THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF CITY PLANNING AND WATER SUPPLY
MINISTRY OF POLICY PLANNING AND ECONOMIC AFFAIRS
NATIONAL WATER SUPPLY AND DRAINAGE BOARD

THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)

SECTION II STRATEGIC SEWERAGE MASTER PLAN ③BADULLA

MAY 2017

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
NIHON SUIDO CONSULTANTS CO., LTD.

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1USD	= 111.313 JPY

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ABBREVIATIONS AND TERMINOLOGY

ADB	Asian Development Bank
ADWF	Average Dry Weather Flow
AFD	Agence Française de Development
Addl. GM	Additional General Manager
ASRT	Aerobic Solids Retention Time
AGM	Assistant General Manager
ATP	Ability to Pay
BOD	Biochemical Oxygen Demand
BOI	Board of Investment
CBO	Community Based Organization
CP	Counterpart
CEA	Central Environmental Authority
CMC	Colombo Municipal Council
CODCr	Chemical Oxygen Demand
DCS	Department of Census and Statistics
DGM	Deputy General Manager
DMMC	Dehiwala – Mt. Lavinia Municipal Council
DNB	Department of National Budget
DNP	Department of National Planning
DO	Dissolved Oxygen
DS	Divisional Secretariats
EC	Electric Conductivity
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMoP	Environmental Monitoring Plan
EPL	Environmental Protection License
EPZ	Export Processing Zone
ERD	Department of External Resource
ETWWA	Energy, Transport, and Water department of the World Bank
F/S	Feasibility Study
FY	Financial Year
GC	Greater Colombo
GOSL	Government of Sri Lanka
GCS	Greater Colombo Sewerage
IBRD	International Bank for Reconstruction and Development
IEE	Initial Environmental Examination
IFRS	International Financial Reporting Standard
IRR	Internal Rate of Return
JBIC	Japan Bank for International Cooperation
JCC	Joint Coordinating Committee
JICA	Japan International Cooperation Agency
JECES	Japan Education Centre of Environmental Sanitation
JPY	Japanese Yen
JSWA	Japan Sewage Works Agency
LKR	Sri Lanka Rupee
MASL	Mahaweli Authority in Sri Lanka

M&E	Mechanical and Electrical
MC	Municipal Council
M/M	Minutes of Meeting
MOPPEA	Ministry of Policy Planning and Economic Affairs
MOCPWS	Ministry of City Planning and Water Supply
MOPCLG	Ministry of Provincial Councils & Local Government
MRT	Minimum Rate Test
MTPS	Manhole Type Pumping Station
NH3-N	Ammonia Nitrogen
NWSDB	National Water Supply & Drainage Board
O&M	Operation and Maintenance
OD	Oxidation Ditch
PDWF	Peak Dry Weather Flow
PMU	Project Management Units
PO	Plan of Operations
PPIAF	Public-Private Infrastructure Advisory Facility
PS	Pradeshiya Sabha
ROA	Return on Asset
ROE	Return on Equity
RSC	Regional Support Centre
R/D	Record of Discussion
SIDA	Swedish International Development Cooperation Agency
SJKMC	Sri Jayawardenapura Kotte Municipal Council
SLS	Sri Lanka Standard
SRT	Solids Retention Time
STP	Sewage Treatment Plant
PPTA	Project Preparatory Technical Assistance
T-N	Total Nitrogen
TOR	Terms of Reference
T-P	Total Phosphorus
TKN	Total Kjeldahl Nitrogen
TSS	Total Suspended Solids
UC	Urban Council
UDA	Urban Development Authority
UNDP	The United Nations Development Programme
WACC	Weighted Average Cost of Capital
WAST	Weighted Average Sewage Tariff
WB	World Bank
WDF	Wastewater Discharge Fee
WHO	World Health Organization
WQI	Water Quality Index
WTP	Water Treatment Plant

EXECUTIVE SUMMARY

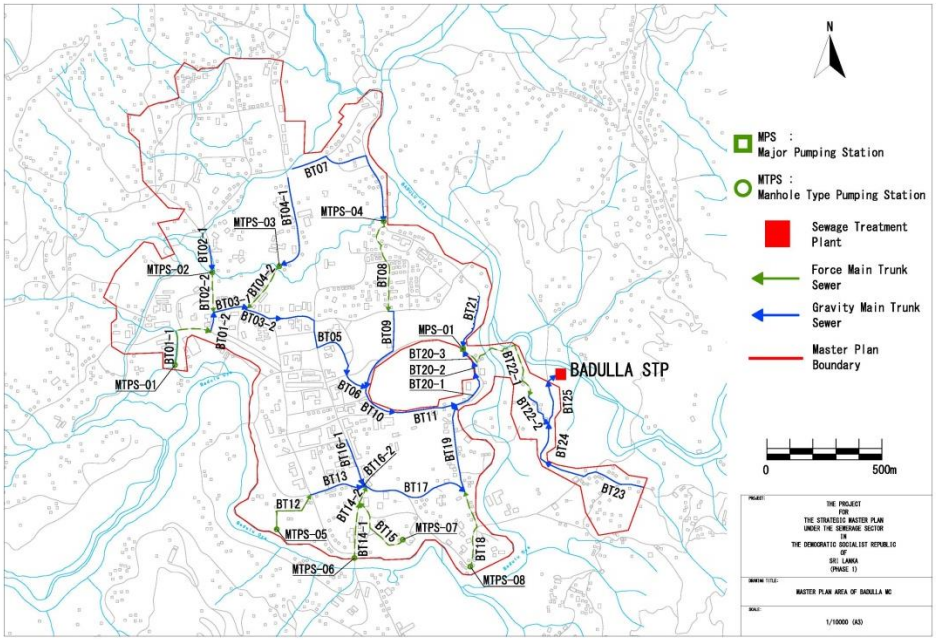
Chapter 1 describes the Project background and objectives and the Strategic Sewerage Master Plan for the entire country. The Master Plan identifies 15 priority cities and explains the process used to select the following five cities to be covered by the City Sewerage Master Plan.

- Sri Jayawardenapura Kotte Municipal Council (MC)
- Anuradhapura MC
- Badulla MC
- Nuwara Eliya MC
- Dehiwala-Mount Lavinia MC

Chapter 2 examines the environmental and socio-economic conditions of the target area for sewerage development in Badulla and describes the necessity of the Sewerage Project. Increasing levels of Biochemical Oxygen Demand (BOD), ammonia, phosphorus and coliform bacteria have been detected in the Badulla Oya River flowing through the target area, indicating the deterioration of water quality caused by human activities. The mean household income in Badulla District is 21% lower than the national average. This means that the service area of the sewerage system needs to be limited to locations where sewage can be collected and treated more cost effectively than other options.

Chapter 3 sets out the basic conditions for the preparation of the sewerage plan for Nuwara Eliya. The plan is to be achieved by 2046 to serve an area of 235 ha. The served population is estimated to be 23,200 and the maximum daily wastewater flow will be 4,000 m^3.

Chapter 4 describes the sewerage facility plan and design. The sewer route and locations of pumping stations and sewage treatment facilities are shown in **Figure 1** Treatment will use the oxidation ditch process similar to the one in Kandy MC, because of its low maintenance requirements and high capability to perform advanced treatment such as nitrogen removal. Sludge generated will be dewatered with screw press machines and then composted.



Source: JET

Figure 1 Map of Sewer System Plan for Badulla MC

Chapter 5 proposes that the sewerage system should be operated and maintained by the NWSDB because it is already providing water supply services thereby enabling cost reductions on bill collection. Another advantage is that NWSDB staff can be utilized to manage the planning and construction. Personnel development and OJT can be provided through improved training programs at NWSDB Training Centres.

Chapter 6 estimates the project costs at approximately 4.9 billion Japanese Yen (JPY) (excluding taxes), and the annual maintenance cost, 44 million JPY as shown in **Table 1**.

Table 1.1-1 Estimated Project Cost

		Amount		Total Amount	Total Amount
		L.C. (LKR)	F.C. (JPY)	LKR	JPY
1	Construction Cost				
A	Badulla STP (Q=4,000m3/day)	558,545,455	645,120,000	1,396,363,636	1,075,200,000
B	Trunk Sewer & Pump Station	880,842,000	257,822,000	1,215,675,000	936,070,000
C	Branch Sewer & Pump Station	478,622,000	161,910,000	688,895,000	530,449,000
D	House Connection	580,000,000	0	580,000,000	446,600,000
	Sub-total of 1(A-D)	2,498,009,455	1,064,852,000	3,880,933,636	2,988,319,000
2	Administration cost	303,000,000	0	303,000,000	233,310,000
3	Consulting cost	378,000,000	701,000,000	1,288,390,000	992,060,000
4	Physical contingency for construction cost	152,000,000	58,000,000	227,325,000	175,040,000
5	Price escalation for construction cost	540,000,000	92,000,000	659,481,000	507,800,000
6	Land acquisition and compensation	-	-	-	-
7	Interest during construction	0	31,000,000	40,260,000	31,000,000
8	Front-end Fee	0	9,000,000	11,688,000	9,000,000
9	Tax and duty	1,082,000,000	0	1,082,000,000	833,140,000
	Sub-total of (2-9)	2,455,000,000	891,000,000	3,612,143,000	2,781,350,000
	Total including Tax and Duty	4,953,009,455	1,955,852,000	7,493,077,000	5,769,669,000
	Total excluding Tax and Duty	3,871,009,455	1,955,852,000	6,411,077,000	4,936,529,000
	Eligible Portion (1, 3, 4, 5 and 7)	3,568,009,455	1,946,852,000	6,096,389,000	4,694,219,000
	Non-Eligible Portion (2, 6, 8 and 9)	1,385,000,000	9,000,000	1,396,688,000	1,075,450,000

Note: L.C. = Local Cost, F.C. = Foreign Cost
Source: JET

Chapter 7 proposes two sewage tariff schemes to recover the maintenance cost. The Type 1 tariff is calculated to cover the maintenance cost for the sewerage system in Badulla, while Type 2 is calculated based on the sewerage systems operated by NWSDB. Type 1 is calculated to be 45.82 LKR/m^3, and Type 2, 38.77 LKR/m^3, both within the limits of affordability estimated by the World Bank (WB). The construction cost will be borne by the central government.

Chapter 8 describes the factors that are likely to affect the local natural or social environment and proposes the parameters to be appraised in an Environmental and Social Considerations Study in the F/S phase.

Chapter 9 concludes that the sewerage service in Badulla will make a significant positive impact on the protection and improvement of the local water environment. However, as the site for the sewage treatment plant (STP) has not been identified, further steps will not be taken to conduct a F/S for this area. Prompt project implementation depends on the timely confirmation of the treatment plant site.

CHAPTER 1 BACKGROUND AND OBJECTIVES

1.1 BACKGROUND

The Democratic Socialist Republic of Sri Lanka had a per capita income of 3,162 US dollars in 2013, and an economic growth rate of 7.3% (source: JETRO website, Basic economic indicators of Sri Lanka). Steady economic growth raised the per capita income to 4,000 USD by 2016, and most Sri Lankans are approaching upper-middle income. The robust economic growth has spurred urbanization and increased water usage, and the volume of domestic and industrial wastewater has increased sharply.

In 2014 only 2.4% of the country is served by urban sewerage infrastructure. A considerable amount of untreated wastewater is discharged into the ocean, rivers, and streams, causing problems related to hygiene and environmental degradation.

The national policy formulated in 2010 (Source: Department of National Planning (DNP), Mahinda Chintana Vision for the Future), highlights the importance of potable water supply and sewerage services as an integral element of sustainable development. The Government announced its intention to achieve 100% sanitation coverage by 2025 through the provision of on and off-site sanitation facilities. In addition, the NWSDB sets forth the target of 7.0 % sewerage system coverage by 2020.

The Government committed to developing the Strategic Master Plan for the sewerage sector to achieve the 2025 target as well as meet the stringent environmental standards introduced by the Central Environmental Authority (CEA) to mitigate pollution of the water environment. The Government sought assistance from Japan. The Japanese government accepted the request and subsequently Japan International Cooperation Agency (JICA) signed the Record of Discussions (R/S)s on this project with the Sri Lankan side in August 2015 and was assigned to carry out a study and formulate the Strategic Master Plan.

As agreed upon with the Sri Lankan side, the outline of the project is as follows.

(1) Purpose

To develop the Strategic Master Plan (M/P) to address the sewerage issues in the major cities in Sri Lanka, to mitigate to some extent the pollution of rivers and ocean.

(2) Outputs

1) Strategic Sewerage M/P for Sri Lanka
2) City Sewerage M/P for priority cities
3) Feasibility Studies (F/S) for selected cities
4) Enhanced capacity at the National Water Supply and Drainage Board (NWSDB) and cities selected for F/S

The Strategic Sewerage M/P was formulated in 2016 (from January to June) - Output (1) (Section I of this Report). The M/P aims to improve the overall water environment through the provision of sewerage systems and improvement of on-site sanitation facilities. 79 major cities in the country were evaluated using the following six criteria and an approach to sewerage system development was indicated.

- Urbanization
- Sanitation

- Urban development
- Sustainability of sewerage service
- Water environment
- Maturity of sewerage project

As a result, 15 cities are designated as priorities for the implementation of sewerage systems to achieve the national target of 7.0% coverage by 2035. These are: Colombo MC, Kandy MC, Sri Jayawardenapura Kotte MC, Anuradhapura MC, Badulla MC, Kelaniya PS, Nuwara Eliya MC, Galle MC, Dehiwala-Mount Lavinia MC, Negombo MC, Koticawatta-Mulleriyawa PS, Ratnapura MC, Hambantota MC, Trincomalee UC, and Maharagam UC.

Septic tanks are commonly used for domestic wastewater treatment. It is important to de-sludge and treat septage to maintain proper operation. Therefore, the M/P outlines a focused approach to improve on-site sanitation with septage treatment facility. 11 cities are identified as urgently requiring septage treatment facilities and another 13 cities will be targeted in the next phase.

Five cities are selected from the 15 priority cities for the development of city sewerage master plan based on the following criteria.

- Colombo MC and cities that have sewerage projects with funding assistance from other countries and international donors.
- Cities that are targeted for local development but have no on-going sewerage projects.

The five cities selected are:

- Sri Jayawardenapura Kotte MC
- Anuradhapura MC
- Badulla MC
- Nuwara Eliya MC
- Dehiwala-Mount Lavinia MC

This Report (Section II-(3)) presents the Sewerage M/P for Badulla MC, as part of the Project's Output (2)

1.2 OBJECTIVES AND SCOPE

The Report describes the sewerage development plan to improve the water environment in Badulla MC. The sewerage service area and the conditions for implementing the project are identified.

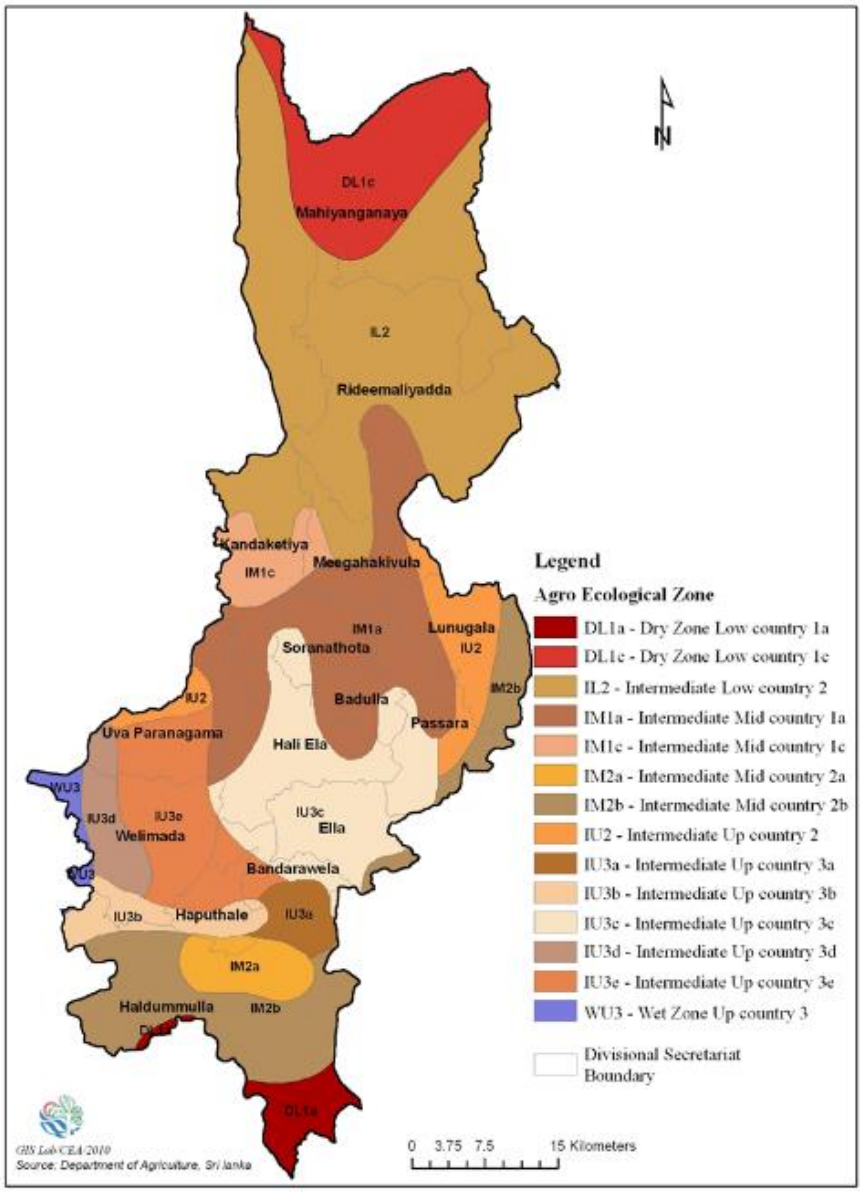
CHAPTER 2 EXISTING CONDITIONS

2.1 EXISTING ENVIRONMENTAL CONDITIONS/NATURAL CONDITIONS

2.1.1 Climate

(1) General

The agro-ecological zone map of Badulla District is shown in **Figure 2.1-1** There are 14 agro-ecological zones that are classified by present land use, soil, vegetation, and rainfall. Badulla City and its surroundings are within the intermediate agro-ecological zone, sub categories IM1a and IU3c.

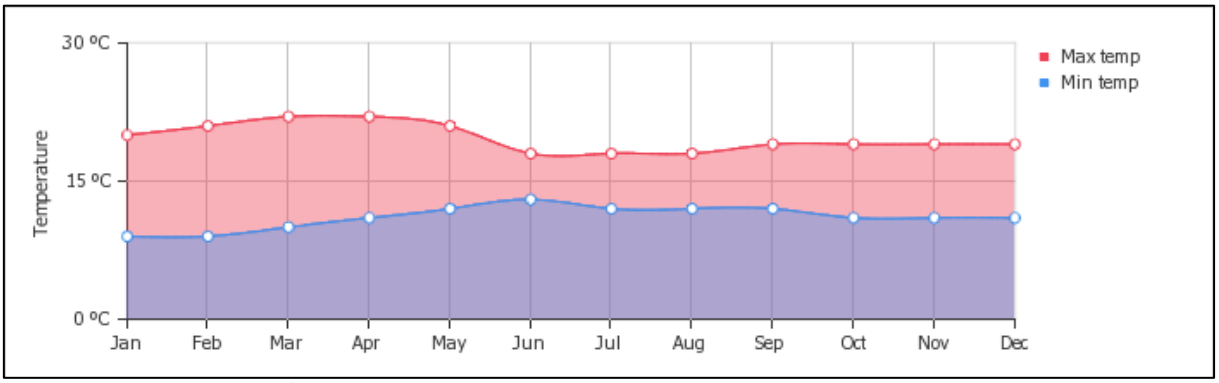


Source: Department of Agriculture

Figure 2.1-1 Agro –ecological Zones – Badulla District

(2) Temperature

The average annual temperature of the district varies between 20–250C depending on the altitude. At Badulla (670 m) the average temperature is 23.20C. At higher altitudes such as Passara (1007 m) and Diyatalawa (1248 m) the annual average temperature is 21.30C and 20.20C. Due to the influence of dry and warm katabatic winds the temperature gradient for stations located on the leeward side of the central highlands is 0.50C per 100 meters as opposed to the normal lapse rate of 0.650C per 100 m on the Western slopes. The mean annual variation of temperature at Badulla and Diyatalawa is 3.20C while at Passara it is 3.50C. The average monthly minimum and maximum temperatures are shown in **Figure 2.1-2**.

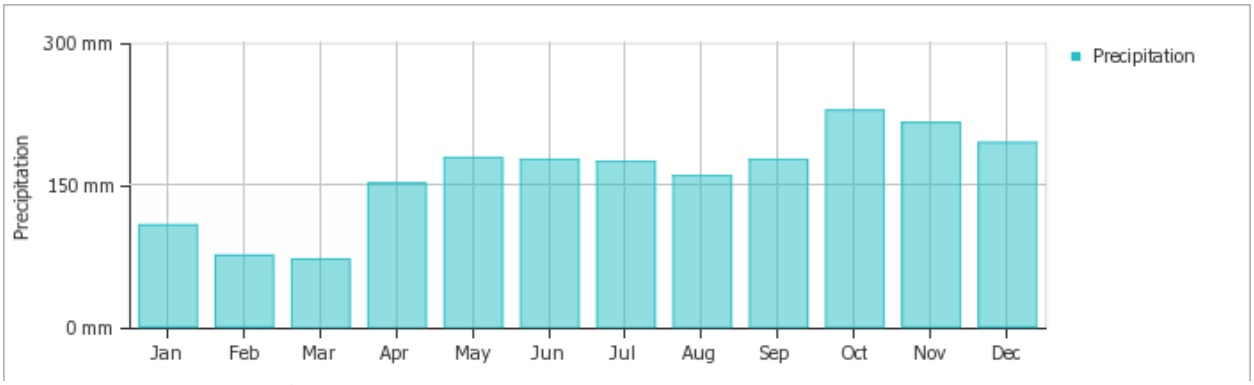


Source: JET, using Department of Meteorology data

Figure 2.1-2 Average Monthly Minimum and Maximum Temperatures

(3) Precipitation

The average annual rainfall in the district is around 2000 mm but varies from 900 mm in the northern and southern most extremities of the district, to over 2500 mm in the eastern flanks of the central highlands, Namunukula and Lunugala ridges. The northeast monsoon provides a comparatively high rainfall to the eastern slopes of the Lunugala and Namunukula ridges between December and February. The Uva basin however lies in the rain shadow during this season. During the first inter-monsoon season (March to mid-May) the whole district receives about 300-500 mm of rain. Drought is an important climatic characteristic in the Badulla District. Partial drought occurs very often during the months of February to July in the Intermediate Zone.

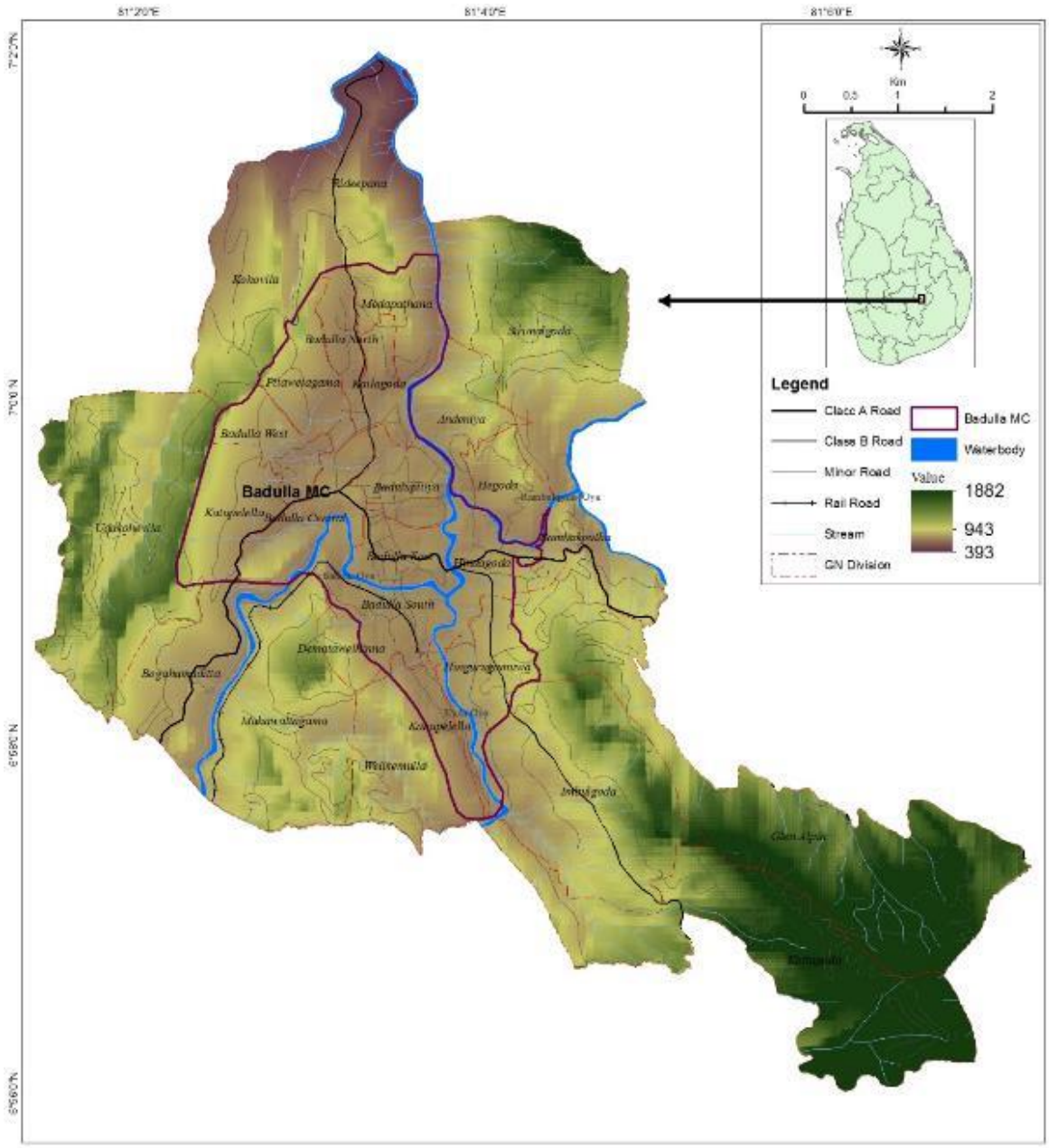


Source: JET, using Department of Meteorology data

Figure 2.1-3 Average Monthly Precipitation

2.1.2 Topography

Badulla District is located to the east of the central highlands. It is a complex region with mountain ranges, dissected plateaus, escarpments, and narrow valleys covering a greater proportion of the district and about 680 m above the sea level. The area is encircled on three sides by the central highlands, the eastern and Namunukula ranges and Lunugala ridges. The area contains both flat plains of Mahiyangana and higher terrains towards Kandaketiya, forming different topography within a small geographic area. Badulla city is overshadowed by the Namunukula range of mountains (highest peak 2,016 m above mean sea level). An elevation map of the area is given in **Figure 2.1-4**.

