labor standards are usually referred. **Table 7.27** summarizes the referable values of chlorine concentration.

Table 7.27 Occupational Safety and Health Guideline for Chlorine

	ppm	mg/m3	Source
Permissible exposure limit	1	3	United States Department of Labor
Advisable limit	0.5	1.5	National Institute of Occupational Safety & Health
Evaluation standard	0.5	1.5	Notification No. 53 Department of Labor（Japan）

This level is achieved by the gas leak detector setting.

7.6.2 Water Quality

(1) Water Quality of Raw Water

Mahakanadarawa tank is located southern part of the Project area and population density is relative higher than northern part. Small villages exist in the vicinity and there are economic activities in catchment area. On the other hand, Wahalkada tank is located in sparse population area. The land of catchment is mainly covered by forest and paddy field, and the less potential of contamination. The monitoring of water quality of the water resources has been done since September 2010. The safety of the raw water was ensured by the research and it is described in Chapter 4.3.2. Some parameters exceeded the Sri Lankan drinking water standards, but these parameters are easy to remove from the water by the usual water treatment process, and any harmful chemicals were not detected in the research period. The monitored parameters and its detection conditions are summarized in **Table 7.28**

Table 7.28 Summary of Water Quality Monitoring

Detection condition	Parameters
Always less than desirable level	Electrical Conductivity, Chloride, Alkalinity, Nitrate, Fluoride, Phosphate, Total residue, Hardness, Sulphate, Anionic detergent, Phenolic compounds, Oil and grease, Ca, Mg, Zn, Chlorophyl a, Arsenic, Cadmium, Cyanide, Lead, Mercury, Selenium, Total Chromium, Pesticides
Sometime exceed desirable level but never exceed permissible level	Color, Chloride, Fluoride, Iron, Cupper, Manganese, Total Plate Count,
Exceed permissible level	Odor, Turbidity, Taste, pH, Ammonia, Albuminoidal ammonia, Nitrite, COD, Aluminum, E. Coli, Total coliform

The treatment plant and intake are located downstream of the tank and elevation of the facilities is lower than the bottom of tank, so there is no chance that any kinds of discharge water pollute the tank water.

(2) Impact of the Project

Two major impacts of the Project are considered significance.

- Change of water environment caused by the new water use.
- Load of discharge from the Project activities

1) Impact of new water use

Currently, the main water use of the tanks is irrigation purpose except a little amount of domestic use of villagers living in vicinity. The capacity of water resources is examined in Chapter 4.3.4, and the conclusion is that the additional water use for the Project does not affect the total impoundment quantity significantly. However, the farmers feel the scarcity of water for irrigation, and in fact, the quantity of irrigation water directory affects the amount of product. Besides, the other projects of irrigation scheme development are ongoing parallel, e.g. NCP canal project and Yan Oja project, and these projects will improve the water supply condition for the cultivation remarkably in this area. Assumingly, the Project will start operation in 2018, and the other projects will have started water supply for the area before 2018. The time schedule is shown in **Table 7.29** .The impact is not significant.

Table 7.29 Time Schedule of Relevant Project

		2012	2013	2014	2015	2016	2017	2018	2019
ANIWSP	DD								
	Construction								
NCP	DD								
	Construction								
Yan Oya	EIA								
	Construction								

2) Impact of discharge water from the Project activities

The standard of discharge water applicable to the Project is shown in **Table 7.30**.

Table 7.30 Tolerable Limit of Discharge to Inland Surface Water

No.	Parameter	Unit type of limit	Tolerance Limit values
1	Total suspended solids	mg/1, max.	50
2	Particle size of the total suspended solids	µm, less than	50
3	pH at ambient temperature	-	6.0 - 8.5
4	Biochemical oxygen demand (BOD_5 5 days at 20℃ or BOD3 $_3$ days at 27℃)	mg/1, max.	30
5	Temperature of discharge	℃, max.	Shall no exceed 400℃ in any section of the stream within 15 m down stream from the effluent outlet.
6	Oils and greases	mg/1, max.	10
7	Phenolic compounds (as C_6H_5OH)	mg/2, max.	1
8	Chemical oxygen demand (COD)	mg/3, max.	250
9	Colour	Wavelength Range 436 nm (Yellow range) 525nm (Red range) 620nm (Blue range)	Maximum spectral absorption coefficient $7m^{-1}$ $5m^{-1}$ $3m^{-1}$
10	Dissolved phosphates (as P)	mg/1, max.	5
11	Total Kjeldahl nitrogen (as N)	mg/1, max.	150
12	Ammoniacal nitrogen (as N)	mg/1, max.	50
13	Cyanide (as CN)	mg/1, max.	0.2
14	Total residual chlorine	mg/1, max.	1
15	Flourides (as F)	mg/1, max.	2
16	Sulphide (as S)	mg/1, max.	2
17	Arsenic (as As)	mg/1, max.	0.2
18	Cadmium (as Cd)	mg/1, max.	0.1
19	Chromium, total (as Cr)	mg/1, max.	0.5
20	Chromium, Hexavalent (as Cr6+)	mg/1, max.	0.1
21	Copper (as Cu)	mg/1, max.	3
22	Iron (as Fe)	mg/1, max.	3
23	Lead (as Pb)	mg/1, max.	0.1
24	Mercury (as Hg)	mg/1, max.	0.0005
25	Nickel (as Ni)	mg/1, max.	3
26	Selenium (as Se)	mg/1, max.	0.05
27	Zinc (as Zn)	mg/1, max.	2
28	Pesticides	mg/1, max.	0.005
29	Detergents/surfactants	mg/1, max.	5
30	Faecal Coliform	MPN/100 ml, max	40
31	Radio Active Material :		
	(a) Alpha emitters	micro curie/ml, max micro	10^{-8}
	(b) beta emitters	curie/ml, max	10^{-7}

<Construction Stage>

The main source of discharge from the construction site is rainwater. The rainwater is collected

separately and let flow into drainage ditch, because the water quality of rain is safe as it is. There is no use of hazardous chemicals during the construction, and only few chance of contamination. Some construction works such as earth excavation, soil transfer, etc can generate turbid water. The turbid water is introduced into the sedimentation basin and turbid material will be settled down. The supernatant fluid will be discharged. If necessary, the coagulant will be used for enhancing the removal of turbid. The discharge water from the site is managed to meet the discharge water standards of Sri Lanka.

The contractor will prepare and manage potable toilets for laborers during construction.

<Operational Stage>
The discharge in operation was divided into two categories, (1) domestic wastewater and (2) water from drying bed.

The domestic wastewater of employees is treated by a septic tank and supernatant is discharged into a soak pit for infiltration into the ground.

The water treatment process is carefully considered to reduce the quantity of discharge by recycling, e.g. backwash water from the filter is transferred to the receiving well for recycling. The largest amount of discharge generated by usual operation is separated water from sludge. The sludge from sedimentation tank is transferred to a thickener tank and the thickened sludge is introduced to a drying bed. The separated water at the thickener is transferred to Backwash waste tank for recycling. The water in sludge will be evaporated in the drying bed, and under drain is discharged after discharge water quality will meet the requirement.

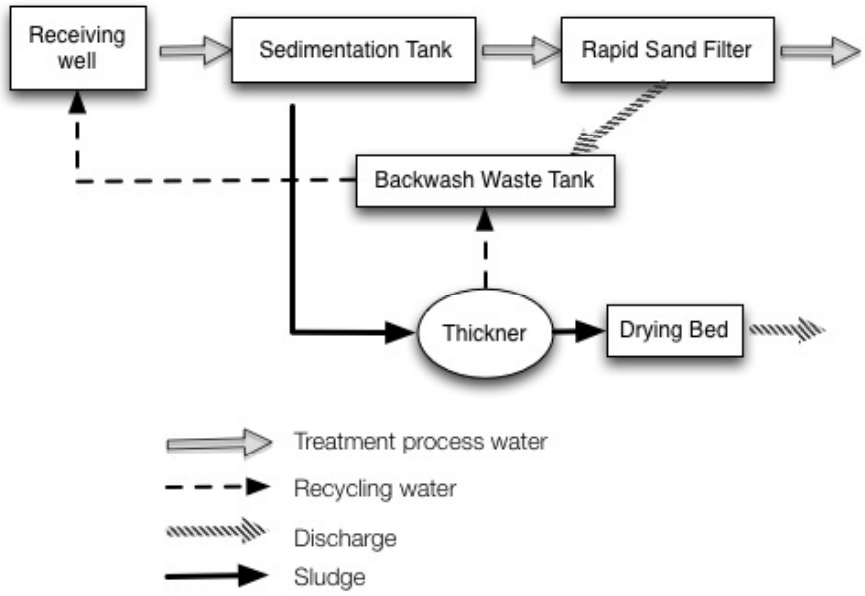


Figure 7.21 Schematic Diagram of Flow of Water and Sludge

7.6.3 Waste

1) Construction waste (Construction Stage only)

Construction waste is defined as waste from construction work, such as, cut tree, excavated soil, removed rock, packing material, and any other material related to construction. These are generated only the time of construction. The construction waste soil or rock material are treated properly by the contractor with the consultation of local authority. The contractor will place recycle bins in the yard for refuse segregation. The can, glass, plastic, cardboard, etc will be stored separately and will be transferred to recycling traders.

There has been started the establishment of recycling system in Sri Lanka in some limited area. The recycling practice is also being done by Anuradhapura municipality. The municipality sends the recyclable waste to a plant in Kurunegala after segregation of collected solid waste. The plant is located about 110km far from Anuradhapura. The Project is able to use the plant for recycling, and some particular material such as cans and empty bottles are collected by local company. The Project utilizes such system fully and reduces any type of solid waste. For this reason the segregation of solid waste is necessary at the consumption site.

2) Domestic waste (Construction and operation stage)

Domestic waste usually consists of garbage and rubbish. The domestic waste is collected to the certain temporally waste-collection point. And it will be transferred to the officially operated disposal field. The decomposable waste is treated by the compost. The solid waste disposal is operated properly with the guidance of the Pradeshiya Sabha.

3) Sludge (Operation stage only)

Sludge processing flow is shown **Figure 7.21**. The Sludge is generated by coagulation process and settled down at the sedimentation tank. The sedimentation is transferred to Thickener, and part of solid is condensed. Condensate is transferred to the drying bed and dried up under open air. The previous practice of NWSDB for sludge management was that the NWSDB went for tender of the disposal of dried sludge, which includes the services of collection, transport, carrying into the dumping site, with the approval letter of the landowner. In case of the Thuruwila WTP in Anuradhapura, the farmer organization is working for this business.

7.6.4 Noise and Vibration

<Construction stage>

Main expected sources of noise and vibration are vehicles and heavy machinery used for

construction work. The permissible noise level for construction work is set by Gazette 924/12 21th May 1996. It is said that noise levels caused by such activity shall not be carried on for a period which in the aggregate exceeds three months, without the written consent of the Authority given in respect of any such particular activity.

Table 7.31 Maximum Permissible Noise Levels at Boundaries of the Land in which the Source of Noise Is Located in Laeq' ,T, for Construction Activities

	Duration	Laeq', T
Day time	6:00 ~ 18:00	75
Night time	18:00 ~ 6:00	50

The noise level generated by construction activities is 90 to 110dB usually. Assumingly the one noise source generates 100dB, the noise at the 7m far is fall in 75dB in open-air condition. Generally, the construction work can be controlled if the certain distance is kept to the boundary. If it is difficult, the use of tools for decreasing noise and vibration is recommended, such as sound insulation wall, sound proof cover, etc. The noise generating construction work is not done in night time. The noise generated construction stage is considered manageable.

<Operation stage>
The requirement of noise level is shown in **Table 7.72**. The Project area is categorized in Rural Residential Area.

Table 9.72 Maximum Permissible Noise Levels at Boundaries in LAeq, T, for Industrial Activities

Aria	Day time	Night time
Rural Residential Area	55	45
Urban Residential Area	60	50
Noise Sensitive Area	50	45
Mixed Residential	63	55
Commercial Areas	65	55
Industrial Area	70	60
Japanese Environmental Standard		
A (residential area)	55	45

Main sources of noise and vibration are pumps and generator.
The following table shows the configuration of noise creating machinery.

Table 7.33 Noise Generating Facilities and Estimated Noise

Pumps

DSD	Name	Noise level/ number of pumps	Number of pumps	Maximum number of operation	Distance from pump to the boundary	Expected maximum noise at boundary
Mahhakanadawara	WTP	80	3	2	32	45
	Intake	75	4	3	12	50
Rambewa	I-1 PS Rambewa	76~83	6	4	>15m	55
Medawachchiya	I-2 PS Medawachchiya	80~81	6	4	>15m	55
Wahalkada	WTP	73~81	3	2	63	40
	Intake	78	4	3	10	53
Kebithigollewa	II-1 PS Kahatagollewa	73~82	9	6	10	56
Kebithigollewa	II-2 Kebithigollewa	80~82	3	2	>15m	55
Horowpothana	II-3 Weerasole	83	3	2	>15m	53
Horowpothana	II-4 Horowpothana	72~84	9	6	10m	58
Kahatagasdigiliya	II-5 Kahatagasdigiliya	79	3	2	10m	52

Generators

DSD	Name	Noise level (Ultra low noise type)	Distance from pump to the boundary	Expected maximum noise at boundary
Mahhakanadawara	WTP	75	25	47
Wahalkada	WTP	75	73	38
	Intake	75	2	69

The expected maximum noise at boundary is calculated by simple noise damping model by use of point source case at the condition of maximum use of pumps. In almost all cases, the daytime noise level requirement is satisfied. But, the nighttime requirement is difficult to achieve if nothing is done. These pumps are set in the building and the wall can work as noise insulation in a certain dB level. The design of the building is considered from the viewpoint of the noise reduction.

Following measures are effective to reduce the noise level

- Use an appropriate foundation to reduce the vibration
- Use the sound decreasing tools or materials such as sound deadener, proof material, and sound insulating wall.
- The alignment is examined carefully to minimize the noise and vibration

By taking the noise protection measures, the noise and vibration level can meet the requirement.

7.6.5 Protected Area

The protected area near the Project site is explained in the **Section 7.2.3 (5)**. The Mahakanadarawa treatment plant was planned to extract water from Mahakanadarawa tank which was designated as the Sanctuary. However, the water intake location was changed to the irrigation canal and the location is now outside of the Sanctuary that was confirmed by the Department of Wildlife conservation. In addition, the location of the water treatment plant and intake point are shifted to hold the distance from the boundary of the Sanctuary more than 100m with the consideration of the concept of the buffer zone by the CEA for the environmental protection. Consequently, the environmental impact is highly decreased.

The all proposed sites are located outside of the protected area. But especially in construction stage, certain plan of transportation should be made to reduce the any negative effect on environment.

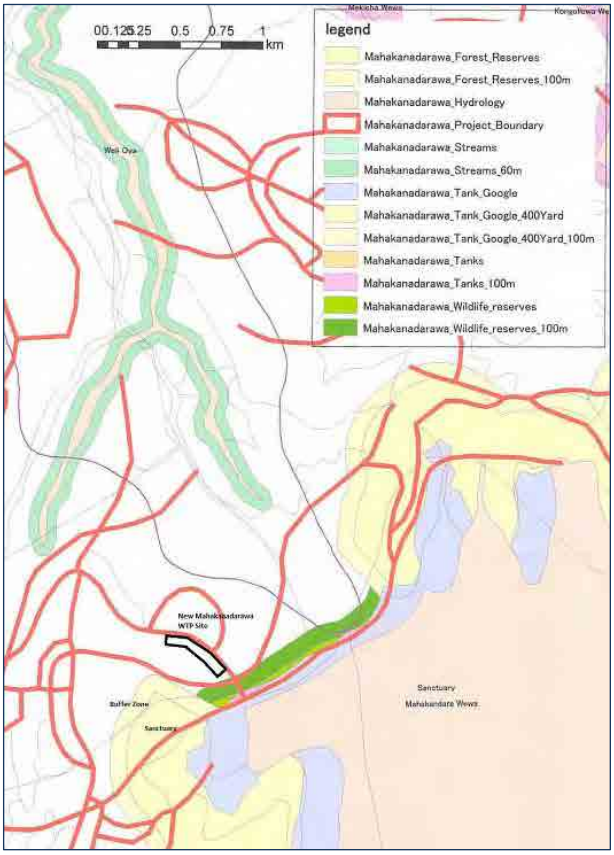


Figure 7.22 Environmental Protected Area in Mahakanadarawa

7.6.6 Eco System

The Fauna and Flora survey was carried out at the proposed project site.

1) Methodology of survey

The survey was limited to sites that are identified for various project activities (the direct impact zone). The principal habitat types found within the direct impact zone was investigated and the fauna and flora present was listed. Interviews were held with officials and communities in the area of influence to discuss safety issues, technical aspects, proposed remedial measures, and to identify environmental impact of proposed interventions.

Study Period: Phase I of this study was conducted during August 2012 while phase II was conducted in October immediately after the onset of North-east monsoon rains.

Sample Locations: During phase I, all sites identified for project activities in the

Mahakanadarawa scheme and some of the sites selected in the Wahalkada scheme were investigated. During Phase II, sites that were omitted during the Phase I and some of the environmentally sensitive sites identified during phase I was investigated. The list of sites investigated during the two phases are listed in the **Table 7.34**.

Table 7.34 The list of sites investigated during the two phases of the biodiversity survey

Name of project Location	Code	Phase 1	Phase 2
Mahakanadarawa Scheme			
Mahakanadarawa Tank and Surrounding Vegetation	(MT & SV)	✓	✓
Mahakanadarawa Water Treatment Plant Location	(M1)	✓	✓
Rambewa Sump & Water Tank Location	(M2)	✓	
Medawachchiya Sump Location	(M3)	✓	✓
Isenbessagala Water Tank Location	(M4)	✓	
Ethakada Water Tank Location	(M5)	✓	✓
East Rambewa Water Tank Location	(M6)	✓	✓
Wahalkada Scheme			
Wahalkada Tank and Surrounding Vegetation	(WT & SV)		✓
Wahalkada Water Treatment Plant Location (WTP)	(W1)		✓
Conveyor Pipeline to Wahalkada WTP	(CP)		✓
Kahatagollewa Water Tank Location	(W2)		✓
Bogahewa Sump Location	(W5)		✓
Weerasole Water Tank Location	(W6)		✓
Horowpothana Sump & Existing Tank Location	(W7)	✓	
Rathmalgahawewa Water Tank Location	(W9)	✓	✓
Kahatagasdigiliya Water Tank Location	(W10)	✓	
Kebithigollewa Existing Tank Location	(W11)	✓	
Kahatagollewa- Kebithigollewa Water Tank Location	(W12)		✓
North Horowpothana Water Tank Location	(W13)		✓
West Horowpothana Alt. 1 Location	(W14)	✓	✓
West Horowpothana Alt. 2 Location	(W15)	✓	
Halmillewa Water Tank Location	(W16)	✓	✓

2) Result of survey

(a) Habitats of the project area

The major natural habitats found in the project area are degraded dry-mixed evergreen forest (secondary forest), rock outcrops in the hills and riverine forests on the banks of streams. The types of habitats observed in each site are listed in the **Table 7.35**.