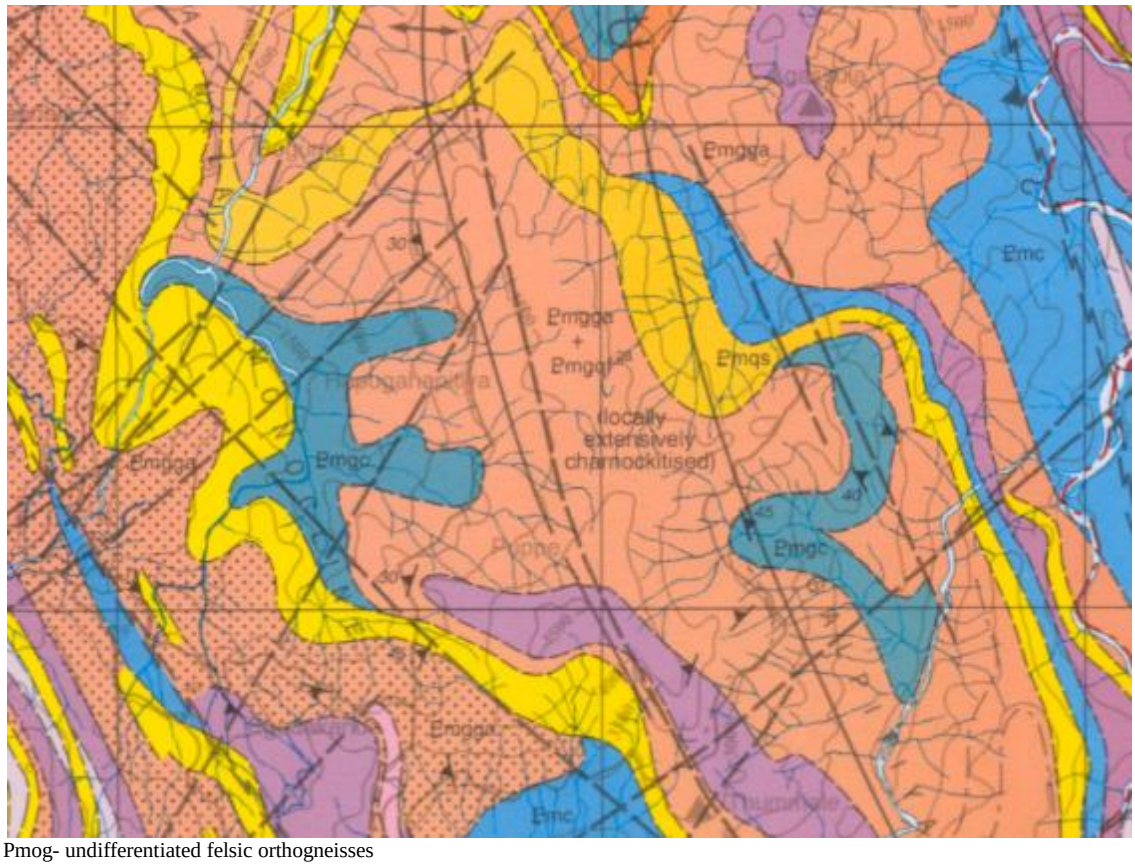


Source: Survey Department of Sri Lanka

Figure 2.1-4 Elevation Map of the Badulla MC area

2.1.3 Geology

Badulla district is covered by Highland and Vijayan rocks and the surrounded by mineralized zones, hot springs and shear zones. Sorabora and Hirrassagala anti-forms are the main geological features in the northern part of Badulla district. The main deformation zone of Mahaweli Loggal Oya is surrounded by shear zones, Rantambe synform and Kohana fold. Many mineralized areas are aligned with these deformed zones and small shear zones. Iron ores and abundant vein quartz are the main components of the mineralized area. Hard rock outcrops are formed along the north-south direction. Hornblende biotite gneiss, migmatitic gneiss, minor charnockites and charnockitic gneisses are prominent rock types. The excessive sand deposits occurring along Mahaweli River within the stretch from Dunuwilapitiya to Yakabendiheena near Rantambe reservoir, fulfils a considerable percentage of sand requirements of the country. These deposits are replenished by sediments from the flow of the Mahaweli river. Regional geology of the area is shown in **Figure 2.1-5**.



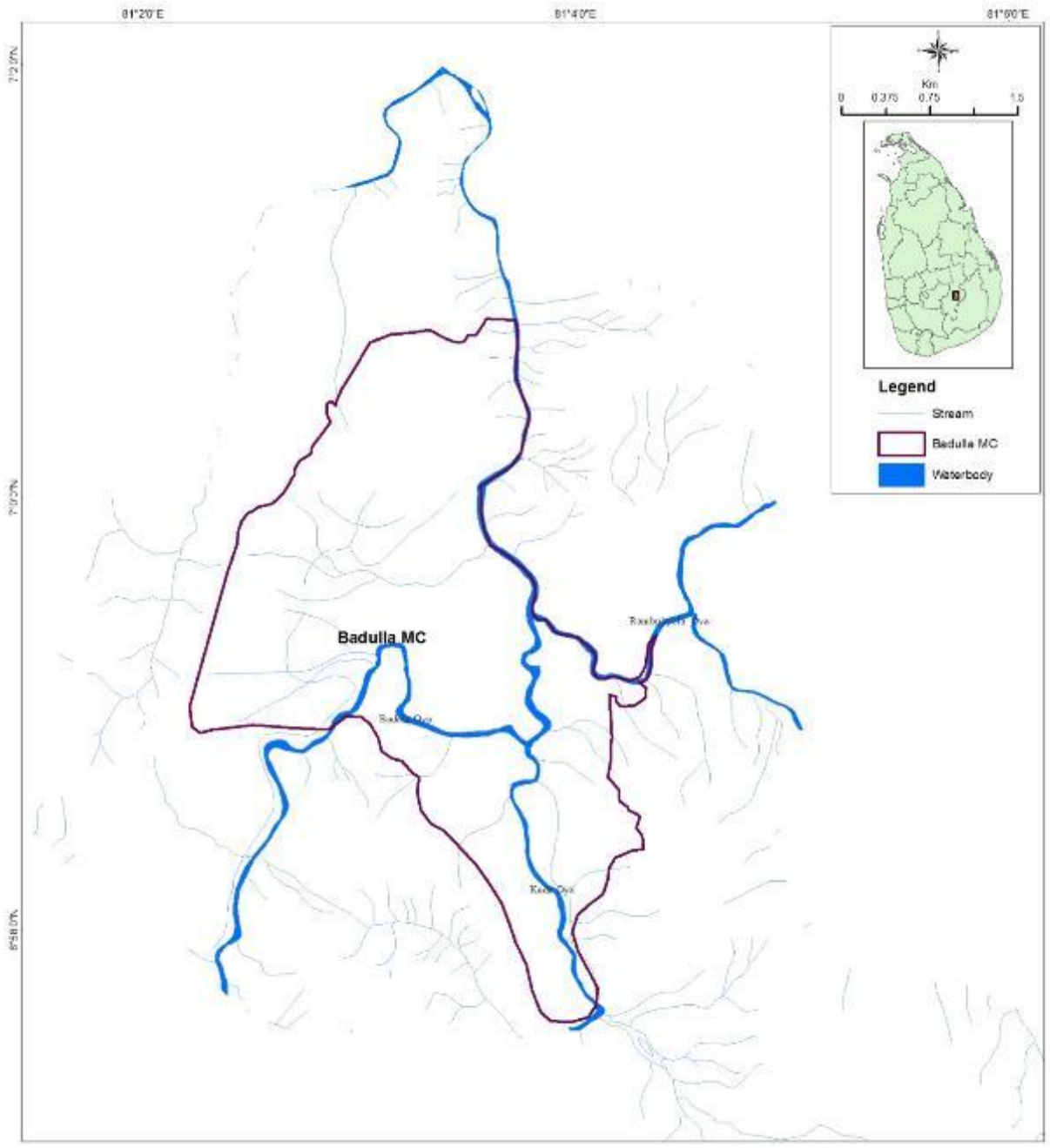
Pmog- undifferentiated felsic orthogneisses
Pmmhb- biotite Hornblende migmatites
Pmgr – Granitic Gneiss
Source: Geological Survey and Mines Bureau

Figure 2.1-5 Regional Geology

2.1.4 Hydrology

Drainage networks and surface water bodies in the area are shown in **Figure 2.1-6**. Encircled on three sides by the central highlands, the eastern and Namunakula ranges and Lunugala ridges, is the distinctive and clearly defined Uva Basin (elevation below 1200 metres). The rim of the Basin and the Uva highlands located in its centre are dissected by the northward flowing Uma, Badulu, Loggal Oyas and their tributaries. Their valley bottoms have undulating floors while the flanking hills rise

sometimes to a height of 900 metres. The Badulu Oya, flows in a deep valley and its lateral tributaries also carved up deep valleys.



Source: Survey Department of Sri Lanka

Figure 2.1-6 Drainage Network and Surface Water Bodies of the Area

2.1.5 Surface Water Quality and Quantity

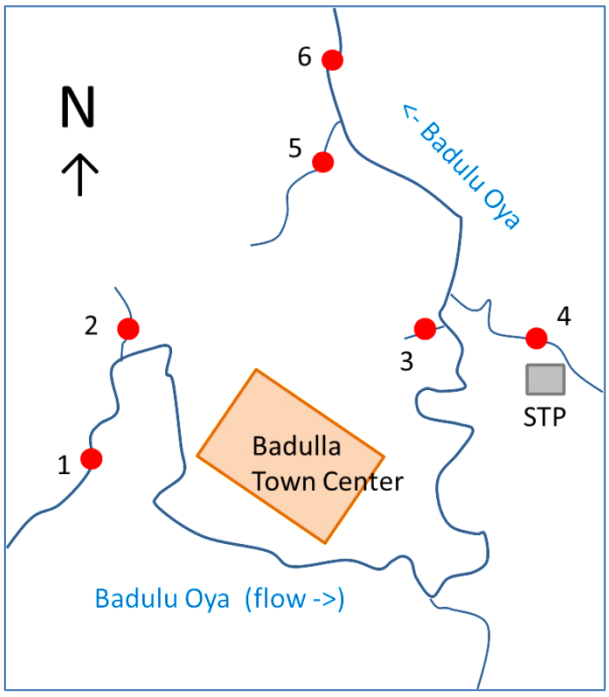
(1) Water Quality

Water quality at sampling stations (1-6) in Badulla is shown in the **Table 2.1-1**. The locations of sampling stations are shown in.

Table 2.1-1 Water Quality (Badulla)

Badulla		1	2	3	4	5	6	Criteria
pH	-	8.1	7.2	8.3	8.2	7.7	7.2	-
Temperature	^{o}C	29.4	28.8	23.6	25.2	27.6	27	-
Odour	-	-	!	!	-	-	-	ND
Colour	mg Pt/L	<15	<15	37	<15	42	<15	100
EC	uS/cm	230	486	484	202	635	298	700
Turbidity	NTU	9	42	52	6	7	14	-
TSS	mg/l	8	76	64	4	5	9	40
TDS	mg/l	170	320	340	140	450	200	-
DO	mg/l	7.8	0.2	1.8	7.3	3.4	6.3	5
BOD	mg/l	<4	120	85	<4	45	5	4
COD	mg/l	12	169	203	<4	40	30	15
Nitrate	mg/l	1.26	0.38	0.41	0.06	0.12	0.32	10
Ammonia	mg/l	3.7	0.24	0.13	0.98	4.5	<0.02	0.59
T-P	mg/l	0.08	1.3	1.48	0.05	0.52	0.18	-
PO_4^{3-} - P	mg/l	0.07	0.59	0.59	0.04	0.42	0.14	0.4
Cl	mg/l	7	54.2	37.5	6	36	9.7	600
Total Nitrogen (T-N)	mg/l	5.15	0.64	0.55	1.13	4.66	0.32	-
Faecal	/100ml	88	$10x10^5$	$71x10^6$	$10x10^2$	$6x10^2$	96	$1x10^3$
Total Coliform	/100ml	$20x10^2$	$2x10^{10}$	$10x10^8$	$10x10^3$	$10x10^4$	$4x10^4$	$1x10^4$

*) ! : Objectionable / Over the criteria
Source: JET



Source: JET

Figure 2.1-7 Water Sampling Locations

The criteria for evaluating water quality are based on the parameters identified in "National Environmental Regulations, No.1 of 2014" and "Draft Revised Ambient Water Quality Standards (2016)". The values are chosen from Category C (Fish and Aquatic Life Water) for normal

environmental standards. When values are not available from Category C, the lowest values from Categories D, E and F are used.

Total Suspended Solids (TSS), DO, BOD, COD, ammonia, phosphate, faecal coliform and total coliform exceed the standard values at most locations. All sampling locations show some level of pollution.

Pollution levels in town centre drains (stations 2, 3 and 5) are significantly higher than the main stream (stations 1 and 6) and tributaries (station 4). The BOD and COD in the main stream is surprisingly not too high and oxygen levels are good. This indicates that the stream has some capacity to dilute the pollutant load discharged from town drains. Nevertheless, high coliform counts at station 6 compared to station 1 indicate contamination by city wastewater.

(2) Effects of Implementing a Sewerage System

High levels of TSS, COD, ammonia, phosphorous and faecal coliform are observed in Badulla, indicating pollution by wastewater.

TSS values are much higher than 40 mg/L set in the standards. The target TSS value in the effluent discharge for the proposed STP is 35 mg/L, therefore it is expected that TSS in the receiving water body will be reduced significantly by the development of a sewage treatment plant.

The proposed treatment process will improve DO values by providing aeration in the reactor tank at the sewage treatment plant and significantly reducing the oxygen demand caused by organic pollutants (BOD and COD). The aerobic treatment process can be operated to convert ammonia to nitrates (nitrification).

Total coliform will be reduced by disinfecting with chlorine. Thus, the introduction of a sewerage system is expected improve the water environment in Badulla MC.

(3) Water Quantity

The flow rates for the main stream (stations 1 and 6) and town drains (stations 4 and 5), measured on 4th August 2016, are shown below.

Table 2.1-2 Water Quantity (Badulla)

Station	Flow Rate (m^3/s)	Incremental Flow (%)	Date
1	0.484	-	04-08-2016
6	0.855	76.49	
4	0.080	n.a.	
5	0.028	n.a.	

Source: JET

2.1.6 Environmental Quality

(1) Air Quality

No recent records on air quality measurements in Badulla area are available.

Traffic along A5 highway (Peradeniya-Badulla-Chenkaladi Highway), B36 (Mahiyanganaya Road) and side roads and train movements lead to elevated levels of air pollutants, such as dust, particulates and smoke, especially during peak hours when traffic is very congested. Sewage and solid wastes thrown in the canals, produce foul odours, especially during dry weather when water level is low.

Use of pesticides, herbicides and nutrients are major causes of air pollution in the area. This is most evident where cultivation of vegetables is undertaken on a commercial scale. Air pollution in the form of early morning smog is a clearly visible in the area. This is primarily attributable to smoke emanating from sugar cane crushing plants and other similar sites. The smoke is trapped by the surrounding mountains.

(2) Noise and Vibration

No records on noise level/vibration measurements in Badulla area are available.

Ambient noise and vibration levels are as expected for urban areas with light industries, businesses, hotels, and restaurants. There is traffic noise from A5 highway (Peradeniya-Badulla-Chenkaladi Highway), B36 (Mahiyanganaya Road), and other roads that carry heavy traffic, during peak hours, as well as at night time. Intermittent high levels of noise and vibration are observed with train operations. Badulla is the terminal of the upcountry railway line also known as the "Main Line". All these urban activities contribute to high noise levels in the project area.

2.1.7 Protected Areas

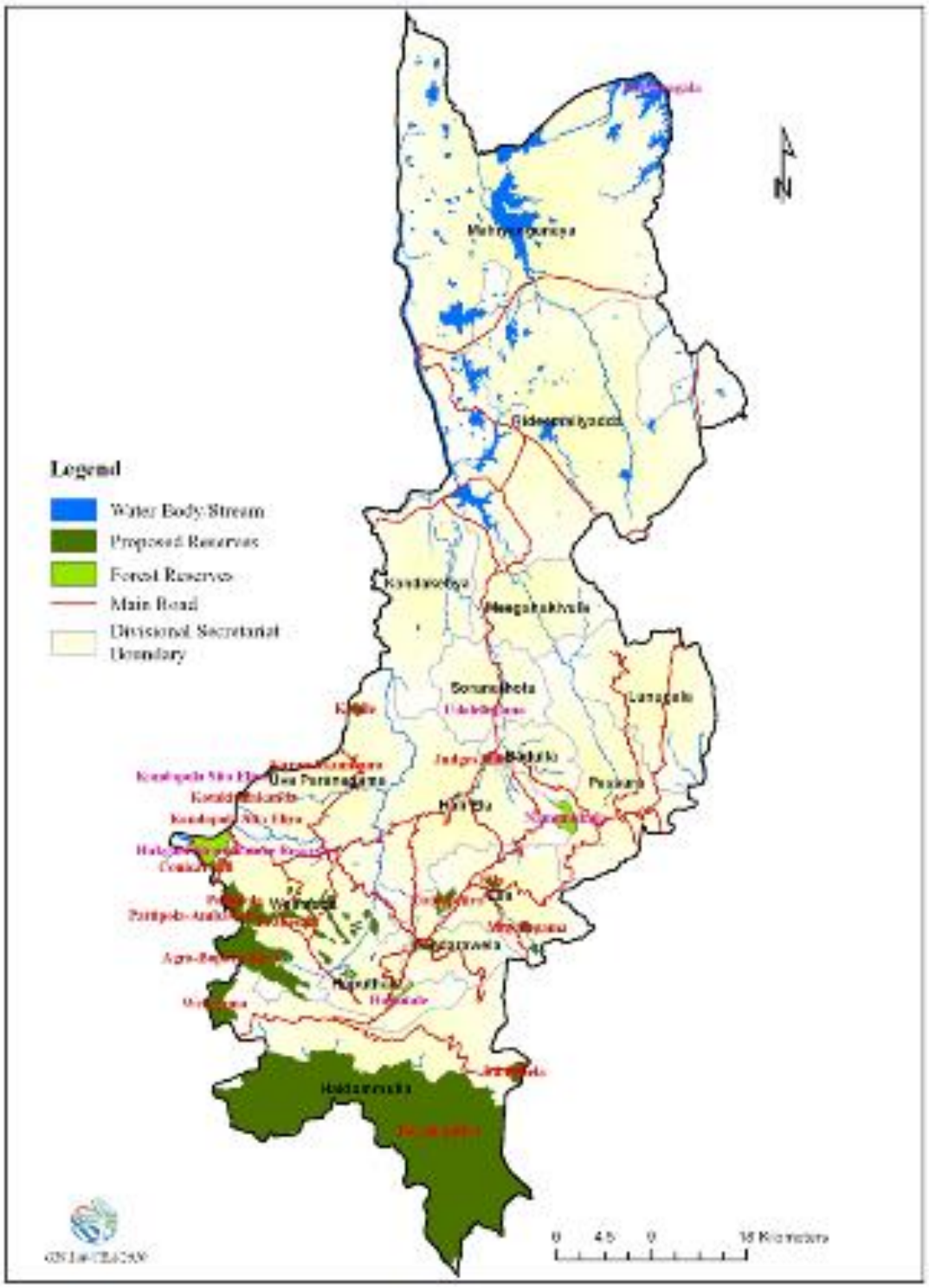
(1) Protected Areas

Natural forest covers 54,271 ha which is approximately 20% of the area of Badulla District (**Table 2.1-3**). The Department of Wildlife Conservation and the Forest Department have declared protected areas shown in **Figure 2.1-8** and **Figure 2.1-9**.

Table 2.1-3 Forest Types within Badulla District

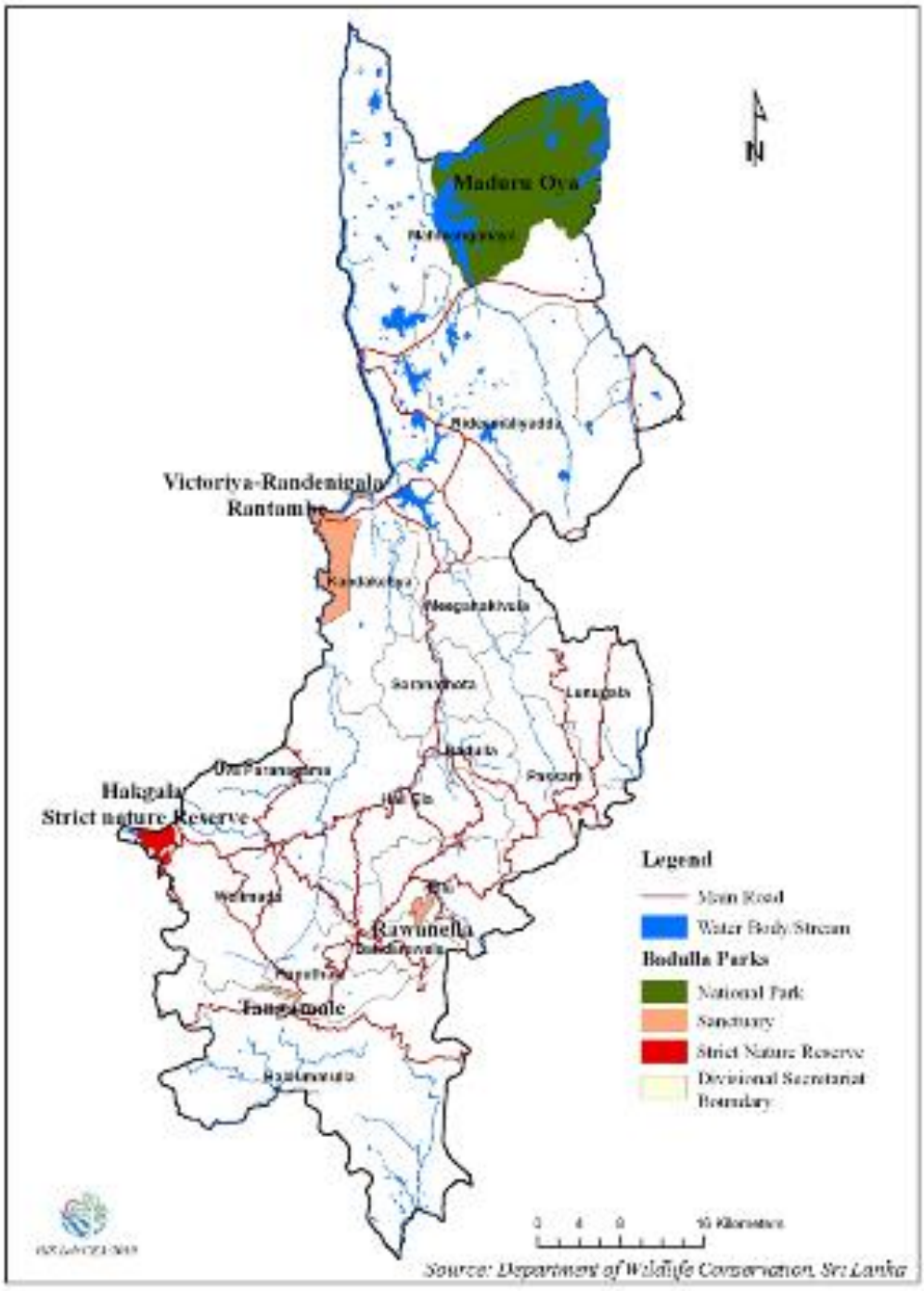
Forest Type	Extent (ha)
Mon-tane forests	93
Sub-Mon tane forests	3888
Lowland rain forests	1577
Moist monsoon forests	17517
Dry monsoon forests	3353
Spare forests	27843
Total	54271

Source: Forestry Department



Source: Forest Department

Figure 2.1-8 Forest Reserves



Source: Department of Wildlife Conservation

Figure 2.1-9 Wildlife Protection Areas

(2) Buffer Zone

Even though there are no buffer zones, a set of sensitive areas has been declared under the CEA regulations. Any development activities within these zones are subject to close monitoring by CEA and relevant authorities.

- 100 m from the boundaries of or within any area declared under the National Heritage Wilderness Act No. 4 of 1988
- 100 m from the boundaries of or within any area declared under the Forest Ordinance (Chapter 451)
- any erodible area declared under the Soil Conservation Act (Chapter 450)
- any flood area declared under the Flood Protection Ordinance (Chapter 449)
- any flood protection area declared under the Sri Lanka Land Reclamation and Development Corporation Act 15 of 1968 as amended by Act 52 of 1982
- 60 m from the bank of public stream as defined in the Crown Lands Ordinance (Chapter 454) and having the width of more than 25 meters at any point of its course
- any reservation beyond the full supply level of a reservoir
- any archaeological reserve, ancient or protected monument as defined or declared under the Antiquities Ordinance (Chapter 188)
- any area declared under the Botanic Gardens Ordinance (Chapter 446)
- within 100 m from the boundaries of, or within, any area declared as a Sanctuary under the Fauna and Flora Protection Ordinance (Chapter 469)
- within one mile of the boundary of a National Reserve declared under the Fauna & Flora Protection Ordinance
- within 100 m from the high flood level contour of, or within, a public lake as defined in the Crown Land Ordinance (Chapter 454) including those declared under section 71 of the said Ordinance.