Table 7.35 Types of Habitat

Code	Name of the sample location	Main Habitat/ Vegetation Types
M1	Mahakanadarawa Water Treatment Plant	Water logged area and associated vegetation, Home garden, Secondary forests, Scrublands, Open area vegetation (Abandoned Land)
M2	Rambewa Sump & Water Tank	Home garden
M3	Medawachchiya Sump	Secondary forest
M4	Isenbessagala Water Tank	Abandoned land
M5	Ethakada Water Tank	Abandoned land, Secondary forest

Code	Name of the sample location	Main Habitat/ Vegetation Types
M6	East Rambewa Water Tank	Secondary forest
MT & SV	Mahakanadarawa Tank and Surrounding Vegetation	Exposed tank bed, Riparian vegetation, Surrounding rock outcrops and associated vegetation, Surrounding scrubland and forest vegetation
W1	Wahalkada Water Treatment Plant Location	Chena land, Secondary forests, Seasonal stream and associated vegetation, Abandoned land, Home gardens, Seasonal paddy lands
CP	Conveyor Pipeline to Wahalkada WTP	Seasonal paddy lands, Forest plantation
W2	Kahatagollewa Water Tank	Abandoned land
W5	Bogahewa Sump	Scrubland
W6	Weerasole Water Tank	Chena land
W7	Horowpothana Sump & Existing Tank	Home Garden
W9	Rathmalgahawewa Water Tank	Rock outcrop associated vegetation
W10	Kahatagasdigiliya Water Tank	Home garden
W11	Kebithigollewa Existing Tank	Home garden
W12	Kahatagollewa- Kebithigollewa Water Tank	Chena land
W13	North Horowpothana Water Tank	Abandoned land, Secondary forest
W14	West Horowpothana Alt. 1	Scrubland
W15	West Horowpothana Alt. 2	Abandoned land
W16	Halmillewa Water Tank	Secondary forest
WT & SV	Wahalkada Tank and Surrounding Vegetations	Exposed tank bed, Surrounding forests

The dry-mixed evergreen forest is the typical dry zone forest found in the project area dominated by species such as Palu (Manilkara hexandra), Wira (Drypetes sepiaria) and Burutha (Chloroxylon swietenia). Forests observed on the surrounding hills of Wahalkada tank and Mahakanadarawa tank resembles dry-mixed evergreen forests. Forest vegetation observed at Mahakanadarawa water treatment plant location, Medawachchiya sump location, Ethakada water tank location, East Rambewa water tank location, Wahalkada water treatment plant location, North Horowpothana water tank location and Halmillewa water tank location are more disturbed and degraded, hence categorized as degraded dry-mixed evergreen forests or secondary forests or open forests.

Most of the forest patches in the project area is degraded due to the forest clearance for chena cultivation. After abandonment, these lands are colonized by pioneer species such as herbs and scrub vegetation. The degraded areas are not converted back to the closed-canopy forests through natural succession and these could be regarded as scrublands.

(b) Flora of the Project Area

A total number of 245 plant species including 12 endemic and 6 nationally threatened species were recorded during the field survey within the study area. A summary of the plant species observed is given in **Table 7.36**. The majority of the plant species recorded are tree species (118) followed by herbaceous species (55), climbers (44), shrubs (26) and epiphyte (2). About 17.5 % of the recoded plant species are exotic to the country and about 77.5 %

of the recorded plants are native species. None of the recorded plant species are unique or restricted to the project area.

Table 7.36 Summary of the Plant Species Recorded During the Study

Plant Type	Total	Threatened	Endemic	Native	Introduced
Tree	118	EN – 1, VU – 3	9	91	18
Shrub	26	0	0	17	9
Herb	55	0	0	41	14
Epiphyte	2	VU – 1	0	2	0
Climber/ Creeper	44	VU – 1	3	39	2
Total	**245**	**EN – 1, VU – 5**	**12 (5%)**	**190 (77.5%)**	**43 (17.5%)**

Abbreviations used: **EN** - Endangered, **VU** – Vulnerable

Out of 245 plant species recorded in the proposed project area during the field study, 12 (5 %) plant species are endemic to the country and 6 endemic plant species observed in and around the project sites are listed as Nationally Threatened. The detailed results are listed in **Appendix 7.6(a)**.

Table 7.37 Endemic and Nationally Threatened Plant Species recorded from the project sites

Family	Scientific Name	Local Name	HA	TS	CS
Apocynaceae	*Wrightia angustifolia*		T	E	
Arecaceae	*Calamus rotang*	Heen Wewel	C	N	VU
Asteraceae	*Vernonia zeylanica*	Pupula	C	E	
Celastraceae	*Cassine glauca*	Neralu	T	E	
Convolvulaceae	*Argyreia populifolia*	Giritilla	C	E	
Ebenaceae	*Diospyros ebenum*	Kaluwara	T	N	EN
Ebenaceae	*Diospyros nummulariifolia*		T	E	
Erythroxylaceae	*Erythroxylum zeylanicum*		T	E	
Euphorbiaceae	*Cleistanthus pallidus*		T	E	
Euphorbiaceae	*Drypetes gardneri*	Gal Wira	T	E	
Euphorbiaceae	*Margaritaria indicus*	Karawu	T	N	VU
Fabaceae	*Derris parviflora*	Kala Wel	C	E	
Melastomataceae	*Memecylon capitellatum*		T	E	
Orchidaceae	*Vanda tessellata*		Ep	N	VU
Rubiaceae	*Haldina cordifolia*	Kolon	T	N	VU
Rubiaceae	*Mitragyna parvifolia*	Helamba	T	N	VU
Rutaceae	*Micromelum minutum*	Wal Karapincha	T	E	
Sapindaceae	*Glenniea unijuga*	Wal Mora	T	E	

Abbreviations used: **HA** - Habit, **T** - Tree, **C** - Climber or Creeper, **Ep** - Epiphyte, **TS** - Taxonomic Status, **E** - Endemic species, **N** - Native species, **CS** - Conservation Status, **EN** - Endangered, **VU** - Vulnerable

(b) Fauna of the Project Area

Total number of 147 faunal species including 7 endemics was recorded during the survey. The faunal assemblage also included 5 species that are listed as Nationally Threatened and 4 speies listed as Glbally Threatened. A further 7 species of butterflies, birds and mammals

that are listed as Nationally Near Threatened (NT) (IUCN SL and MENR, 2007) were also recorded in the project area. The faunal assemblage recorded in the project area also included two species of exotic fish and two species of migrant birds.

Table 7.38 Summary Information of the Fauna Observed during the Survey

Taxonomic Group	Total	Endemic	Migrant	Exotic	CR	EN	VU	NT
Dragon flies	9							
Butterflies	22					1		1
Fish	11	1		2				
Amphibians	3							
Reptiles	12	1					1	
Birds	74	2	2					4(2)
Mammals	16	3				1(3)	2(1)	2(1)
Total	147	7	2	2	0	2(3)	3(1)	7(3)

Abbreviations used: **CR** - Critically Endangered, **EN** - Endangered, **VU** - Vulnerable, **NT** - Near Threatened

A total of seven endemic species of fauna were recorded from the study area (**Table 7.38**). Many of these endemic species show an island wide distribution. None of the endemic species observed are restricted to the study area. Observed low endemicity in the project area is not an unusual phenomenon given the fact that dry zone habitats support lesser number of endemics.

Three Nationally and four Globally Threatened species of fauna were recorded from the study area. In addition, Seven Nationally and three Globally Near Threatened species were also recorded in the various habitats present in the direct impact zone of the project site. As in the case of endemic species number of threatened species was also found to be low in the immediate impact zone of the project. This is usually the case in the dry zone as most of the threatened species are restricted to the wet zone of Sri Lanka. Further, none of the threatened species are restricted to this area since all of these species show relatively wide distributions in Sri Lanka albeit being listed as threatened due to number of threats that operate on these species. The detailed results are listed in **Appendix 7.6(b)**.

Table 7.39 List of endemic and threatened fauna observed during the survey

Family	Scientific Name	English Name	TS	NCS	GCS
BUTTERFLIES					
Lycaenidae	*Jamides alecto*	Metallic Cerulean	N	NT	
Nymphalidae	*Junonia orithya*	Blue pansy	N	EN	
FISHES					
Cyprinidae	*Puntius singhala*	Filamented Barb	E		
REPTILES					
Agamidae	*Otocryptis nigristigma*	Black spotted kangaroo lizard	E		
Testudinidae	*Geochelone elegans*	Indian star tortoise	N	VU	

Family	Scientific Name	English Name	TS	NCS	GCS
BIRDS					
Bucerotidae	*Anthracoceros coronatus*	Malabar Pied Hornbill	N	NT	NT
Burhinidae	*Burhinus oedicnemus*	Eurasian Thick-knee	N		NT
Ciconiidae	*Ciconia episcopus*	Woolly-necked Stork	N	NT	
Hirundinidae	*Hirundo daurica*	Red-rumped Swallow	M	NT	
Phasianidae	*Gallus lafayetii*	Sri Lanka Junglefowl	E		
Timalidae	*Pellorneum fuscocapillum*	Sri Lanka Brown-capped Babbler	E	NT	
MAMMALS					
Cercopithecidae	*Macaca sinica*	Sri Lanka toque monkey	E	NT	EN
Cercopithecidae	*Semnopithecus vetulus*	Purple-faced leaf monkey	E	VU	EN
Cercopithecidae	*Semnopithecus priam*	Grey langur	N	NT	NT
Elephantidae	*Elephas maximus*	Elephant	N	VU	EN
Sciuridae	*Ratufa macroura*	Giant squirrel	N		NT
Ursidae	*Melursus ursinus*	Sloth bear	N	EN	VU

Abbreviations: **NCS** - National Conservation Status; : **GCS** – Global Conservation Status; **EN** - Endangered, **VU** - Vulnerable, **NT** - Near Threatened;

(c) Conclusion

The proposed project areas lie within the low country dry zone. The most abundant habits/ landuse types observed in the direct impact zone of the project sites include home gardens, abandoned lands and cultivated lands. The area supported mostly common plant or animal species associated with such human influenced habitats. Only few species of endemic or threatened fauna and flora were observed in and around the project site. This low numbers of endemic and threatened species in the area is consistent with the distribution pattern of endemic and threatened species in Sri Lanka, where majority of these species are restricted to the natural habitats in the wet zone of Sri Lanka. None of these endemic or threatened species observed are restricted to the project area or will be adversely affected by the proposed project activities. No major invasive plant species was observed at the project sites. No critically endangered species were found in the project area. There is no nesting place in the Project site and many of fauna species can move . For these reasons, the adverse impact on ecosystem is not so large. However, the land clearance and construction work could disturb the ecosystem, so the mitigation measures should be taken.

	
Mahakanadarawa Tank and Surrounding Vegetations	Mahakanadarawa Water Treatment Plant Site (M1)
	
Rambewa Sump & Tank Site (M2)	Medawachchiya Sump Site (M3)
	
Isenbessagala Tank Site (M4)	Ethakada Tank Site (M5)

Figure 7.23 Photographic Catalogue of Study Sites

	
East Rambewa Tank Site (M6)	Wahalkada Tank and Surrounding Vegetations
	
Wahalkada Water Treatment Plant Site (W1)	Conveyor Pipeline to Wahalkada WTP
	
Kahatagollewa Water Tank Site (W2)	Bogahewa Sump Site (W5)

Figure 7.23 Photographic Catalogue of Study Sites (Cont'd)

	
Weerasole Water Tank Site (W6)	Horowpothana Sump & Existing Tank Site (W7)
	
Rathmalgahawewa Tank Site (W9)	Kahatagasdigiliya Tank Site (W10)
	
Kebithigollewa Existing Tank Site (W11)	Kahatagollewa- Kebithigollewa Water Tank Site (W12)

Figure 7.23 Photographic Catalogue of Study Sites (Cont'd)

	
North Horowpothana Water Tank Site (W13)	West Horowpothana Alternative-2 Site (W14)
	
West Horowpothana Alternative-1 Site (W15)	Halmillewa Tank Site (W16)
	
Junonia orithya (Blue Pansy), Recoded Endangered (EN) Butterfly Species	

Figure 7.23 Photographic Catalogue of Study Sites (Cont'd)

7.6.7 Living and livelihood

The living and livelihood of people in the Project area is changed greatly in water sources and water use pattern.

Currently, the main water source in this area is groundwater even if the case of piped water supply. There are two types of water supply scheme; CBO and NWSDB that use the groundwater for supply.

100% CBO users are willing to have the water supply by the new scheme of NWSDB. And they expect to get better quality water for 24 hours supply. The water resource they want is tank water (70%), spring water (7%), and others answered 'good water' (23%). On the other hand, the 100% of existing NWSDB water supply users are also willing to have the new water supply scheme with the use of other water source. 83% of respondents wish to receive the supply water of treated tank water 4% wish spring water, other 13% wish 'good water'.
In case of the people who don't have piped water supply service, 99% are willing to have the water supply and 85% of them wish the tank water as water source, 8% wish spring water, 7% wish 'good water' and near 1% wish ground water.

Almost all people living in the area hope to have the new water supply scheme with the use of surface or spring water.

The willingness to pay for the new water supply scheme is summarized in **Table 7.40**. The parenthetic value is current payment amount of water supply for reference. NWSDB users pay a little more than CBO users in average, and are willing to pay a bit more in the same way. The Non-user group shows more amount for willingness to pay.

Table 7.40 Willingness to Pay for New Water Scheme

User group	Minimum	Medium	Mean	Maximum	% of RA*
CBO User WTP	80 (70)	300 (300)	354 (346)	2,500 (1,500)	44
NWSDB User WTP	200 (70)	400 (300)	477 (409)	1,000 (2.300)	72
Non user	100	300	460	10,000	54

* RA: The answer 'relevant amount' or 'reasonable price'

In this questionnaire survey, many of respondents didn't answer with the apparent figure for the amount. More than half respondents answered such as 'relevant amount' or 'reasonable price'. The percentage of such answered is shown in same table.

The research result shows the positive attitude of the people for the new water supply scheme. The people already have the supplied water service want to pay a bit more for the better quality water and better service.

7.6.8 Heritage

The project site is located outside of the archaeological reserves and protected monuments which are declared by the Department of Archaeology. Not only that, the project obtained the clearance for carrying out the survey and construction at the proposed site from the Department of Archaeology. However, the whole Anuradhapura is known as ancient kingdom and there is a possibility to have buried antiquity. The special treat procedure during construction stage has to be determined in a contract document with the guidance of Department of Archaeology.

In case the antiquities are excavated during construction, the usual procedure what the project proponent should follow is shown as follows, and the all of discovered things will belong to Department of Archaeology.

1) The project proponent should stop the construction work, and make a contact to the regional office of the Department of Archaeology.
2) The Department of Archaeology sends an officer to the site. The officer provides the guidance how to carry out the construction work. And the construction will continue. The officer does not stay continuously, but responsible for the supervising.
3) In case the antiquity is excavated again, the project proponent should stop the work and wait for the direction by the Department of Archaeology.

These protocols are clearly written in contract document. The example of ICTAD chapter 4.16, it is said that ‘All fossils, coins, articles of value or antiquity, and structures and other remains or items of geological or archaeological interest found on the Site shall be placed under the care and authority of the Employer. The Contractor shall take reasonable precautions to prevent Contractor’s Personnel or other persons from removing or damaging any of these findings.’

7.6.9 Minority and Ethnic Group

According to the report of the social survey, the indigenous group does not exist in the project site. The minority group in this area is Muslim and Tamil. The directly affected person who needs to resettle the house belongs to majority group.

7.6.10 Labor Environment

<Construction stage>

Labor environment is managed by the contractor with the guidance of PMCU. The essential required measures for occupational safety, health, and hazard management are written in a contract paper in accordance with the Sri Lankan Law and international practice. The general specification document of bigger contract price project is prepared on the basis of the 'Standard Bidding Document Procurement of Works (Major Contracts)' published by Institute for Construction Training and Development (ICTAD) in Sri Lanka. In case of international bidding, ' Conditions of Contract for Works of Civil Engineering Construction'published by Federation Internationale des ingenieurs-conseils（FIDIC）is used as a basis. The labor environment is conserved with these contract conditions. The contractor is responsible for implementing the conditions and providing the safety facility, safety tools, and training for safety program.

For example, following expression is said as an important duty in above documents.

The contractor shall, throughout the execution and completion of the Works and the remedying of any defects therein:

(a) have full regard for the safety of all persons entitled to be upon the Site and keep the Site and the Works in an orderly state appropriate to the avoidance of danger to such persons

(b) provide and maintain at his own cost all lights, guards, fencing, warning signs and watching, when and where necessary or required by the Engineer or by any duly constituted authority, for the protection of the Works or for the safety and convenience of the public ore others.

(c) take all reasonable steps to protect the environment on and off the Site and to avoid damage or nuisance to persons or to property of the pubic or others resulting from pollution, noise or other causes arising as a consequence of his methods of operation.

Table 7.41 Legal System of Labor Environment

Field	Corresponding law
Terms and conditions of employment	• The Shop and Office Employees (Regulation of employment & remuneration) Act • Wages Board Ordinance
Social security	• Employees provident Fund • Employees Trust Fund • Payment of Gratuity Act
Industrial safety	• Factories Ordinance • Workmen's Compensation Ordinance
Employment of women and children	• Employment of Women, Young Persons and Children Act • Maternity Benefits Ordinance

The Factory Ordinance defines and orders the issues related to occupational safety, health and hazards management. The activities required on the Ordinance will be secured by the contract

condition which is made under the 'Standard Bidding Document Procurement of Works' or 'Conditions of Contract'.

<Operation Stage>
The labor environment is under responsibility of the NWSDB in operation stage. NWSDB should prepare the safety materials as an actual thing, and provide training and drill as a capacity development of the labors. The special safety tools such as eye washer and shower for emergency case of chlorine leakage are designed.

7.7 Mitigation Measures

List of adverse impacts and its mitigation measures
The adverse impacts and its mitigation measures are listed in **Table 7.42**. The column of Impact shows the evaluation of potential impact after taking mitigation measures.