Reservations from the banks of rivers and canals have been declared under the 'Development Plan for Badulla Urban Development Area' prepared by the Urban Development Authority (UDA). Details are given in the following Table.

Table 2.1-4 River and Canal Reservations – Badulla MC Area

No.	Name of the River / Canal	Reservation from the bank (m)
1	Badulu Oya	15.0
2	Kuda Oya	15.0
3	Rambukpotha Oya	15.0
4	Dalada Ela	3.0
5	Kendala Ela	3.0
6	Badulupitiya Ela	3.0
7	Aluth (new) Ela	3.0
8	Hindagoda Ela	3.0
9	Hingarugmuwa Ela	3.0
10	Angane Ela	3.0
11	Hambawela Andeniya Ela	3.0
12	All Kanduru and Mal kanduru	3.0
13	All other canals	3.0
14	All springs	100 meters radius from the centre point or centre line of the spring
15	All other water sources	100 meters radius from the centre point or centre line of the water source

Source: UDA

2.1.8 Fauna and Flora

Fauna of the general area as documented in literature and site surveys are summarized in **Table 2.1-5**. Further investigation is necessary to determine the fauna and flora specific to the project sites.

Table 2.1-5 Fauna in the Badulla Area

Species	Significant Species	Common Name	Source
Butterflies	*Troides darsius* Gray,1852	The Common Birdwing	Abrera, 1996
	Nacaduba Sinhala Ormiston,1924	The Pale Ceylon 6-Lineblue	Abrera, 1996
Amphibians	*Bufo atukoralei* Bogert and Senanayake,1966	Athukorale's Dwarf Toad	Dutta & Mammendra-Arachchi, 1996
	Rana gracilis Gravenhorst,1829	Sri Lanka Wood-frog	Dutta & Mammendra-Arachchi, 1996
Reptiles	*Balanophis ceylonensis* Gunther,1858	Blossom Krait	De Silva, 1980
	Boiga barnesi Gunther,1869	Barnes's cat Snake	De Silva, 1980
	Cercaspis carinatus Kuhl,1820	Sri Lanka Wolf Snake	De Silva, 1980
	Chrysopelea taprobanica Smith,1943	Sri Lankan Flying Snake	De Silva, 1980
	Lycodon striatus sinhaleyus Shaw,1802	Shaw's Wolf Snake	De Silva, 1980
	Oligodon sublineatus Dum. & Bibr.,1854	Dumeril's Kukri Snake	De Silva, 1980
	Xenochrophis asperrimus Boulenger,1891	Checkered Keelback	De Silva, 1980
	Cylindrophis maculates Linne,1754	Sri Lanka Pipe Snake	De Silva, 1980
Birds	*Galloperdix bicalcarata*	Sri Lanka Spurfowl	Henry, 1971
	Gallus lafayetii	Sri Lanka Junglefowl	Henry, 1971
	Loriculus beryllinus	Sri Lanka Hanging Parrot, Lorikeet	Henry, 1971
	Psittacula calthropae	Sri Lanka Layard's Parakeet	Henry, 1971
	Ocyceros gingalensis	Sri Lanka Grey Hornbill	Henry, 1971
	Pycnonotus melanicterus	Black-crested Bulbul, Black-capped Bulbul	Henry, 1971
Mammals	*Trachypithecus senex* Erxleben,1777	Purple-faced Leaf Monkey	Petiyagoda, 1991
	Macaca sinica Linnaeus,1771	Toque Monkey	Petiyagoda, 1991
	Melursus ursinus Shaw,1791	Sloth Bear	Petiyagoda, 1991
	Paradoxurus zeylonensis Pallas,1777	Golden Palm-cat	Petiyagoda, 1991
	Pteropodidae	Flying foxes, Old World fruit bats	Petiyagoda, 1991
Fresh Water Fishes	*Garra ceylonensis* Bleeker,1863	Stone sucker	Petiyagoda, 1991
	Clarias brachysoma Gunther,1864	Walking catfish	Petiyagoda, 1991
	Aplocheilus dayi Steindachner,1892	Day's killifish	Petiyagoda, 1991

Vegetation

Natural vegetation in the District consists of non-productive wet-zone forest, non-productive intermediate zone forest, scrubland, and grassland. The dense and open forest lands made up 19.6% of the area and cover 55,450 ha. The main land uses are as follows:

- built-up Land
- non-Agri. Land
- homesteads
- tea
- rubber
- coconut
- mixed tree and other perennial crops
- paddy
- sparsely used cropland
- other cropland
- dense forest
- open forest
- forest plantations
- scrubland
- grassland

Barren land forest plantations cover 12,890 ha or 4.6% of the district. Dry pathana grassland covers 10,230 ha located mostly in the crests and upper slopes of hills in Passara, Ella, Haldumulla and Migahakivula, where the soil is shallow. Scrubland covers 14,240 ha and are concentrated predominantly in Mahiyangana and Ridimaliyadda. These scrublands were formed when Chena lands were abandoned after continuous cultivation.

The total natural forest cover found in the Badulla district is about 68,340 ha, which is approximately 24.2% of the area.

Some dominant plant species found in the Badulla District are:

Species	**Common Names**
Terminalia chebula	Aralu
Terminalia belerica	Bulu
Phyllanthus emblica	Nelli
Pterocarpus marsupium	Gammalu
Euphoria longana	Mora
Vitex alticima	Milla
Berrya cordifolia	Halmilla
Cymbopogon confertiflorus	Mana

2.2 EXISTING SOCIAL CONDITIONS

2.2.1 Administration

Badulla MC was established in 1963 to promote, public health and welfare, develop sanitation infrastructures and amenities of the city. The city area is located within the Badulla Divisional Secretariat Division (DSD), in Badulla District, in the Uva Province.

The administrative area of the Badulla Municipality Council is 10.4 km^2 consisting of 15 wards. Badulla DSD is 51 km^2 and Badulla District is 2,861 km^2,while the Uva Province is 8,520 km^2. The forest area in the District and the Province is 814 km^2 and 2.959 km^2. Inland water in the district and the province occupies an area of 61 km^2 and 310 km^2.

2.2.2 Population and Demography

According to the Census and Statistics Department of Sri Lanka, the population density of the Badulla DSD is 1471 persons per km^2 compared to 299 persons per km^2 in Badulla District and 158 persons per km^2 in Uva Province. In 2012 the population for the Badulla MC was 42,237 which is 56% of the Divisional Secretariat population of 75,042. The population Figures and gender distribution, obtained from the Grama Niladari Division, are tabulated below.

Table 2.2-1 Population in Badulla MC Area

Name of GND	Total	Male		Female	
		No	%	No	%
Pitawelagama	2,824	1,308	46	1,516	54
Badulla North	4,062	1,948	48	2,114	52
Medapathana	2,297	1,086	47	1,211	53
Kailagoda	2,440	1,157	47	1,283	53
Badulupitiya	5,153	2,357	46	2,796	54
Badulla Central	3,347	1,462	44	1,885	56
Badulla West	2,753	1,203	44	1,550	56
Katupelella	2,437	1,134	47	1,303	53
Badulla South	3,557	1,668	47	1,889	53
Badulla East	4,159	2,156	52	2,003	48
Hindagoda	3,079	1,451	47	1,628	53
Hingurugamuwa	4,139	1,960	47	2,179	53
Kanupelella	1,990	919	46	1,071	54
Total	42,237	19,809	47	22,428	53

Source: Census of Population and Housing 2012, Department of Census and Statistics (DCS)

2.2.3 Health/Disease

The prevalence of chronic illnesses in the Badulla District compared to the national data by age is shown in **Table 2.2-2**.

Table 2.2-2 Prevalence of Chronic Illnesses by Age Groups

	Less than 15 years	15-24 years	25-59 years	60 and above
Badulla District	3.5%	4.8%	15.7%	44.8%
Sri Lanka	2.8%	3.3%	18.5%	55.2%

Source: National Survey on Self-Reported Health in Sri Lanka 2014, Department of Census, and Statistics

The prevalence of chronic illnesses is higher than that of the national average for the two age groups below 25. However it is less than the national average for the age groups 25 and over.

The prevalence of diabetes and high blood pressure among those 15 years and older is less than the national average.

Table 2.2-3 Prevalence of Diabetes and High Blood Pressure

	Diabetes	High Blood Pressure
Badulla District	4.8%	7.0%
Sri Lanka	7.2%	9.2%

Source: National Survey on Self-Reported Health in Sri Lanka 2014, Department of Census, and Statistics

2.2.4 Religion/Ethnicity

The population is predominantly Buddhist Sinhalese, with a relatively strong representation of Tamil Hindus.

Table 2.2-4 Population by Religion

Buddhist	Hindu	Islam	Roman Catholic	Other Christian	Other	Badulla District Total
591,980	157,372	47,293	12,231	6,523	0	815,400
72.6%	19.3%	5.8%	1.5%	0.8%	0.0%	100%

Source: Economic and Social Statistics of Sri Lanka -2014, Central Bank of Sri Lanka, April 2014

Population statistic for the Badulla District based on the ethnicity is illustrated below;

Table 2.2-5 Population by Ethnic Group

Sinhala	SL Tamil	Indian Tamil	SL Moor	Other	Badulla District Total
595242	22,016	150,849	44,847	3,261	815,400
73	2.7	18.5	5.5	0.4	100%

Source: Economic and Social Statistics of Sri Lanka -2014, Central Bank of Sri Lanka, April 2014

2.2.5 Poverty Rate

Household income and expenditure surveys (HIES) at the national and provincial levels were carried out by the Census and Statistics Department of Sri Lanka for 2006/7 to 2012/13. A significant decline in poverty is observed at the national and provincial levels.

Table 2.2-6 Poverty Rates

	% of Poor Households		
	2006/07	2009/10	2012/13
Sri Lanka	12.6	7.0	6.7
Uva Province	23.8	12.0	15.4
Badulla District	21.0	10.9	12.3

Source: Census and Statistics Department

2.2.6 History and Culture (Heritage)

In the 20th century Badulla was a regional hub for the British rulers. They made it the capital of Uva Wellassa, now known as Uva Province. There are still some British colonial buildings in the city. The Badulla train station is one such example. It is the last train station in one of the main train lines in Sri Lanka. The Upcountry train line was used by the British to send tea collected from the Badulla district to Colombo. Badulla district is one of the leading tea producers, second only to the Nuwara-Eliya district.

Badulla is a multinational city with the ancient Muthiyangana Temple situated in its centre. The Catholic Church has a diocese headquartered here. It is emerging as a well-developed city with a state of the art provincial hospital and many other developments. Sites with cultural significance are summarized in **Table 2.2-7**.

Table 2.2-7 Culturally Significant Sites

No.	Name of the land & the Building	ownership	GND	
1	Valuers' Building at Ridipana	Govt.	78 A	Badulla North
2	Sorabora Inscription at Public Library	Govt.	78 B	Badulla East
3	Salusala Building	Govt.	78 B	Badulla East
4	District Secretariat	Govt.	78 B	Badulla East
5	Prison Building	Govt.	78 B	Badulla East
6	Old Provincial Council Building	Govt.	78 B	Badulla East
7	Willspark Playground	Govt.	78 B	Badulla East
8	Old Govt. Agent Office and land	Govt.	78 B	Badulla East
9	Uva Club Building	Govt.	78 B	Badulla East
10	Four Kachcheri Quarters at Powatta	Govt.	78 P	Badulla West
11	Irrigation Quarters at Polwatta	Govt.	78 C	Badulla Central
12	Old Fort at Welekade	Govt.	78 D	Badulla Central
13	Old building complex in the Hospital	Govt.	78 D	Badulla Central
14	Old building complex and land around the vicinity of the Inn (Ambalama)	Govt.	78 D	Badulla Central
15	Court Building	Govt.	78 D	Badulla Central
16	Badulla Municipal Building	Govt.	78 D	Badulla Central
17	SSP Bungalow	Govt.	78 D	Badulla Central
18	Judge's Bungalow	Govt.	78 D	Badulla Central
19	Asst. Govt. Agent Office and its land	Govt.	78 D	Badulla Central

No.	Name of the land & the Building	ownership	GND	
20	Railway Station and its Quarters	Govt.	78 F	Badulla -Kanupalalla
21	Building Material Corporaton	Govt.	78 F	Badulla -Kanupalalla
22	Director of Health Services Office	Govt.	78 P	Badulla - Kalagoda
23	Paddy Marketing Board Building	Govt.	78 P	Badulla - Kalagoda
24	Rose bank Building	Govt.	78 P	Badulla - Kalagoda
25	Health Education Unit Office	Govt.	78 P	Badulla - Kalagoda
26	Tisahami's Tomb at Badulupitiya	Govt.	78 J	Badulla - Badulupitiya
27	Malwatta Land of Municipality	Govt.	78 J	Badulla - Badulupitiya
28	Race Course Ground	Govt.	78 J	Badulla - Badulupitiya
29	Old Building in Malwatta	Govt.	78 J	Badulla - Badulupitiya
30	Kothaawala Walawwa (in front of Bus Depot of Passara Road	Govt.	78 K	Hindagoda
31	Museums Walawwa	Private	78 A	Budulla North
32	Muthiyangana Raja Maha Vihara	Private	78 B	Budulla East
33	Badulla Katharagama Devalaya	Private	78 B	Budulla East
34	Hindu Kovil at Badulla Pahala Veediya	Private	78 B	Budulla East
35	Monk' Quarter of Methodist Church	Private	78 B	Budulla East
36	Old Mosque at Maha Veediya	Private	78 B	Budulla East
37	Methodist Church at Wele Kade	Private	78 D	Budulla Central
38	Uva Hotel in front of Muthiyangana Raja Maha Viharaya	Private	78 D	Badulla Central
39	Quarter of Commercial Company located at right side of Springville Road	Private	78 E	Badulla - Hingarugamuwa
40	Quarters of Commercial Company	Private	78 E	Badulla - Hingarugamuwa
41	Browns Bungalow	Private	78 E	Badulla - Kanupalalla
42	Commercial Company's Building	Private	78 F	Badulla - kailagoda
43	Ratwatta Walawwa and its land	Private	78 P	Badulla - kailagoda
44	Taldena Walawwa and its land	Private	78 P	Badulla - kailagoda
45	Dimbulana Walawwa and its land	Private	78 P	Badulla - kailagoda
46	Kailagoda Pirivena	Private	78 P	Badulla - kailagoda
47	Old Gallinda (Rocked well) in font of Taldena Walawwa	Private	78 P	Badulla - kailagoda
48	Talagoda Walawwa	Private	78 P	Badulla - kailagoda
49	Rambukpotha Walawwa	Private	78 P	Badulla - kailagoda
50	Elder's Home	Private	78 P	Badulla - Kailagoda
51	Gal Bungalow (Rock bungalow) at Katupalalla Area	Private	78 H	Badulla - katupallala
52	Anglican Church and its land	Private	78 J	Badulla - Badulupitiya
53	Mosque and land	Private	78 J	Badulla - Badulupitiya
54	Old building of Vihara maha Devi Girls Vidyalaya	Private	78 J	Badulla - Badulupitiya

Source: Development Plan for Badulla Urban Development Area', UDA

2.2.7 Economy

(1) General

Agriculture is the main occupation. Agriculture is diverse from rice cultivation where irrigation is available, to vegeTables and other cash crops such as tea coffee, cocoa, and pepper. Badulla is famous for tea production, second only to Nuwara Eliya. Agriculture related businesses and tourism also contribute to a strong local economy. **Table 2.2-8** shows the GDP by sector for Uva Province.

Table 2.2-8 GDP by Sectors for Uva Province (Current Prices)

Unit: Million Sri Lanka Rupee (LKR)

No.	Sector	2010		2011		2012		2013	
1	Agriculture	82,298	32.5%	84,822	28.5%	94,581	26.1%	107,981	26.3%
2	Industry	49,023	19.4%	67,339	22.6%	80,391	22.2%	90,486	22.1%
3	Services	121,857	48.1%	145,173	48.8%	187,003	51.7%	211,505	51.6%
	GDP	253,177	100.0%	297,335	100.0%	361,975	100.0%	409,972	100.0%
	GDP Share Percentage	4.5		4.5		4.8		4.7	

Source: CBSL Annual Report 2014

Uva Province contributes to 4 or 5% of the national GDP. Service sector, the largest sector, contributes to about 50% (national average: 56.8%) of the total provincial GDP. The agricultural sector contribute

sd to about 30% (national average: 10.8%). The service sector contributes the largest amount, but relatively smaller percentage compared to the national level.

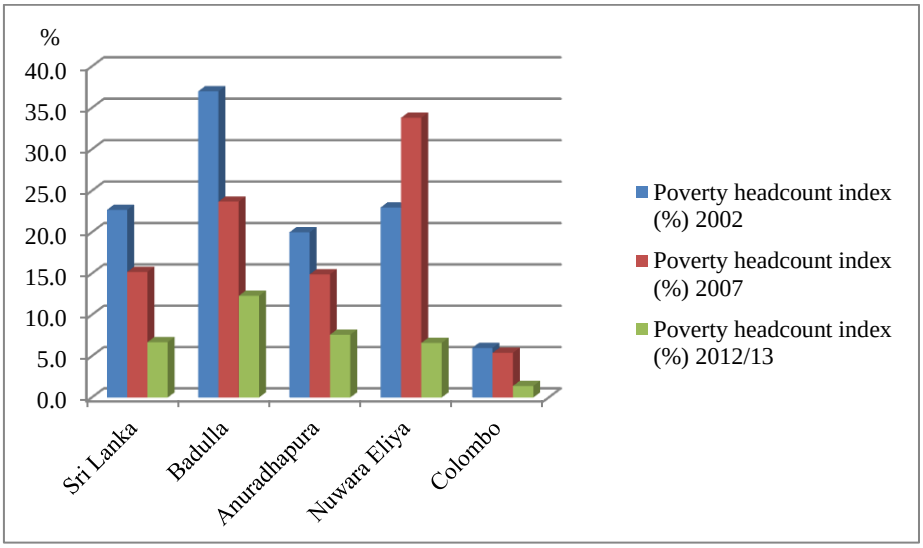
(2) Income Level

Badulla District has one of the highest poverty level in the country. The Official Poverty Line (OPL) in 2002 was 1,423 LKR per person per month. The poverty headcount index, adjusted for inflation by the Colombo Consumer Price Index is shown in **Table 2.2-9** and **Figure 2.2-1**. The index for Badulla District was 37% in 2002 but improved to 23.7% in 2007 and 12.3% in 2012/2013. Although the poverty headcount index has improved over the last decade it is still worse than the national average.

Table 2.2-9 Poverty Headcount Index for Selected Districts

District	Poverty headcount index (%)		
	2002	2007	2012/13
Sri Lanka	22.7	15.2	6.7
Badulla	37.0	23.7	12.3
Anuradhapura	20.0	14.9	7.6
Nuwara Eliya	23.0	33.8	6.6
Colombo	6.0	5.4	1.4

Source: JET, based on The Spatial Distribution of Poverty in Sri Lanka, DCS - Sri Lanka, 2015, and Poverty Indicators Household Income and Expenditure Survey - 2006/07, DCS, 2008



Source: JET, based on The Spatial Distribution of Poverty in Sri Lanka, DCS - Sri Lanka, 2015, and Poverty Indicators Household Income and Expenditure Survey - 2006/07, DCS, 2008

Figure 2.2-1 Poverty Headcount Index for Selected Districts

(3) Household Income

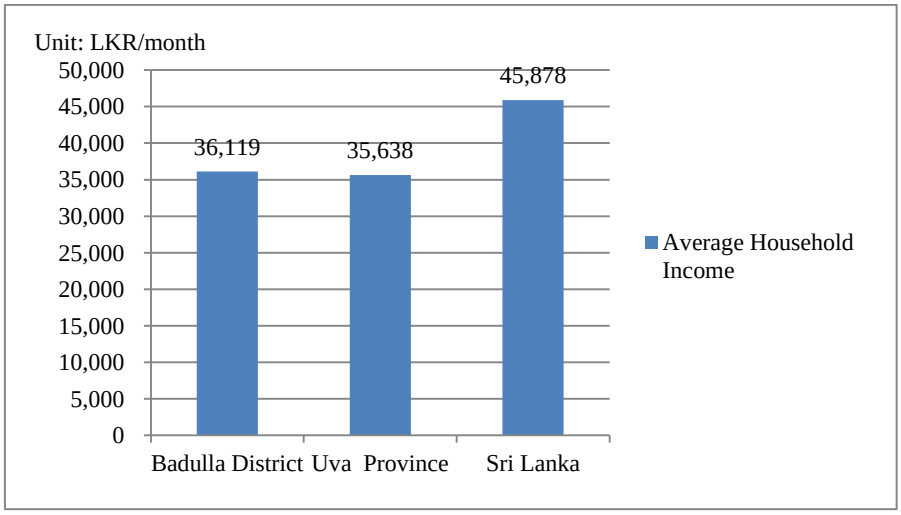
Average household income data is available from "Household Income and Expenditure Survey 2012/2013" some of which are presented in **Table 2.2-10** and **Figure 2.2-2**. The average monthly household income in Badulla District was 36,119 LKR in 2012/13. Most of the income came from "wages/salaries" (29.9%). The household income in Badulla District is 21% lower than the national average and a little higher than the provincial average. In Badulla, the design of a sewage tariff should carefully consider the ability to pay.

Table 2.2-10 Breakdown of Monthly Household Income for Badulla District (2012/13)

Unit: LKR/month

No.	Sector	Badulla District	%
1	Average Household Income	36,119	
2	Per capita	9,369	
3	Ave. No. of Income Receivers	1.7	
4	Wage/ Salaries	11,587	29.9%
5	Agricultural Activities	6,800	17.5%
6	Non Agric. Activities	4,455	11.5%
7	Other Cash Income	4,783	12.3%
8	Income by Adhoc Gain	3,182	8.2%
9	Non-Monetary Income	5,312	13.7%
10	Income in Kind	2,669	6.9%

Source: Household Income and Expenditure Survey 2012/2013, DCS, Ministry of Policy Planning Economic Affairs



Source: Household Income and Expenditure Survey 2012/2013, DCS, Ministry of Policy Planning Economic Affairs

Figure 2.2-2 Comparison of Monthly Household Income

2.2.8 Land Use

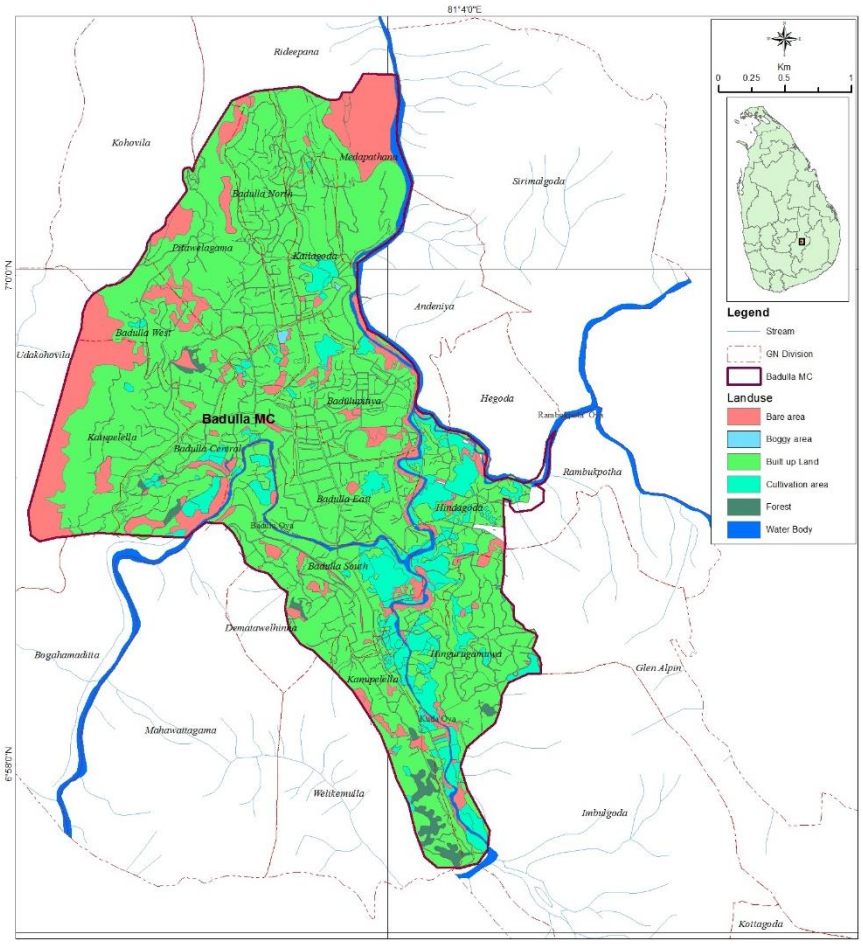
Land use in Badulla District and the MC are shown in **Table 2.2-11**, **Table 2.2-12** and **Figure 2.2-3**.