Table 7.42 List of Adverse Impacts and Its Mitigation Measures

Pre construction stage

Impact	Object	Mitigation measures	Impact	In charge or implemented by	Supervising
Noise and vibration	Pump, generator and other noise generation facility	● Low noise/vibration pump and generator are specified in tender document. ● Building is designed with the consideration to decrease noise and vibration to meet the requirement. ● Location of these facilities is examined.	Minor	NWSDB HO	PMU (CEA)
Waste	Construction waste and Domestic waste	● Waste management plan is prepared under discussion with CEA and DS. ● Temporally dumping area is secured.	Minor	NWSDB RSC	PMU DS CEA
Ecological impact	Clearing land	● Clearing land and cutting tree are planned under the discussion with Forest Dept and/or CEA.	Minor	NWSDB RSC	PMU Forest Dept CEA
	Rare species	● Making a plan of transplant and recovery of habitat	Minor	NWSDB RSC	PMU Wildlife dept CEA
Resettlement	Resettlement	● Progress of resettlement and its fairness are monitored.	Minor	NWSDB RSC	PMU DS
Social impact	Stakeholder meeting	● Discussion and making agreement about construction schedule, procedure, and impact	Minor	NWSDB RSC	PMU PCC
	Public relation activities for local residents	● Explanation for local residents and to develop understanding about construction work schedule, expected impacts, mitigation measures etc.	Minor	NWSDB RSC	PMU DS

NWSDB RSC : National Water Supply and Drainage Board
PMU: Project Management Unit
PCC: Project Coordination Committee
DS: Divisional Secretariat
Additional GM for water supply

Construction stage

Impact		Mitigation measures	Impact	In charge or implemented by	Supervising
Air pollution	Exhaust gas	● To ensure the use of vehicles and machineries officially registered, and properly maintained.	Minor	Contractor	PMU
	Dust	● To cover the earth or dusty materials ● To sprinkle water to prevent the dust raising.	Minor	Contractor	PMU
	Leakage of chlorine gas	● Guidance of proper installation ● Safety training to laborer	Minor	Contractor	PMU

Impact		Mitigation measures	Impact	In charge or implemented by	Supervising
Noise	Vehicles and machinery	● To ensure the use of vehicles and machineries officially registered, and properly maintained. ● Unnecessary idling is not allowed. ● Route of transportation is examined to prevent noise or other effect on vicinity.	Minor	Contractor	PMU
	Construction work	● To avoid doing the work generating noise and vibration at nighttime. ● Sound insulation wall will be used if necessary.	Minor	Contractor	PMU
Water quality	Water source	● Making water resource protection plan with the commitment of relevant authority	Minor	PMU	PD
	Discharge water	● Clean water such as rain water is separately collected to prevent from mixing with muddy materials ● Turbid water generated by earthwork is introduced to the sedimentation basin and turbid material will be settled. ● If necessary further treatment (use of coagulant) is done.	Minor	Contractor	PMU
	Domestic effluent	● Effluent is treated by the soak pit.	Minor	Contractor	PMU
	Oil and grease	● Oil and grease are kept separately in the container. ● Oil absorbent is prepared.	Minor	Contractor	PMU
Waste	Construction waste	● The waste reduction plan and dumping procedure will be proposed at the tender document and implemented. ● The temporally dumping yard for construction waste is secured. ● Waste is segregated in order to recycling purpose. ● Recyclable material is transferred to the recycling manufacturer. ● Waste which is not recyclable is disposed to follow the fixed rule of relevant DS.	Minor	Contractor	PMU
	Domestic waste generated by laborer	● Domestic waste is placed at the temporally damping yard, and transferred to the officially operated disposal field	Minor	Contractor	PMU
Ecological environment	Violation to ecosystem	● Training and awareness program for laborer is planned and done. ● Scheduled patrol of the site	Minor	Contractor	PMU
	Trees and plant	● Clearing land is minimized and the large tree is remained as far as possible, or transplanted.	Minor	Contractor	PMU

Impact		Mitigation measures	Impact	In charge or implemented by	Supervising
	Rare species	● If the special species will be found out at the site, report to NWSDB and receive the guidance of CEA or wildlife dept.	Minor	Contractor	PMU CEA Wildlife dept
Archaeological impact	Excavating antiquity	● If the antiquity will be excavated at the site, report to NWSDB and receive the guidance of Archaeological dept.	Minor	Contractor	PMU Archaeological dept.
Social impact	Social conflict caused by laborer	● Training and awareness program for laborer are planned and done. ● Security guard is appointed.	Minor	Contractor	PMU
	Inconvenience of livelihood	● Pipe laying work on the road is planned carefully to prevent inconvenience as much as possible. ● Refraining from working during peak hours to prevent road traffic blocks ● Public notice prior to construction	Minor	Contractor	PMU
Working condition	Occupational safety	● Training and awareness program for laborer is planned and done. ● Safety tools are provided to laborer by Contractor.	Minor	Contractor	PMU

Operation stage

Impact		Mitigation measures	Impact	In charge or implemented by	Supervising
Air pollution	Leakage of chlorine gas	● Gas monitor is working always at proper condition ● Safety training to laborer	Minor	NWSDB RSC	NWSDB HO
Noise	Noise generation facility (pump etc)	● To ensure the proper operation and maintenance	Minor	NWSDB RSC	NWSDB HO
Water quality	Discharge water	● Under drain water from sludge drying bed should be managed to meet the standards.	Minor	NWSDB RSC	NWSDB HO
	Domestic effluent	● Effluent is treated by the soak pit.	Minor	NWSDB RSC	NWSDB HO
	Oil and grease	● Oil and grease are kept separately in the container	Minor	NWSDB RSC	NWSDB HO
Waste	Domestic waste	● Domestic waste is placed at the temporally collection place, and transferred to the officially operated disposal field	Minor	NWSDB RSC	NWSDB HO
	Sludge	● Sludge is dried up at the drying bed to reduce its quantity ● Dried sludge is dumped by the contract with the approval of land	Minor	NWSDB RSC	NWSDB HO

Impact		Mitigation measures	Impact	In charge or implemented by	Supervising
		owner.			
Working condition	Safety and health	● Safety and emergency tool is always ready. ● Safety training is provided on schedule. ● Newly hired employee shall have safety training.	Minor	NWSDB RSC	NWSDB HO

7.8 Monitoring Plan

The monitoring is important to check whether the impacts on environmental and social conditions are mitigated and controlled sufficiently. The monitoring activities divide into three stages; designing stage, construction stage operational stage.

<Monitoring of designing stage>
The design regarding mitigation measures is examined in this stage. And the progress of obtaining permission and progress of resettlement are checked too.

<Monitoring of construction stage>
The expected impacts caused by the construction activities are mainly monitored by the Contractor under the supervision of the NWSDB. The concept of monitoring scheme is shown in **Figure 7.23**.

<Monitoring of Operational stage>
NWSDB is responsible for continuous monitoring for protecting environmental and social condition, and for checking proficiency of the operation.

7.8.1 Structural plan of monitoring

In order to carry out successful and effective monitoring, the structural establishment with appropriate assigning of task and responsibility is important.

Project Coordination Committee will be established and it will provide the table of discussion for any issues arises at the site.

The monitoring structure is proposed as follows.

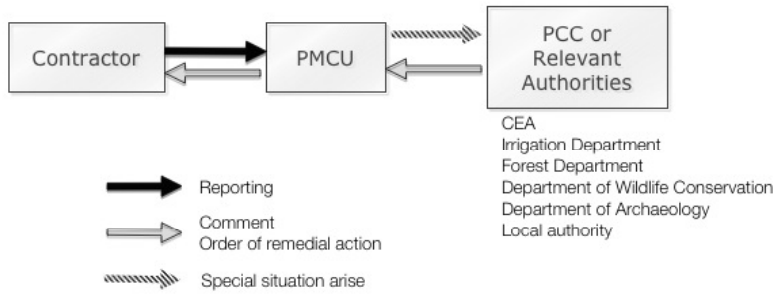


Figure 7.23 Monitoring Structure for Construction Stage

The tasks of concerning organizations are summarized in **Table 9.43**

Table 7.43 Tasks of Relevant Organization for Resettlement

Organization	Task
Construction Contractor	Implementing mitigation measures as proposed Conducting monitoring Reporting to the NWSDB
PMU (Project Management Unit)	Making monitoring plan Examine the monitoring result and provide appropriate guidance to contractor Reporting to DS Reporting to other authority if needs arise
PCC (Project Coordination Committee)	Supervising project activities in any regards
CEA	Providing consultation for environmental protection issues
Divisional Secretariat	Superintending the whole project activities Managing the public consultation
Irrigation department	Providing consultation for the design, construction procedure, monitoring of construction, and water intake operation
Forest department	Providing consultation for clearing land and proper land use
Department of Archaeology	Supervising the construction work in case of the important antiquity is excavated
Department of Wildlife Conservation	Providing consultation for any issues regarding ecosystem

Table 7.44 Monitoring Plan

Items	Monitoring parameters	Procedure	Frequency	Implemented and reported by	Report to
Designing stage					
Procurement	Suitability of specification	Checking the specification to meet the proposed mitigation measures	1 time	NWSDB	PMU
Waste	Waste management procedure	Checking dumping plan and obtaining agreement with local authority	1 time	NWSDB	PMU
Resettlement	Progress of resettlement plan	Checklist of resettlement plan	1 time	NWSDB	PMU
Ecological environment	Clearing land procedure	Checking the plan of clearing and obtaining permission	1 time	NWSDB	PMU
	Rare species	Checking the plan of transplant and recovery of habitat	1 time	NWSDB	PMU
Social impact caused by laborer of construction	Awareness raising program	Training plan of laborer	1 time	NWSDB	PMU
Construction stage					
Air quality	Vehicle maintenance condition	Check the registered vehicles and its maintenance record	Once a month	Contractor	PMU
	Dust	Observation at the site	Once a month	Contractor	PMU
	Chlorine gas emission	Check and calibrate the gas leak detector	Once a month	Contractor	PMU
Water quality	Discharge water quality	Measurement of turbidity	Everyday during soil work	Contractor	PMU
Noise	Working time of construction	Working record	Once a week	Contractor	PMU
	Noise at boundary	Measurement of noise at the boundary of the site	Once a month both in daytime and night time	Contractor	PMU
Ecological environment	Violation to ecosystem, such as cutting tree, hunting, killing taking plants and animals, disturbing habitat etc.	Patrol of construction site	Once a week	Contractor	PMU
Waste	Construction waste	Condition of segregation Past record of recycling	Every 3 months	Contractor	PMU

Items	Monitoring parameters	Procedure	Frequency	Implemented and reported by	Report to
	Domestic waste	Observation of temporally dumping yard	Every 3 months	Contractor	PMU
Operation stage					
Air quality	Chlorine gas leakage	Measurement of gas concentration and check and calibration of gas leak detector	Once a week	NWSDB RSC	NWSDB
Raw water quality	Parameters listed in drinking water quality	Chemical analysis by laboratory	Once a month	NWSDB RSC	NWSDB
Distributing water quality	Parameters listed in drinking water quality	Chemical analysis by laboratory	Once a month	NWSDB RSC	NWSDB
Discharge water quality	Parameters listed in discharge water quality	Chemical analysis by laboratory	Every 3 months	NWSDB RSC	NWSDB
Occupational safety	Chlorine gas leakage	Measurement of gas concentration	Checking the daily record	NWSDB RSC	NWSDB
Noise	Noise at the boundary	Measurement of noise	Every 3 months	NWSDB RSC	NWSDB
Waste	Sludge	Observation of the drying bed Checking the record of sludge disposal	Every 4 months	NWSDB RSC	NWSDB

7.9 Stakeholder Meeting

7.9.1 Information Sharing with Stakeholders

Public participation is a part of the EIA process. The public has a right to be informed about the coming projects. In order to prevent future conflict, activities regarding information sharing and raising public awareness are important and essential.

(1) Information sharing with CBOs
NWSDB holds technical training program for CBOs on a regular basis and utilizes the opportunity for public information.

(2) Information sharing with the local representatives
A meeting titled 'Anuradhapura district water supply activities progress review meeting' was held on 11 June 2012, chaired by the Minister of Water Supply and Drainage. The main attendants were representatives and officials from the north central province, such as member of provincial council, chairman of Pradeshiya Saba, district secretary, divisional secretary, and relevant authorities. DGM (NC) explained about the ongoing and future water supply projects including the ANIWSP. A questions and answers session was held and many issues regarding project implementation were discussed among the stakeholders.

(3) Information sharing with the local authority
The meeting to discuss the environmental compliance with local authority was held on 30th May 2012 in order to confirm necessary actions for environmental and social issues regarding the Project implementation. The meeting minute is attached as Appendix 9.9(a).

7.9.2 Explanation Meeting

NWSDB and DSD held the explanation meeting to the direct affected people on 7th August, 8th and 23rd September and 10th October. Agendas, attendant lists and meeting minute are attached as Appendix 9,9(b). The villagers who are mainly beneficially of irrigation had shown negative attitude to the Project understood the necessity of the Project and agreed to cooperate with the Project. The MOU was concluded between ?? It is attached as Appendix 9.9(c).

7.10 Land Acquisition and Human Resettlement

7.10.1 Necessity of resettlement and land acquisition

NWSDB searched the project area in government land as much as possible, and most of land is in government land. The largest land use of the Project is land for the water treatment plant. The land for two treatment plants were found in government land and the current land leaseholders agreed to transfer the right. The other land necessary for the Project is the land for distribution network. Following table shows the required land area. The site was examined carefully to minimize the private land use and to maximize the efficiency of the distribution. Only a small area of land is private land.

Table 7.45 Land Acquisition Plan

Land Type	Area (Ac)	Land Acquisition Process
Public	30	Lease
Private	2.2	Purchase
NWSDB	4	N/A
Total	36.2	

NWSDB found the illegal occupants in both treatment plant sites. On the basis of Sri Lankan policy of resettlement and JICA guideline, the people who are expected to move from present living place should be compensated and received appropriate assistance even if they are illegal occupant.

7.10.2 Legal Framework and Its Organization for Acquisition and Human Resettlement

(1) Sri Lankan Legal Framework

Sri Lanka has many laws and regulations in terms of land acquisition and resettlement.

- Land Acquisition Act No 9 of 1950
- National Environmental Act No 47 of 1980
- Road Development Authority Act No 73 of 1981
- State Lands Act No 13 of 1949
- State Lands (Recovery of Possession) Act No 7 of 1979
- Urban Development Authority Law No 41 of 1978
- Municipal Councils Ordinance No 29 of 1947
- Urban Development Projects (Special Provisions) Act No 2 of 1980
- Sri Lanka Land Reclamation and Development Corporation Act No 15 of 1968
- Land Development Ordinance No 19 of 1935
- Prescription Ordinance No 22 of 1971
- Law of Compensation for Improvements

The most important documents are explained in following text.

1) Land Acquisition Act

The Land Acquisition Act (LAA) of 1950 was established for financial compensation at current market prices, and compensate for income loss from certain types of affected economic activities. It has been amended to fit the current requirement. It does not require project executing agencies (PEA) to address key resettlement issues such as (a) exploring alternative project options that avoid or minimize impacts on people; (b) compensating those who do not have title to land; (c) consulting affected people and hosts on resettlement options; (d) providing for successful social and economic integration of the affected people and their hosts, and (e) full social and economic rehabilitation of the affected people.

All land acquisition work is carried out under the Land Acquisition Act. The NWSDB was given the authority to obtain the land for public purpose with the concurrence of the landowners. The main actions should be taken are listed as follows.

a) Submission of proposals

NWSDB has the investigations for the land selection for public purpose

b) Submission of application, publication

NWSDB submits the application to the relevant Ministry for land acquisition, which contains (a) Application for acquisition of land, (b) Special report of the Head of the institution, (c) and tracing of the proposed land. After obtaining the approval of the Ministry, NWSDB is going to publish a notification on Gazette.

c) Calling for objection

Minister of Land sends the order to the Acquiring officer for publication. The officer prepares notice and expose to public to provide an opportunity for enabling objection for minimum 14 days and maximum 21 days.

d) Taking possession of land

e) Publication for providing opportunity to the public for complaining.

2) NIRP

The Government of Sri Lanka adopted the National Involuntary Resettlement Policy (NIRP) in May 2001 to ensure that affected persons by development projects are treated in a fair and equitable manner and to ensure they are not impoverished in the process, thereby establishing the framework for project planning and implementation.

Key requirements stated in the NIRP are as follows.

- Take all necessary steps to avoid or reduce involuntary resettlement
- Prepare a comprehensive Resettlement Action Plan (RAP) where 20 or more families are affected. If less than 20 families are affected, a plan at a lesser level of detail

should be prepared.

- Where involuntary resettlement is unavoidable, affected persons should be informed fully and consulted on resettlement and compensation options.
- Affected persons should be fully involved in the selection of relocation sites, livelihood compensation and development options at the earliest opportunity.
- Cash compensation should be an option for all affected persons. Replacement land should be an option for compensation in the case of loss of land.
- Compensation for loss of land, structures, other assets, and income should be based on full 'replacement cost'.
- Resettlement should be planned as a development activity for the affected persons.
- Absence of formal title to land by some affected persons should not be a bar to compensation.
- Particular attention to be paid to households headed by women, and vulnerable groups among affected persons, and appropriate assistance provided to help them improve their status.
- Full cost of compensation and resettlement should be borne by the project proponent.
-

NIRP stipulates that any development project that causes the physical or economic resettlement of affected persons requires the preparation of a Resettlement Action Plan (RAP). In case less than 20 families are involved in the resettlement, an abbreviated RAP shall be prepared. The components of an abbreviated RAP are as follows.

a) Scope of land acquisition and resettlement
b) Policy framework and entitlements
c) Public participation and grievance redress
d) Compensation, relocation and income restoration
e) Institutional framework
f) Resettlement budget and financing plan
g) Implementation schedule
h) Monitoring and evaluation

3) Guidelines for the preparation of a resettlement action plan

This document was prepared by the Ministry of Land in June 2003 in order to provide assistance in the preparation of a Resettlement Action Plan (RAP) as required under the NIRP. It provides practical detailed procedure to make a RAP, e.g., the required research, contents, information to be included in each component, and action required for preparation.

(2) JICA Policy

The key principle of JICA policies on involuntary resettlement is summarized below.

I. Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by

exploring all viable alternatives

II. When, population displacement is unavoidable, effective measures to minimize the impact and to compensate for losses should be taken

III. People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels

IV. Compensation must be based on the full replacement cost5 as much as possible

V. Compensation and other kinds of assistance must be provided prior to displacement

VI. For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. It is desirable that the resettlement action plan include elements laid out in the World Bank Safeguard Policy, OP 4.12, Annex A.

VII. In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people.

VIII. Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans

IX. Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.(

Above principles are complemented by World Bank OP 4.12, since it is stated in JICA Guideline that “JICA confirms that projects do not deviate significantly from the World Bank’s Safeguard Policies”. Additional key principle based on World Bank OP 4.12 is as follows

X. Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits

XI. Eligibility of Benefits include, the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying.

XII. Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based

XIII. Provide support for the transition period (between displacement and livelihood restoration

XIV. Particular attention must be paid to the needs of the vulnerable groups among those

displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc

XV. For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, abbreviated resettlement plan is to be prepared

In addition to the above core principles on the JICA policy, it also laid emphasis on a detailed resettlement policy inclusive of all the above points; project specific resettlement plan; institutional framework for implementation; monitoring and evaluation mechanism; time schedule for implementation; and, detailed Financial Plan etc

(3) Comparison between the JICA Guideline and Sri Lanka Law

The following table shows the result of comparison between the JICA Guideline and Sri Lanka Law

Table 7.46 Comparison between JICA Guideline and Sri Lankan Law

No.	JICA Guidelines	NIRP	Gap between JICA Guideline and NIRP
1.	Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. (JICA GL)	Involuntary resettlement should be avoided or reduced as much as possible by reviewing alternatives to the project as well as alternatives within the project. (NIRP – 4. Policy Principles, Bullet 01)	No difference between JICA guideline and NIRP on this issue.
2.	When population displacement is unavoidable, effective measures to minimize impact and to compensate for losses should be taken. (JICA GL)	Where involuntary resettlement is unavoidable, affected people should be assisted to re-establish themselves and improve their quality of life. (NIRP – 4. Policy Principles, Bullet 02)	The NIRP concurs with JICA policy on this issue.
3.	People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels. (JICA GL)	Affected persons should be fully involved in the selection of relocation sites, livelihood compensation and development options at the earliest opportunity. (NIRP – 4. Policy Principles, Bullet 04)	The NIRP concurs with JICA policy on this issue.
4.	Compensation must be based on the full replacement cost as much as possible. (JICA GL)	Compensation for loss of land, structures, other assets and income should be based on full replacement cost and should be paid promptly. This should include transaction costs. (NIRP – 4. Policy Principles, Bullet 06)	No difference between JICA guideline and NIRP on this issue.
5.	Compensation and other kinds of assistance must be provided prior to displacement. (JICA GL)	Not mentioned particularly	The NIRP does not mention the timing of compensation.

No.	JICA Guidelines	NIRP	Gap between JICA Guideline and NIRP
6.	For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. (JICA GL)	A comprehensive Resettlement Action Plan will be required where 20 or more families are affected. If less than 20 families are affected the policy still applies but a plan can be prepared to a lesser level of detail. (NIRP – 3 Scope, Bullet 2 and 3)	This case the affected households are supposed to be four. JICA guideline does not mention clearly the case of small-scale resettlement.
7.	In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. (JICA GL)	To assist those affected to be economically and socially integrated into the host communities, participatory measures should be designed and implemented. (NIRP – 4 Policy Principles, Bullet 08)	The NIRP concurs with JICA policy on this issue.
8.	When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people.	Not mentioned particularly	Not mentioned particularly
9.	Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans. (JICA GL)	Affected persons should be fully involved in the selection of relocation sites, livelihood compensation and development options at the earliest opportunity. (NIRP – 4. Policy Principles, Bullet 06)	No difference between JICA guideline and NIRP on this issue.
10.	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities. (JICA GL)	A system of internal monitoring should be established by PEAs to monitor implementation of Resettlement Action Plans, including budget, schedule, and delivery of entitlements, consultation, grievances and benefits. (NIRP – 6.Monitoring and Evaluation, Bullet 01)	No difference between JICA guideline and NIRP on this issue.
11.	Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits. (WB OP4.12 Para.6)	Not mentioned particularly	The NIRP does not mention establishing a population record through census

No.	JICA Guidelines	NIRP	Gap between JICA Guideline and NIRP
12.	Eligibility of benefits includes, the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying. (WB OP4.12 Para.15)	Affected persons who do not have documented title to land should receive fair and just treatment. (NIRP – 4. Policy Principles, Bullet 11)	No difference between WB OP4.12 and NIRP on this issue
13.	Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based. (WB OP4.12 Para.11)	Not mentioned particularly	The NIRP does not mention about this issue.
14.	Provide support for the transition period (between displacement and livelihood restoration). (WB OP4.12 Para.6)	Not mentioned particularly	The NIRP does not mention about transition period support.
15.	Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc. (WB OP4.12 Para.8)	Vulnerable groups should be identified and given appropriate assistance to substantially improve their living standards. (NIRP – 4. Policy Principles, Bullet 12)	No difference between WB OP4.12 and NIRP on this issue

7.10.3 Project Policy and Entitle Matrix

The Project implements the resettlement under following policy.