Table 2.2-11 Land Use in Badulla District

ඉඩම් ස්වභාවය Nature of land	භූමි ප්‍රමාණය (හෙක්ටයාර) Area (Hec)	ප්‍රතිශතය Percentage (%)
01.අස්වද්දන ලද කුඹුරු` - Asweddumized paddy land		
1. වාරිමාර්ග - Irrigated	24979.6	8.7
11.අහස්දියෙන් - Rainfed	6056.0	2.1
02.තේ - Tea	34042.0	11.9
03. රබර් - Rubber	922.0	0.3
04. පොල් - Coconut	3608.0	1.3
05. කුරුදු- Cinnamon	330.0	0.1
06. වෙනත් වගාවන් - Other crops	32929.7	11.5
07.වනාන්තර- Forests		0.0
1. ඝන වනාන්තර - Dense forests	47782.0	16.7
11. විවෘත වනාන්තර - Open forests	26646.0	9.3
111. වගා කරන ලද වනාන්තර - Planted forests	7034.0	2.5
08.ලඳු කැළෑ හා හේන - Grass lands/Chena	58328	20.4
09. වගුරු හා කඩොලාන කැළෑ - Marshes and Mangroves	165.0	0.1
10.ගෙවතු - Home gardens	1556.0	0.5
11.ජලාශ - Reservoirs	6098.0	2.1
12.ගොඩනැගිලි- Building	3093.0	1.1
13වැලි හා ගල් පර - Sand and Mountain	4731.0	1.7
14. මුඩු බිම් හා අත්හරින ලද ඉඩම් - Abandoned land	350.1	0.1
15.වෙනත් (පුජා භූමි, මාර්ග,සුසාන භූමි ආදිය) Otherß (sacred places, roads,cemetery etc)	27449.6	9.6
එකතුව - Total	286100.0	100.0

Source: District Land use Planning Office

About 65% of Badulla District is residential land. Rice paddies, which occupy 6% of the total area, are situated along Badulu Oya, while forests, occupying 17% of the distrcit surround the city.



Source: Survey Department of Sri Lanka

Figure 2.2-3 Land Use in Badulla MC

Table 2.2-12 Land Use in Badulla MC

Land use Type	Area (Ha)
Built-up Area	0.04
Barren Land	4.65
Cemetery	1.66
Forest	12.34
Grassland	9.30
Homesteads	719.38
Water	24.89
Mixed Crop	12.25
Marshy	0.76
Other Cultivation	12.69
Park	3.91
Paddy	65.98
Playground	11.07
Rubber	4.24
Railway	0.55
Road	47.60
Sand	0.39
Scrubs	131.92
Tea	1.95

Source: Survey Department of Sri Lanka

2.2.9 Water Supply and Sanitation

(1) Water Supply

Table 2.2-13 shows access to drinking water sources in Badulla MC. Piped water supply covers 100% of the population. Water is supplied by NWSDB's Badulla Water Supply Scheme (WSS) to the MC and its suburbs. Despite the 100% coverage ratio, some households are still using well water.

Table 2.2-13 Access to Drinking Water Sources in Badulla MC

No.	Name of GND	GN Code	Total	Protected Well Within Premises	Protected Well Out Side Premises	Un Protected Well	Tap Within Unit	Tap Within Premises	Tap Outside Premises	Rural Water Project	Tube Well	Bourses	River , Tank, Stream	Rain Water	Bottle Water	Other
1	Pitawelagama	78 L	721	7	2	4	522	124	52	0	0	0	1	0	0	9
2	Badulla North	78 A	1058	9	5	2	765	144	122	4	1	0	6	0	0	0
3	Medapathana	78 M	593	47	32	16	295	17	39	107	1	0	20	0	0	19
4	Kailagoda	78 G	590	21	2	0	507	46	6	1	1	0	2	0	0	4
5	Badulupitiya	78 J	1135	5	0	0	1081	29	14	0	2	0	3	0	1	0
6	Badulla Central	78 D	793	19	8	4	699	52	6	1	0	0	1	0	0	3
7	Badulla West	78 C	684	15	6	2	529	98	12	3	0	0	13	0	0	6
8	Katupelella	78 H	642	5	1	3	387	51	137	6	0	0	40	0	0	12
9	Badulla South	78	914	75	41	6	472	179	115	8	0	0	8	0	4	6
10	Badulla East	78 B	998	2	0	0	894	83	12	1	1	0	0	0	4	1
11	Hindagoda	78 K	761	7	10	0	638	90	15	0	0	0	1	0	0	0
12	Hingurugamuwa	78 E	1106	19	33	3	704	154	35	149	1	0	7	0	0	1
13	Kanupelella	78 F	526	16	11	6	419	49	9	16	0	0	0	0	0	0
	Badulla MC Total		10521	247	151	46	7912	1116	574	296	7	0	102	0	9	61
	Badulla DSD Total		18835	911	1029	225	9162	1955	1235	1595	131	0	2508	0	9	75

Source: Census of Population and Housing 2012, DCS

These water schemes take water from Badulu Oya at the intake points in Mediriya, Kumarasinghe, Mawatha, and Westmorland.

Badulla's central area experiences serious water shortages during the dry season. NWSDB is constructing a new reservoir in Demodera alongside Badulu Oya.

Water consumption by customer category is shown in **Table 2.2-14**.

Table 2.2-14 Water Consumption by Consumer Category

Unit: m^3/year

Year / Type of Consumption	2013	2014	2015
Household	2,063,006	2,169,158	2,075,569
Commercial and Industrial	216,540	242,306	238,915
Institutional	456,482	453,392	399,838
Others	143,958	168,217	142,040

Source: JET

(2) Sanitation

Table 2.2-15 shows the distribution of sanitation facilities in Badulla MC. About 99% of households (16,883) have water sealed toilets (i.e. with traps to block odour) connected to septic tanks.

Table 2.2-15 Access to Sanitary Facilities in Badulla MC

No.	Name of GND	Total	Water Seal Toilet	Pour Flush Toilet (Not Water Trap)	Direct Pit	Other	Not Using Toilet
1	Pitawelagama	721	717	1	1	0	2
2	Badulla North	1,058	1057	0	1	0	0
3	Medapathana	593	588	1	4	0	0
4	Kailagoda	590	589	0	1	0	0
5	Badulupitiya	1,135	1132	0	3	0	0
6	Badulla Central	793	792	0	1	0	0
7	Badulla West	684	684	0	0	0	0
8	Katupelella	642	639	2	1	0	0
9	Badulla South	914	910	0	0	1	3
10	Badulla East	998	976	22	0	0	0
11	Hindagoda	761	761	0	0	0	0
12	Hingurugamuwa	1,106	1105	0	1	0	0
13	Kanupelella	526	525	0	1	0	0
	Total	10,521	1,0475	26	14	1	5
	Badulla DSD Total	18,835	18,542	219	48	1	25

Source: Census of Population and Housing 2012, DCS

Badulla MC has no sewerage system. Toilet waste is treated by septic tanks while greywater from household kitchens and bathrooms is discharged untreated into Badulu Oya via public canals.

Problems in Badulupitiya and other densely populated areas include: foul water overflows from septic/infiltration tanks during rainy season, because water cannot easily permeate into the ground, eventually causing pollution in Badulu Oya.

Badulla General Hospital with 1,490 beds has its own sewerage system, which treats wastewater using an anaerobic treatment and trickling filter process. Treated effluent is disinfected with chlorine before discharging into a drainage canal that leads to Badulu Oya.

There are no large factories in Badulla MC. Toxic wastewater from automobile shops, hotels, slaughterhouses, and other industries is treated in accordance with the Environmental Protection License (EPL), which is issued by Badulla District Office of the Central Environmental Agency (CEA).

2.2.10 Solid Waste Collection and Disposal

Badulla MC generates 50 tons of waste per day, 25–28 tons of which is collected by the MC and transported to the disposal site within the city. This site, however, is only for separating garbage. Construction of a final disposal site is being considered.

Sauce: JET

Figure 2.2-4 Solid Waste Disposal Site

2.3 NEED FOR THE PROJECT

In its national policy enacted in 2010, Sri Lanka aims to achieve 100% access to sanitation through on and off-site sanitary facilities. NWSDB's service plan sets out an objective to achieve 7.0% piped sewer coverage by 2020.

The United Nations sets Sustainable Development Goals (SDGs) as the next development agenda for the Millennium Development Goals (MDGs). The goal related to sanitation and hygiene is to ensure universal access to safely and sustainably managed water and sanitation by 2030, and some of the specific targets include;

- By 2030, achieve access to adequate sanitation and hygiene facilities for all
- By 2030, improve water quality by halving the proportion of untreated wastewater

As of 2012, sewerage system coverage is only at 2.4% in Sri Lanka. Badulla MC, has no sewage treatment plant, and relies on septic tanks and other on-site facilities, which, do not function adequately. Increasing levels of BOD, ammonia, phosphorus, and coliform bacteria are detected in Badulu Oya (See 2.1.5).

To improve water quality, it is necessary to construct a sewerage system that can efficiently collect and treat increasing volumes of wastewater

CHAPTER 3 PLANNING BASIS FOR SEWERAGE SYSTEM

3.1 SANITATION PROVISION

In November 2014, NWSDB prepared the Pre-Feasibility Report on Wastewater Collection, Treatment, and Disposal System for the Badulla Urban Area at its own expense. The plan identifies 17 km of gravity sewers, 5.3 km of force mains and a 4,000 m^3/day activated sludge treatment plant for the population in 2044. Population projections are based on 2012 Census data.

The City M/P will be based on this study and considers population for a larger collection area.

3.1.1 Target Year

According to "NWSDB Design Manual D7 Wastewater Collection, Treatment, Disposal & Re-Use 2012", design period for Collection Network, Pumping Station, Sewage Treatment Plant, and Effluent Disposal and Utilization is 30 years. Therefore, the year 2046 is selected as the target year for this Master Plan.

3.1.2 Planning and Design Criteria

(1) Sewage Flow Estimate

Table 3.1-1 shows wastewater volume calculation matrix.

Table 3.1-1 Basis for Estimating Sewage Flow

Item	Value	Remarks
Per capita water consumption	120 lpcd	
Domestic Flow	80%	of water consumption
Non-domestic Flow	35%	of Domestic Flow
Average dry weather flow (ADWF)	Domestic + Non-domestic flow	
Daily maximum dry weather flow	1.1 times	of ADWF
Hourly maximum dry weather flow	1.6 times	of ADWF
Peak dry weather flow (PDWF)	3 times	of ADWF
Infiltration	20%	of ADWF

Planning of Sewer Pipe System: Peak Dry Weather Flow (PDWF) + Infiltration
Planning of Pumping Station: Hourly Maximum Dry Weather Flow + Infiltration
Source: JET

(2) Trunk Sewer

a. Hydraulic Calculations for Trunk Sewers

Manning formula is used for hydraulic calculation of gravity sewers, and Hazen William formula is used for force mains (pressure flow):

Manning Formula
$Q = A \times V$, $V = 1/n \times R2/3 \times S1/2$
where, Q: Flow (m^3/sec), V: Velocity of Flow (m/sec),
n: Roughness Coefficient, R: Hydraulic Radius (m),
S: Hydraulic Gradient, A: Cross Section Area (m^2)
Hazen William Formula
$Q = A \times V$, $V = 0.84935 \times C \times R0.63 \times S0.54$
where, Q: Flow (m^3/sec), V: Velocity of Flow (m/sec),
C: Flow Velocity Coefficient, R: Hydraulic Radius (m),
S: Hydraulic Gradient, A: Cross Section Area (m^2)

Table 3.1-2 Coefficients for Sewer Design

Type of Pipe	n (Roughness Coefficient)	C (Flow Velocity Coefficient)
PVC Pipe	0.013	120
HDPE Pipe	0.013	120
GRP Pipe	0.013	120
DI Pipe (Ductile Cast Iron Pipe)	0.013	120

The design slopes of gravity sewers are checked based on tractive force required to flush the sand particles expected in sewage flow.
Source: JET

b. Flow Velocities
Minimum velocity: 0.65 m/s
Maximum velocity: 3.0 m/s

c. Sewer Capacities
Diameter of 600 mm or less: capacity exceeds the estimated flow by at least 200%
Diameter greater than 600 mm: capacity exceeds the estimated flow by at least 150%

d. Minimum Earth Covering
1.0 m

e. Minimum Sewer Diameter
Trunk sewer: 225 mm, rider sewer & branch sewer: 160 mm, lateral sewer: 110mm

f. Pipe Materials

Table 3.1-3 Pipe Materials

Diameter	Purpose	Pipe Material
200 mm or less	Gravity	PVC Pipe
225 to 355 mm	Gravity	HDPE Pipe
400 mm or above	Gravity	GRP
100 to 400 mm	Force Main	HDEP
Above 400 mm	Force Main	DI Pipe

Source: JET

(3) Pumping Stations

Table 3.1-4 shows the types of pumping station: manhole type pumping station (MTPS) or major pumping station (MPS). The Ceylon Electricity Board (CEB) requires the electrical demand of a pumping facility to be 42 kVA or less, where a transformer is not provided. Where the electrical demand exceeds 42 kVA, a transformer will be necessary in which case an MPS is more suitable. It should be noted that MTPS entails site acquisition, depending on the surrounding environment and location.

Table 3.1-4 Types of Pumping Stations

Type of Pumping Station	Site	Electricity
MTPS: Manhole Type Pumping Station	Under Road	Less than 42 kVA
MPS: Major Pumping Station	Property Required	42 kVA and above

Source: JET

(4) Treatment Facilities

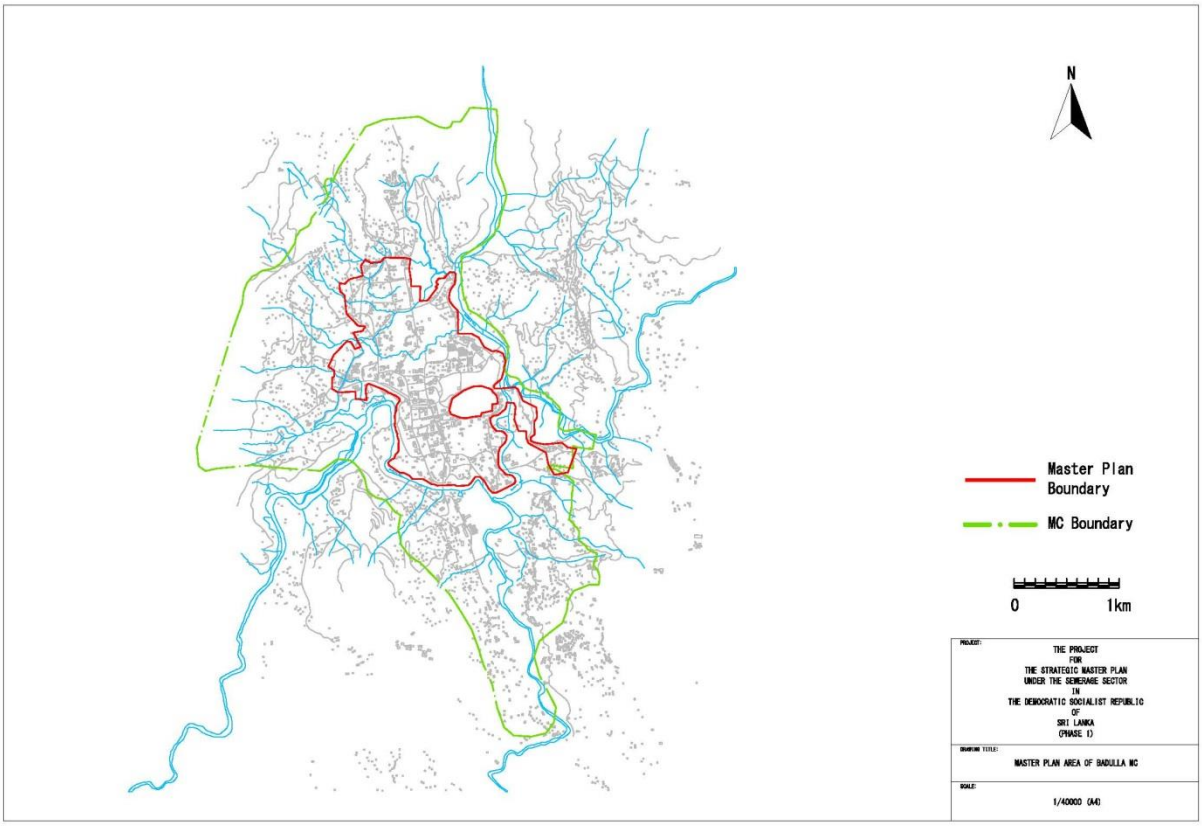
The treatment process is selected by considering the following factors:

- influent sewage quality and effluent discharge standards
- land availability
- construction and O&M cost
- ease of operation and maintenance (O&M)

3.1.3 Sewage Collection Area

The sewerage service area selected for the Master Plan is shown in **Figure 3.1-1** and includes:

- developed and populated areas that will be almost fully saturated by 2046
- city centre including large-scale commercial areas, large-scale facilities, such as schools, hotels, housing estate, religious and institutional buildings
- high density residential areas
- areas suitable for applying centralized sewerage system.



Source: JET based on data of Survey Department of Sri Lanka

Figure 3.1-1 Proposed Sewage Collection Area for Badulla MC

Table 3.1-5 shows Divisional Secretary Divisions (DSDs) and Grama Niladhari Divisions (GNDs) included in the target area.

Table 3.1-5 DSDs and GNDs included in the M/P Area

S/No.	GND No.	GND
1	**Badulla DSD**	
1.1	78L	Pitawelagama
1.2	78A	Badulla North
1.3	78G	Kailagoda
1.4	78J	Badulupitiya
1.5	78D	Badulla Central
1.6	78C	Badulla West
1.7	78B	Badulla East
1.8	78K	Hindagoda

Source: JET based on data of DCS

3.1.4 Design Sewage Flow

Rate of population increase in the project area and planned population is calculated as shown in Section 1 **APPENDIX 12**. Sewage flow to be treated is calculated as shown in **Table 3.1-6**. Detailed calculations can be found in **APPENDIX 1**.

Table 3.1-6 Design Sewage Flow

M/P Area (ha)	Item	2046	Remarks	
35	a Population	23,200		
	b Water Consumption (l/d/cap)	120		
	c Return Factor (%)	80		
	d Domestic Flow (m^3/d)	2,227	d = a x b x c	
	e Non-Domestic Flow (m^3/d)	779	e = d x 35%	
	f Point Source (m^3/d)			
	g Infiltration (m^3/d)	601	g = (d + e + f) x 20%	
	h Daily Average Flow (m^3/d)	3,607	h= d + e + f + g	
	i Daily Maximum Flow (m^3/d)	3,908	i = (d + e + f) x 1.1 + g	For STP design
	j Hourly Maximum Flow (m^3/d)	5,411	j = (d + e + f) x 1. 6+ g	For PS design
	k Peak Flow (m^3/d)	9,619	k= (d + e + f) x 3.0+ g	For Sewer design

Source: JET

3.1.5 Influent Sewage Quality

The design influent wastewater quality, based on sampling and analysis, and in consultation with NWSDB, is shown in **Table 3.1-7**. Details of the design influent wastewater quality are shown in **APPENDIX 2**.

Table 3.1-7 Design Influent Sewage Quality

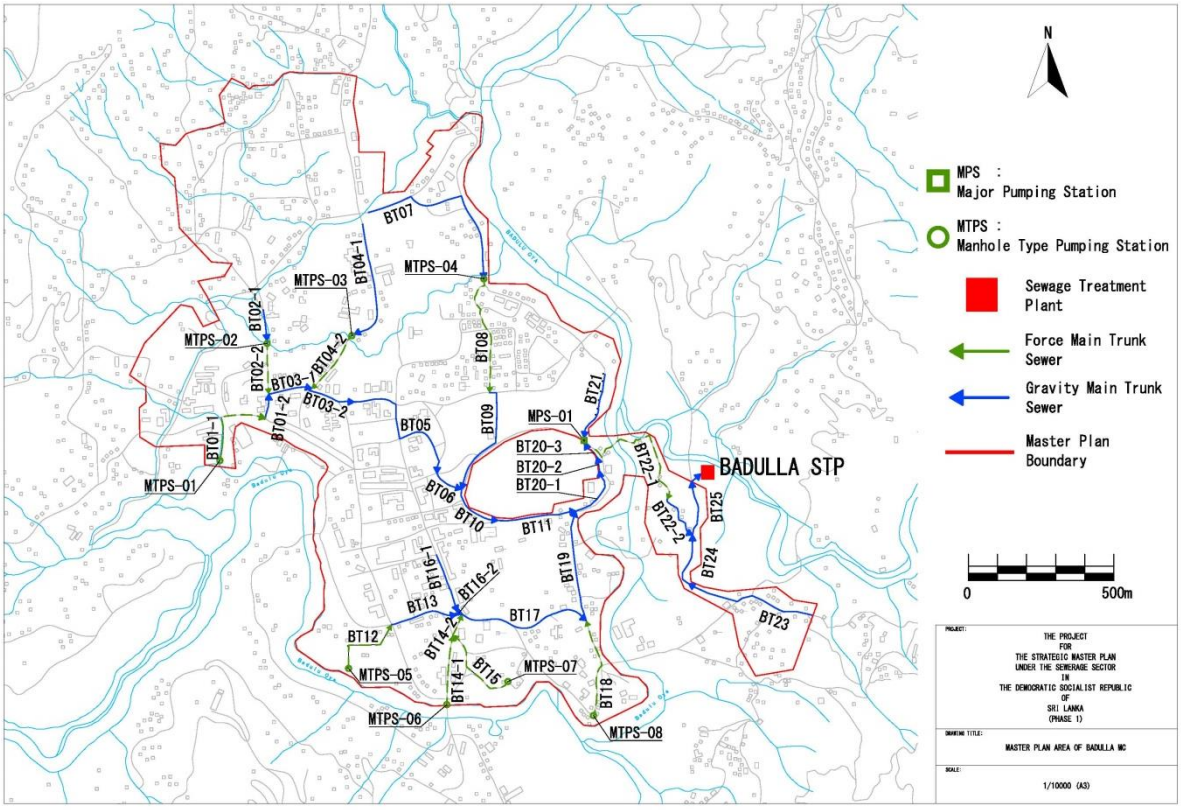
	Influent Sewage
	Design
BOD_5	240
COD	600
TSS	160
T-N	45
T-P	6

Unit: mg/L
Source: JET

CHAPTER 4 PRELIMINARY PLAN AND DESIGN OF THE SEWARAGE SYSTEM

4.1 GENERAL LAYOUT

The proposed sewerage development plan for Badulla MC is shown in **Figure 4.1-1**. An enlarged map, flow calculations, and a longitudinal sectional view are attached in **APPENDIX 3**.



Source: JET

Figure 4.1-1 Sewerage Development Plan for Badulla MC

4.2 SEWAGE COLLECTION FACILITIES

The design of the sewage treatment plant and location of major pumping stations depends on the layout of the trunk sewers. The length of branch sewers will be like those in other similar projects. The length of lateral sewers to the houses and buildings is estimated based on the projected population.

4.2.1 Sewer Network

The trunk sewer mains are listed in **Table 4.2-1**.

Table 4.2-1 Major Sewer Mains

Item	Diameter	Material	Length	Remarks
Branch Sewer	225mm	HDPE Pipe	35,250m	Including Force Main
	Sub-Total (Branch Sewer)		35,250m	
Trunk Sewer	225mm	HDPE Pipe	2,208m	Pipe Jacking (121m)
	315mm	HDPE Pipe	1,053m	
	355mm	HDPE Pipe	785m	Pipe Jacking (59m)
	400mm	GRP Pipe	750m	Pipe Jacking (119m)
	450mm	GRP Pipe	105m	
	500mm	GRP Pipe	185m	
	600mm	GRP Pipe	726m	Pipe Jacking (57m)
	700mm	GRP Pipe	725m	Pipe Jacking (95m)
	110mm	HDPE Pipe	1,540m	Force Main
	125mm	HDPE Pipe	175m	Force Main
	160mm	HDPE Pipe	659m	Force Main
	355mm	HDPE Pipe	537m	Force Main, Pipe Jacking (142m)
	Sub-Total (Trunk Sewer)		8,881m	
Total	Branch Sewer + Trunk Sewer		44,131m	
	Crossing: Railway Crossing (None), River Crossing (1 location)			

*Pipe Jacking of HDPE Pipe & GRP Pipe is installed by the slip lining method.
Source: JET

4.2.2 Sewage Pumping Stations

The main pumping stations are shown in **Table 4.2-2**.

Table 4.2-2 Main Pumping Stations

Item No.	Design Flow	Total Pump Head	Unit	Remarks
MPS-01	Approximately 6.3 m^3/min	20 m	3+(1)	land requirement is about 0.08 ha
MTPS-01	Approximately 0.3 m^3/min	15 m	1+(1)	
MTPS-02	Approximately 0.8 m^3/min	20 m	1+(1)	
MTPS-03	Approximately 1.2 m^3/min	25 m	1+(1)	
MTPS-04	Approximately 1.2 m^3/min	30 m	1+(1)	
MTPS-05	Approximately 0.5 m^3/min	15 m	1+(1)	
MTPS-06	Approximately 0.3 m^3/min	15 m	1+(1)	
MTPS-07	Approximately 0.2 m^3/min	15 m	1+(1)	
MTPS-08	Approximately 0.3 m^3/min	15 m	1+(1)	

Notes: MPS: Major Pumping Station MTPS: Manhole Type Pumping Station (1): One pump unit for stand-by
Source: JET

4.2.3 Service/House Connections

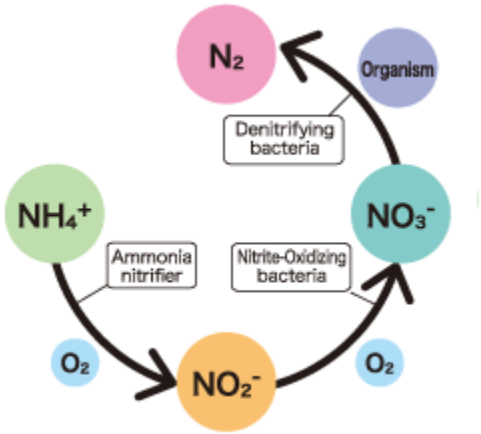
Based on the projected population of 23,200 people and an average family size of four people, in 2046, there will be approximately 5,800 households (Household Income and Expenditure Survey 2012/13 issued by the DCS).

4.3 SEWAGE TREATMENT FACILITY

4.3.1 Treatment Method

(1) Compliance with the Allowable Discharge Limits

The allowable discharge limits (shown in **APPENDIX 4**) are being amended and a draft is available to the public, although it has not yet been gazetted. The effluent quality from the proposed treatment plant will comply with the amended discharge limits. The allowable limits for organic substances in the amended version are not expected to change much. Limits for heavy metals will be stricter. The amendment introduces an allowable discharge limit for nitrates, set at 10 mg/l as NO3-N. This new requirement will have a significant impact on the selection of treatment methods.