I. The Government of Sri Lanka will use the Project Resettlement Policy for the Anuradhapura North Integrated Water Supply Project specifically because existing national laws and regulations have not been designed to address involuntary resettlement according to international practice, including JICA's policy. The Project Policy is aimed at filling-in any gaps in what local laws and regulations cannot provide in order to help ensure that PAPs are able to rehabilitate themselves to at least their pre-project condition. This section discusses the principles of the Project Policy and the entitlements of the PAPs based on the type and degree of their losses. Where there are gaps between Sri Lanka legal framework for resettlement and JICA's Policy on Involuntary Resettlement, practicable mutually agreeable approaches will be designed consistent with Government practices and JICA's Policy.

II. Land acquisition and involuntary resettlement will be avoided where feasible, or minimized, by identifying possible alternative project designs that have the least adverse impact on the communities in the project area.

III. Where displacement of households is unavoidable, all PAPs (including communities) losing assets, livelihoods or resources will be fully compensated and assisted so that they can improve, or at least restore, their former economic and social conditions.

IV. Compensation and rehabilitation support will be provided to any PAPs, that is, any person or household or business which on account of project implementation would have his, her or their: Standard of living adversely affected Right, title or interest in any house, interest in, or right to use, any land (including premises, agricultural and grazing land, commercial properties, tenancy, or right in annual or perennial crops and trees or any other fixed or moveable assets, acquired or possessed, temporarily or permanently;Income earning opportunities, business, occupation, work or place of residence or habitat adversely affected temporarily or permanently; orSocial and cultural activities and relationships affected or any other losses that may be identified during the process of resettlement planning

V. All affected people will be eligible for compensation and rehabilitation assistance, irrespective of tenure status, social or economic standing and any such factors that may discriminate against achievement of the objectives outlined above. Lack of legal rights to the assets lost or adversely affected tenure status and social or economic status will not bar the PAPs from entitlements to such compensation and rehabilitation measures or resettlement objectives.)All PAPs residing, working, doing business and/or cultivating land within the project impacted areas as of the date of the latest census and inventory of lost assets(IOL), are entitled to compensation for their lost assets (land and/or non-land assets), at replacement cost, if available and restoration of incomes and businesses, and will be provided with rehabilitation measures sufficient to assist them to improve or at least maintain their pre-project living standards, income-earning capacity and production levels.

VI. PAPs that lose only part of their physical assets will not be left with a portion that will be inadequate to sustain their current standard of living. The minimum size of remaining land and structures will be agreed during the resettlement planning process

VII. People temporarily affected are to be considered PAPs and resettlement plans address the issue of temporary acquisition.

VIII. Where a host community is affected by the development of a resettlement site in that community, the host community shall be involved in any resettlement planning and decision-making. All attempts shall be made to minimize the adverse impacts of resettlement upon host communities.

IX. The resettlement plans will be designed in accordance with Sri Lanka’s National Involuntary Resettlement Policy and JICA’s Policy on Involuntary Resettlement.

X. The Resettlement Plan will be translated into local languages and disclosed for the reference of PAPs as well as other interested groups.

XI. Payment for land and/or non-land assets will be based on the principle of replacement

cost

XII. Compensation for PAPs dependent on agricultural activities will be land-based wherever possible. Land-based strategies may include provision of replacement land, ensuring greater security of tenure, and upgrading livelihoods of people without legal land titles. If replacement land is not available, other strategies may be built around opportunities for re-training, skill development, wage employment, or self-employment, including access to credit. Solely cash compensation will be avoided as an option if possible, as this may not address losses that are not easily quantified, such as access to services and traditional rights, and may eventually lead to those populations being worse off than without the project.

XIII. Replacement lands, if the preferred option of PAPs, should be within the immediate vicinity of the affected lands wherever possible and be of comparable productive capacity and potential6. As a second option, sites should be identified that minimize the social disruption of those affected; such lands should also have access to services and facilities similar to those available in the lands affected.

XIV. Resettlement assistance will be provided not only for immediate loss, but also for a transition period needed to restore livelihood and standards of living of PAPs. Such support could take the form of short-term jobs, subsistence support, salary maintenance, or similar arrangements

XV. The resettlement plan must consider the needs of those most vulnerable to the adverse impacts of resettlement (including the poor, those without legal title to land, ethnic minorities, women, children, elderly and disabled) and ensure they are considered in resettlement planning and mitigation measures identified. Assistance should be provided to help them improve their socio-economic status.

XVI. PAPs will be involved in the process of developing and implementing resettlement plans

XVII. PAPs and their communities will be consulted about the project, the rights and options available to them, and proposed mitigation measures for adverse effects, and to the extent possible be involved in the decisions that are made concerning their resettlement.

XVIII. Adequate budgetary support will be fully committed and made available to cover the costs of land acquisition (including compensation and income restoration measures) within the agreed implementation period. The funds for all resettlement activities will come from the Government

XIX. Displacement does not occur before provision of compensation and of other assistance required for relocation. Sufficient civic infrastructure must be provided in resettlement site prior to relocation. Acquisition of assets, payment of compensation, and the resettlement and start of the livelihood rehabilitation activities of PAPs, will be completed prior to any construction activities, except when a court of law orders so in expropriation cases. (Livelihood restoration measures must also be in place but not

necessarily completed prior to construction activities, as these may be ongoing activities.)

XX. Organization and administrative arrangements for the effective preparation and implementation of the resettlement plan will be identified and in place prior to the commencement of the process; this will include the provision of adequate human resources for supervision, consultation, and monitoring of land acquisition and rehabilitation activities

XXI. Appropriate reporting (including auditing and redress functions), monitoring and evaluation mechanisms, will be identified and set in place as part of the resettlement management system. An external monitoring group will be hired

Based on the Project Policy, the entitle matrix is defined as **Table 7.39**.

Table 7.47 Entitle Matrix for the Project

	Type of Loss	Application	Definition of Entitled Person	Compensation Policy	Implementation Issues	Responsible Agency
1	Loss of land	Vacant plot, Agricultural land homestead land	Irrespective of title	• Compensation at replacement value or land-for-land where feasible. If land-for-land is offered, titles will be in the name of original landowners. Joint titles in the name of husband and wife will be offered in the case of married APs. • Fees, taxes, and other charges related to replacement land. • Notice to harvest standing seasonal crops and compensation in item 2.	•Finding alternative lands	• The Divisional Secretary will make arrangements for alternative lands and determine the rental allowance in case of emergency shifting.
2	Loss of Residential Structure	Permanent and full loss of residential structure	Occupants irrespective of title	• Project bare the cost of construction of the Affected Residential Structure as per District Housing Committee regulations. • Shifting assistance for households. • Rental allowance per month in case of emergency shifting until the offer of permanent relocation to new house. • Replacement value of the structure and other assets in the land (or part of the structure and other assets, if remainder is viable).	•Finding alternative lands	• The Divisional Secretary will determine the rental allowance in case of emergency shifting.
3	Impacts on vulnerable APs	All impacts	Vulnerable APs Vulnerable APs including the poor, elderly APs, ethnic minority households, female-headed households, and disabled	•Land. Further to item 1, in case of total loss of land, and a total dependency on agriculture, land-for-land compensation if signified by the AP. •A special grant of Rs 15,000 per AP/household to improve living standards of vulnerable APs and households •Vulnerable families eligible for government welfare assistance, will be supported with Samrudhi poverty alleviation scheme or PIMA scheme	•Vulnerable households will be identified during the census.	•Regional Office will verify the extent of impacts through a 100% surveys of AHs determine assistance, verify and identify vulnerable households.

	Type of Loss	Application	Definition of Entitled Person	Compensation Policy	Implementation Issues	Responsible Agency
				•Employment in civil works for this Project		
3	Loss and temporary impacts on common resources	Common resources	Communities	• Replacement or restoration of the affected community facilities – including public water stand posts, public utility posts, temples, shrines, etc.	-	•EA and Contractor.
4	Livelihood Restoration (Grant & Training)	Permanent effects on livelihood	APs/household	•Training for up to two members (male and female where applicable) of AP households to receive skills and vocational training, to an amount of Rs 12,000 per member; •Training, credit access and skill training support for maximum two youths (one male and one female) from the resettled families for livelihood strengthening with the help of NGOs	•Requirement of the training need to be identified	Regional Office
5	Any other loss not identified	-	-	• Unanticipated resettlement impacts will be documented and mitigated based on the principles of the Resettlement Framework.	-	• Regional Office will ascertain the nature and extent of such loss. EA will finalize the entitlements in line with the Resettlement Framework.

7.10.4 Scope of Land Acquisition and Resettlement Impact

Most of the sites are located in government land, and NWSDB will lease the land with payment. On the other hand, there are two private lands and the total area of these is 2.2 acres.

1) Number of Project affected Units

The number of the Project affected units and persons is listed in **Table 7.48**.

Table 7.48 Number of Project Affected Persons

Type of loss	No of PAUs (HH)			No of PAPs		
	Legal	Illegal	Total	Legal	Illegal	Total
Required for displacement						
1 Structure owner on Gov. land	0	1	1	0	0	0
Total	0	1	1	0	0	0

Land

Location	Land Type	Affected (m2)	Total
Mahakanaradawa Project Site	Housing Land	1,000	1,000
Total	Housing Land	1,000	1,000

Premises

Location	Type of building	Sub total	Total
Mahakanaradawa Project Site	Single stories, brick, asbestos sheet roof	1	1

2) Cut off date

The cut-off-date of eligibility refers to the date prior to which the occupation or use of the project area makes residents/users of the same eligible to be categorized as PAPs and be eligible to Project entitlements. In the Project, Cut-off dates for titleholders will be the date of notification under the Land Acquisition Act and for non-titled holders will be the beginning date of the population census. This date has been disclosed to each affected village by the relevant local governments and the villages have disclosed to their populations. The establishment of the eligibility cut-off date is intended to prevent the influx of ineligible non-residents who might take advantage of Project entitlements.

7.10.5 Measures of Compensation and Assistance

(1) Institutional responsibility

Institutional responsibility is listed in **Table 7.49**.

Table 7.49 Institutional Responsibility

Institution	Responsibility
Project Management and Coordination Unit (PMCU) in NWSDB	Preparation of RAP, holding stakeholder meeting, implementing RAP with DS,
Board of directors in NWSDB	Internal approving body for RAP
Project Director (PD)	Management of planning and implementation, monitoring
NWSDB	Payment of compensation
District secretariat	Estimation of compensation (evaluation officer)
Divisional secretariat	Approving RAP, finding and providing land for relocation, providing permission of survey, providing long-term lease permission, implementing RAP with NWSDB, grievance management
Grama Niladhari	Addressing of PAP
Other stakeholders	Consulting the RAP implementation,

(2) Compensation

Currently identified PAP is one household in Mahanakandarawa area, The result of interview done by NWSDB is attached as **Appendix 7.10(a)**, The identified PAP and his entitle, compensation are shown in **Table 7.50**.

Table 7.50 Identified PAP

	Name of affected person Entitlement	Impact	Compensation
1	Mr. A. O. Anurusiri Permanent and full loss of residential structure Occupants irrespective of title	Loss of house in Mahakanadarawa WTP site	• Project bare the cost of construction of the Affected Residential Structure as per District Housing Committee regulations. • Shifting assistance for households. • Rental allowance per month in case of emergency shifting until the offer of permanent relocation to new house. • Replacement value of the structure and other assets in the land (or part of the structure and other assets, if remainder is viable).

7.10.6 Grievance Redress Mechanism (GRM)

The first contact person respond to a grievance is the Divisional Secretariat land officer. The land officer and social specialist will take care to resolve grievances. If the grievance is not settled, DS will contact to PMCU and PMCU will make a discussion for grievance mediation in presence of DS officer . If the problem is not solved, the person can appeal to the court.

7.10.7 Monitoring

PMCU is responsible for monitoring and appoints one social specialist to carry out it. The

monitoring form is used for reporting. The result of monitoring has to be shared by periodic reports and ad hoc reports with the request of PD.
The monitoring form is shown below.

Table 7.51 Monitoring Form

Preparation of resettlement site

No	Explanation of the site (e.g. Area, etc.)	Status (Completed (date) / not complete)	Details (e.g.Site selection, identification of candidate sites, discussion with PAPs, Development of the site, etc.)	Expected Date of Completion
1				
2				
3				
4				

Public Consultation

No	Date	Place	Contents of the consultation / main comments and answers
1			
2			

Resettlement activities

Resettlement activities	Planned Total	Unit	Progress in Quantity			Progress in %		Expected Date of Completion	Responsible Organization
			During the Quarter	Till the Last Quarter	Up to the Quarter	Till the Last Quarter	Up to the Quarter		
Preparation of RAP									
Approval of RAP									
Finalization of PAPs List									
Progress of Compensation Payment									
Progress of Land Acquisition (All Lots)									
Lot 1									
Lot 2									
Progress of Relocation of People									

7.10.8 Human Resettlement Cost and Finance

NWSDB made an estimation for resettlement cost, and it is shown in **Table 9.52**.

Table 7.52 Human Resettlement Cost

	Activity	Total (SLR)
1	Estimate cost for the structure (House)	3,634,874
2	Cost for providing Water	30,000
3	Cost for providing Electricity	100,000
4	Transportation cost for furniture and other house equipments	5,000
5	Rental allowance (if necessary) Rs 5,000 per month	60,000
	Total	3,829,847

The estimation was done by NWSDB, but officially, it should be done by District Estimation Officer. The official estimation will be submitted.
The all cost regarding resettlement is bared by a project proponent, NWSDB.

7.10.9 Implementation Schedule of Land Acquisition and Resettlement

The schedule prepared by the NWSDB for the land acquisition and resettlement are shown below.

Table 7.53 Schedule for acquiring Private Lands

Step	Description	Period	
		from	to
1	Publication of gazette notification under section 92 of NWSDB Act and sending proposal for acquisition to the land ministry.	Completed	
2	Order under section 2 of land acquisition Act and relevant matters after which, Divisional Secretary publish the section 02 notice in three languages and send a survey requisition to the senior superintend of surveys to prepare an advanced tracing.	01 Nov2012	30 Nov 2012
3	Senior superintend of surveys prepare the advance tracing and send it to the Divisional Secretary	01 Dec 2012	28 Feb 2013
4	Action under section 4 includes calling for objections and inquiry.	01 Mar 2013	31 May 2013
5	Action under provision 38 (a) and section 5 (after the inquiries over) which will indicate that ministry of lands decides to acquire the land for public purpose.	01 Jun 2013	31 Aug 2013
6	Preparing survey plan and compensation measures as per Section 7 and section 8 the Land Acquisition Act.	01 Sep 2013	31 Dec 2013

Table 7.54 Schedule for acquiring Government Lands

Step	Description	Period	
		From	To
1	Send the request to the Divisional Secretary to get the scheduled land by NWSDB	Completed	
2	Divisional Secretary and NWSDB requests regarding the land and details, consent of the relevant organization to which land belongs	01 Nov 2012	31 Dec 2012
3	Preparation of report by the Divisional Secretary regarding the state land get approval from land commission. Through the provincial land commission. If the land belong to any other organization, then preparation of report by Divisional Secretary regarding the land and get approval from Land use Planning committee and send to land commission	01 Jan 2013	30 Apr 2013
4	After the land commission General's approval, land will be handed over to the NWSDB by the Divisional Secretary.	01 May 2013	30 Sep 2013
5	Signing the lease agreement with NWSDB	01 Oct 2013	30 Apr 2013

Table 7.55 Relocation and Resettlement Plan for House holder at Mahakanadarawa Treatment plant site

Steps	Description	Period	
1.	Prepare a resettlement action plan for resettlement process	01 Oct 2012	31 Dec 2012
2.	Negotiation and agreement with the House holder for resettlement process	Already House holder has agreed with NWSDB for the resettlement	
3.	Prepare memorandum of understanding MOU), sign it with the house holders and send MOU to Divisional Secretary and request a land to construct house	01 Oct 2012	31 Dec 2012
4.	Construction of the house and resettlement of the House holder	01 Jan 2014	31 Dec 2014

The NWSDB and DSD made an agreement with the occupant. He said in the agreement that he understood the condition and he agreed to leave the place after he receive new house constructed at the 20P plot of land allocated by the DS. (Appendix 9.10(b))

7.11 Environmental Check List

The evaluation with the JICA checklist is shown in **Table 7.49**.

Table 7.56 Environmental Checklist

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/A (b) N/A (c) N/A (d) Y	(a) (b) (c)Under currently proposed project condition, EIA is not required. On the other hand, IEE level research was done by the Project. (d) Obtained clearances are as follows; ・ Clearance of Archeology dept ・Clearance of Irrigation dept ・ Clearance of Forest dept ・Clearance of CEA
	(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) Y	(a) NWSDB carried out the explanation session on 7th August. After election (8th September), NWSDB held the stakeholder meeting-23th September.(For Wahalkada) (b) The water intake procedure is changed due to the comment of the Irrigation Dept. The water intake quantity ~~is~~ will be decided with the agreement of stakeholders in case of unexpected drought.
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) Y	(a) Water intake procedure, location of facilities, course of pipe laying, treatment procedure were examined and the relative low impact plan was selected..

<table>
<tr><th>Category</th><th>Environmental Item</th><th>Main Check Items</th><th>Yes: Y
No: N</th><th>Confirmation of Environmental Considerations
(Reasons, Mitigation Measures)</th></tr>
<tr><td>2 Pollution Control</td><td>(1) Air Quality</td><td>(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?</td><td>(a) N
(b) N</td><td>(a) The chlorine gas neutralization system is provided. The gas leak detector will be installed whih is able to start the neutralization system automatically so that the possibility of chlorine gas leakage is very low.
(b) Sri Lankan Occupational Health Standards for chlorine is not existing. The facility will be designed to satisfy the American standards. Operation of exhaust fan acchives the standard requirement.

Occupational Safety and Health Guideline for Chlorine
<table><tr><th></th><th>ppm</th><th>mg/m3</th><th></th></tr><tr><td>Permissible exposure limit</td><td>1</td><td>3</td><td>US dept of Labor</td></tr><tr><td>Advisable limit</td><td>0.5</td><td>1.5</td><td>NIOSH</td></tr><tr><td>Evaluation standard</td><td>0.5</td><td>1.5</td><td>Japan</td></tr></table>
Ambient Air Quality
<table><tr><th></th><th>Pollutant</th><th>Averaging Time*</th><th>Maximum Permissible Level</th><th></th><th>Method of measurement</th></tr><tr><th></th><th></th><th></th><th>µgm-3</th><th>ppm</th><th></th></tr><tr><td>1</td><td>Particulate Matter - Aerodynamic diameter is less than 10 µm in size (PM 10)</td><td>Annual</td><td>50</td><td>Ñ</td><td>Hi-volume sampling and Gravimtric or Beta Attenuation</td></tr><tr><td></td><td></td><td>24 hrs.</td><td>100</td><td>Ñ</td><td></td></tr><tr><td>2</td><td>Particulate Matter - Aerodynamic diameter is less than 2.5 µm in size (PM 2.5)</td><td>Annual</td><td>25</td><td>Ñ</td><td>Hi-volume sampling and Gravimtric or Beta Attenuation</td></tr><tr><td></td><td></td><td>24 hrs.</td><td>50</td><td>Ñ</td><td></td></tr><tr><td>3</td><td>Nitrogen Dioxide (NO 2)</td><td>24 hrs.</td><td>100</td><td>0.05</td><td>Colorimetric using saltzman Method or equivalent Gas phase chemiluminescence</td></tr><tr><td></td><td></td><td>8 hrs.</td><td>150</td><td>0.08</td><td></td></tr><tr><td></td><td></td><td>1hr.</td><td>250</td><td>0.13</td><td></td></tr><tr><td>4</td><td>Sulphur Dioxide (SO 2)</td><td>24 hrs.</td><td>80</td><td>0.03</td><td>Pararosaniliene Method or equivalent Pulse Flourescent</td></tr><tr><td></td><td></td><td>8 hrs.</td><td>120</td><td>0.05</td><td></td></tr><tr><td></td><td></td><td>1hrs.</td><td>200</td><td>0.08</td><td></td></tr><tr><td>5</td><td>Ozone (O 3)</td><td>1 hr.</td><td>200</td><td>0.1</td><td>Chemiluminescence Method or equivalent Ultraviolet photometric</td></tr><tr><td>6</td><td>Carbon Monoxide (CO)</td><td>8 hrs.</td><td>10,000</td><td>9</td><td>Non-Dispersive Infrared SpectroscopyÓ</td></tr><tr><td></td><td></td><td>1 hr.</td><td>30,000</td><td>26</td><td></td></tr><tr><td></td><td></td><td>Any time</td><td>58,000</td><td>50</td><td></td></tr></table></td></tr>
</table>

<table>
<tr><th>Category</th><th>Environmental Item</th><th>Main Check Items</th><th>Yes: Y
No: N</th><th>Confirmation of Environmental Considerations
(Reasons, Mitigation Measures)</th></tr>
<tr><td rowspan="2"></td><td>(2) Water Quality</td><td>(a) Do pollutants, such as SS, BOD, COD contained in effluents discharged by the facility operations comply with the country’s effluent standards?</td><td>(a) Y</td><td>(a) Turbid water generated during construction works is collected to the sedimentation pond for solid-liquid separation. Domestic wastewater of employees is treated by a septic tank and supernatant is discharged into a soak pit for infiltration into the ground. The backwash drain generated during by the usual plant operation is collected in to drain ponds for solid-liquid separation. So the treated effluent will meet the Sri Lankan discharge water quality standard.
Tolerable limit of discharge to inland surface water
<table><tr><th>No.</th><th>Parameter</th><th>Unit type of limit</th><th>Tolerance Limit values</th></tr><tr><td>1</td><td>Total suspended solids</td><td>mg/1, max.</td><td>50</td></tr><tr><td>2</td><td>Particle size of the total suspended solids</td><td>µm, less than</td><td>50</td></tr><tr><td>3</td><td>pH at ambient temperature</td><td>-</td><td>6.0 - 8.5</td></tr><tr><td>4</td><td>Biochemical oxygen demand (BOD $_5$ 5 days at 20 ºC or BOD3 - days at 27ºC)</td><td>mg/1, max.</td><td>30</td></tr><tr><td>5</td><td>Temperature of discharge</td><td>℃, max.</td><td>Shall no exceed 400 ℃ in any section of the stream within 15 m down stream from the effluent outlet.</td></tr><tr><td>6</td><td>Oils and greases</td><td>mg/1, max.</td><td>10</td></tr><tr><td>7</td><td>Phenolic compounds (as C $_6$H$_5$OH)</td><td>mg/2, max.</td><td>1</td></tr><tr><td>8</td><td>Chemical oxygen demand (COD)</td><td>mg/3, max.</td><td>250</td></tr><tr><td>9</td><td>Colour</td><td>Wavelength Range
436 nm (Yellow range)
525nm (Red range)
620nm (Blue range)</td><td>Maximum spectral absorption coefficient
7m^{-1}
5m^{-1}
$^{-}$5^{-1}</td></tr><tr><td>10</td><td>Dissolved phosphates (as P)</td><td>mg/1, max.</td><td></td></tr><tr><td>11</td><td>Total Kjeldahl nitrogen (as N)</td><td>mg/1, max.</td><td>150</td></tr><tr><td>12</td><td>Ammoniacal nitrogen (as N)</td><td>mg/1, max.</td><td>50</td></tr><tr><td>13</td><td>Cyanide (as CN)</td><td>mg/1, max.</td><td>0.2</td></tr><tr><td>14</td><td>Total residual chlorine</td><td>mg/1, max.</td><td>1</td></tr><tr><td>15</td><td>Flourides (as F)</td><td>mg/1, max.</td><td>2</td></tr><tr><td>16</td><td>Sulphide (as S)</td><td>mg/1, max.</td><td>2</td></tr><tr><td>17</td><td>Arsenic (as As)</td><td>mg/1, max.</td><td>0.2</td></tr><tr><td>18</td><td>Cadmium (as Cd)</td><td>mg/1, max.</td><td>0.1</td></tr><tr><td>19</td><td>Chromium, total (as Cr)</td><td>mg/1, max.</td><td>0.5</td></tr><tr><td>20</td><td>Chromium, Hexavalent (as Cr6+)</td><td>mg/1, max.</td><td>0.1</td></tr><tr><td>21</td><td>Copper (as Cu)</td><td>mg/1, max.</td><td>3</td></tr><tr><td>22</td><td>Iron (as Fe)</td><td>mg/1, max.</td><td>3</td></tr><tr><td>23</td><td>Lead (as Pb)</td><td>mg/1, max.</td><td>0.1</td></tr><tr><td>24</td><td>Mercury (as Hg)</td><td>mg/1, max.</td><td>0.0005</td></tr><tr><td>25</td><td>Nickel (as Ni)</td><td>mg/1, max.</td><td>3</td></tr><tr><td>26</td><td>Selenium (as Se)</td><td>mg/1, max.</td><td>0.05</td></tr><tr><td>27</td><td>Zinc (as Zn)</td><td>mg/1, max.</td><td>2</td></tr><tr><td>28</td><td>Pesticides</td><td>mg/1, max.</td><td>0.005</td></tr><tr><td>29</td><td>Detergents/surfactants</td><td>mg/1, max.</td><td>5</td></tr><tr><td>30</td><td>Faecal Coliform</td><td>MPN/100 ml, max</td><td>40</td></tr><tr><td>31</td><td>Radio Active Material :</td><td></td><td></td></tr><tr><td></td><td>(a) Alpha emitters</td><td>micro curie/ml, max</td><td>10^{-8}</td></tr><tr><td></td><td>(b) beta emitters</td><td>micro curie/ml, max</td><td>10^{-7}</td></tr></table></td></tr>
<tr><td>(3) Wastes</td><td>(a) Are wastes, such as sludge generated by the facility operations properly treated and disposed in accordance with the country’s regulations?</td><td>(a) Y</td><td>(a) The generated sludge is collected from chemical sedimentation basins and condensed by thickener. Condensed sludge is transferred to sludge lagoons to be dried by solar evaporation. The dried sludge is hauled to the solid waste dumping site for final disposal.</td></tr>
</table>

<table>
<tr><th>Category</th><th>Environmental Item</th><th>Main Check Items</th><th>Yes: Y
No: N</th><th>Confirmation of Environmental Considerations
(Reasons, Mitigation Measures)</th></tr>
<tr><td rowspan="2"></td><td>(4) Noise and Vibration</td><td>(a) Do noise and vibrations generated from the facilities, such as pumping stations comply with the country’s standards?</td><td>(a) Y</td><td>(a) The main generating sources of noise and vibration are generator and pump. The low-noise type and low- vibration type equipment is selected for reduction of noise and vibration and installed in the building so as to meet the Sri Lankan standards. The standards to be followed is shown below.

Maximum permissible Noise Levels at Boundaries of the land in which source of noise is located in LaeqÕ ,T, for construction activities
<table><tr><th></th><th>LaeqÕ, T</th></tr><tr><td>Day time</td><td>75</td></tr><tr><td>Night time</td><td>50</td></tr></table>
Maximum permissible Noise Levels at Boundaries in LAeq, T, for industrial activities
<table><tr><th>Aria</th><th>Day time</th><th>Night time</th></tr><tr><td>Rural Residential Area</td><td>55</td><td>45</td></tr><tr><td>Urban Residential Area</td><td>60</td><td>50</td></tr><tr><td>Noise Sensitive Area</td><td>50</td><td>45</td></tr><tr><td>Mixed Residential</td><td>63</td><td>55</td></tr><tr><td>Commercial Areas</td><td>65</td><td>55</td></tr><tr><td>Industrial Area</td><td>70</td><td>60</td></tr><tr><td colspan="3">Japanese Environmental Standard</td></tr><tr><td>A (residential area)</td><td>55</td><td>45</td></tr></table></td></tr>
<tr><td>(5) Subsidence</td><td>(a) In the case of extraction of a large volume of groundwater, is there a possibility that the extraction of groundwater will cause subsidence?</td><td>(a) N</td><td>(a) The project does not extract groundwater.</td></tr>
<tr><td>3 Natural Environment</td><td>(1) Protected Areas</td><td>(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?</td><td>(a) N</td><td>(a) The project area is located outside of protected area. However, the environmental impact should be minimized.</td></tr>
</table>

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(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/A (d) N	(a) Some part of project area is located in the forest but the forest does not require special attention for conservation. (b) According to the report of ecological survey, a few number of endemic and endangered species were found. But these species are dominant in the wet area, and the protection of habitat in the project area is not so seriously required. . (c) The significant ecological impact is not expected. (d) The project takes water from irrigation canal so the adverse effect to the aquatic environment is limited. Furthermore, the purpose of the use of the project, the water will let flow on a steady basis. it will improve the environment.
	(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) Currently, the water is used only the purpose of irrigation. The project will share a part of current water use, so the effect is negligible.

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) Y (b) Y (c) Y (d) Y (e) Y (f) N/A (g) Y (h) Y (i) Y (j) Y	(a) One illegal occupants house is located in the Mahakanadarawa WTP site. NWSDB is preparing RAP in accordance with the JICA guidelines and Sri Lankan 'National Involuntary Resettlement Policy' . (b) NWSDB and DSD explained the Project and necessity of change of the land use to the occupant. The occupant understood the necessity of the Project and agreed to leave the place. (c) Compensation with full replacement costs, restoration of livelihoods and living standards are secured. (d) Compensations will be paid prior to the physical resettlement. (e) Sri Lanka has 'National Involuntary Resettlement Policy' approved by Cabinet in 2001. And there is no big gap from JICA Guideline. (f) The occupants are married couple only and belong to ethnically major group. They will be supplied the new land near their relatives. They are not considered as people in vulnerable group. (g) NWSDB obtained the agreement letter from occupants. (h) NWSDB shall bare the cost for resettlement. The estimation is done by District evaluation officer. Divisional secretariat and NWSD are responsible for taking care of the ocupants. (i) Monitoring plan is written in the RAP. (j) DS is the first contact window of grievance. If the problem is not solved, DS will request the participation of NWSDB and find the solution.
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) Y (b) N	(a) Currently, the farmers in the area feel that the water supply capacity is not sufficient, but the other parallel going project for integration of irrigation system will increase the water supply in the area and the total water demand will be secured. (b) The villagers living the surrounding of the tank use tank water for domestic use. But same reason described above can solve the potential problem.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(3) Heritage	(a) Is there a possibility that the project will damage the local archaeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a) N	(a) The project area is not located in archaeological reserves. However, the project will take care and make an action plan in the case of excavating antiquities.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) N	(a) The size of all facilities are small and the effect on the landscape is ignorable.
	(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/A (b) N/A	There is no indigenous group in the project area. And any ethnic minorities are not affected by the project.
	(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) N (b) Y (c) Y (d) Y	(a) NWSDB follows the Labor law, Factories Ordinance. (b) The contract condition is made under the 'Standard Bidding Document Procurement of Works' or 'Conditions of Contract'. And the Occupational safety and hazardous management will be secured. (c) It will be specified in a contract document, and implemented (d) It will be specified in a contract document, and implemented.

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) Y (c) Y (d) Y	(a) The contractor has to obey the contract document and take appropriate measures to protect environment and social conditions. ・Noise and vibration is controlled by the proper use of well maintained vehicles and machineries. The night time work is avoided. In case, the use of special tools or material to reduce the noise and vibration such us sound barrier is used. ・Turbid water is collected separately and treated by sedimentation basin. if necessary the coagulant will be used. ・Waste will be managed by the contractor. It shall be segregated and recycled as much as possible. Temporally stock place is secured and the waste is treated with the consultation of DS. ・Dust is controlled by watering and use of cover. ・Emission of exhausted gases is manageable by use of registered vehicles and machinery with proper maintenance. (b) The protection and mitigation measures are taken. (c) The people living in the project site is only one married couple,. RAP is prepared for them for fair resettlement.. (d) The construction activities are prenticed to the inhabitant who is potentially affected for traffic congestion. Construstion plan is descloised.

<table>
<tr><th>Category</th><th>Environmental Item</th><th>Main Check Items</th><th>Yes: Y
No: N</th><th>Confirmation of Environmental Considerations
(Reasons, Mitigation Measures)</th></tr>
<tr><td>5 Others</td><td>(2) Monitoring</td><td>(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?</td><td>(a) Y
(b) refer the plan
(c) Y
(d) Y</td><td>(a)(b)(c)The project prepares the monitoring plan, shown below.
(d) The project is requested to obtain the EPL (Environmental Protection License). The reporting format is included. The license is fixed-term and reporting is requested.
Monitoring Plan
<table>
<tr><th>Items</th><th>Monitoring parameters</th><th>Procedure</th><th>Frequency</th><th>Implemented and reported by</th><th>Report to</th></tr>
<tr><td>Designing stage</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Procurement</td><td>Suitability of specification</td><td>Checking the specification to meet the proposed mitigation measures</td><td>1 time</td><td>NWSDB</td><td>PMCU</td></tr>
<tr><td>Waste</td><td>Waste management procedure</td><td>Checking dumping plan and obtaining agreement with local authority</td><td>1 time</td><td>NWSDB</td><td>PMCU</td></tr>
<tr><td>Resettlement</td><td>Progress of resettlement plan</td><td>Checklist of resettlement plan</td><td>1 time</td><td>NWSDB</td><td>PMCU</td></tr>
<tr><td>Ecological environment</td><td>Clearing land procedure</td><td>Checking the plan of clearing and obtaining permission</td><td>1 time</td><td>NWSDB</td><td>PMCU</td></tr>
<tr><td></td><td>Rare species</td><td>Checking the plan of transplant and recovery of habitat</td><td>1 time</td><td>NWSDB</td><td>PMCU</td></tr>
<tr><td>Social impact caused by laborer of construction</td><td>Awareness raising program</td><td>training plan of laborer</td><td>1 time</td><td>NWSDB</td><td>PMCU</td></tr>
<tr><td>Construction stage</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Air quality</td><td>Vehicle maintenance condition</td><td>Check the registered vehicles and its maintenance record</td><td>Once a month</td><td>Contractor</td><td>PMCU</td></tr>
<tr><td></td><td>Dust</td><td>Observation at the site</td><td>Once a month</td><td>Contractor</td><td>PMCU</td></tr>
<tr><td></td><td>Chlorine gas emission</td><td>Check and calibrate the gas leak detector</td><td>Once a month</td><td>Contractor</td><td>PMCU</td></tr>
<tr><td>Water quality</td><td>Discharge water quality</td><td>Measurement of turbidity</td><td>Everyday during soil work</td><td>Contractor</td><td>PMCU</td></tr>
<tr><td>Noise</td><td>Working time of construction</td><td>Working record</td><td>Once a week</td><td>Contractor</td><td>PMCU</td></tr>
<tr><td></td><td>Noise at boundary</td><td>Measurement of noise at the boundary of the site</td><td>Once a month both in daytime and night time</td><td>Contractor</td><td>PMCU</td></tr>
<tr><td>Ecological environment</td><td>Violation to ecosystem such as cutting tree, hunting, killing taking plants and animals, disturbing habitat etc.</td><td>Patrol of construction site</td><td>Once a week</td><td>Contractor</td><td>PMCU</td></tr>
<tr><td>Waste</td><td>Construction waste</td><td>Condition of segregation
Past record of recycling</td><td>Every 3 months</td><td>Contractor</td><td>PMCU</td></tr>
<tr><td></td><td>Domestic waste</td><td>Observation of temporally dumping yard</td><td>Every 3 months</td><td>Contractor</td><td>PMCU</td></tr>
<tr><td>Operation stage</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Air quality</td><td>Chlorine gas leakage</td><td>Measurement of gas concentration and checkand calibration of gas leak</td><td>Once a week</td><td>NWSDB RSC</td><td>NWSDB</td></tr>
<tr><td>Raw water quality</td><td>Parameters listed in drinking water quality</td><td>Chemical analysis by laboratory</td><td>Once a month</td><td>NWSDB RSC</td><td>NWSDB</td></tr>
<tr><td>Distributing water quality</td><td>Parameters listed in drinking water quality</td><td>Chemical analysis by laboratory</td><td>Once a month</td><td>NWSDB RSC</td><td>NWSDB</td></tr>
<tr><td>Discharge water quality</td><td>Parameters listed in discharge water quality</td><td>Chemical analysis by laboratory</td><td>Every 3 months</td><td>NWSDB RSC</td><td>NWSDB</td></tr>
<tr><td>Occupational safety</td><td>Chlorine gas leakage</td><td>Measurement of gas concentration</td><td>Checking the daily record</td><td>NWSDB RSC</td><td>NWSDB</td></tr>
<tr><td>Noise</td><td>Noise at the boundary</td><td>Measurement of noise</td><td>Every 3 months</td><td>NWSDB RSC</td><td>NWSDB</td></tr>
<tr><td>Waste</td><td>Sludge</td><td>Observation of the drying bed
Checking the record of sludge disposal</td><td>Every 4 months</td><td>NWSDB RSC</td><td>NWSDB</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Category</th><th>Environmental Item</th><th>Main Check Items</th><th>Yes: Y
No: N</th><th>Confirmation of Environmental Considerations
(Reasons, Mitigation Measures)</th></tr>
<tr><td></td><td></td><td></td><td></td><td>Monitoring plan of resettlment
Preparation of resettlement site
<table><tr><th>No</th><th>Explanation of the site (e.g. Area, etc.)</th><th>Status (Completed (date) / not complete)</th><th>Details (e.g.Site selection, identification o candidate sites, discussion with PAPs, Development of the site, etc.)</th><th>Expected Date of Completion</th></tr><tr><td>1</td><td></td><td></td><td></td><td></td></tr><tr><td>2</td><td></td><td></td><td></td><td></td></tr><tr><td>3</td><td></td><td></td><td></td><td></td></tr><tr><td>4</td><td></td><td></td><td></td><td></td></tr></table>Public Consultation
<table><tr><th>No</th><th>Date</th><th>Place</th><th>Contents of the consultation / main comments and answers</th></tr><tr><td>1</td><td></td><td></td><td></td></tr><tr><td>2</td><td></td><td></td><td></td></tr></table>Progres
<table><tr><th rowspan="2">Resettlement activities</th><th rowspan="2">Planned Total</th><th rowspan="2">Unit</th><th colspan="3">Progress in Quantity</th><th colspan="2">Progress in %</th><th rowspan="2">Expected Date of Completion</th><th rowspan="2">Responsible Organization</th></tr><tr><th>During the Quarter</th><th>Till the Last Quarter</th><th>Up to the Quarter</th><th>Till the Last Quarter</th><th>Up to the Quarter</th></tr><tr><td>Preparation of RAP</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Approval of RAP</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Finalization of PAPs List</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Progress of Compensation Payment</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Progress of Land Acquisition (All Lots)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Lot 1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Lot 2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Progress of Relocation of People</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table></td></tr>
<tr><td rowspan="2">6 Note</td><td>Reference to Checklist of Other Sectors</td><td>(a) Where necessary, pertinent items described in the Dam and River Projects checklist should also be checked.</td><td>(a) N/A</td><td>(a) The project does not develop the dam and canal. The project only use the existing facilities for irrigation. There is no item to conflict with the Dam and River Projects checklist.</td></tr>
<tr><td>Note on Using Environmental Checklist</td><td>(a) If necessary, the impacts to transboundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).</td><td>(a) N/A</td><td>(a) There is no negative impact to transboundary or global issues because the project is small scale water supply scheme targeting the improvement of living standards.</td></tr>
</table>

7.12 Recommendation

The pre-F/S was done by the NWSDB in 2011 for the Project. At that time, the Mahakanadarawa tank was not recognized as the Sanctuary, and the problem regarding water extraction was not noticed. In this study, the site selection and design were proposed for the purpose of preventing any conflict and adverse effect as much as possible. Some remaining problems are solved with the proper action of mitigation measures. Therefore the management is important to complete the mitigation measures.