Source: http://www.zeolite-anammox.com/#!faq/c12z9

Figure 4.3-1 Nitrogen Cycle

Figure 4.3-1 shows the reaction cycle of nitrogen during biological wastewater treatment. Ammonia nitrogen (NH3-N) and a portion of organic nitrogen is converted to nitrite and nitrate through nitrification carried out by ammonia oxidizing bacteria (AOB) and nitrite oxidizing bacteria (NOB). Nitrate produced by the nitrification process should be reduced through denitrification to less than 10 mg/L to meet the amended allowable discharge limit. Nitrification occurs naturally in small-scale STP which are usually operated with long solids retention time (SRT). High wastewater temperature promotes nitrification. Suppression of nitrification in any biological process is therefore not easy and is not a realistic option. Therefore, the treatment process must have the ability to denitrify to reduce nitrates. Denitrification is relatively easy to achieve with activated sludge processes but is more difficult for biofilm processes and stabilization ponds.

(2) Selection of Treatment Process for Estimating Land Requirements

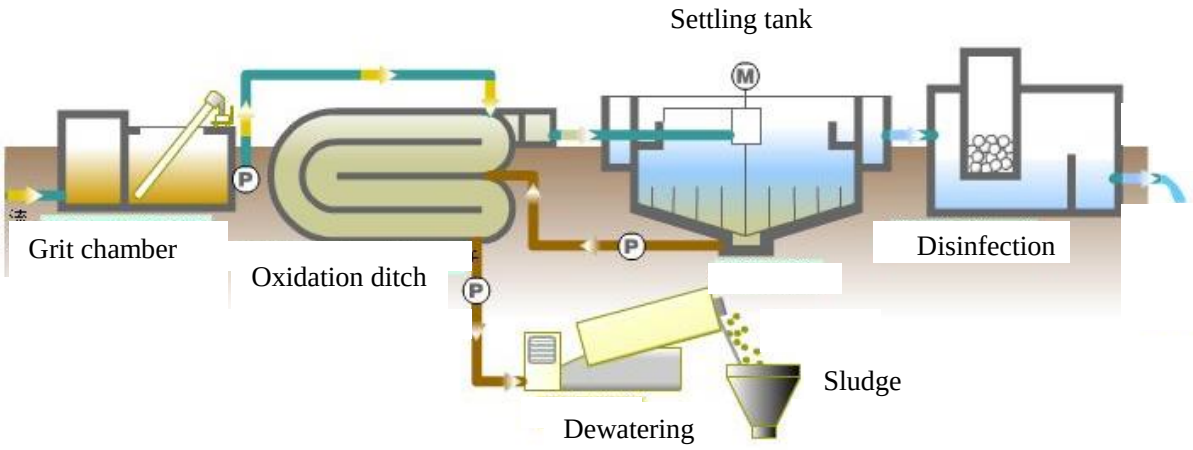
The site for the Badulla STP is not yet decided. Badulla sewerage plan will have a 4,000 m^3/d daily maximum inflow. The most common treatment process for this scale of operation is the oxidation ditch (OD) process. The process can be slightly modified to conduct denitrification, similar to what is being done for the Kandy STP, which is now under construction. **Figure 4.3-2** shows the Kandy STP, which has a reactor equipped with a diffuser and agitation propeller. The diffuser can be switched on and off, for equal periods of time to create anoxic or aerobic condition. The land required for the Badulla STP can be estimated based on the assumption that this process will be used. More information on the site condition is necessary for the final determination of the treatment process.

Source: JFE

Figure 4.3-2 Kandy Sewage Treatment Plant
(14,000 m^3/day, OD Process with Nitrogen removal)

(3) Characteristics of the Oxidation Ditch Process

The OD process is shown in **Figure 4.3-3**.



Source: JET

Figure 4.3-3 Schematic of Oxidation Ditch Process

The oxidation ditch (OD) process used mainly in small-scale STPs has the following characteristics:

- simple configuration, limited number of equipment and easy operation
- bioreactor is oval or horseshoe shape
- no primary settling tank
- large reactor can adapt to inflow load fluctuation and assure long HRT
- tolerance to minor problems due to redundancy of the process
- nitrogen is removed by introducing anoxic condition in the reactor
- reduced excess sludge production

It is not suitable for large-scale STP because of the large area requirement.

4.3.2 STP Site and General Layout of Unit Processes

(1) STP Site

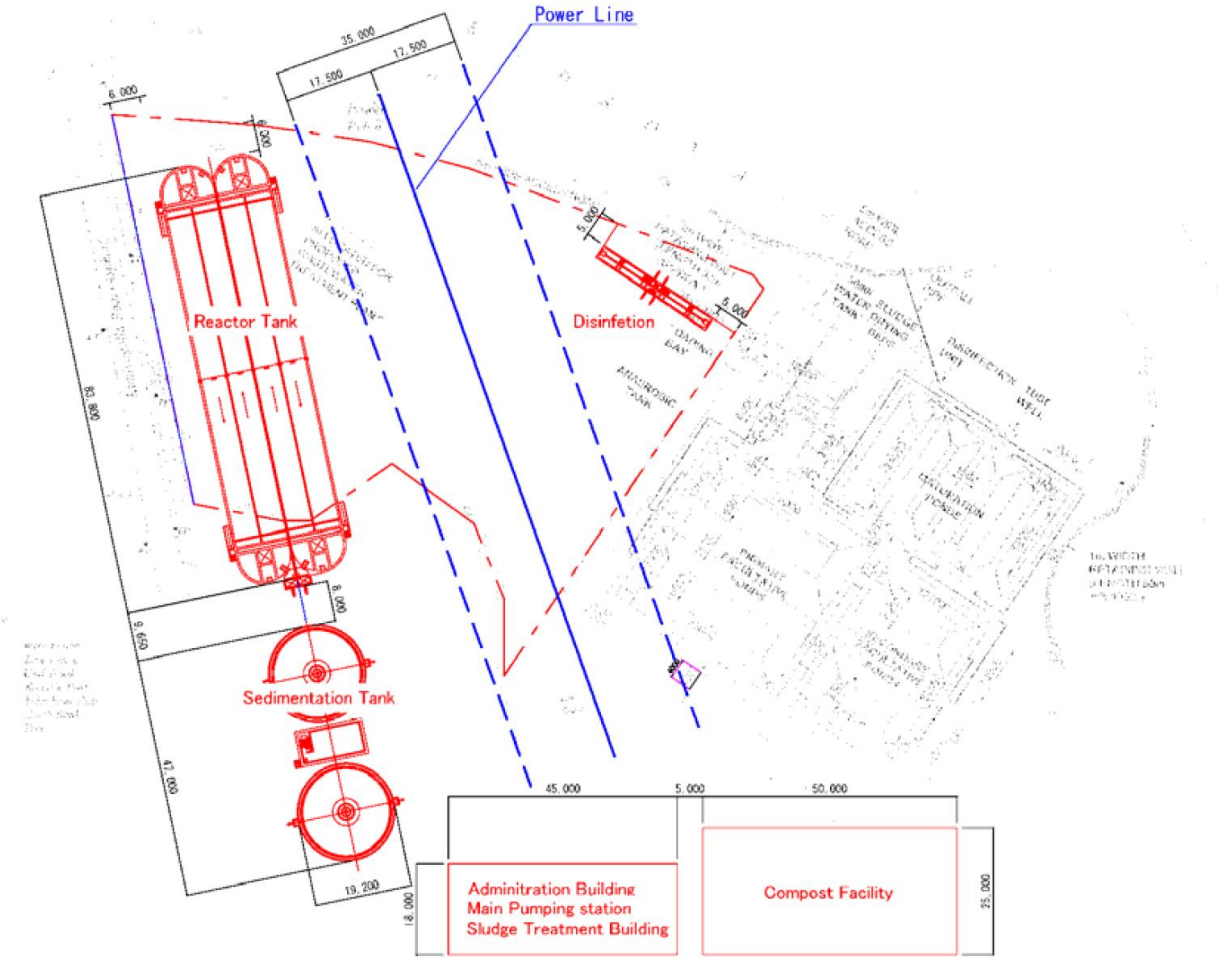
The candidate site (**Figure 4.3-4**) of 0.8 ha, on privately owned land, is located along the Kuda Oya river in the southeast at the outskirt of the city. A septage treatment plant is now planned for the site. The process of purchasing the land is under way but residents in the neighbourhood are opposed to the construction of such a facility. There is a high voltage power line in the middle of the site. Since no buildings are allowed within 17.5 m of high voltage lines, the net area available for development is much reduced.

Source: JET

Figure 4.3-4 Candidate STP Site

(2) General Layout

The land required for the oxidation ditch process with nitrogen removal is calculated to be 1.3 ha. **Figure 4.3-5** shows the layout of the plant on the proposed site. The site is not large enough to accommodate the oxidation ditch process. Options that should be considered include: purchase more land next to the candidate site, find another site, or select a more compact process that can fit the proposed site.

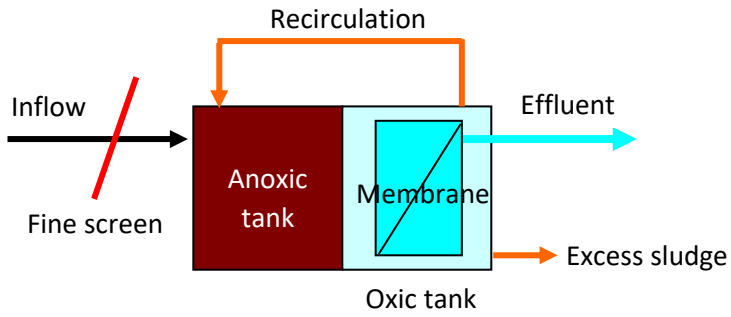


Notes: Figure in the bracket denotes land area excluding composting facility
Source: JET

Figure 4.3-5 Layout of the Proposed Oxidation Ditch Treatment Plant

Saving space with a more compact process is essential but it must also be capable of nitrification and denitrification to comply with the allowable discharge limits identified in 4.3.1(1).

In general, 10-12 hours of hydraulic retention time (HTR) in bioreactors is necessary for biological nitrogen removal. Membrane bioreactors (MBR) can be operated to remove nitrogen and require only 6 hours of HRT. MBR is a variation of the activated sludge process featuring solid-liquid separation by membrane filters instead of gravity settling. The membranes make it possible to save space by eliminating clarifiers and keep much higher MLSS concentrations in the aeration tank (as high as 10,000 mg/L), thereby enhancing the bio-reaction rate. **Figure 4.3-6** shows the schematic for the MBR process (submerged membrane type).



Source: JET

Figure 4.3-6 Schematic for Membrane Bioreactor (MBR)

The following characteristics of the MBR process help reduce the footprint to one fifth of space required by the OD process:

- HRT of bioreactor is only 6 hours
- primary and final settling tanks are not necessary
- disinfection facilities can be omitted since Escherichia. coli cannot pass through the membrane
- sludge thickening facilities can be omitted since waste activated sludge concentration is high

The disadvantages of MBRs are the high energy requirement for pumping filtrate through the membrane and continuous air scouring of the membrane surface. Recent technological improvements have reduced energy consumption to levels that are only slightly higher than CAS.

A moving bed bio-reactor (MBBR) that uses biological carrier media can also save space. The biological carrier media increases the residence time of the microorganisms which leads to an increase in biomass and treatment capacity. However, more space is required MBR because the HRT is about 9 hours and primary and final settling tanks are necessary.

4.3.3 Odour Control

Odour can come from:

- septage receiving facility
- grit chamber
- oxidation ditch
- sludge treatment

The septage receiving facility, grit chamber and sludge treatment are the main odour emission points. Odour from the oxidation ditch is usually not very offensive.

The necessity for odour control depends on the environmental condition near the STP.

Odour control options are:

- activated carbon adsorption
- biological deodorization in combination with the above
- circulation of odour containing air to reactor
- soil bio-filter

Soil bio-filter is a simple method but periodical soil turnover is required to more efficient odour reduction. Activated carbon is necessary if intensive odour control is required

4.3.4 Sewage Treatment Process

The treatment plant will accept septage from the areas that will not be connected to the sewage collection network in the foreseeable future. Since there is no primary settling tank, the maximum amount of septage that can be accepted should be 0.5% of inflow wastewater volume.

(1) Required Treatment Level

The assumed quality of sewage influent and effluent treated by OD are shown in **Table 4.3-1**. The quality of sewage was determined in consultation with MWSDB taking into consideration the sewage quality of Moratuwa/Ratmalana STP, Ja-Ela/Ekala STP and other STPs that are in the neighbourhood of Colombo City. The target effluent quality is set to meet the allowable discharge limits. The dilution ratio of the effluent will vary depending on the flow rate in the stream at the discharge point.

Table 4.3-1 Assumed Quality of Influent and Effluent

Unit: mg/L	Inflow	Effluent
	Design Raw Water Quality	Tolerance limit
BOD5	240	30
COD	600	250
TSS	160	50
T-N	45	-
TKN	-	150
NH4-N	-	50
NO3-N	-	10
T-P	6	-
Soluble-P	-	5

Source: JET

(2) Main Unit Processes

1) Screen and Grit Chamber

Wastewater first flows through the screens and grit chamber where grit and solid wastes are removed to prevent damage to machines and equipment.

2) Oxidation Ditch

After the grit chamber, wastewater flows into the oxidation ditch, the bioreactor of the process. Wastewater is mixed with activated sludge and retained in the tank for about 24 hours. The mixed liquor is continuously agitated either by rotor or propeller. Rotor movement supplies oxygen. When propellers are used, a diffuser supplies oxygen. Organic substances are biologically decomposed and ammoniac nitrogen is converted to nitrate. By introducing anoxic condition in the oxidation ditch, denitrification occurs and nitrate is reduced to nitrogen gas. Anoxic condition can be introduced in some sections of the tank either by intermittent aeration or by adjusting aeration intensity.

3) Settling Tank

The mixed liquor flows into the circular settling tanks and is retained for about 6 hours while solid-liquid separation takes place. The clarified supernatant flows over the effluent weir of the settling tank. The activated sludge in the tank is collected in the sludge hopper. Some of the activated sludge is returned to the oxidation ditch to keep the process going and the excess is sent to thickening and dewatering.

4) Disinfection Tank

Treated wastewater is disinfected before discharge to minimize the health risks associated with pathogens. Disinfection will be with chlorine in the form of sodium hypochlorite (NaOCl), added to the effluent after the final settling tank. If the receiving water is found to be sensitive to chlorine by-products (e.g. fish) then UV radiation will be considered as an alternative.

4.3.5 Sludge Treatment and Disposal

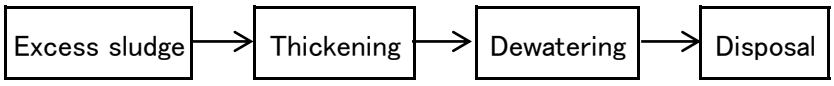
(1) Characteristics of Waste Sludge

Since the oxidation ditch process has no primary settling tank, only waste activated sludge (WAS) is produced.

WAS contains mostly protein which is the main constituent of biomass. WAS from the oxidation ditch process is aerobically stabilized because of the long SRT of the process. Odour emission therefore is generally much less than primary sludge.

(2) Sludge Treatment

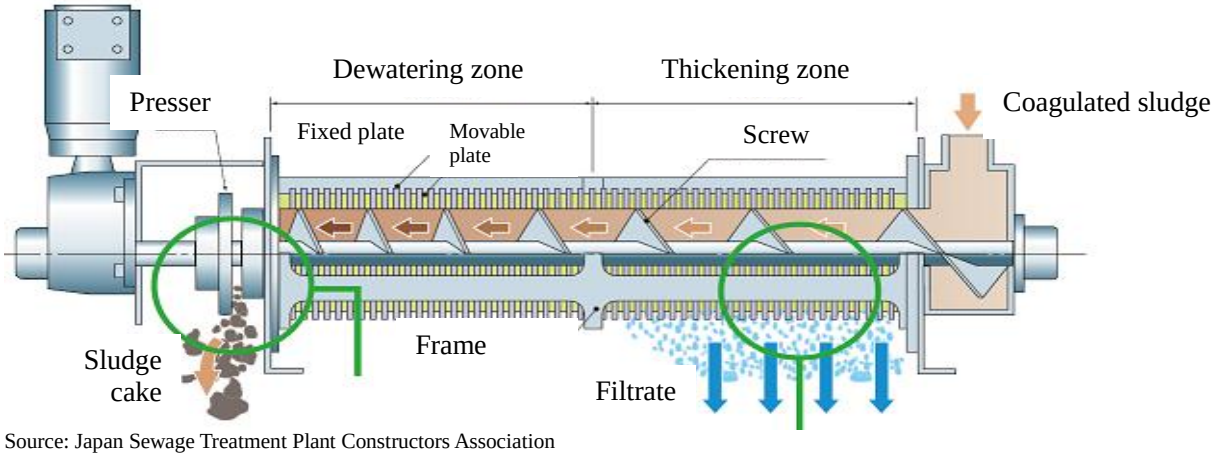
A typical sludge treatment process is shown in **Figure 4.3-6**. Excess sludge is thickened then dewatered. Thickening is carried out by gravity. Depending on the type of dewatering machine, thickening is sometimes omitted and excess sludge is dewatered directly. Anaerobic digestion is usually not used since WAS is not easily decomposed anaerobically.



Source: JET

Figure 4.3-7 Schematic for Sludge Treatment

Filter belt press or screw press type dewatering machines are commonly used. Both types of machine require sludge conditioning by polymer coagulant prior to dewatering. Screw press type dewatering machines are becoming popular for the following reasons: 1) compact size supplied as a unit containing dewatering equipment, coagulation equipment, and control panel; 2) easy to operate, unmanned operation is possible; 3) direct dewatering of excess sludge without thickening is possible.



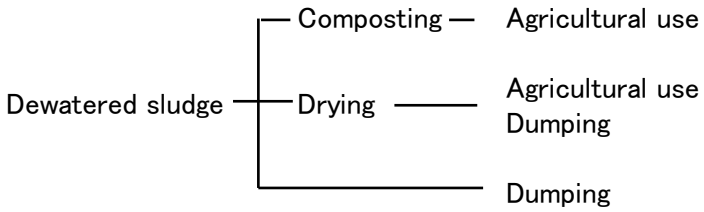
Source: Japan Sewage Treatment Plant Constructors Association

Figure 4.3-8 Diagram of Pressurized Screw Press

(3) Sludge Disposal

The quantity of waste sludge can be calculated by multiplying the amount of suspended solids removed by 0.75. In general, SS removal efficiency of the OD process is 95%. Therefore, in the case of Badulla, sludge produced at the daily maximum flow rate is 0.46 DSt/d (4,000×(160-8) ×0.75×10-6). Assuming the moisture content of dewatered sludge is 80%, the amount of the dewatered sludge will be 2.3 tons/day.

The options for the disposal of dewatered sludge are listed in **Figure 4.3-9**.

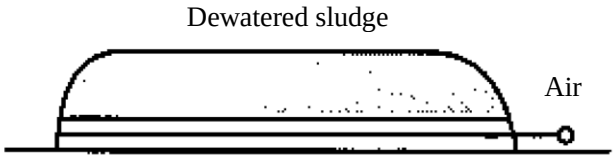


Source: JET

Figure 4.3-9 Sludge Disposal Options

Nitrogen and phosphorus in sewage sludge are essential nutrients for plant growth. The composting process breaks down the organic substances and matured compost has no offensive odour. During composting, fermentation temperature will rise to 80-90℃, destroying pathogenic bacteria in the process. Composting is preferable to drying and dumping because it recycles the nutrients and is also hygienic. Composted sludge can be used as fertilizer for tea plantations, since it has a high nitrogen content. However, strict quality control and education of users are essential.

There are various sludge composting processes. The simplest is pile composting, shown in **Figure 4.3-10**. Sludge is dewatered to a moisture content of around 60% by adding organic materials such as sawdust, rice hull, straw, bark, or composted sludge. The dewatered sludge is piled on a flat concrete bed. Air is supplied through a pipe or by periodic turnover using a shovel or tractor. It usually takes 10-14 days for the first stage fermentation. The second stage will take 1 to 3 months to produce matured compost.



Source: JET

Figure 4.3-10 Pile Composting

Sludge compost contains nitrogen and phosphorus but only a small amount of potassium. Composting with other organic wastes such as cow dung can increase the potassium content and thus the value of compost products.

If there are no agricultural activities in the area to use the composted sludge, dumping may be the only option. Some dump sites do not accept materials with more than 60% moisture content. Dewatered sludge usually at around 80% moisture content must be dried before dumping.

4.4 ON-SITE FACILITIES AND SEPTAGE MANAGEMENT

4.4.1 On-site Facilities

Since the proposed sewerage system will not cover the whole of Badulla MC, wastewater treatment with on-site septic tanks will provide effective sanitation for sparsely populated areas. Design, construction, and maintenance of septic tanks should comply with Sri Lanka's standards (SLS 745 Part 2: 2009) so that their proper functioning can be maintained.

4.4.2 Septic Tanks

Septic tanks retain wastewater, allowing the solids to separate from the suspension, and facilitate partial decomposition to reduce pollution load. A septic tank must be adequately sized to perform these functions properly.

The schematic of a typical septic tank is shown in **APPENDIX 5**. The tank should be waterproof and durable enough to withstand external soil load as well as internal water pressure. Where the tank is placed under a driveway or parking area, the specifications must ensure the ability to withstand reasonable vehicle loads.

4.4.3 Operation & Maintenance for Septic Tanks

Periodic maintenance is important for functional sustainability. Therefore, users and owners should be aware of the following precautions:

(i) Sludge Removal

A septic tank requires sludge removal at regular intervals. In general, when filled with sludge and scum, the tank should be cleaned, leaving about one-third to half of the sludge as a 100 to 150 mm layer of "seed sludge" to restart the treatment process. The sludge pumped from the tank is disposed at a sewage treatment plant to be constructed.

(ii) Access Cover

An access cover is kept tightly shut to prevent other waste from entering the tank. When damaged, it should be repaired or replaced immediately.

(iii) Mosquitoes

To prevent mosquito breeding, make sure that the septic tank is kept tightly closed. Vents must be provided with mosquito mesh and checked periodically. The mesh must be replaced, as required.

(iv) Blockage

Blockage is typically caused by solids clogging the inlet of the septic tank. Preventive measures should be taken. Solid matter should be cleared from the access cover, using a long and flexible stick.

CHAPTER 5 INSTITUTIONAL ARRANGEMENTS FOR IMPLEMENTATION

The implementation of sewerage systems requires planning, design, construction, and eventually operation and maintenance. Capacity development of staff from NWSDB, relevant regional support centres (RSCs), and MCs is needed to ensure required tasks are satisfactorily conducted at each level.

5.1 PROJECT IMPLEMENTATION AND MANAGEMENT

5.1.1 Examples of Implementation Structures in Sri Lanka

Table 5.1-1 shows the implementation structure of water and sewerage works in 6 municipalities. Some sewerage works are under implementation or at the planning stage.

Table 5.1-1 Organization of Water and Sewerage Works in 6 Municipalities

Area	Water works			Sewerage works			
	Ownership	Management	O&M	Ownership	Management	O&M	
						STP	Pipe
CMC	N	N	N	MC	MC	---	MC
Kandy	MC	MC	MC	MC	MC (unfixed)	N (unfixed)	MC (unfixed)
Ratmalana-Moratuwa	N	N	N	N	N	N	N
Ja-ela/Ekala	N	N	N	N	N	N	N
Hikkaduwa	N	N	N	N	N	N	N
Kataragama	N	N	N	N	N	N	N

(N: NWSDB)
Source: JET

Colombo MC (CMC) owns the sewerage works and operates and maintains the pumping stations and sewer networks, while the water works is owned and managed by NWSDB.

Kandy MC owns the water and sewerage works, but the O&M of STP will be outsourced to NWSDB, while the MC will conduct sewer maintenance

The water and sewerage works in Ratmalana-Moratuwa, Ja-ela/Ekala, Hikkaduwa, and Kataragama, are owned and managed by NWSDB.

The ownership and the implementation structure of the sewerage works is determined by each municipality.

5.1.2 Public Works in Badulla MC

Table 5.1-2 shows the water supply, solid waste collection and disposal, on-site sanitation, road construction/maintenance, and storm-water management in the MC.

Table 5.1-2 Public Works in Badulla MC

Water works	Responsible organization		NWSDB, RSC Uva
	Water supply schemes		30
	Blanch offices		23
	Planning & Designing		Engineer 4, Technical 3
	WTP	Full scale	2
		Partial scale	2
		Out-sourcing	New house connection, security, cleaning service
	Laboratory		2
		Out-sourcing	Analysis of pesticides and heavy metals
	Meter reading		40
	Charge collection		40
		Out-sourcing	-
Solid waste management	Responsible organization		MC
	Works		Collection, Transportation to dump site and Composting
	Type of tasks	Planning & Designing	Implementing
		Construction	Implementing
		O&M	Implementing
	Financing sources		MC budget
	Service charge		no
	Dumping site	Location	owned by MC
		Capacity	100,000 tons
	Collection	Method	
		Vehicles	Compactor 1, Tractor 2, Cart 10
	Staff	Supervisor	1
		PHI	3
		Upper level labor	-
		Labors	-
	Out-sourcing		no
On-site sanitation	Responsible organization		MC
	Works		Provide instruction on construction of facilities, de-sludging of sepitc tanks,taking legal action against rules violation .
	Type of tasks	Planning & Designing	Implementing
		Construction	Implementing
		O&M	Implementing
	No. of septic tanks	At present	5,400
		Future	10,000
	Financing sources		Service charge, MC budget
	Services	Installation	Provide contractors for Property /land owner or House holder
		Approval	MC
		Supervisor	MC
	Sludge removal	Frequency	Depending on situation, 1~3 times/year
		Procedure	Submit application to the MC, site visit, if the job can be done, the client pays the service chage.
		Sludge disposal site	Sludge Disposal Site and temporary use the Solid waste management site which is not adequate and suitable.
	Service charge	Installation	By Property /land owner or House holder
		Sludge disposal	Tariff (2,634 LKR)
	Staff	Supervisor	1
		PHI	3
		Labors	10
	Out-sourcing		no
Road construction and maintenance works	Responsible organization		MC
	Works		Type C and D
	Type of tasks	Planning & Designing	Implementing
		Construction	Implementing
		O&M	Implementing
	Financing sources		MC budget, Government subsidy
	Staff	Engineer	1
		Technical officer	3
		Others	80
	Out-sourcing	Details	no
		Type of contract	no
Storm water management	Responsible organization		MC
	Works		Construction of drains, clearing of blockages, cleaning of drains
	Type of tasks	Planning & Designing	Implementing
		Construction	Implementing
		O&M	Implementing
	Existing drainage system		No proper drainage pipe system exist and dreains (Open /Closesd) been used.
	Financing sources		MC budget, Government subsidy
	Staff	Engineer	1
		Technical officer	3
		Others	30
	Out-sourcing		no

Source: MC

As shown in the Table, the water works are conducted under the ownership of NWSDB. RSC UVA of NWSDB, implements one of the 30 water supply schemes. On-site sanitation is managed by house or land owners, who pay the MC for sludge removal and disposal service.

The Badulla water supply is one of the 30 water supply schemes operated by NWSDB, UVA RSC. The MC carries out all the other public works services from planning to O&M without outsourcing. The MC budget and government subsidies are used to cover the costs of providing services.

5.1.3 Organizational Options for Implementing Sewerage Works

5 options are prepared for the implementation of sewerage works as shown in **Table 5.1-3**.

Table 5.1-3 Organizational Options for Implementing Sewerage Works

Activity	Option 1	Option 2	Option 3	Option 4	Option 5
Request of sewerage works	NWSDB	NWSDB	LA	LA	LA
Approval of sewerage works	MWSD	MWSD	MWSD ⇨ MLGPC	MWSD ⇨ MLGPC	MWSD ⇨ MLGPC
Budget Preparation	MWSD ⇨ NWSDB	MWSD ⇨ NWSDB	MLGPC ⇨ LA	MLGPC ⇨ LA	MLGPC ⇨ LA
Project Planning	NWSDB assisted by LA	NWSDB assisted by LA	NWSDB assisted by LA	NWSDB assisted by LA	NWSDB assisted by LA
Planning & Designing	NWSDB & C/C	NWSDB & C/C	NWSDB & C/C	NWSDB & C/C	NWSDB & C/C
Construction	P/C	P/C	P/C	P/C	P/C
Construction Supervision	NWSDB & C/C	NWSDB & C/C	NWSDB & C/C	NWSDB & C/C	NWSDB & C/C
Ownership of facilities	NWSDB	NWSDB	LA	LA	LA
O&M Sewer Networks	NWSDB	P/O supervised by NWSDB	LA	P/O supervised by LA	LA
O&M STP			NWSDB		
Loan Settlement	MWSD ⇨ NWSDB	MWSD ⇨ NWSDB	MLGPC ⇨ LA	MLGPC ⇨ LA	MLGPC ⇨ LA

Notations : 1. LA- Local Authority (MC, Urban Council(UC), Pradeshiya Sabha (PS))
2. NWSDB- National Water Supply & Drainage Board
3. MWSD- Ministry of Water Supply & Drainage
4. MLGPC- Ministry of Local Government & Provincial Councils
5. C/C- Appointed Consultants/Contractor
6. P/C- Private Contractor
7. P/O- Private Operator

Source: JET

In Options 1 and 2, the sewerage system is owned and managed by NWSDB, in one case the O&M is outsourced to the private sector.

In Options 3 and 4, the MC owns the system but O&M of the STP is outsourced either to NWSDB (Option 3), or to the private sector (Option 4),

In Option 5 the system is owned, operated, and maintained by MC.

In all five options, the planning, design, and construction is carried out by NWSDB because they are experienced with these tasks.

5.1.4 Preferred Implementation Structure for Sewerage Works

Water works in the MC area are managed by NWSDB, therefore it makes sense that the sewerage works should also be managed by NWSDB for the following advantages:

A) Service charge can be set lower

The integration of water and sewerage services will reduce the duplication of functions such as accounting, personnel management, customer service, and billing. The savings in administrative overhead can help reduce the sewerage service charge.

B) Experience and knowledge

NWSDB has many experienced engineers and skilled labourers that are working in RSC North Central and managing the MC's water works. The Greater Colombo Sewerage (GCS) Office, organized under Assistant General Manager (AGM) (O&M-GC), is responsible for managing several existing sewerage works. Some NWSDB staff can be transferred to the sewerage works in Sri Jayawardenapura Kotte MC to ensure a smooth start-up and operation.

Therefore, Options 1 or 2 are preferred for implementing the sewerage works in Badulla MC.

5.2 ORGANIZATION FOR IMPLEMENTATION

To organize the implementation of the sewerage system in Badulla MC, the detailed roles of NWSDB, relevant RSC and MC must be defined. **Table 5.2-1** shows the roles for each party from planning to O&M for Options 1 and 2.

Table 5.2-1 Role of NWSDB and MC at Various Implementation Stages

Option-1		Stage of sewerage works			
		Planning	Designing	Construction	O&M
NWSDB	Tasks	Supervision Decision of STP site and others	Supervision	Supervision	O&M of sewerage works Consideration of out-sourcing
	Staff	* Technical Team	* PD under DGM * Staff in Project Management Units (PMU)	⇒	* Staff in STP * Staff for sewer networks
RSC	Tasks		Supporting project activities	⇒	Supporting O&M of sewerage system Public awareness Promotion of house connection
	Staff		* Manager in sewerage works	⇒	⇒
MC	Tasks	Cooperation for planning works	Cooperation for land acquisition	Cooperation for STP and sewer networks construction	Monitoring of effluent Public awareness Promotion of house connection
	Staff	* Staff for tasks above	⇒	⇒	⇒

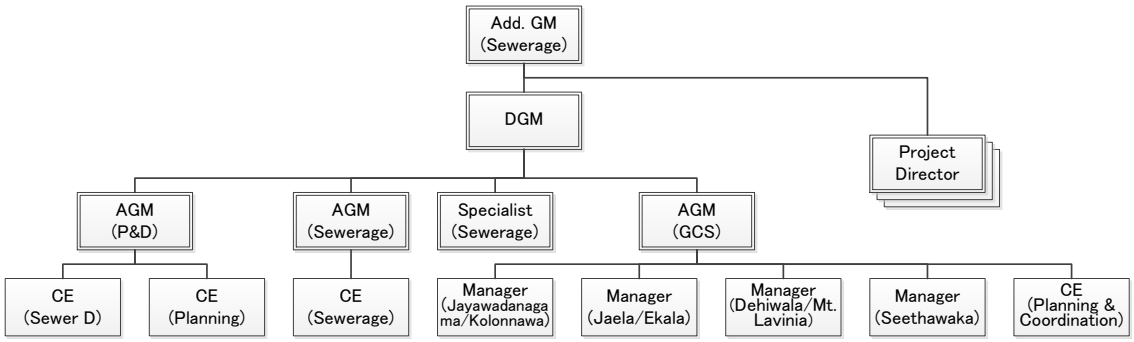
Option-2		Stage of sewerage works			
		Planning	Designing	Construction	O&M
NWSDB	Tasks	Supervision Decision of STP site and others	Supervision	Supervision	Supervision
	Staff	* Technical Team	* PD under DGM * Staff in PMU	⇒	* Supervisor of O&M of sewerage system
RSC	Tasks		Supporting project activities	⇒	Supporting O&M of sewerage system

					Public awareness Promotion of house connection
	Staff		* Manager in sewerage works	⇒	⇒
MC	Tasks	Cooperation for planning works	Cooperation for land acquisition	Cooperation for STP and sewer networks construction	Monitoring of effluent Public awareness Promotion of house connection
	Staff	*Staff for tasks above	⇒	⇒	⇒

Source: JET

5.2.1 Organization of the NWSDB Sewerage Department

The organization of the NWSDB sewerage department is as shown in **Figure 5.2-1**. When the sewerage project is implemented, the engineering tasks in planning, design, construction, and O&M will increase.

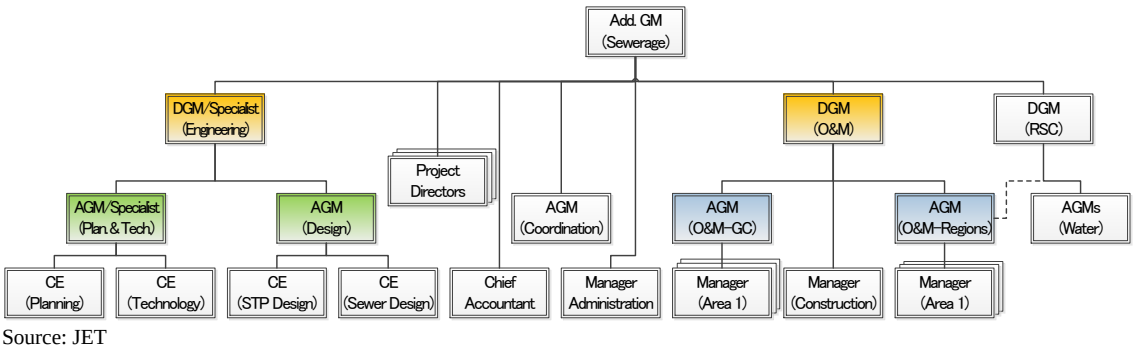


Source: JET

Figure 5.2-1 Organization of the NWSDB Sewerage Department

Some re-organization of the sewerage department must be made to cope with the increased tasks as shown in **Figure 5.2-2**

The responsibilities of the Deputy General Manager (DGM) can be split into DGM/Specialist (Engineering) and DGM (O&M). AGM for planning and design (P&D) can be split into AGM (Plan & Tech.) and AGM (Design). AGM (O&M-Regionals) can be added to AGM (O&M-GC) to cope with the increased work load.

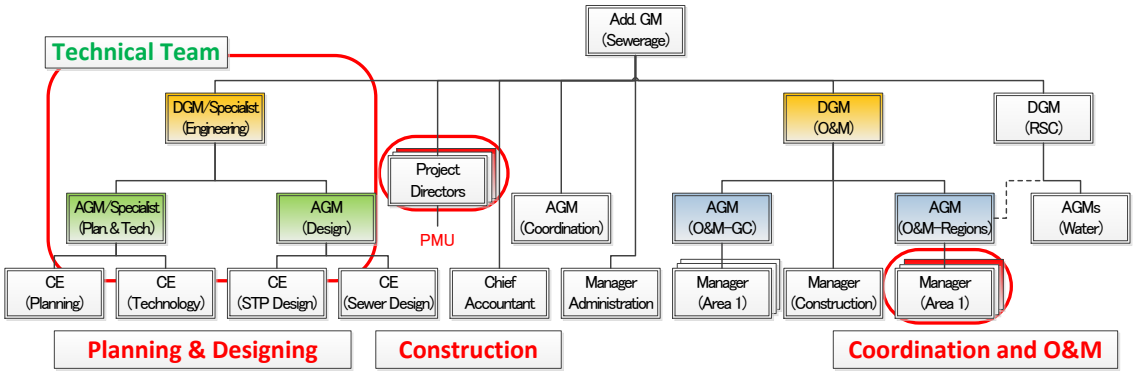


Source: JET

Figure 5.2-2 Proposed Re-organization of the NWSDB Sewerage Department

At the planning and design stage, NWSDB will establish a Technical Team, as shown in **Figure 5.2-3**, to work with the consultants. At the construction stage, a Project Director (PD) will be added under the Additional General Manager (Addl. GM) and a PMU for supervising the construction works will be established under the PD.

A Manager under the AGM (O&M-Regionals), will work with the RSC, to coordinate the O&M of STP and sewer networks.



Source: JET

Figure 5.2-3 NWSDB Sewerage Department Responsibilities for Project Implementation

5.2.2 Organization of RSC North Central

A Manager in charge of the project will be recruited from RSC North Central and will report to DGM (RSC North Central). Because the RSC has little experience in sewerage works, technical support will be provided by AGM (O&M-Regionals). RSC North Central will be responsible for operations and customer services.

5.2.3 Organization of Badulla MC

Badulla MC will support the implementation of the sewerage works by securing the STP site and providing input and assistance to NWSDB during the planning, design, and construction stages.

At the O&M stage, the MC will monitor STP effluent quality and the nearby environment to ensure compliance. The MC will assist NWSDB with building public awareness and promotion of house connections.

5.3 CAPACITY DEVELOPMENT

5.3.1 Securing Human Resources

(1) NWSDB

A PD and a PMU are required at the construction stage. A Manager reporting to the AGM (O&M-Regionals) and engineers, technical staff, drivers, and labourers are needed to operate and maintain the facilities. Some staff can be transferred from existing sewerage and water supply operations to facilitate the start up. New staff will have to be hired to fill the vacancies left by the transfers.

As shown in **Table 5.3-1**, besides 13 national universities (most with faculties of civil, mechanical, electrical engineering, chemistry, and environmental sciences), there are 8 technical colleges/high-schools. There will be many graduates who will have the required knowledge to join the work force in the sewerage sector.

Table 5.3-1 Faculties at National Universities and Technical Colleges/High Schools

University	Civil Works	Electrical	Mechanical	Chemistry	Environment
Colombo				✓	
Peradeniya	✓	✓	✓	✓	
Sri Jayewardenepura				✓	
Kelaniya				✓	
Moratuwa	✓	✓	✓	✓	
Jaffna	✓	✓	✓	✓	
Ruhuna	✓	✓	✓	✓	✓
Open University	✓	✓	✓	✓	✓
Eastern				✓	
South Eastern	✓	✓	✓		
Rajarata				✓	✓
Sabaragamuwa					
Wayamba		✓			
Uva Wellassa					
Visual & Performing Arts					
College/High school	Civil Works	Electrical	Mechanical	Chemistry	Environment
Construction Industry Development Authority	✓	✓	✓		
Ceylon-German Technical Training Institute		✓	✓		
National Apprentice & Industrial Training Authority	✓	✓	✓		
National Vocational Training Authority	✓	✓	✓		
Industrial Technical Institute				✓	✓
National Building Research Organization	✓				✓
Institute of Chemistry				✓	✓

Source: JET

Satisfactory working conditions and compensation are important to keep staff motivated. As shown in **Table 5.3-2**, NWSDB salaries are higher than those of similar positions in the private sector. NWSDB has a decent promotion system and staff is motivated to perform well.

Table 5.3-2 Comparison of Salaries and Benefits between NWSDB and Private Sector

Grade		Staff of NWSDB		Staff of a private sector	
		Salary (LKR)	Benefits (in LKR)	Salary (LKR)	Benefits in (LKR)
1	Engineer	125,000	39,500	105,000	21,000
2	Supervisor	75,000	30,500	37,500	6,000
3	Skilled Labourer	50,000	28,500	27,500	8,000
4	Un-skilled Labourer	40,000	28,000	19,000	5,000

Source: JET

(2) MC

Additional MC staff will be required for coordination with NWSDB in the acquisition of STP and pumping station sites and in the construction of sewer networks.

At the O&M stage the MC's health department would likely be given extra responsibilities such as monitoring the STP effluent and surrounding areas, public awareness campaigns and promotion of house connections. Therefore additional human resources and training will be required.

5.3.2 Development of Human Resources

A lot of technical knowledge and experience is required from planning to O&M. Capacity development is very important especially when many new staff with almost no experience will be hired. Training seminars and OJT are necessary.

(1) Training at the NWSDB Training Centre

The Training Centre is not offering many technical programs on sewerage systems. As many staff will need training, this aspect of the Centre's curriculum will have to be enhanced. **Table 5.3-3** shows the programs that should be added.

Table 5.3-3 Required Training Programs for Sewerage Systems

Category	No.	Title of the Program
Planning	1	Planning of Sewage Works
	2	Principle of Asset Management
Designing	1	Designing of Sewer System
	2	Jacking Method
	3	Rehabilitation of Pipe Networks
	4	Designing of STP
	5	Mechanical System Design in STP
	6	Electrical System Design in STP
O&M	1	Maintenance of Sewer System
	2	Operation of STP
	3	Maintenance of Mechanical System in STP
	4	Maintenance of Electrical System in STP
	5	Water Quality Management
	6	Commercial and Industrial Wastewater Management
Safety Management	1	On-site Safety management
Risk Management	1	On-site Risk Management

Source: JET

NWSDB staff, as well as those from relevant MCs and private sector companies (if outsourcing is used), should participate in the training programs.

(2) On-the-Job Training (OJT)

OJT in the STP, at pumping stations, and sewer networks is necessary. Generally, the contractor will conduct OJT for staff of STP at commissioning. Staff should also be dispatched to other STPs for 6 months to a year to gain experience in maintenance and trouble-shooting.

5.3.3 Sewer Maintenance Equipment and Vehicles

Scheduled sewer cleaning is carried out regularly and at emergency situations. There should be adequate number of specialized machines and vehicles for the work. The operation can start with the number of machines and vehicles other systems are using, as shown in **Table 5.3-4**. More can be added as the service area expands and as more maintenance is required.

Table 5.3-4 Sewer Maintenance Equipment & Vehicles used at Existing Sewerage Works

	Dehiwala – Mount Lavinia	Jayawadanagama - Kolonnawa	Ja-ela/Ekala
Gully/ Jetting Combined Machine	-	1	-
Gully Bowser	2	1 (with frequent breakdown)	1
PorTable Jetting Machine	1	1 (with frequent breakdown)	-
Crane Truck	-	1 (with frequent breakdown)	-
High Pressure Jet Machine	1	1	1
High Pressure Water Spraying Machine	-	1	-

Source: JET

5.3.4 Customer Service

RSC North Central is already managing customer service for water supply. When sewerage is added to their responsibilities, they will have to deal with and track customer complaints such as foul odour and clogged pipes. They can learn from other locations where sewerage systems are already in operation.

5.4 CONSTRUCTION MANAGEMENT FOR THE PROJECT

The PMU established under the PD will oversee the activities during construction.

5.4.1 PMU

There will be 40 staff in the PMU, including engineers and labourers.

5.4.2 Project Office

It would be ideal to have the PMU office in the RSC. However, if this arrangement cannot be accommodated, the office can be set up near the project site. The office should be big enough to house the contractors as well. Another matter to bear in mind is the need to have enough parking for people who have to visit the project site.

CHAPTER 6 COST ESTIMATE AND PROCUREMENT

6.1 PROJECT COST

6.1.1 Construction and Project Costs

Construction cost is estimated based on NWSDB's "RATES 2016". The rates not contained in this schedule are calculated based previous JICA projects and Pre-F/S reports in Sri Lanka. Construction costs are presented in in **APPENDIX 6**.

Project cost is estimated based on the following conditions.

Construction Cost	:	Estimated with price level at January, 2017
Consulting cost	:	Estimated with price level at January, 2017
Consulting period	:	2019～2023
Construction period	:	2021～2023
Administration cost	:	5%
Physical contingency	:	5%
Interest during construction	:	Construction：0.3% Consulting：0.01%
Front end fee	:	0.2%
Tax and duty	:	15%
Price escalation	:	Local currency : 3.8%, Foreign currency : 1.6%
Exchange rate	:	LKR 1 ＝JPY 0.77

Project cost is estimated at approximately 64 billion LKR (4.9 billion JPY) (not including tax and duty) as shown in **Table 6.1-1**. Details of project cost estimate are presented in **APPENDIX 7**.

Table 6.1-1 Estimated Project Cost

		Amount		Total Amount	Total Amount
		L.C. (LKR)	F.C. (JPY)	LKR	JPY
1	Construction Cost				
A	Badulla STP (Q=4,000m3/day)	558,545,455	645,120,000	1,396,363,636	1,075,200,000
B	Trunk Sewer & Pump Station	880,842,000	257,822,000	1,215,675,000	936,070,000
C	Branch Sewer & Pump Station	478,622,000	161,910,000	688,895,000	530,449,000
D	House Connection	580,000,000	0	580,000,000	446,600,000
	Sub-total of 1(A-D)	2,498,009,455	1,064,852,000	3,880,933,636	2,988,319,000
2	Administration cost	303,000,000	0	303,000,000	233,310,000
3	Consulting cost	378,000,000	701,000,000	1,288,390,000	992,060,000
4	Physical contingency for construction cost	152,000,000	58,000,000	227,325,000	175,040,000
5	Price escalation for construction cost	540,000,000	92,000,000	659,481,000	507,800,000
6	Land acquisition and compensation	-	-	-	-
7	Interest during construction	0	31,000,000	40,260,000	31,000,000
8	Front-end Fee	0	9,000,000	11,688,000	9,000,000
9	Tax and duty	1,082,000,000	0	1,082,000,000	833,140,000
	Sub-total of (2-9)	2,455,000,000	891,000,000	3,612,143,000	2,781,350,000
	Total including Tax and Duty	4,953,009,455	1,955,852,000	7,493,077,000	5,769,669,000
	Total excluding Tax and Duty	3,871,009,455	1,955,852,000	6,411,077,000	4,936,529,000
	Eligible Portion (1, 3, 4, 5 and 7)	3,568,009,455	1,946,852,000	6,096,389,000	4,694,219,000
	Non-Eligible Portion (2, 6, 8 and 9)	1,385,000,000	9,000,000	1,396,688,000	1,075,450,000

Note: L.C. = Local Cost, F.C. = Foreign Cost
Source: JET

6.1.2 Operation and Maintenance (O&M) Cost

O&M cost is estimated based on the Ratmalana/Moratuwa sewerage system as shown in **Table 6.1-2**. It includes staff cost, utilities, chemical cost, repair expenses, installation cost, security expenses, and other expenses. The detailed estimate is presented in **APPENDIX 8**.

Table 6.1-2 O&M CostTable 6.1-2

	Total Amount (LKR)	Total Amount (JPY)
Badulla	57,129,000	44,128,000

6.2 PHASED CONSTRUCTION

The project is not big enough to need phased construction (service area - 235 ha and planned STP capacity - 4000 m^3/day and project cost - 64 billion LKR or 4.9 billion JPY).

CHAPTER 7 FINANCIAL PLAN

7.1 FINANCIAL CONDITION OF BADULLA MUNICIPAL COUNCIL

Table 7.1-1 shows a summary of the Income & Expenditure Statement for the Badulla MC. Revenue should cover total expenditures. Any surplus or deficit is rolled over to the next year. Like other MCs, Badulla MC pays the monthly salaries of central government employees working at the MC and gets reimbursed annually through a central to provincial government budgetary transfer. This is included in the "Revenue, Grant & Reimbursement" account.

Table 7.1-1 Summary of Income & Expenditure of Badulla MC

Unit: million LKR

	Year	2012	2013	2014	2015
Actual Revenue					
	Assessment Rates	16.8	18.54	17.54	19.07
	Rent	30.2	20.16	29.98	32.57
	License Fees	7.76	10.38	11.75	11.34
	Charges for Service	3.97	5.6	4.84	4.11
	Warrant Cost / Fine	3.56	1.24	2.09	2.78
	Stamp Duty	11.94	17.82	7.32	23.44
	Court Fines	2.11	1.22	11.29	5.4
	Other Revenue	8.3	1.25	20.62	1.28
	Total	**84.64**	**76.21**	**105.43**	**99.99**
Recurrent Expenditure					
	Personal Emoluments	62.73	105.24	119.7	177.26
	Travelling Expenses	0.63	0.84	0.42	0.27
	Supplies & Equipment	13.54	13.68	16.58	14.73
	Repairs to Capital Assets	22.43	27.12	15.7	35.2
	Transport – Communication	3.21	6.29	11.4	13.26
	Interest & Dividends Utility	6.56	5.27	5.08	6.06
	Grants – Contribution	2.26	2.13	3.72	4.01
	Pension Gratuity	2.92	3.09	3.6	2.67
	Total	**114.28**	**163.66**	**176.20**	**253.46**
Actual revenue less Recurrent Expenditure		**-29.64**	**-87.45**	**-70.77**	**-153.47**
	Revenue, Grant & Reimbursement	75.04	85.74	104.56	161.35
	Capital Receipts & Grants	6.15	5.05	9.11	22.59
	Capital Expenditure	8.14	19.85	31.99	36.32
	Total Surplus (deficits)	**43.41**	**-16.51**	**10.91**	**-5.85**

Source: Badulla MC

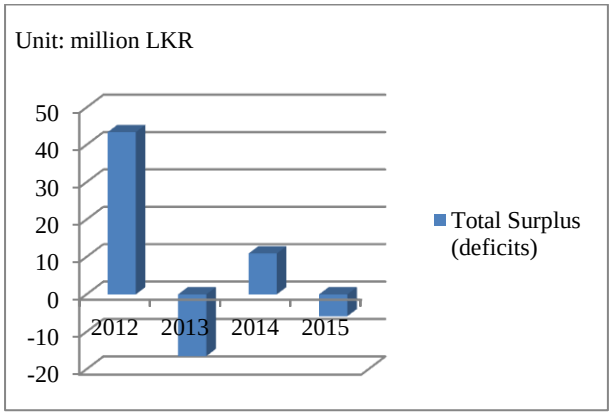
Badulla MC has recorded profits in 2012 and 2014, and deficits in 2013 and 2015. The deficits as a percentage of "Revenue, Grants & Reimbursement" are 10.2% (2013) and 2.2% (2015). These deficits are considered modest and controllable (**Figure 7.1-1**).

Staff salaries have increased every year (**Figure 7.1-2**), resulting in recurrent expenditures exceeding actual revenue, and the difference is getting larger year by year (**Figure 7.1-3**). However, the increases in "Revenue, Grant & Reimbursement" have been enough to balance recurrent expenditures (**Figure 7.1-4**). That is to say, salary of staff belonging to Badulla MC was controlled to avoid rapid increase.

According to the MC, there is approximately 10 million LKR in cash in the MC's account. Although Badulla MC has tried to manage its budget responsibly, the cash balance is not enough to cover any deficits in the future. Careful financial planning and fiscal management is required.