The environmental adverse effect is generally limited in a water supply project. The impact is mainly created by the construction activities. For that reason, the tender document and contract paper are important to clarify the responsibility of contractor to do the positive action of environmental and social protection. The concrete monitoring scheme is also required and it must lead to immediate remedial action.

The quantity of water is limited in the area so that the Project relies on the other irrigation water developing projects. The result of social survey shows the positive willingness to obtain new safe water supply. However, the same people appealed the scarcity of water and fear of reduction of irrigation water. The explanation and awareness campaign are important to educate the people in the area and this type of work should be carried out by the NWSDB in proper manner.

CHAPTER 8

FINANCIAL AND ECONOMIC ANALYSIS

CHAPTER 8 FINANCIAL AND ECONOMIC ANALYSIS

8.1 General

This chapter of financial and economic analysis shows whether this water supply project is financially feasible and economically beneficial. The former financial feasibility is measured by the project financial internal rate of return (FIRR). If project investors are private, FIRR is thought to usually or internationally be at 12%, but this depends on the commercial bank loan interest rate and inflation rate. In Sri Lanka, the Average Weighted Lending Rate was 14.59% in May 2012, according to the web site of the Central Bank of Sri Lanka. The interest rate of ten years' Government Securities is 14.75% in July 2012. Therefore, the bank lending rate can be considered to be between 14% and 15%. The average inflation rate (consumer price) is approximately 7.5% in 2012. According to the National Account (statistics) of Sri Lanka, the deflators (used to convert gross or market price GDP to net or constant price GDP) in 2010 and 2011 are 7.29% and 7.88%, respectively. Thus, the inflation rate can be considered to be between 7% and 8%. Private investors calculate FIRR to be more than the difference between the lending rate of 14 % or 15%, and the inflation rate of 7% or 8%. That means that the minimum FIRR is 7% to 8% in net terms. However, private investors expect profits while considering risks. For example, if the investors want 5% more than the minimum FIRR, then the FIRR would become 12% or 13%.

This water supply project is a public project. The Government or NWSDB does not need to think about profit, but rather be assured of the soft loan interest rate. Therefore, the FIRR of this project should be more than the soft loan interest rate. This is the criterion for project feasibility. If the project FIRR does not satisfy the above criterion, or is too low, this does not necessarily mean that the project should not proceed.

The next method is to use economic cost-benefit analysis. If the FIRR is high enough, the project can be implemented without concern about financing because the project can be covered by the project profits. But if a project is necessary because it improves health or the welfare of the residents, and cannot be financed by the project entity, the project can be supported by the government budget and/or financed from international organizations. For example, roads excluding toll roads do not generate income, but it is necessary to invest in roads because these can facilitate development of regional industries and support people's lives. In this case, economic benefits are estimated in monetary amounts.

In this water supply project, the benefits are in the form of satisfaction expressed by willingness-to pay (WTP) and health impacts (medical cost reduction). Instead of income in the FIRR calculation, these economic benefits are estimated annually and discounted year by

year. The cost is the same as the FIRR calculation, namely, consisting of investment cost and annual operation expenses. Thus, the economic internal rate of return (EIRR) can be calculated similarly to the FIRR.

Past World Bank projects have pegged EIRR to be a minimum of 12%, but usually the EIRRs of water supply projects seem lower than the other project EIRRs. In addition to the statistical data, an *ad hoc* social and economic survey in the project site was conducted in order to define and estimate the project benefits. While the income of the project is usually related to tariffs, the payment of tariff largely depends on the economic situation of project site users, namely, their affordability of payment and/or willingness-to-pay. Therefore, the social and economic situation of the project site is summarized indicating the data on estimated benefits of the project, and affordable tariffs, taking into account willingness-to-pay.

Next, the project finance with FIRR is analyzed. After that, the economic (cost-benefit) analysis with EIRR is made to examine the project viability. Lastly, sensitivity analyses are made on the financial and economic estimates to examine uncertainties and risks.

8.2 Social and Economic Conditions (Tariffs and Economic Situations) in Project Area

This section presents the existing tariffs of CBO and NWSDB, after a summary of the general social and economic situation in the project area in Chapter 9, "Environmental and Social Considerations." In addition, willingness-to-pay and other related matters, directly related to the benefit calculation, are indicated in each benefit explanation.

After the project is completed, new water supply users can be divided into two groups. One is a direct NWSDB water user group. The other is a CBO user group, which is supplied with NWSDB water through CBO systems. The direct NWSDB users will pay the charges based on the tariffs shown in 3.3, Chapter 3. Most of the potential users in the project area are domestic and the domestic charges, which depend on the consumed water volume (m^3 per month), is shown in **Figure 8.1**. The curve seems to become steep from around 30 m^3 per month. The charges per water volume unit (m^3 per month) can be calculated and these are shown in **Figure 8.2**. The charge per unit is based on a minimum consumption of 10 m^3 per month and as consumption increases from 5 m^3 per month, the charge per unit increases. If a customer uses 18 m^3 per month, the charge is 295 Rs. and the charge per unit is 295/ 18 = 16.4 Rs./ m^3.

The CBO users at present are charged based on the tariffs of the CBOs and each CBO sets its tariff independently based on its financial situation. From the CBO survey results, the average charge per water volume unit (m^3) can be calculated by dividing monthly water sales

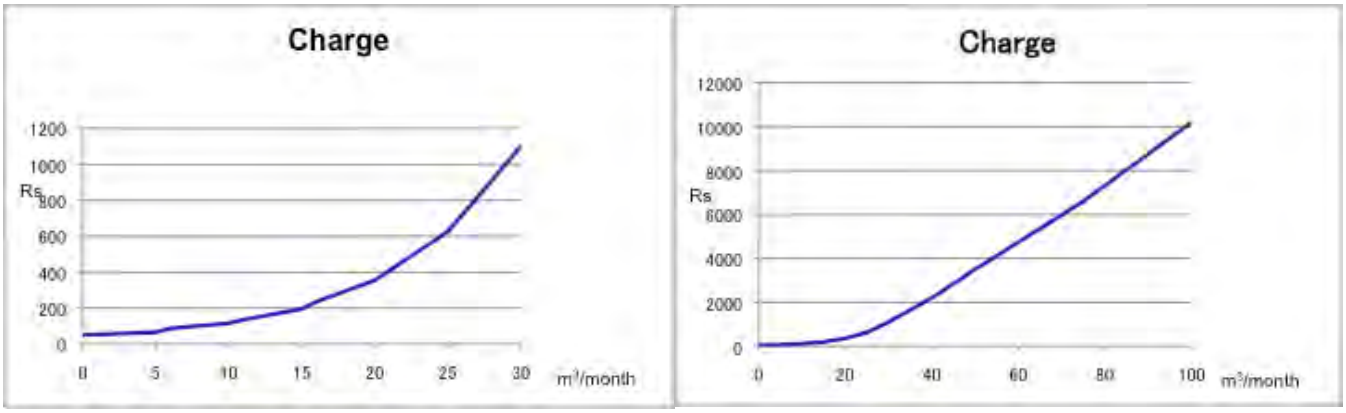


Figure 8.1 Domestic Consumer Charges

Figure 8.2 Domestic Charges per Unit

(Rs.) by monthly consumption (m^3). On the other hand, if this project is completed, the NWSDB will supply the CBOs with water. Potential users not connected to the CBOs prefer NWSDB water because of concerns about the quality of water supplied by CBOs, although some CBOs are confident about their water quality. NWSDB has tariffs for supplying bulk water to rural water supply schemes maintained by the CBOs. The NWSDB's charges based on the tariffs for CBO and the calculated charges per unit are shown in **Figure 8.3**. Using the CBO's monthly consumption, charges of the NWSDB to CBOs can be calculated and charges per unit can be obtained by dividing this by the monthly consumption. (However, note that consumption is likely to increase because CBOs supply capacities are limited as of now.) The CBO survey also questioned about the model charge for a supposed $18m^3$ monthly use based on the CBO tariffs, and the answers can be divided by the $18m^3$ and charges per unit can be obtained. These results are shown in **Table 8.1**. The water sales per unit (m^3) of the CBOs indicate an average charge which ranges from 4.7 Rs./m^3 to 44.5 Rs./m^3, the average of which is 19.6 Rs./m^3. NWSDB's average overall charge (revenue per m^3) in 2011 is 38.7 Rs./m^3 (13,320MRs./ 344.3 Mm^3) nationally and 36.1 Rs./m^3 in North Central Region. Obviously, the CBO's average charge is

cheaper than NWSDB's, although there are a few CBOs whose charges are higher than NWSDB's.

The model charges per unit (assuming 18m^3/month consumption) are cheaper than sales/m^3 except in seven cases. If the tariffs of NWSDB for CBOs are applied to the current consumption of CBOs, the charges per unit (m^3) will range from 19.3 to 24.6 of which the average is 21.4 Rs./m^3. Therefore, while some CBOs' current charges per unit are more expensive than NWSDB's charges per unit, most CBOs' are actually cheaper than NWSDB's as the averages (19.6 and 21.0, respectively) show. However, in this calculation, the average non-revenue water rate of 20%, is used in order to compare the user price. Specifically, consumption is multiplied by 1.25 (=1/0.8) to calculate the charge of NWSDB bulk water, but the NWSDB charge is divided by consumption without multiplication.

The CBO survey included a question about the proposed (willing-to-pay) price for NWSDB's bulk water. The CBO answers ranged from 20 to 30 Rs./ m^3, but most answers were 25 Rs./m^3. Therefore, CBOs may be satisfied with the NWSDB's bulk tariffs from the viewpoint of the CBO purchase unit price because the NWSDB charge is divided by consumption (multiplied by 1.25). However, the NWSDB tariffs were raised from October 1, 2012 and if the new tariffs are applied to CBO bulk payments, then the situation changes.

If the project is implemented, the CBOs will connect to the NWSDB system and will have to pay the charges to NWSDB. This will increase the CBO expenditures. Among the present expenditures of CBOs that would remain or partially remain are personnel costs, chemical costs, and maintenance costs. However, electricity costs will not be necessary.

Assuming that chemical and maintenance costs are half of the present expenditures, the cost-basis prices of the CBOs can be calculated by summing the water purchase unit price from NWSDB, personnel costs and half of the chemical and maintenance costs per unit (converting annual to monthly based on the CBO survey results). The results are shown in the right column of **Table 8.1** for reference. Some CBOs estimated cost prices are cheaper than the present CBO's charges per unit (five CBOs); however in most CBOs they are higher. The average shows an increase from 19.6 to 30.4Rs./m^3, or an increase of approximately 55%.

In addition, the tariffs of NWSDB were raised from October 1, 2012 and the usage charge was increased from 12 Rs./m^3 to 18 Rs./m^3, or a 50% increase, and monthly service charge

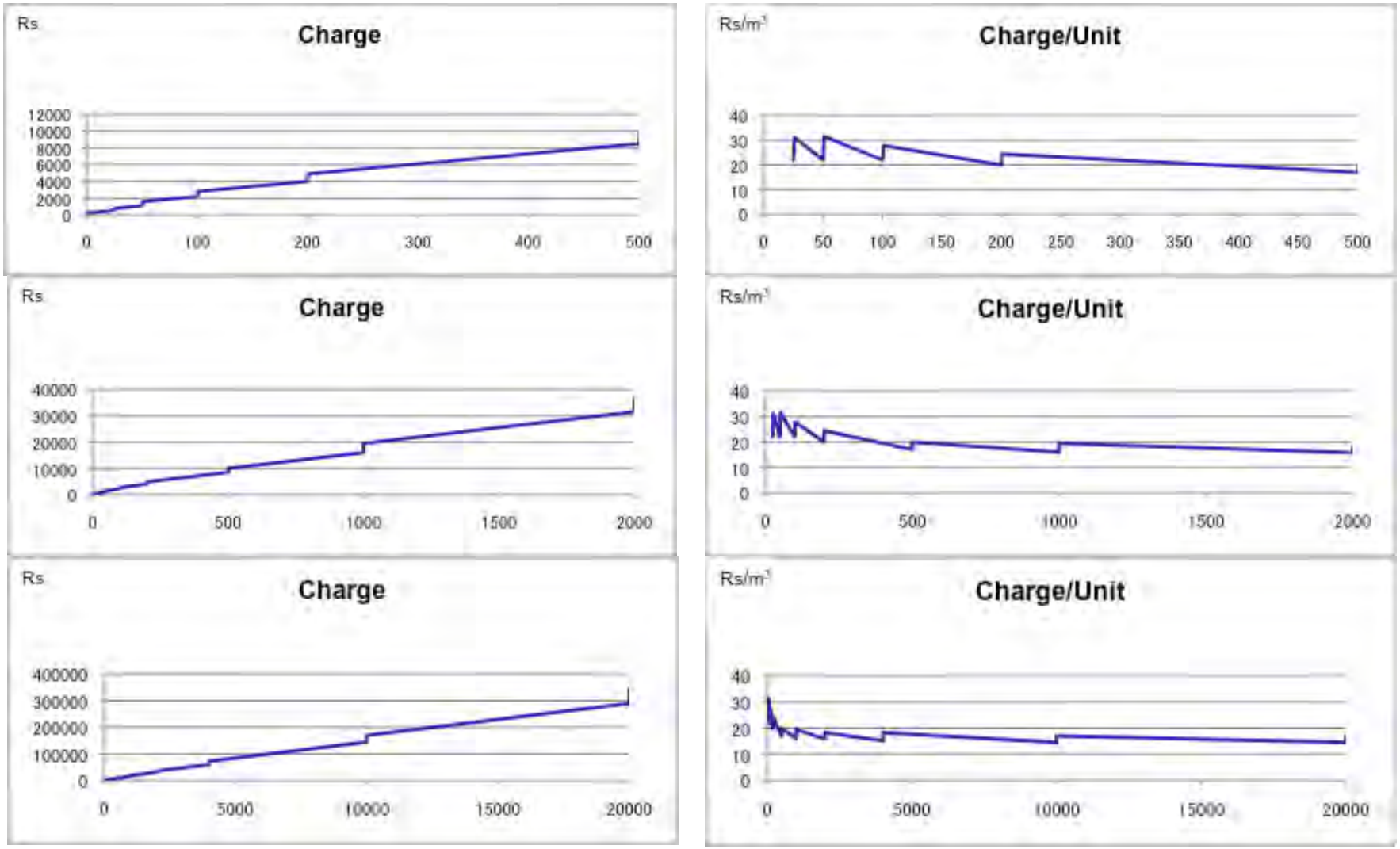


Figure 8.3 Charges of NWSDB to CBO and Charges per Unit

Table 8.1 Charges of CBOs

(Unit: Rs.)

DSD	GND	CBO	Consumption (m^3/month)	Water sales (Rs./month)	Sales/m^3 (Aver. Charge)	Model charge/m^3	NWSDB tariff	Proposed bulk tariff/ m^3	Cost-based price estimate
Padaviya	Padaviya	Suwasehana	1,989	34,502	17.3	13.1	21.3	25.0	29.8
	Parakramapura	Parakum	9,307	43,435	4.7	11.5	20.4	20.0	24.0
	Bogahawewa	Suwasetha	2,661	58,421	22.0	17.2	19.7	22.0	27.4
Kebithigollewa	Ayyatigewewa	Shakthi	2,583	39,069	15.1	12.6	19.8	25.0	29.6
Medawachchiya	Kidawarankulama	Sisila Diyadahara	1,762	36,255	20.6	15.0	22.1	-	29.7
	Maha Kumbugollewa	Diriyamatha	1,460	36,739	25.2	23.9	20.1	NWSDB Tariff	33.4
	Periyakulama &Yakawewa	Diriyashakthi	1,365	37,400	27.4	20.0	20.5	-	29.3
	Hirulugama	Ekamuthu	1,953	29,868	15.3	14.8	21.4	-	31.0
	Athakade	Ridinadi	938	27,756	29.6	21.7	23.0	25.0	35.1
	Ataweeragollewa	Samagi	1,266	19,486	15.4	15.0	20.9	NWSDB Tariff	27.6
	Maha Divulwewa	Gemunu	487	13,057	26.8	-	23.2	25.0	28.3
	Kadawathgama	Isuru	1,967	44,213	22.5	19.8	21.4	30.0	34.0
	Viralmurippuwa	Ran Arulnalu	1,907	31,522	16.5	12.0	21.6	30.0	26.1
	Katuwela	Jayashakthi	2,932	60,917	20.8	16.4	19.3	30.0	28.3
	Helabagaswewa	Samagi	1,818	80,882	44.5	15.0	21.9	25.0	32.2
	Kirigalwewa	Nelum	655	22,525	34.4	-	21.1	-	30.3
	Unagasewewa	Randiya Dhahara	1,018	34,005	33.4	25.0	22.4	25.0	30.1
Rambewa	Wewelketia & Thamarahamillewa	Rangiri	797	26,511	33.3	15.8	20.0	-	30.1
	Talgahawewa	Samagi	973	27,839	28.6	20.0	22.7	30.0	38.1
	Balahodawewa	Pragithi	726	11,731	16.2	19.6	20.5	-	28.7
	Ihala Kolongasw.	Dimuthu	417	9,936	23.8	21.7	24.6	25.0	34.5

DSD	GND	CBO	Consumption (m^3/month)	Water sales (Rs./month)	Sales/m^3 (Aver. Charge)	Model charge/m^3	NWSDB tariff	Proposed bulk tariff/ m^3	Charge estimate
Rambewa	Mahakandarawa 2	Mahasen	1,336	20,918	15.7	16.7	20.6	25.0	28.5
	Mahakandarawa 1	Nildiyadahara	1,175	24,283	20.7	21.3	21.4	25.0	30.7
	Kedewa & Galkandegama	Swashakthi	949	30,433	32.1	22.8	22.9	-	34.1
	Ikirigollewa	Ikra	8,645	145,680	16.9	13.1	20.8	-	26.1
	Katukeliyawa	Eksath	1,632	24,871	15.2	18.0	19.6	25.0	26.4
	Wahamalgollewa 3	Ekamuthu	1,448	41,210	28.5	20.0	20.2	25.0	30.3
	Sangilikanadarawa	Arunalu	2,834	58,842	20.8	15.8	19.4	20.0	26.3
Horowpothana	Wadigawewa	Pradeepa	1,578	19,409	12.3	13.0	19.8	30.0	27.6
	Maradankadawela	Hansajala	1,231	31,412	25.5	25.0	21.1	25.0	25.9
	Kapugollewa	Jalasavi	1,768	26,277	14.9	10.0	22.1	25.0	27.2
	Parangiyawadiya	Upul	1,691	46,244	27.3	17.2	22.4	30.0	29.5
Kahatagasdigiliya	Moragahawela	Pragathi	855	23,650	27.7	20.0	23.8	NWSDB Tariff	36.1
	Kubukgollewa	Ekamuthu	447	15,075	33.7	26.4	23.9	25.0	33.9
	Pandarellewa & Panwella	Sobasisila	2,254	42,560	18.9	15.0	20.5	25.0	25.2
	Mee-Kumbukwewa	Apsara	492	16,716	34.0	21.7	23.1	NWSDB Tariff	39.7
	Mahawewa	Praja Shakthi	1,089	36,520	33.5	20.0	21.9	25.0	37.9
	Maha Kubukwewa	Vajira	1,233	29,033	23.5	21.5	21.1	NWSDB Tariff	35.7
	Gonumeru Wewa	Senath	525	22,776	43.4	30.0	22.6	NWSDB Tariff	28.6
	Palippothana ~ Kirigallewa	Janasetha	1,952	30,789	15.8	16.1	21.4	25.0	27.0
	M. Kiribbewa & Kurukuragama	Eksath	930	17,900	19.2	15.0	23.1	25.0	32.6
Average			1,782	34,894	19.6	18.2	21.4	25.6	30.4

Source: CBO Survey

was raised by 10%. Therefore, the estimated cost prices have risen within 50%. The discussion above is based on the NWSDB's old tariffs, but it is better because the NWSDB tariffs were old during the CBO survey. When the new tariffs are applied to the CBO, the average CBO bulk payment unit to NWSDB becomes 29.7 Rs./m^3, or 1.39 times increase. Thus, it becomes higher than what the CBOs expect to pay (25 Rs./m^3). However, most users accept the charges if they are set relevantly according to the social economic survey.

In practice, tariff increases of CBOs are discussed and decided in member meetings. One CBO president said that their increase in tariff may not be so high, because they would try to keep the increase to a minimum.

8.3 Financial Analysis

8.3.1 Preconditions and Methods

The preconditions and methods of Financial Internal Rate of Return (FIRR) calculation are as follows.

- The calculation is based on the net or constant price because tariffs are controlled by the government and not easy to raise although inflation is occurring.
- The investment amount and the construction schedule are used as proposed for the Project. The investment costs include taxes, but they exclude interest payments during the construction period, because IRR treats only cash flow.
- Part of the invested assets such as buildings and plants has longer lives (depreciation periods) such as 50 or 60 years and the planning period is shorter so that the remaining residual values of these long life assets are input as minus investment at the end of the calculation period. However, shorter life assets such as machines and vehicles are not reinvested after their lifetimes such as seven or 10 years end within the planning period because they are usually used continuously and not reinvested.
- The income from operations is based on the tariffs, but specifically, the billed amount and water used in 2011 shown by the NWSDB statistics are used to calculate income per water volume (national total 38.7 Rs./m^3 or North Central Region domestic 25.0 Rs./ m^3) and this unit is multiplied by the estimated demand water volume. However, the NWSDB tariffs were raised from October 1, 2012 and new income per water volume is not clear because there is no statistic data after the tariff increase. Assuming the income per water volume becomes 1.5 times because domestic usage charge increases 2.67 to 1.33 times depending on the consumption and bulk supply usage charge increases 1.5 times and bulk supply monthly service charge increases 1.1 times. The North Central Region domestic 25.0 Rs./ m^3 increases to 37.5 Rs./ m^3 (=25 x 1.5). Therefore, this FIRR calculation uses 37.5 Rs./ m^3 as income per water volume.
- The operations costs are estimated based on the actual expenditures at NWSDB RSC (N/C). Specifically, the personnel costs are fixed, but the other costs such as electricity

and chemicals are dependent on the consumed water volumes (demands).

8.3.2 FIRR Results

(1) Mahakanadarawa

FIRR of the Mahakanadarawa water source area was calculated for two cases. In Case 1, Phase 2 investment is made and so the water demand is satisfied. But in Case 2, Phase 2 investment is not made and the water demand after 2025 is the same as that in 2024. In both cases, FIRRs are minus and so this project cannot be covered by the profits. The difference between the two cases is 0.12% and small. In order to make it positive, the tariffs should be raised 2.5 times of the present level. In addition, since this is calculated in net (constant price), it is assumed that tariffs are almost always revised based on the inflation in gross (market price).

Since the tariffs need to be 2.5 times of the present level in order to make FIRR positive, sensitivity analyses that change the revenues or expenditures including investment by plus or minus 10% are neither effective nor useful. Therefore, sensitivity analysis is omitted. However, if a water supply project is located in a rural area, 80% of investment cost is covered by the government grant. Therefore, NWSDB will bear only 20% of the investment costs in this project because this project area includes no municipalities. If the income per water volume increases 1.5 times (37.5 Rs./m^3) because of the tariff raise, the FIRR becomes positive (0.42%). In this case, NWSDB can pay interest and repay JICA if making efforts. However, this does not mean that the total project is covered by the profits. Of course, this 1.5 times increase of tariffs is also based on the additional inflation coverage.

(2) Wahalkada

FIRR of the Wahalkada water source area was calculated for two cases. In Case 1 (with Phase 2 investment in 2024), the FIRR is -2.88% and in Case 2 (without Phase 2 investment), it is -2.80%. The results are a little worse than those of Mahakanadarawa Cases because Wahalkada is a lower-density area and the investment is less efficient than Mahakanadarawa.

Similarly to the Mahakanadarawa case, a case in which NWSDB's burden is 20% of the investment is calculated and the FIRR becomes 1.5% in Case 1, better than that of Mahakanadarawa because of the proportion of investment reduction to revenues.

8.3.3 Tariffs and Future Direction

The tariffs of NSWDB are very low and cannot be easily raised. This distorts the management of NSWDB. Tariffs should be raised to reflect inflation because Sri Lanka has had recent inflation rates of 7% or 8% on the average. In addition, the government controls the tariffs and so NSWDB receives grants and loans from the government. **Table 8.2** shows the international

comparison of water supply tariffs. Some countries such as India, China and Tanzania show that costs are not covered, and it is actually the government that supports these water supply entities. Excluding these countries, Sri Lanka's revenue/ m^3 is relatively low considering the low revenue/m^3/GNI (Gross National Income). Thus, government's financial support to NWSDB at keeping the tariff low cannot be continued nor is it sustainable. NWSDB should be an independent management entity able to cover all its costs. In the long term, fiscal autonomy or privatization can be examined.

Table 8.2 International Comparison of GNI and Financial Indexes of Water Supply Entities

(Unit: US$)

Country	Year	GNI per capita	Revenue/m^3	Cost/m^3	Cost coverage	Rev./GNI
Sri Lanka	2006	1,050	0.22	0.22	100.0%	0.00021
Bangladesh	2009	576	0.14	0.10	71.4%	0.00024
India	2009	1,134	0.15	0.26	173.3%	0.00013
Pakistan	2006	700	0.17	0.27	158.8%	0.00024
Indonesia	2004	1,140	0.20	0.15	75.0%	0.00018
Malaysia	2007	5,400	0.39	0.34	87.2%	0.00007
Philippines	2004	1,170	0.28	0.21	75.0%	0.00024
Vietnam	2007	650	0.24	0.13	54.2%	0.00037
China	2009	1,870	0.32	0.37	115.6%	0.00017
Laos	2008	460	0.15	0.14	93.3%	0.00033
Cambodia	2007	380	0.28	0.12	42.9%	0.00074
Mexico	2006	7,000	0.73	0.63	86.3%	0.00010
Panama	2006	4,400	0.25	0.18	72.0%	0.00006
Paraguay	2005	1,200	0.36	0.17	47.2%	0.00030
Peru	2006	2,700	0.45	0.34	75.6%	0.00017
Bolivia	2006	1,020	0.40	0.26	65.0%	0.00039
Kenya	2006	520	0.48	0.25	52.1%	0.00092
Tanzania	2008	410	0.24	0.29	120.8%	0.00059
Ghana	2005	400	0.60	0.53	88.3%	0.00150
Malawi	2004	-	0.26	0.16	61.5%	-
Nigeria	2004	430	0.20	0.14	70.0%	0.00047

Source: C. Berg and A. Danilenko, "The IBNET Water Supply and Sanitation Performance Blue Book," The World Bank, 2011

8.4 Economic Analysis

8.4.1 Preconditions and Methods

The preconditions and methods of EIRR calculation are similar to those of FIRR above, but with some differences, as follows.

- The calculation is on the net or constant price basis.
- The investment amount and the construction schedule are used as described in Chapter 7,

"Project Cost," and Chapter 8, "Project Implementation," but the investment costs exclude taxes and interest payments during the construction period. In addition, domestic currency part of the investment is converted to border price using a conversion factor. The conversion factor, 0.9[1], used in Sri Lanka will also be used in this analysis.

- The long life investment assets are treated similarly to those in FIRR analysis above.
- Benefits are estimated instead of the operation income in FIRR, but it is necessary to explain the benefits in detail so that they are described separately below.
- The operation costs are the same as those in FIRR analysis.

8.4.2 Benefits

Main benefits are derived from willingness-to-pay (WTP) amounts. The other benefits are reduction of medical and related costs caused by water borne diseases such as diarrhea, dysentery and viral hepatitis.

(1) WTP

Willingness-to pay amounts that users of the new water supply project intend to pay can be seen as benefits in monetary terms. A social and economic survey was conducted in this project study and WTP amounts were surveyed. In addition, income, present water consumption quantity (mainly for drinking) and payment for the water were surveyed. It is said that 3.5% to 5% of income can be paid for water according to the World Bank or ADB. Payment for water, WTP amount and 4% of income are divided by the consumed water quantity in order to compare these. The survey results are shown in **Table 8.3**.

Table 8.3 Actual Payment, WTP

(Unit: Rs./m^3)

DSD	Average Actual Payment for Water				WPT				4% of Income/ m^3			
	WB	CBO	No Supply	Total	WB	CBO	No Supply	Total	WB	CBO	No Supply	Total
KD	20.9	28.2	358.4	28.3	33.3	16.3	29.6	26.5	55.3	137.4	469.4	176.1
HP	63.7	21.8	−	26.8	−	17.4	28.6	24.9	155.6	106.3	293.2	207.2
KG	35.8	32.0	361.1	38.0	−	39.3	78.5	74.1	140.8	99.0	138.8	137.3
Pad	44.8	27.9	188.9	53.2	34.7	39.6	42.1	40.3	79.5	78.0	158.7	110.5
Ram	20.5	27.3	91.1	28.1	−	28.4	97.1	40.2	70.1	94.3	255.5	132.3
Med	22.0	38.6	962.7	36.3	24.0	38.8	43.9	37.9	95.4	136.6	305.4	166.4
Total	27.3	29.9	237.7	33.6	28.6	31.1	52.3	40.6	89.5	114.2	266.3	157.0

Source: JICA Study Team

[1] [1] ADB, "Sri Lanka: Upper Watershed Management Project," October 2006
ADB, "Sri Lanka: Forest Resources Management Sector Project," September 2010

However, there are some points to be noted as follows.

- There are small sample number groups such as NWSDB water user groups in Horowpothana (Hp), Rambewa (Ram) and Padaviya (Pad).
- In addition, there are some groups in which WTP answers are none such as NWSDB water user groups in Hp, Kebithigollewa (Kg) and Ram.
- WTP answers are fewer in CBO water user groups in Kahatagasdigiliya (Kd), Hp and Kg and No Supply user groups in Kd, Pad and Kg,
- Actual payment per m3 and 4% income per m3 in No Supply user groups are much larger than those of other user groups such as CBO and NWSDB because No Supply users may use less water at much more expensive prices. For example, a private company is selling purified water at Rs. 2 per liter, namely Rs. 2,000 per m3.

Based on these points, the WTP amounts are set as follows.

- New users of this project are No Supply group users above. This group does not have water supply and may not have suitable WTP amounts as most of the answers are required or relevant prices and answered WTP amounts are low and the specific amount answered is fewer.
- CBO user groups can use tap water, but CBO water quality is not fully acceptable compared with the NWSDB water.
- Therefore, the WTP amount is set based on the No Supply group and the WTP should be set as the lower amount of either actual payment per m3 or 4% income per m3 of the No Supply group because No Supply group and CBO users can use safer water of NWSDB by the project. In addition, these benefits are calculated only for No Supply group and CBO user group. Although some existing NWSDB water users use well water, the benefits of NWSDB users are excluded in this benefit calculation because the benefits should be conservative.

The WTP set is shown in **Table 8.4**.
The existing NWSDB water users may get the same benefits expressed in WTP originally, but having already received the benefits, this set of users are ignored in this calculation because EIRR should be estimated conservatively.

Table 8.4 WTP (Unit: Rs./m^3)

DSD	WB	CBO	No Supply
KD		358	
HP		293	
KG		139	
Pad		159	
Ram		255	
Med		305	

Source: JICA Study Team

(2) Water Borne Diseases

Water borne diseases such as fluorosis, diarrhea, dysentery and viral hepatitis can be reduced as this project enables the residents to use clean and better quality water. Although some diseases

such as diarrhea, dysentery and viral hepatitis are not only caused by water but also by bad foods and unsanitary conditions, the social economic survey separated the users into three groups, namely NWSDB, CBO and No Supply, so that the water borne disease rates in these groups can be compared.

1) Fluorosis

Fluorosis is caused by fluorides in water. **Table 8.5** shows the fluorosis occurrence rates in the social economic survey result. It is very clear that the rate of NWSDB water user group is the lowest, that of the CBO group is the middle and that of the No Supply group is the highest.

The benefits of fluorosis reduction are measured by medical cost reduction. According to the interview with an official (medical doctor) of North Central Provincial Health Services, medical costs of fluorosis are as follows.

- One fluorosis tooth requires Rs. 2,500 to 3,000 as medical treatment cost.
- One patient has 8 to ten teeth.
- Without good water, the patients need to have such treatment within two or three years.

Thus, the annual medical cost of one patient is computed as follows: 2,750 Rs. x 9 teeth /2.5 years = 9,900 Rs. /year.

Table 8.5 Fluorosis Rates

DSD	Fluorosis patients				Population				Patient ratio (%)			
	WB	CBO	No supply	Total	WB	CBO	No supply	Total	WB	CBO	No supply	Total
KD	35	43	86	164	137	253	352	742	25.5%	17.0%	24.4%	22.1%
HP	5	22	72	99	25	111	360	496	20.0%	19.8%	20.0%	20.0%
KG	0	3	11	14	116	32	225	373	0.0%	9.4%	4.9%	3.8%
Pad	0	3	14	17	71	118	186	375	0.0%	2.5%	7.5%	4.5%
Ram	1	69	57	127	48	406	349	803	2.1%	17.0%	16.3%	15.8%
Med	10	19	54	83	160	336	417	913	6.3%	5.7%	12.9%	9.1%
Total	51	159	294	504	557	1,256	1,889	3,702	9.2%	12.7%	15.6%	13.6%

Source: JICA Study Team

The fluorosis rate differences between the NWSDB and the CBO groups and between the NWSDB and the No Supply groups can be seen as the potential beneficial patient rates. Specifically, 15.6 – 12.7= 3.5% and 13.6 – 9.2 = 4.4% are fluorosis rates of beneficial patients, respectively. Therefore, these difference rates are multiplied by CBO population and No Supply (or New Supply) population, respectively. It is assumed that the NWSDB group do not get the benefits as they already use NWSDB water. Or it can also be assumed that the NWSDB group users have fluorosis because of other causes or use of water such as well water or something in addition to NWSDB water.

2) CKD (Chronicle Kidney Disease)

CKD is caused by kidney functional deterioration. However, there are relatively more CKD patients found around the dry zone in Sri Lanka including this project area. This CKD is called CKD unknown origin (CKDU) and the Ministry of Health and WHO, etc. have been studying CKDU, but its causes or are not clear. Therefore, these CKD benefits are treated separately as additional benefits in this calculation.

Table 8.6 shows the CKD rates in the social economic survey result. It is also very clear that the rate of NWSDB water user group is the lowest, that of the CBO group is the middle and that of the No Supply group is the highest, similar to the case of fluorosis.

Table 8.6 CKD Rates

DSD	Fluorosis patients				Population				Patient ratio (%)			
	WB	CBO	No supply	Total	WB	CBO	No supply	Total	WB	CBO	No supply	Total
KD	1	2	11	14	137	253	352	742	0.73%	0.79%	3.13%	1.89%
HP	0	3	3	6	25	111	360	496	0.00%	2.70%	0.83%	1.21%
KG	2	1	7	10	116	32	225	373	1.72%	3.13%	3.11%	2.68%
Pad	2	5	7	14	71	118	186	375	2.82%	4.24%	3.76%	3.73%
Ram	0	7	3	10	48	406	349	803	0.00%	1.72%	0.86%	1.25%
Med	5	11	16	32	160	336	417	913	3.13%	3.27%	3.84%	3.50%
Total	10	29	47	86	557	1,256	1,889	3702	1.87%	2.31%	2.49%	2.32%

Source: JICA Study Team

The CKD rate differences between the groups are also used as CKDU potential beneficial patient rates similarly to the case of fluorosis. However, according to a former medical doctor of Anuradhapura Hospital specializing in kidney disease, these CKD rates are lower than actual patient rates because in 3,000 urine samples collected and tested in a village of Vavuniya, a neighboring district in the north of the project area, it was found that the CKD rate was 15%. There are five stages in CKD. The final fifth stage requires dialysis or kidney transplant operation and without one of these treatments, the patients will die, but before that stage patients may be able to live. Therefore, the actual patients exist more than the rate of 2.3% on average in the social economic survey. Assuming the average CKD rate is 15%, the differences of the three groups are estimated using the ratios as follows.

- The average CKD rates of the three groups and the total average are 1.87% (NWSDB), 2.31% (CBO), 2.49% (No Supply) and 2.32% (total), respectively.
- If the total average is assumed as 1, the three groups ratios become 0.806, 0.996 and 1.073.
- Thus, the total average is assumed 15% and so the group rates become 15 x 0.806 =12.1%, 15 x 0.996 = 14.9% and 15 x 1.073 = 16.1%.

The differences of the above CKD rates can be used to calculate the beneficial CKD patients similarly to the fluorosis case.

The medical costs of CKD depend on the five stages. According to the kidney specialist doctor above, the stage 5 patients rate is approximately 2% of the total patients and the stage 4 rate is 5 to 10%, and so 8% is assumed. At the stage 5, the medical costs of dialysis are Rs. 100,000 /month (3 times per week); while a transplant operation costs Rs. 1 million for one patient and donor; and Rs. 30,000 / month is needed after the operation. But transplant opportunities are scarce, and so dialysis is the medical treatment used in this calculation. At the stage 4, the medical costs are Rs. 15,000 / month. At the stages 1 to 3 that account for remaining 90% of the total CKD patients, the medical costs are Rs. 10,000 / month. In addition, the cost of transportation to and from hospital is assumed at Rs. 5,000 / time.

3) Diarrhea

According to a medical doctor of Padaviya Hospital, there are approximately 30 diarrhea cases per month. With 30 cases /month x 12 months /Pad. population 35,359 = 1.02% is the computed diarrhea rate. In order to get the differences between the user groups, CKD ratios above, namely 0.806, 0.996 and 1.073, and similar fluorosis ratios, 0.677, 0.934 and 1.147, are averaged and 0.742, 0.965 and 1.11 are used for this disease rate differences. The medical costs are Rs. 5,000 / day x 3 days =Rs. 15,000. In addition, the transportation costs are Rs. 5,000 / day, similarly to the CKD case. Furthermore, there are patients who do not go to hospitals. They are approximately three times of the above patients going to hospitals. Their medical costs are Rs. 1,000 per patient.

4) Viral Hepatitis

According to the same medical doctor of Padaviya Hospital, viral hepatitis cases are 1 to 2 cases per month and so 1.5 cases /month x 12 months /Pad. population 35,359 = 0.0509% becomes the disease rate. The ratios between the user groups above are also similar. The medical costs are Rs. 5,000/ day x 8 days= Rs. 40,000. Same transportation costs are also added.