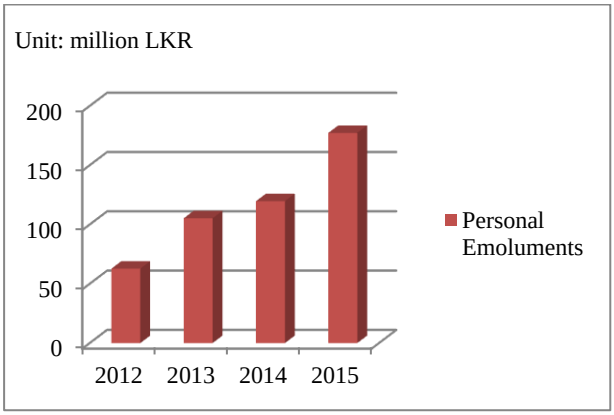
Badulla MC's financial situation is fair but not strong enough to take on a large-scale project. Therefore, it is recommended that the sewerage facilities be implemented and operated with the cost burden for

construction shifted to the central government (in the event of an ODA loan, repayment should be borne by the central government). The sewage tariff should be set to fully recover the O&M costs.



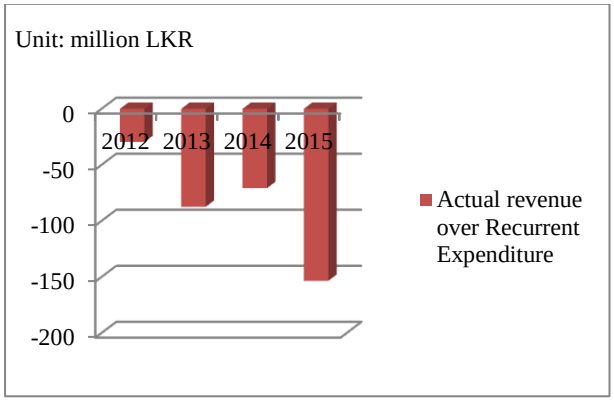
Source: JET, based on Badulla MC data

Figure 7.1-1Trend of Total Surplus (deficits) - Badulla MC



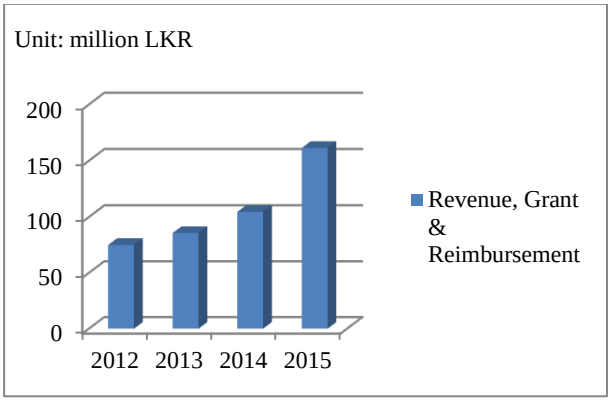
Source: JET, based on Badulla MC data

Figure 7.1-2 Trend of Staff Salaries - Badulla MC



Source: JET, based on Badulla MC data

Figure 7.1-3 Trend of Revenue minus Recurrent Expenditure - Badulla MC



Source: JET, based on Badulla MC data

Figure 7.1-4 Trend of Revenue, Grant & Reimbursement - Badulla MC

7.2 FINANCING SEWERAGE FACILITY CONSTRUCTION AND O&M

7.2.1 Construction, O&M, and Replacement Costs

The Cabinet Memorandum "Regularizing Foreign Financing Mechanism in Relation to Water Supply and Sewerage Project", dated 26 January 2016, stipulates that the Treasury will bear 100% of the debt service (capital & interest) for sewerage projects.

In many countries including Japan, the sewage tariff does not cover the full cost of construction, O&M, and future replacement. In many developing countries such as Malaysia, Thailand, and Vietnam, it is usually difficult for the sewage tariff to cover even just the O&M costs because of the low willingness to pay.

The following cost burden principle for sewerage service should be used in Sri Lanka:

- 100% of the construction cost to be covered by the central government, i.e. 100% grant to NWSDB or MC.
- O&M costs shall be covered by the sewage tariff which will be implemented gradually.
- small-scale replacements should be covered by NWSDB's or the MC's own budget, but large-scale ones will be conducted as projects funded by the central government.

Therefore, the sewage tariff is structured to cover the only the O&M costs of the sewerage facilities.

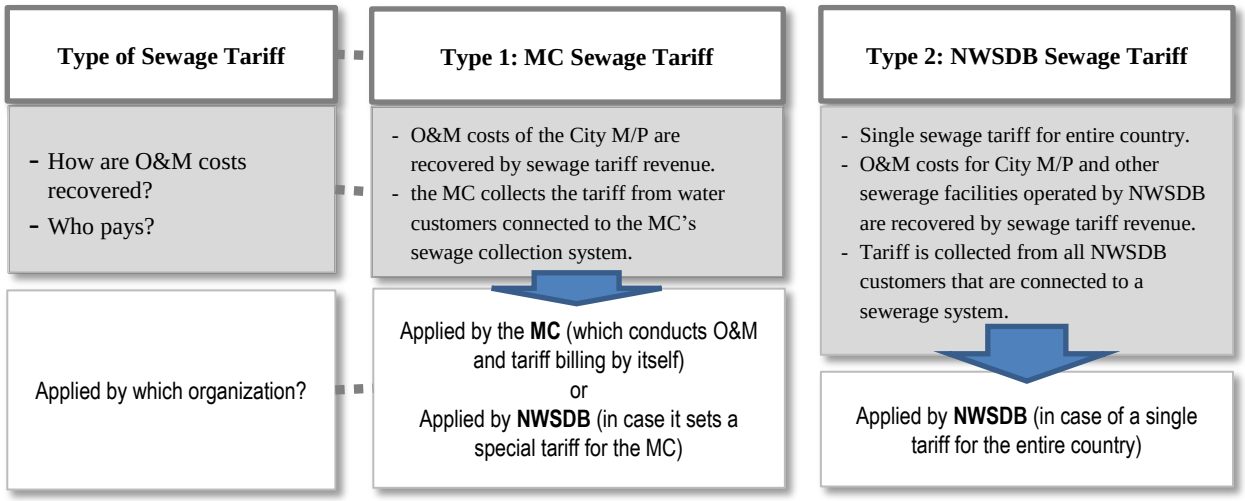
7.2.2 Sewage Tariffs

(1) Two Types of Tariffs

Two types of sewage tariffs are proposed to recover the full costs of O&M for sewerage systems:

Type 1 recovers the O&M costs of the sewerage facilities that serve customers in the MC's sewer service area. MCs would use this type of tariff when they own, operate, and maintain the sewerage system or if NWSDB applies a project specific tariff to the MC instead of the Type 2 tariff.

Type 2 is a uniform, nationwide tariff, that would recover O&M costs of all sewerage facilities owned, operated, and maintained by the NWSDB including those identified in the City M/P. (refer to **Figure 7.2-1**).



Source: JET

Figure 7.2-1 Difference Between Type 1 and Type 2 Sewage Tariff

(2) Calculation Methodology

The sewage tariff is calculated by dividing the estimated annual O&M costs (excluding depreciation and replacement) by total water consumption of the sewerage customers.

A profit margin is provided to set aside funds for small-scale replacements and contingencies such as unexpected disasters or sudden price hike of cost items. It is set at 10% of the O&M costs for Type 1 and 5% for Type 2 tariff. The higher rate reflects the much smaller budget for MCs compare to that of NWSDB.

Sewage charges will be added to the water bill. The sewage charge will be calculated by dividing the total O&M costs by the water consumption volume. Therefore, the sewage charge to each customer is proportional to the amount of water they consume.

(3) Sewage Tariff Proposed by Strategic M/P

The sewage tariff proposed by the Strategic M/P is calculated for NWSDB to recover all the O&M costs under current conditions. To improve the financial condition, the tariff would be incrementally implemented in 2019 and 2022 (Strategic M/P, Section 7.3.1). The sewage tariff to cover the O&M costs is calculated by considering that it can take up to ten years to reach full operational capacity.

When NWSDB is responsible for the O&M and billing on behalf of the MC, the sewage tariff proposed by the Strategic M/P should be implemented as planned. A tariff increase for each City M/P would be implemented after the STP is operating at full capacity (Figure 7.2-2).

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025
1st Tariff Raise of Strategic M/P			△						
2nd Tariff Raise of Strategic M/P						△			
3rd Tariff Raise of City M/P (if necessary)								△	

Source: JET

Figure 7.2-2 Implementation Schedule for Tariffs

When the MC is responsible for sewerage services, the sewage tariff can be implemented in one step. The timing can be at the discretion of the MC but it should be done before the facilities start to operate.

7.2.3 Assumptions for Calculating Proposed Sewage Tariffs

The following assumptions are used to calculate the sewage tariff in the City M/P:

- total volume of water consumed by customers is based on the Design Criteria.
- price inflation is not reflected in the calculation. Inflation adjustment would be included in the calculation of the actual sewage tariff.
- customers are charged for connecting to the sewage collection system (as is the present practice).

7.2.4 Sewage Tariff Calculation

The following Tables show the Types 1 and 2 sewage tariff to cover the O&M cost of the proposed City M/P project. The calculated tariffs are a weighted average that is based on the total water consumption of domestic, commercial, and industrial customers.

(1) Type 1: MC O &M and Billing or NWSDB Sets Special Tariff for MC

Table 7.2-1 Calculation of Type 1 Sewage Tariff - Badulla MC

No.	Items	Unit	Description	Amount
1	Annual O&M costs	LKR/year	Total	57,128,738
2	Expected profit (10%) (=1x10%)	LKR/year	Total	5,712,874
3	**O&M costs with profit** (=1+2)	LKR/year	**Total**	**62,841,612**
4	Sewage Flow	m^3/day	Domestic Flow	2,227
		m^3/day	Non-Domestic Flow	779
		m^3/year	Total	1,097,190
5	Sewage Return Factor	%		80.0
6	**Water Consumption Volume** *1	m^3/year	**Total**	**1,371,488**
7	**Sewage tariff** (=3/6)	LKR/m^3		**45.82**
No.	**Items**	Unit	**Description**	**Amount**

Note: *1; Sewerage Ratio is the average share of sewage volume among water consumption volume of a user. Therefore, water consumption volume is calculated by dividing sewage flow by "sewage ratio/100".
Source: JET

Sewage tariff is estimated at 45.82/m^3 LKR to be multiplied to metered water consumption volume. If the MC is responsible for O&M of sewerage facilities and tariff billing, the MC is recommended to prepare the sewage tariff to cover these expenses.

(2) Type 2: NWSDB Sewage Tariff

Table 7.2-2 Calculation of Type 2 Sewage Tariff (3rd Increment) - Badulla MC

Items	Unit	Description	Amount
Operating Expense	LKR	Existing (2015) *1	410,282,866
		New facilities (City M/P) *2	57,128,738
		Total	**467,411,604**
Income to be subtracted from Expense	LKR	Connection Charge	25,531,614
		P&D/Bowser *3	160,854,906
		Total	**186,386,520**
O&M costs after subtraction	LKR	**Total**	281,025,084
Expected Profit (5%)	LKR	**Total**	14,051,254
O/M costs after subtraction plus profit	LKR	**Total**	**295,076,338**
Water Consumption Volume of Sewerage Customers	m^3/year	Existing (2015)	6,240,008
		New facilities (City M/P)	1,371,488
		Total	**7,611,496**
Sewage tariff	LKR	-	**38.77**

Note: *1; As O&M costs of the existing sewerage facilities with operational costs of head office, actual costs data in 2015 was utilized.
*2; As O&M costs of the City M/P, maximum O&M costs by full capacity was utilized.
*3; Average value of 3 years data was utilized, including contract service fee, planning and design service, and gully bowser (desludging septic tanks) revenue.
Source: prepared by JET, based on the data from NWSDB

If the City M/P is implemented, the NWSDB sewage tariff would be increased to 38.77/m^3. LKR (by the third increment) when the STP operation reaches full capacity.

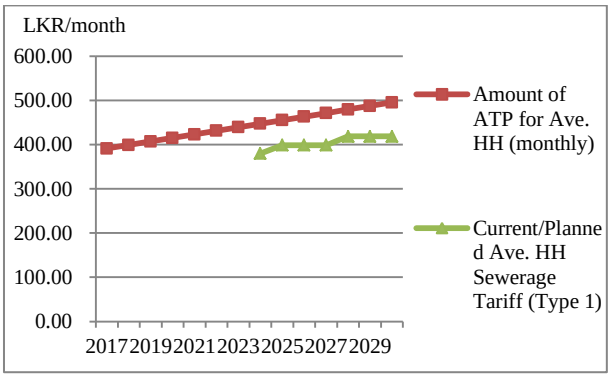
7.2.5 Affordability and Ability to Pay

The following 3 assumptions are made in the analysis of household ability to pay (ATP) sewage charges:

- Implementation of third tariff increment for City M/P is set for 2024
- trend of household income increase shall continue.
- increase in sewage tariff for domestic, commercial, and industrial customers should be the same.

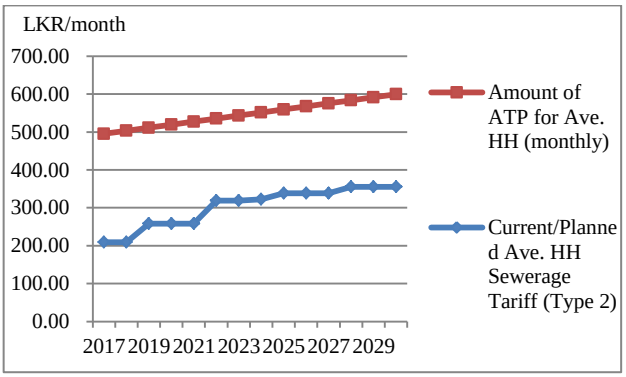
If the increase for commercial and industrial customers is higher than that of domestic customers, monthly charge for households should be set lower.

Figure 7.2-3 shows the monthly charge based on Type 1 sewage tariff and the ATP based on household income data of Badulla District. **Figure 7.2-4** shows the monthly charge based on Type 2 sewage tariff for NWSDB and the ATP based on national average household income data. ATP is estimated to be 1% of the average household income (International Bank for Reconstruction and Development (IBRD), WB).



Note: ATP is estimated based on the District HH income data.
Source: JET

Figure 7.2-3 Comparison of Type 1 Tariff and Ability to Pay



Note: ATP is estimated by national average HH income data.
Source: JET

Figure 7.2-4 Comparison of Type 2 tariff and Ability to Pay

As shown in the **Figure 7.2-3**, monthly household sewage charge (Type 1) is 85 to 88% of the ATP, close to the limit of affordability. It will be necessary to check the income levels again when the actual tariffs are prepared and carefully consider the issue of affordability.

As shown in **Figure 7.2-4**, the monthly household sewage charge (Type 2) is 42% to 61% of the of ATP and is affordable.

7.2.6 **Sewage Tariff** Tables **(Type 2 NWSDB)**

The previous tariff calculation was based on a weighted average applied to all consumer categories.
Table 7.2-3 and **Table 7.2-4** are examples of how the sewage tariff (Type 2) can be calculated from the NWSDB water tariff Tables. This method makes it easier to calculate and avoid charging a customer more for sewage than for water consumption. In this example, the domestic sewage tariff would be 50% of the water tariff and would be added to the water bill.

Table 7.2-3 Example of Domestic Sewage Tariff (for 2024)

Domestic Sewage Tariff = 50% of the following water supply tariffs

No. of units	Domestic - Samurdhi Recipient		Domestic - Non Samurdhi Tenement Garden		Other than for Samurdhi Recipient and Tenement Garden	
	Usage charge (LKR/Unit)	Monthly Service Charge (LKR)	Usage charge (LKR/Unit)	Monthly Service Charge (LKR)	Usage charge (LKR/Unit)	Monthly Service Charge (LKR)
00 - 05	5	50	8	50	12	50
06 - 10	10	50	11	65	16	65
11 - 15	15	50	20	70	20	70
16 - 20	40	80	40	80	40	80
21 - 25	58	100	58	100	58	100
26 - 30	88	200	88	200	88	200
31 - 40	105	400	105	400	105	400
41 - 50	120	650	120	650	120	650
51 - 75	130	1,000	130	1,000	130	1,000
Over 75	140	1,600	140	1,600	140	1,600

Source: JET

Table 7.2-4 Example of Non-Domestic Sewage Tariff: (in 2024)

Non-domestic Sewage Tariff as a % of the following water supply tariffs:

- Commercial; 70%
- Government hospital; 70%
- Industries (SME); 150%
- Industries (non-SME & Govt. Institution) 150%

No. of units	Commercial		Government Hospital		Industries under SME*		Industries other than SME & Government Institution	
	Usage charge (LKR/ Unit)	Monthly Service Charge (LKR)	Usage charge (LKR/ Unit)	Monthly Service Charge (LKR)	Usage charge (LKR/ Unit)	Monthly Service Charge (LKR)	Usage charge (LKR/ Unit)	Monthly Service Charge (LKR)
00 - 25	75	290	53	250	56	265	58	275
26 - 50	75	575	53	500	56	525	58	550
51 - 75	75	1,150	53	1,000	56	1,050	58	1,100
76 - 100	75	1,150	53	1,000	56	1,050	58	1,100
101 - 200	75	1,840	53	1,600	56	1,680	58	1,760
201 - 500	75	2,875	53	2,500	56	2,625	58	2,750
501-1,000	75	4,600	53	4,000	56	4,200	58	4,400
1,001-2,000	75	8,625	53	7,500	56	7,875	58	8,250
2,001-4,000	75	14,375	53	12,500	56	13,125	58	13,750
4,001-10,000	75	28,750	53	25,000	56	26,250	58	27,500
10,001-20,000	75	57,500	53	50,000	56	52,500	58	55,000
Over 20,000	75	115,000	53	100,000	56	105,000	58	110,000

Note: *; Small and Medium Enterprises
Source: JET

Any future increase in water tariffs would result in a corresponding increase in the sewage tariff. The planning for water and sewage tariff increases must therefore be well-coordinated.

The third tariff increment should be implemented by 2024. By then the water supply tariff will have almost certainly been increased. In such a case, the percentages applied to the water tariff (50% of domestic water tariff in

Table 7.2-3) would be lower.

7.3 FINANCIAL PLAN CONCLUSIONS

A) Badulla MC's financial situation is fair but not strong enough to take on a large-scale project. Therefore, it is recommended that the sewerage facilities be implemented and operated with the cost burden for construction shifted to the central government (in the event of an ODA loan, repayment should be borne by the central government). The sewage tariff should be set to fully recover the O&M costs.
B) The following cost burden principle for sewerage service should be used in Sri Lanka:
   - central government should cover 100% of the construction cost, i.e.100% grant for NWSDB or MC.
   - sewage tariff should be calculated to cover O&M costs, implemented incrementally.
   - small-scale replacements should be covered by NWSDB's or the MC's own budget, but large-scale ones should be funded as projects by the central government.
   - 2 types of sewerage tariff is calculated: Type 1 is to recover the O&M costs of the project from sewerage tariff revenue collected from the customers in the MC area, Type 2 is to recover the total O&M costs of the sewerage sector of NWSDB including the O&M costs of City M/P by total revenue with sewerage tariff revenue of NWSDB collecting from entire sewerage customers of NWSDB.
C) Type 1 sewage tariff for MC is estimated at 45.82/m^3 LKR
D) Type 2 sewage tariff for NWSDB is estimated at 38.77/m^3 LKR
E) Both sewage charges (Type 1 and Type 2) are within the ATP of households (1% of average household income). This indicates that an average household can afford the sewage charge.
F) The latest average household income data should be used for tariff calculation.

CHAPTER 8 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

8.1 EXISTING CONDITIONS

Environmental and Social conditions in the Project area are outlined in CHAPTER 2.

8.2 REGULATIONS AND ORGANIZATIONS RELATED TO ESC

Laws and regulations related to ESC at the national level, and organizations responsible for implementation, were studied in the Strategic Sewerage Master Plan under this Project (Refer to Section I Progress Report). No regulations specific to or published by Anuradhapura MC relevant to the Project were identified. National regulations described in the Strategic Sewerage Master Plan can be found in **APPENDIX 9**.

8.3 COMPARISON WITH JICA GUIDELINES

Comparison of national regulations with those of JICA is given in **APPENDIX 10**.

8.4 INTERNATIONAL COMMITMENTS

The Government of Sri Lanka (GOSL) is party to several international agreements related to environment and human rights. Agreements specific to Badulla MC could not be found. The national agreements are given in **APPENDIX 11**.

8.5 ENVIRONMENTAL SCOPING

Scoping is defined as the process of identifying the content and extent of the environmental information to be submitted to the competent authority under the EIA procedure. Scoping of the project components and the reasons for the evaluation are shown in **Table 8.5-1**.

Table 8.5-1 Environmental Scoping

Item	Evaluation		Reason
1 Air pollution	P/C	B-	Dust and exhaust gases are generated during construction.
	O	D	No impacts are expected during operation.
2 Water pollution	P/C	B-	Excavation and runoff will cause turbidity during construction.
	O	B+	Treatment of sewage and greywater will reduce water pollution.
3 Soil pollution	P/C	B-	Construction equipment and transfer of construction materials contribute to soil pollution.
	O	D	No impacts are expected during operation.
4 Waste	P/C	B-	Construction waste will be generated.
	O	B-	Sludge will be generated during operation of treatment facilities.
5 Noise and vibrations	P/C	B-	Noise and vibrations will be generated during construction.
	O	B-	Noise and vibrations will be generated during operation.
6. Ground subsidence	P/C	C-	Impacts are unknown and require investigation.
	O	C-	Impacts are unknown and require investigation.
7. Offensive odours	P/C	D	No impacts are expected during construction.
	O	B-/B+	B-: Odour will be generated at the STP during operation. B+: Improved sewerage collection and environmental conditions will reduce offensive odours in the Project area.
8 Geographical features	P/C	C-	Impacts are unknown and require investigation.
	O	D	No impacts are expected during operation.

Item	Evaluation		Reason
9 Bottom sediments	P/C	D	No impacts are expected during construction.
	O	B+	Collection and treatment of waste water will improve benthic conditions of water bodies.
10 Biota and ecosystems	P/C	C-	Impacts are unknown and require investigation. (Included in EIA)
	O	C+/C-	C+: Ecosystems will benefit from improved water quality. C-: Negative impacts of STP are unknown and need investigation.
10b Protected lands	P/C	D	There are no protected natural lands in the Project area.
	O	D	
11 Water usage	P/C	C-	Impacts are unknown and require investigation.
	O	C-	Water usage downstream of Project has not been investigated. Thus, impacts are unknown and require investigation.
12 Accidents	P/C	B-	Construction activities and disruption to traffic will increase risk of accidents.
	O	B-	Accidents may occur in treatment facilities during operation.
13 Global warming	P/C	D	No impacts are expected during construction.
	O	D	No impacts are expected during operation.
14 Land acquisition	P/C	B-	Land for treatment plant, pumping stations, and sewerage lines will be required.
	O	D	No impacts are expected during operation.
15 Local economies	P/C	C+/C-	C+: Construction activities may increase in local employment and economic activities. C-: Construction activities may inconvenience local businesses.
	O	C+	Improved water environment will positively impact aquaculture and businesses (tourism etc)
16 Land use	P/C	C-	Land use patterns may be impacted by acquisition, resettlement, and construction of facilities.
	O	D	No additional impact caused by operation is expected.
17 Social institutions	P/C	D	No impacts are expected during construction.
	O	D	No impacts are expected during operation.
18 Existing social infrastructures and services	P/C	B-	Traffic disturbance will be caused by construction activities.
	O	B+	Infrastructure for sewerage collection and treatment will be created.
19 Poor (low income households)	P/C	C-	Low income people may be impacted by construction activities.
	O	C-	Impacts are unknown and require investigation.
19a Indigenous and ethnic populations	P/C	C-	Socially vulnerable populations may be impacted by construction activities.
	O	C-	Impacts are unknown and require investigation.
20 Misdistribution of benefits and damages	P/C	C-	Impacts are unknown and require investigation.
	O	C-	Impacts are unknown and require investigation.
21 Local conflicts of interest	P/C	C-	Impacts are unknown and require investigation.
	O	C-	Impacts are unknown and require investigation.
22 Gender	P/C	C-	Women may receive unequal economic opportunities during construction.
	O	C+	Women, who suffer disproportionately from water borne diseases, are expected to benefit from improved water environment.
23 Children's rights	P/C	C-	Child labour may occur during construction.
	O	C+	Children, who suffer disproportionately from water borne diseases, are expected to benefit from improved water environment.
24 Cultural heritage	P/C	C-	Construction activities may impact heritage sites.
	O	C+	Improved water environment and sanitation facilities are expected to reduce negative impacts on heritage sites (especially during pilgrimage and festival periods).
24a Landscapes	P/C	B-	Construction activities will impact landscape in the Project area.
	O	B-	Newly constructed facilities will impact landscape in the Project area.
25 Infectious diseases such as HIV/AIDS	P/C	B-	Influx of construction workers will increase risk of infectious diseases.
	O	B+	Improved sanitation services will decrease incidence of infectious diseases (especially during and following peak pilgrimage periods).

【Evaluation】
A：Significant impact is expected,
B：Some impact is expected,
C：Extent of impact is unknown,
D：No impact is expected
+ / - : Impact is Positive / Negative
Source: JET

8.6 TOR FOR ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

8.6.1 Purpose

The purpose of the survey at this preparatory stage is to predict and assess the type and scale of possible project impacts to the natural and social environment.

8.6.2 Items to be Targeted in the Study and Evaluation

Items that receive A, B, or C ranking (**Table 8.5-1**) should be reviewed and evaluated. Other items identified as the survey proceeds should also be included.

8.6.3 Target Areas

The target areas are the proposed construction sites, and the areas immediately surrounding the Project facilities.

8.6.4 Target Periods

Target periods are the stages of planning, execution, and operation of the constructed facilities.

8.6.5 Contents and Methods for ESC Study

The information to be collected and the typical counter-measures that need review are presented in **Table 8.6-1**.