5) Dysentery

Based on the same doctor's information, dysentery cases are approximately 10 /month and so 10 x 12 / 35,359 = 0.34% is the disease rate.

The medical and transportation costs are Rs. (10,000 + 5,000) /day x 3 days = Rs. 45,000

6) Enteric Fever

The doctor said that enteric fever cases are rare and so this is omitted.

8.4.3 EIRR Results

(1) Mahakanadarawa

The Mahakanadarawa water resource area mainly consists of Rambewa and Medawachchiya DSDs. Therefore, WTPs of these two DSDs are used.

In Case 1 (with Phase 2 investment), the EIRR is 6.91% and is better as compared with those of other water supply projects. In addition, if CKD benefits are included, the EIRR becomes 11.8%, a satisfactory figure. In Case 2 (without the additional investment), the EIRR is 5.54%, less than that of Case 1. If CKD benefits are included, the EIRR becomes 10.4%.

In order to estimate sensitivity, the investment, operational costs and benefits are changed to plus 10% or minus 10%. The results are shown in **Table 8.7**. The investment cost change affects the EIRR the most, but the difference is only -0.73% or +0.86%. The second most effective change is the operations cost and the difference is -0.06% or +0.07%. The benefit change difference is very small at –0.01% or +0.01%.

Table 8.7 Mahakanadarawa Sensitivity Analysis Results

Alternatives	Investment Plus 10%	Op. Cost Plus 10%	Benefits Minus 10%	Standard (Case 1)	Investment Minus 10%	Op. Cost Minus 10%	Benefits Plus 10%
EIRR	6.18%	6.85%	6.90%	6.91%	7.77%	6.98%	6.92%

Source: JICA Study Team

(2) Wahalkada

The Wahalkada water resource area mainly consists of the DSDs other than Rambewa and Medawachchiya. WTPs of these four DSDs are used. If CKD benefits are included, the EIRR becomes 11.5%. Case 2 EIRR is 4.46% and lower than that of Case 1 (6.59%).

In order to estimate sensitivity, the investment, operational costs and benefits are changed to plus 10% or minus 10%. The results are shown in **Table 8.8**. The investment cost change affects the EIRR most, but the difference is only -0.7% or +0.81%. The second most effective change is the operations cost and the difference is -0.10% or +0.09%. The benefit change difference is very small at –0.01% or +0.01%.

Table 8.8 Wahalkada Sensitivity Analysis Results

Alternatives	Investment Plus 10%	Op. Cost Plus 10%	Benefits Minus 10%	Standard (Case 1)	Investment Minus 10%	Op. Cost Minus 10%	Benefits Plus 10%
EIRR	5.89%	6.49%	6.58%	6.59%	7.40%	6.68%	6.60%

Source: JICA Study Team

The project area covers an area with an extraordinarily high prevalence of CKD and drinking water has a possibility as one of causes for such a disease. Therefore, the people are waiting for drinking water supply by NWSDB eagerly. Since the cause of CKD is still unknown, the economic analysis was done as a basis for the case of exclusion of medical expenses for CKD and the inclusion case is given as a reference. Anyway, if taking into account the willingness of the people to seek for safe water, it is considered reasonable to use the amount in the economic analysis that the people will be able to pay as willingness-to-pay. In addition, it is difficult to get enough water during the drought season in the project area and the stable water supply by NWSDB is also the great hope of the people and it is reasonable to handle the willingness-to-pay as the benefit from this aspect.

8.5 Toward Sustainability of Operation and Maintenance and What Water Supply Management Should Be

In both cases for Mahakanadarawa and Wahalkada, the revenue is bigger than the O&M cost and it is possible to well manage the proposed water supply system, if there is no investment. Although the investment (cost) is too big resulting in minus FIRR, the business income and expenditure is plus, which makes operations possible. However, it should be noted that depreciation is excluded herein due to a focus of the cash flow. In fact, since the project area is rural, the government bears 80% of the investment while NWSDB shoulders the remaining 20%. In this case, FIRR is plus, namely 0.71% for Mahakanadarawa and 2.0% for Wahalkada, respectively. But when the investment is financed by the loan, the repayment can’t be done as long as the interest rate doesn’t keep this level of FIRR. It is sure that the revenue over the O&M cost will be maintained.

From the viewpoint what the water supply management should be, the revenue should cover the expenditures including an investment and the principal and interest repayment is possible if FIRR is equal to the interest rate in case of full cover of an investment with a loan. For a private company to operate the water supply business, if the income will be offset by principal and interest repayment with no profit, it is meaningless to make an investment and therefore a company seeks for higher FIRR. It is considered that NWSDB is the public entity and acceptable to such FIRR if it is equal to the interest rate. However, even NWSDB can’t manage the business in the situation that FIRR is minus. Therefore, as long as the revenue to maintain FIRR equal to the interest rate in case of an investment financed through a loan is not assured, that is to say, the tariff increase is assured, NWSDB can’t operate as a self-support accounting entity. However, the tariff increase is controlled by the government, NWSDB has to receive the subsidy from the government, if so.

For the future direction, if the per capita GDP in Sri Lanka will increase with an average income, the customer will afford to pay the water tariff or should pay the proper water tariff and the

government will be released from the policy to control the water tariff in a low level.

On the other hand, if the government is proper, it should accept the tariff increase at least at the level equal to an annual inflation rate (an increment of Consumer Price Index (CPI)). However, the government will setting the equation of [CPI – α] and estimate α as a challenge for productivity improvement to direct NWSDB or negotiate with NWSDB. Since the financial analysis in this report as well as the economical analysis is done with the net, the gross will not be the same as an estimation, as long as the inflation portion will not be added to the actual income and expenditure. That is to say, the revenue, if the tariff will not reflect the inflation, will decrease against the actual cost

CHAPTER 9

OPERATION AND EFFECT INDICATORS

Chapter 9 Operation and Effect Indicators

To check the progress and effect of the proposed Project, the operation and effect indicators are set as shown in **Table 9.1** and **Table 9.2**, respectively.

9.1 Operation Indicators

The operation indicators are to show to what extent the water supply scheme is operated efficiently, to achieve the target.

In the study area, NWSDB has already operated five water supply schemes in the urban centres of the DSDs except for Rambewa DSD and, in addition, a number of the Community-Based Organizations have operated their own small scale water supply schemes. In this report, the objects are the newly proposed integrated water supply schemes and their service areas in Mahakanadarawa and Wahalkada, respectively, therefore the present situation is regarded as none.

- The served population by pipe borne water supply is obtained from multiplying the number of connections by per housing unit population which is calculated from the number of housing units and population by GND in census 2011 (as of October 1, 2012, data is not declared). This served population included those by CBOs as stated below.
- For reference, as the served population by CBO water supply schemes is unknown, the number of connections shall be reported annually by CBOs to NWSDB RSC(NC) as well as water consumption. The data can be used for calculation of per capita water consumption and NRW ratio in respective CBO water supply schemes using the bulk water supply amount.
- The daily maximum and average water supply amount shall exclude that for miscellaneous use in the water treatment plant.
- Some CBOs shows the high level of NRW ratio. However, in case of bulk water supply to existing CBOs, the practice in CBO water supply schemes is separated from the data of NWSDB and, in addition, almost water transmission and distribution pipes will be newly installed in the Project. The NRW ratio is set as 20% almost nearly equal to the present performance of NWSDB RSC(NC).
- The purpose of this project to supply safe water to customers especially focusing on the Sri Lankan Drinking Standard for a fluoride concentration of 0.6 mg/L. The compliance rate of the said standard should be 100%. The analysis shall be conducted semi-monthly.

9.2 Effect Indicators

The effect indicators shows that the people's living will be comfortable and the risk reduction that may be suffered from skeletal and dental fluorosis as well as chronic kidney diseases.

- The services area is divided into two categories, namely one for pipe borne water supply and the other for water delivery service by bowsers. In the pipe borne water supply service area, water can be used for multi purposes as general domestic water, while in the water delivery service area, water use will be limited to drinking and cooking only due to water-fetching works using plastic tanks, etc. The population coverage for an access to safe water is calculated as the total of both services.
- The identification of served population in the water delivery service by bowsers will be expectedly difficult. For a meanwhile, it is recommended that the practice of water use will be estimated through an questionnaire survey at the people's meeting, etc. and an accuracy in estimation will be enhanced through an improvement of such ways.
- 94% of the people in the project area have already any kinds of existing water sources (almost groundwater). When the water consumption will be rather below an amount estimated from the population coverage ratio, it suggests that the people use water selectively either from well water or tap water. Therefore, the timing of water treatment facility augmentation should be decided based on an increase of actual daily average water consumption but not the population coverage.
- Fluorosis risk rate

  When the water source of existing CBO has a fluoride concentration above the Sri Lankan Drinking standard (0.6 mg/L), such served population is defined as the population with a risk for fluorosis. Assuming that the percentage of the population with a risk to the total population within the existing CBO service area is applicable to the entire study area, it can be reduced with the connection to a proposed integrated water supply system

Table 9.1 Fluorosis Risk Rate

Mahakanadarawa Service Area

Population with a risk for fluorosis (2012)	16,930 persons	
Population with no risk for fluorosis (2012)	3,135 persons	
Percentage of population with a risk (2012)	16,930 / 20,065 × 100 = 84.4%	
Water supply mode in 2020	Total population	Served population
Pipe borne water supply	70,680 persons	40,749 persons (57.7%)
Bowser water supply	21,393 persons	21,393 persons (100%)
Total	92,073 persons	62,142 persons (67.5%)
Prevalence risk in 2020	(92,073 – 62,142) / 92,073 × 100 = 32.5%	

Wahalkada Service Area

Population with a risk for fluorosis (2012)	12,530 persons	
Population with no risk for fluorosis (2012)	5,370 persons	
Percentage of population with a risk (2012)	12,530 / 17,600 × 100 = 71.2%	
Water supply mode in 2020	Total population	Served population
Pipe borne water supply	107,907 persons	64,077 persons (59.4%)
Bowser water supply	24,615 persons	24,615 persons (100%)
Total	132,522 persons	88,692 persons (66.9%)
Prevalence risk in 2020	(132,522 – 88,692) / 132,522 × 100 = 33.1%	

Table 9.2 Operation Indicators for Water supply

Mahakanadarawa System

Cate-gorty	Indicators	Calculation Equation of Indicators	Target				Purpose
			Present	2020	2024		
Basic	Served population (persons)	Served population by pipe borne water supply = (No. of connections) × (Average per HU population)	25,900	40,700	47,800		
		Served population by bowsers = (total population)	0	21,400	22,300		
		Total served population = Served population + Served population by bowsers	25,900	62,100	70,100		
Basic	Water distribution (m^3/day)	Daily maximum water distribution = (the biggest one in the daily water distribution records throughout a year)	0	7,193	8,585		
		Daily average water distribution = (annual water distribution amount) / (annual days)	0	5,994	7,154		
Basic	Facility utilization rate (%)	Facility utilization rate (Max.) = (Daily maximum water production) / (treatment capacity) × 100	0	83	103		
		Facility utilization rate (Ave.) = (Daily average water production) / (treatment capacity) × 100	0	70	90		
Basic	Compliance rate of drinking standard for fluoride (%)	No. of samples with a fluoride concentration of below 0.6 mg/L / Total no. of samples *100	-*1	100	100		*1 The drinking standard for fluoride is not complied to at 19 schemes out of 24 existing CBOs
Basic	NRW ratio (%)	NRW ratio＝(NRW volume) / (water distribution) × 100	-*2	20%	20%		*2 Current NRW at NWSDB RSC(N/C) is 19.8% (2008)

Source: Prepared by the Study Team

Table 9.2 Operation Indicators for Water supply (Cont'd)

Wahalkada System

Cate-gorty	Indicators	Calculation Equation of Indicators	Target				Purpose
			Present	2020	2024		
Basic	Served population (persons)	Served population by pipe borne water supply = (No. of connections) × (Average per HU population)	26,900	64,100	74,700		
		Served population by bowsers = (total population)	0	24,600	25,700		
		Total served population = Served population + Served population by bowsers	26,900	88,700	100,400		
Basic	Water distribution (m^3/day)	Daily maximum water distribution = (the biggest one in the daily water distribution records throughout a year)	0	11,203	13,318		
		Daily average water distribution = (annual water distribution amount) / (annual days)	0	9,336	11,098		
Basic	Facility utilization rate (%)	Facility utilization rate (Max.) = (Daily maximum water production) / (treatment capacity) × 100	0	78	93		
		Facility utilization rate (Ave.) = (Daily average water production) / (treatment capacity) × 100	0	65	77		
Basic	Compliance rate of drinking standard for fluoride (%)	No. of samples with a fluoride concentration of below 0.6 mg/L / Total no. of samples *100	-*1	100	100		*1 The drinking standard for fluoride is not complied to at 13 schemes out of 20 existing CBOs
Basic	NRW ratio (%)	NRW ratio＝(NRW volume) / (water distribution) × 100	-*2	20%	20%		*2 Current NRW at NWSDB RSC(N/C) is 19.8% (2008)

Table 9.3 Effect Indicators for Water Supply

Mahakanadarawa System

Cate-gorty	Indicators	Calculation Equation of Indicators	Target				Purpose
			Present (2012)	2020	2024		
Basic	Population coverage by water supply	(Pipe borne water supply) Population coverage = (Served population) / (Administrative population) × 100 (Water delivery service by bowsers) Population coverage = (Served population) / (Administrative population) × 100 (Population coverage for an access to safe water) Population coverage = (Served population) / (Administrative population) × 100	41% 0 % 31%	58% 100% 68%	64% 100% 72%		Status of risk avoidance being suffered from fluorosis and CKD through shifting of water source from well water to tap water
Basic	Fluoride risk rate	(Fluoride risk rate) = 100 - (Population coverage for an access to safe water)	-	32%	28%		The current rate is 84.4% at the existing service area.
Assist	Per capita consumption	Per capita daily maximum consumption = (Daily maximum domestic consumption) / (Served population) Per capita daily average consumption = (Daily average domestic consumption) / (Served population)	96 Lpcd 80 Lpcd	101 Lpcd 84 Lpcd	103 Lpcd 86 Lpcd		Shifting of water source from well water to tap water

Source: Prepared by the Study Team

Table 9.3 Effect Indicators for Water Supply (Cont'd)

Wahalkada System

Cate-gorty	Indicators	Calculation Equation of Indicators	Target				Purpose
			Present (2012)	2020	2024		
Basic	Population coverage by water supply	(Pipe borne water supply) Population coverage = (Served population) / (Administrative population) × 100 (Water delivery service by bowsers) Population coverage = (Served population) / (Administrative population) × 100 (Population coverage for an access to safe water) Population coverage = (Served population) / (Administrative population) × 100	28% 0 % 23%	59% 100% 67%	65% 100% 72%		Status of risk avoidance being suffered from fluorosis and CKD through shifting of water source from well water to tap water
Basic	Fluoride risk rate	(Fluoride risk rate) = 100 - (Population coverage for an access to safe water)	-	33%	28%		The current rate is 71.2% at the existing service area.
Assist	Per capita consumption	Per capita daily maximum consumption = (Daily maximum domestic consumption) / (Served population) Per capita daily average consumption = (Daily average domestic consumption) / (Served population)	96 Lpcd 80 Lpcd	101 Lpcd 84 Lpcd	103 Lpcd 86 Lpcd		Shifting of water source from well water to tap water

Source: Prepared by the Study Team

CHAPTER 10

PROJECT RISK

Chapter 10 Project Risk

10.1 Project Risk

The proposed Project is constructed based on the important preconditions described below. If any of them will be lacking, it may cause a serious problem in the management, operation and maintenance of proposed water supply systems.

(1) Water Availability

This project assures the sustainability of drinking water supply from Mahakanadarawa Wewa and Wahalkada Wewa as water sources under the assumption that the NCP Canal Project and Yan Oya Reservoir Project will be implemented. These irrigation projects will be expectedly completed in the year of 2017 and be commissioned at the time of completion of this integrated water supply project in 2018. However, they have not yet commenced the construction works and it cannot be said that there will be no possibility of delay or suspension. As stated in "**4.3 Water Availability"**, the water balance will be in the tight condition between water use for irrigation and water supply. It can't be foreseen whether the farmers' association will allow with no objection that reservoir water is used for drinking water supply before the completion of the irrigation project. Therefore, the progress of the irrigation projects concerned should be carefully monitored and prompt action be taken to drive the project. as required.

(2) Water Quality of Proposed Water Sources

During the JICA study period covering from May to October 2012, in spite that the study area has experienced the severer drought than usual with no precipitation, the fluoride concentrations of both Mahakanadarawa Wewa and Wahalkada Wewa as the proposed water sources for drinking water supply were 0.52 mg/L and 0.38 mg/, respectively, at the maximum below the Sri Lankan Drinking Water Standard of 0.6 mg/L, although they have shown an increase of fluoride concentrations for April to July. On the Contrary, that of the Yan Oya River has recorded at 1.2 mg/L in July above the Japanese Drinking Water Standard of 0.8 mg/L. There is no problem in terms of the Yan Oya River, since it will not be used for a drinking water source. However, it can't be denied that the basin of proposed water sources has geologically an increasing trend in the dry season. For this reason, fluoride concentrations of both Mahakanadarawa Wewa and Wahalkada Wewa should be monitored subsequently thereafter.

In the North Central Province, water is used repeatedly for irrigation in the cascade irrigation system. If agricultural chemicals are used frequently in their basins, the reservoirs receive the

influent with condensed agricultural chemicals. Although according to the water quality examination results for proposed water sources covering the period from November 2011 to April 2012, any abnormal values have not been found in pesticide residues and toxic chemical requirements such as arsenic, cadmium, cyanide, lead, selenium and chromium, attention be paid for the use of agricultural chemicals in their basins and measures to ban their use should be taken to ensure the safety of water sources for drinking water, if required.

(3) Increase of Coverage and Water Demand in the Proposed Water Supply System

In the project area, a high fluoride concentration in groundwater used for drinking water causes the dental fluorosis and is suspected as one of causative substances for chronic kidney diseases (CKDs) which occur in a high level especially in the area. Therefore, the shift of water source from groundwater to surface water with a less fluoride concentration is desired earnestly. For this reason, the people have great expectations for the project and the willingness to connect the new integrated water supply system is considered to be high. However, as NWSDB has so far experienced the difficulty to increase the coverage by pipe borne water supply in the rural area, it is a risk to over-estimate such situations with the following reasons:

- In the project area, the percentage of household population below poverty line is relatively high in the district.
- Almost people have another water sources and the connection to a new pipe borne water supply is left to the people's discretion.
- Even though connecting to a new system, there is the possibility of selective use of either groundwater or tap water.
- The increase of connections has not been so high even in water supply schemes operated by NWSDB in the project area
- It is expected to take a long time to achieve the 100% coverage by pipe borne water supply in the project area due to a very low population density.

It depends on to what extent those problems can be overcome through an awareness campaign to the people. Attention be paid for not only the coverage but also the increase of actual water consumption.

If actual water consumption will be less than the estimation, the income will be decreased resulting in a heavy financial burden on NWSDB.

10.2 Considerations in Planning

(1) Geological Survey Not Conducted for Some Facility Sites

The geological survey for some facility sites such as elevated tanks, intake works, etc. couldn't be conducted from some reasons during the study period. It should be noted that the preliminary design of such facilities was done based on the assumption that the general geological characteristics obtained from other sites surveyed in the project area can be applicable to the above sites.

(2) Quanty Survey for Distribution Systems

Since the project area is too huge and the communities are located sparsely, the topographic survey was not done for a water distribution system as well as the designing. The size and length of water distribution pipes given in this report are estimated by selecting the model area in the project are, conducting a distribution network analysis, checking the pipe length by size, applying the per connection pipe length by size to the entire project area. It should be therefore noted that such size and length of distribution pipes will not correspond to the actual requirement.