Table 8.6-1Table 8.6-1: The ESC Study Associated with the Project

Item				Study/Countermeasure	Status
No.	Title	Evaluation			
01	Air Pollution	P/C	B-	Study: Air pollution standards, construction vehicles and methods. Method: Site survey, literature survey of regulations and standards.	In progress (M/P, F/S stage)
		O	D	N/A	N/A
02	Water Pollution	P/C	B-	Study: Water pollution standards, construction methods. Method: Site survey, literature survey of regulations and standards.	In progress (M/P, F/S stage)
		O	B+	Study: Water pollution standards, treatment methods, water quality, flow rates, pollution loads.	Complete (M/P stage)
03	Soil Pollution	P/C	B-	Study: Soil pollution standards, prevention measures/construction methods, construction equipment Method: Site survey, literature survey of regulations and standards.	In progress (M/P, F/S stage)
		O	D	N/A	N/A
04	Waste	P/C	B-	Study: Waste management regulations/procedures, Collection and disposal methods, disposal site conditions. Method: Site surveys, Interview surveys of concerned parties.	Complete (M/P stage)
		O	B-	Study: Sludge generation. Method: Treatment method.	F/S stage
05	Noise and Vibrations	P/C	B-	Study: Noise regulations, current condition, construction methods. Method: Site surveys, Interview surveys of concerned parties, noise measurement surveys.	Complete (M/P stage)
		O	B-	Study: Treatment method and possible noise generation.	F/S stage
06	Ground Subsidence	P/C	C-	Study: Geographic conditions. Method: Geographic survey.	F/S stage
		O	C-		

07	Offensive Odours	P/C	D	N/A	N/A
		O	B-/B+	Study: Current odour conditions, treatment method. Method: Site surveys, Interview surveys of concerned parties.	In progress (M/P, F/S stage)
08	Geographical Features	P/C	C-	Study: Geographic conditions. Method: Geographical survey.	F/S stage
		O	D	N/A	N/A
09	Bottom Sediments	P/C	D	N/A	N/A
		O	B+	Study: Sediment conditions of water bodies. Method: Site surveys, literature surveys, water quality surveys.	F/S, EIA stage
10	Biota and Ecosystems	P/C	C-	Study: Inventory of flora and fauna in the construction area. Method: Site survey, Interview survey of concerned parties	F/S, EIA stage
		O	C+/C-		
10a	Protected lands	P/C	D	N/A	N/A
		O	D	N/A	N/A
11	Water Usage	P/C	C-	Study: Water use practices of local communities, impacts of sewerage treatment on water usage. Method: Site surveys, Interview surveys of concerned parties.	In progress (M/P, F/S stage)
		O	C-		
12	Accidents	P/C	B-	Study: Construction/industrial safety regulations, traffic safety/accident prevention methods. Method: Site surveys, literature survey, Interview surveys of concerned parties.	In progress (M/P, F/S stage)
		O	B-	Study: Industrial safety regulations. Method: Literature surveys.	In progress (M/P, F/S stage)
13	Global Warming	P/C	D	N/A	N/A
		O	D	N/A	N/A
14	Land Acquisition	P/C	B-	Study: Land requirements, acquisition procedures, compliance to JICA guidelines. Method: Site surveys, literature surveys, Interview surveys of concerned parties.	In progress (M/P, F/S stage)
		O	D	N/A	N/A
15	Local Economies	P/C	C+/C-	Study: Local economic environment, industries, markets. Relevant laws and regulations. Method: Site surveys, literature surveys, Interview surveys of concerned parties.	In progress (M/P, F/S stage)
		O	C+		
16	Land Use	P/C	C-	Study: Land use practices of local communities. Method: Site surveys, Interview surveys of concerned parties.	F/S
		O	D		
17	Social Institutions	P/C	D	N/A	N/A
		O	D	N/A	N/A
18	Existing Social Infrastructures and Services	P/C	B-	Study: Traffic patterns, location of important social infrastructure (schools, hospitals, religious institutions, etc) Method: Site survey, inventory survey, public consultation.	In progress (M/P, F/S stage)
		O	B+		
19	Poor (low income households)	P/C	C-	Study: Census/demographic data, economic status, and land use patterns of affected peoples. Method: Interview survey of concerned parties, relevant laws, and regulations.	In progress (M/P, F/S, EIA stage)
		O	C-		
19a	Indigenous and ethnic populations	P/C	C-	Study: Census/demographic data, economic status, and land use patterns of affected peoples. Method: Interview survey of concerned parties, relevant laws, and regulations.	In progress (M/P, F/S, EIA stage)
		O	C-		
20	Misdistribution of benefits and damages	P/C	C-	Study: Social and economic conditions. Method: Interview surveys of concerned parties, public consultation.	In progress (M/P, F/S stage)
		O	C-		
21	Local Conflicts of interest	P/C	C-	Study: Risks and prevalence of conflicts of interest. Method: Interview surveys of concerned parties, public consultation.	In progress (M/P, F/S stage)
		O	C-		
22	Gender	P/C	C-	Study: Working conditions/statistics of women, gender equality policies. Method: Interview survey of concerned parties, relevant laws, and regulations.	In progress (M/P, F/S stage)
		O	C+	Study: Health and working conditions of women. Method: Interview survey of concerned parties, data collection.	In progress (M/P, F/S stage)
23	Children's	P/C	C-	Study: Child labour laws.	In progress

	Rights			Method: Interview survey of concerned parties, relevant laws, and regulations.	(M/P, F/S, EIA stage)
		O	C+	Study: Water borne diseases and children Method: Interview survey of concerned parties, data collection.	In progress (M/P, F/S stage)
24	Cultural Heritage	P/C	C-	Study: Location of cultural heritage sites. Method: Site survey, location of registered heritage/historical sites, Interview survey of concerned parties.	In progress (M/P, F/S, EIA stage)
		O	C+	Study: Impacts of pollution on heritage sites. Method: Interview survey of concerned parties.	
24a	Landscapes	P/C	B-	Study: Location of significant cultural, religious, and tourism sites, construction locations and methods. Method: Site survey, Interview survey of concerned parties.	In progress (M/P, F/S, EIA, D/D stage)
		O	B-		
25	Infectious Diseases such as HIV/AIDS	P/C	B-	Study: Prevalence of AIDS/HIV and other infectious diseases, current prevention programs. Method: Data collection, Interview surveys of concerned parties.	In progress (M/P, F/S stage)
		O	B+	Study: Prevalence of water borne and other environmental diseases. Method: Data collection, Interview surveys of concerned parties	

Source: JET

8.6.6 Prediction and Evaluation of Potential Impacts

Prediction and evaluation of potential impacts should be conducted for items ranked A, B, or C in Section 8.5: Scoping.

Each item should be re-evaluated as the survey proceeds, and the scoping Table updated accordingly. Subsequently, items with A or B ranking should be evaluated in terms of the extent of the impact.

8.6.7 Consideration for the EMP and EMoP

When the Project causes foreseeable but unavoidable environmental impacts, the Environmental Management Plan (EMP) will identify how to mitigate the extent of the impacts, and the Environmental Monitoring Plan (EMoP) will identify steps to be taken by relevant authorities to ensure that mitigation measures are effectively implemented. Execution plans, frequency of measures, organization, necessary reinforcement of the organization, and budget should be provided for EMP and EMoP.

8.6.8 Stakeholder Consultation

Consultations with UNI and NGO were held at the start of the study to gain information about the needs and attitudes in the area, and the relevance of the Project. Details of the meeting minutes are given in **APPENDIX 12**.

The results of the ESC studies should be presented at stakeholder consultations, and the stakeholder feedback should be collected.

8.7 DRAFT EMP AND EMOP

Environmental and social considerations will be managed through the EMP. EMP will be implemented through EMoP. Development of the EMP is not appropriate at this stage. Draft versions of the EMP and EMoP are presented in **APPENDIX 13**. They will be further developed as the Project proceeds and

more information becomes available.

8.8 SCHEDULE OF ESC ACTIVITIES

Surveys related to ESC will be performed according to the schedule below (**Figure 8.8-1**).

Stage	Period		ESC Expert	EIA Study	Target		Environmental Study	Remark
					Original	Selected		
Strategic MP	2016	Jan			335 local authorities (79)	(Approx.) 5 local authorities	Primary study	➢ Environmental policies, plans and programs ➢ National level research
		Feb						
		Mar						
		Apr						
5 Cities MP (Pre-F/S)		May			5 local authorities	2 local authorities	Preparation study for IEE/EIA	➢ Literature search ➢ Site survey
		Jun						
		Jul						
		Aug						
		Sep						
Feasibility Study (F/S)	2017	May			Badulla MC (If selected for F/S)		EIA Study	➢ EMP(draft) ➢ Monitoring Plan(draft) ➢ EIA Report ➢ Resettlement Action Plan ➢ Stakeholder Meeting
		Jun						
		Jul						
		Aug						
		Sep						
		Oct						
		Nov						
		Dec						

Source: JET

Figure 8.8-1 Schedule for ESC Surveys

CHAPTER 9 CONCLUSION AND RECOMMENDATION

F/S Implementation

Badulla is one of Sri Lanka's Regional Growth Centers and an important gateway to the eastern regions. Increasing values of BOD, ammonia, phosphorus, and coliform originating from sewage are being detected in Badulu Oya that flows through the city. Construction of a sewerage system can efficiently treat large volumes of wastewater and will preserve and improve the water quality.

Solids such as dewatered waste activated sludge, screenings, and grit produced by the sewage treatment plant must be disposed of at a properly designed facility to minimize environmental impact. A solid waste disposal site in Badulla is being considered but it will take some time before the facility can be operational.

9.1 CONCLUSION AND RECOMMENDATIONS

Constructing a sewerage system in Badulla MC would bring significant benefits in conserving and improving water environment. However, it would not be appropriate to include Badulla MC in the F/S, as the Project cannot be implemented immediately due to uncertainties surrounding the final disposal site. The MC is advised to secure a final disposal site for solid waste.

APPENDICES

APPENDICES

APPENDIX 1 Badulla Waste Water Flow Forecast

BADULLA WASTE WATER FLOW CALCULATION

Water consumption	120 lpcd
Domestic Waste Water /Water	80%
Non-Domestic ww/Domestic	35%
Infiltration	20%

1	Badulla DSD		Population 2001	Population 2012	Population 2046	% covered	Population 2046 in covered area	Domestic Water consumption(cum/d)	Domestic Waste Water Flow (cum)	Non-Domestic Flow(cum/d)	Domestic + Non-Domestic Waste Water Flow (cum/d)	Infiltration (cum/d)	Total Waste Water Flow (cum/d)
1.1	78L	Pitawelagama	2,711	2824	3019	65%	1962	235	188	66	254	51	305
1.2	78A	Badulla North	3,528	4062	5117	50%	2559	307	246	86	332	66	398
1.3	78G	Kailagoda	2,276	2440	2734	85%	2324	279	223	78	301	60	361
1.4	78J	Badulupitiya	4,373	5153	6743	100%	6743	809	647	227	874	175	1049
1.5	78D	Badulla Central	5,213	3347	3347	100%	3347	402	321	112	434	87	521
1.6	78C	Badulla West	2,381	2753	3492	30%	1048	126	101	35	136	27	163
1.7	78B	Badulla East	5,253	4159	4159	100%	4159	499	399	140	539	108	647
1.8	78K	Hindagoda	2,603	3079	4054	25%	1014	122	97	34	131	26	158
			28,338	27817	32665		23155	2779	2223	778	3001	600	3601

APPENDIX 2: Inflow Sewage Quality

Inflow sewage quality - Measured data of inflow sewage -

The planned inflow water quality values of Moratuwa/Rathmalana STP are considerably higher than the actual data.

		Raddolugama 1)	Maththegoda 1)	Hikkaduwa 1)	Moratuwa/ Rathmalana**	Ja-Ela/ Ekara***	Average	Design raw water quality	Moratuwa/Rathmalana (First stage planned values)	
pH at 26^{0}C		6.7	6.4	7.0	6.6-8.5	-	6.7			pH at 26^{0}C
Total Suspended Solids at 104^{0}C	mg/l	163	90	139	232	-	156	160	458	Total Suspended Solids at 104^{0}C
Chemical Oxygen Demand Total	mg/l	609	473	446	274	628	486	600	1057	Chemical Oxygen Demand Total
Chemical Oxygen Demand Soluble	mg/l	241	241	206	-	-	229	-	-	Chemical Oxygen Demand Soluble
Biochemical Oxygen Demand- 5Total	mg/l	383	247	240	87	187	229	240	355	Biochemical Oxygen Demand- 5Total
Biochemical Oxygen Demand- 5 Soluble	mg/l	159	116	149	-	-	141	-	-	Biochemical Oxygen Demand- 5 Soluble
Nitrate- Nitrogen and Nitrite Nitrogen	mg/l	2.3	2.5	5.7	1.0	-	2.9	-	-	Nitrate- Nitrogen and Nitrite Nitrogen
Ammoniacal Nitrogen	mg/l	26	28	24	14	-	23	-	-	Ammoniacal Nitrogen
Total Nitrogen	mg/l	39	34	33	42	-	37	45	55	Total Nitrogen
Total Phosphorous	mg/l	5.9	3.3	2.9	2.8	-	3.7	6	12	Total Phosphorous

1) Average values of the three measurements which were conducted from December 2016 to January 2017 (Annex 1)

**Data taken between October 2013 and February 2016

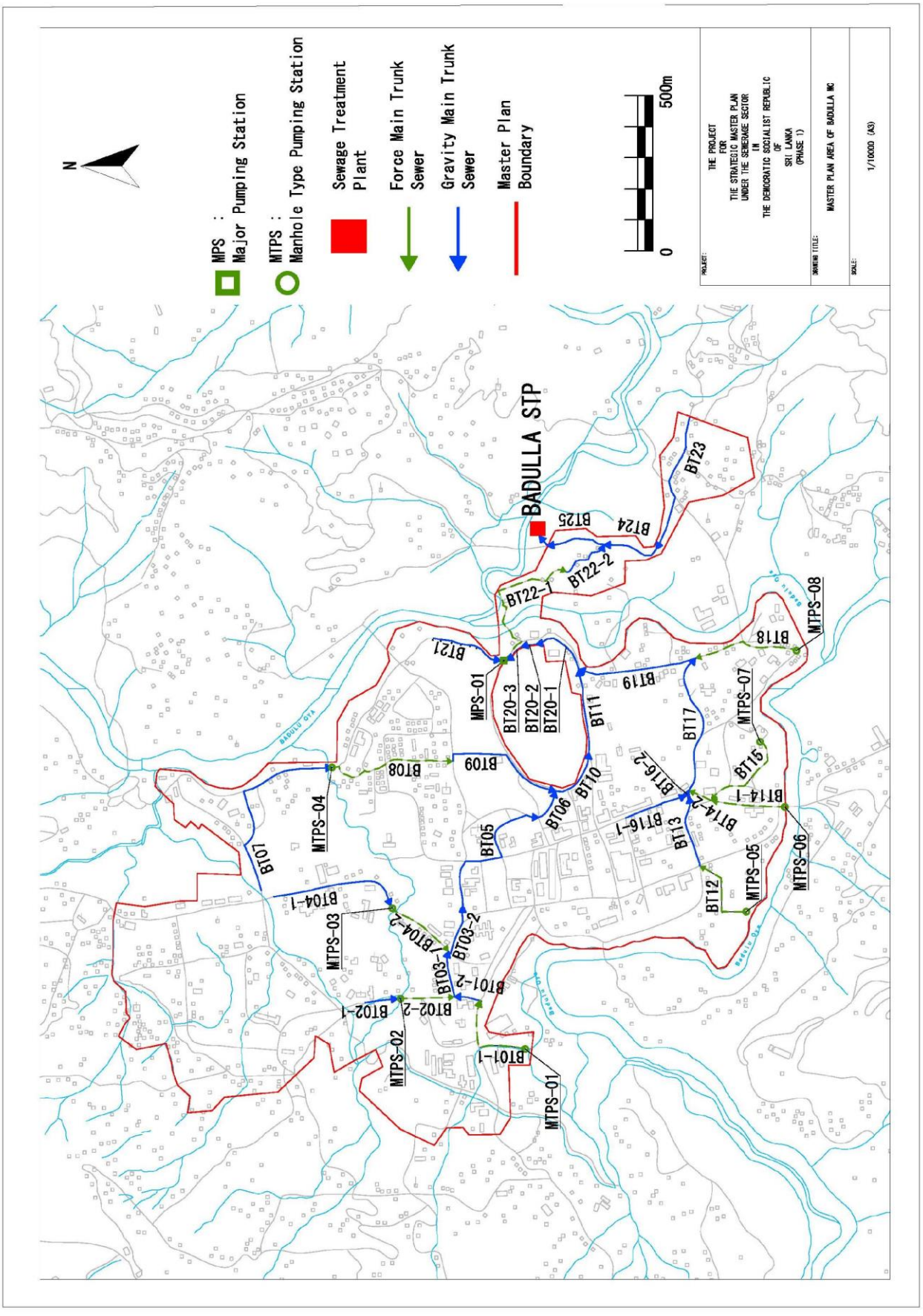
***Average of 1-year measurement

The Result of Sewage Analysis

		Raddolugama			Maththegoda			Hikkaduwa		
		23,24 Nov.2016	29,30 Nov.2016	5,6 Dec 2016	25,26 Nov.2016	1,2 Dec 2016	7,8 Dec 2016	27,28 Dec 2016	3,4 Dec 2016	9,10 Dec 2016
pH at 26^0C		6.6	6.93	6.7	6.2	6.9	6.2	7.3	6.42	7.4
Total Suspended Solids at 104^0C	mg/l	814*	115	211	54	115	100	59	165	194
Chemical Oxygen Demand Total	mg/l	752*	650	567	510	670	239	344	406	587
Chemical Oxygen Demand Soluble	mg/l	184*	261	220	312	330	80	206	201	212
Biochemical Oxygen Demand- 5Total	mg/l	669*	402	363	189	390	162	186	213	321
Biochemical Oxygen Demand- 5 Soluble	mg/l	99.8*	136	181	120	181	48	109	167	172
Nitrate- Nitrogen and Nitrite Nitrogen	mg/l	2.2	28*	2.4	2.5	1.4	3.5	1.2	13.7	2.2
Ammoniacal Nitrogen	mg/l	10	30	38	19	42	24	18	19	35
Total Nitrogen	mg/l	13	61	42	25	46	32	21	35	42
Total Phosphorous	mg/l	4	8.8	4.8	0.4	5.8	3.8	0.6	4.1	4.1

*JET considered values in gray as outliers and not used for the design.

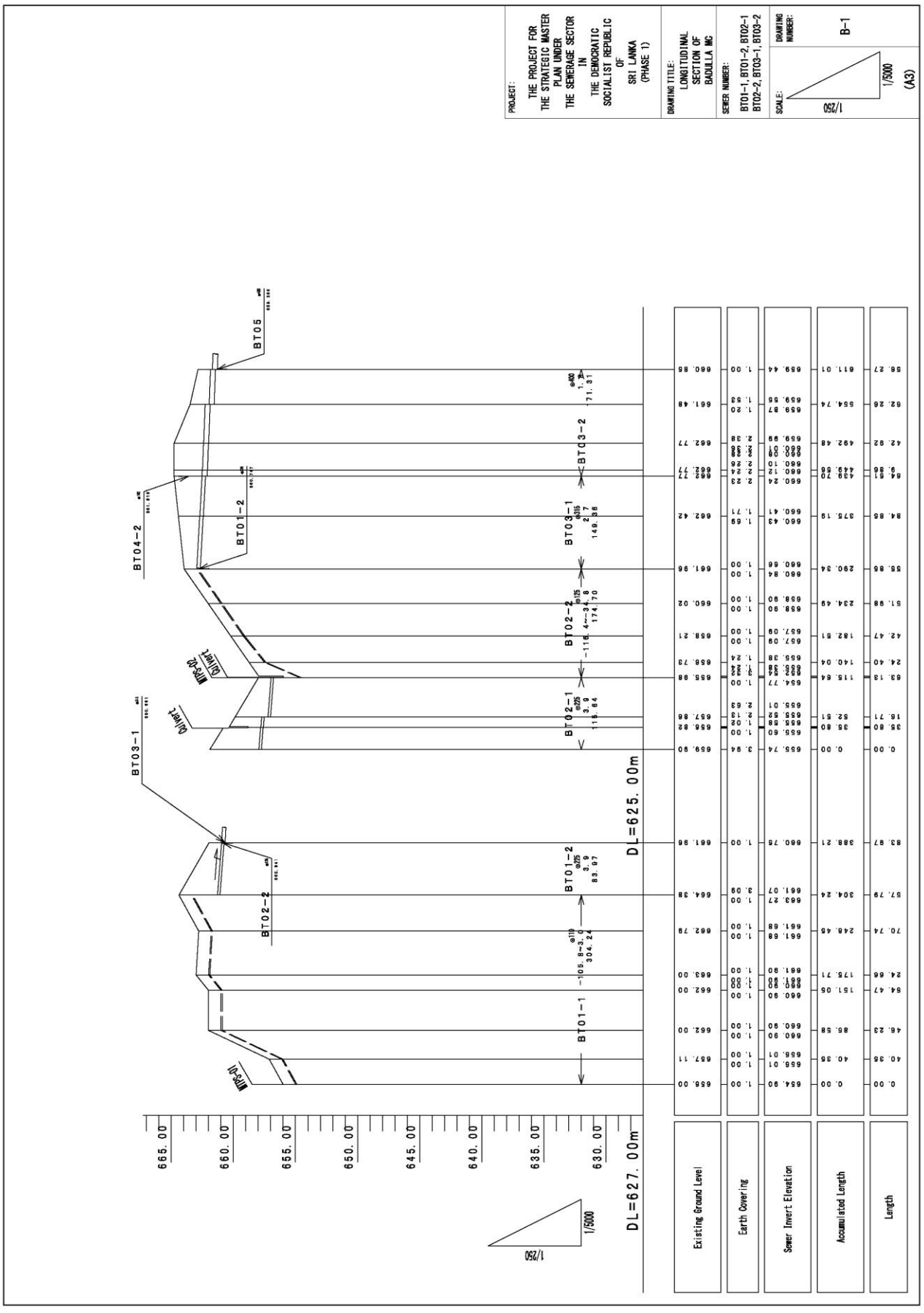
APPENDIX 3: Layout Plan, Sewer Design Calculations and Longitudinal Cross Section

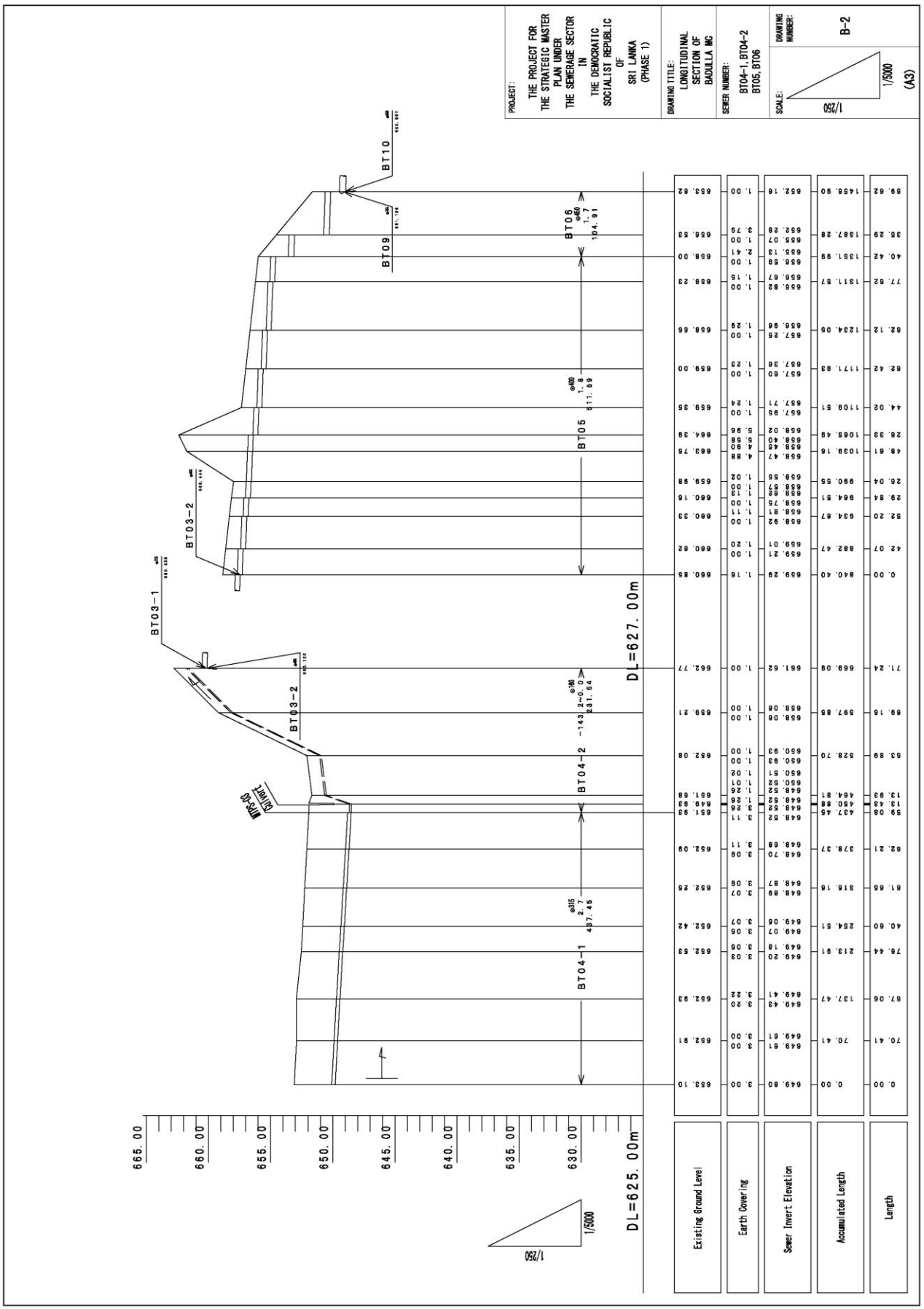


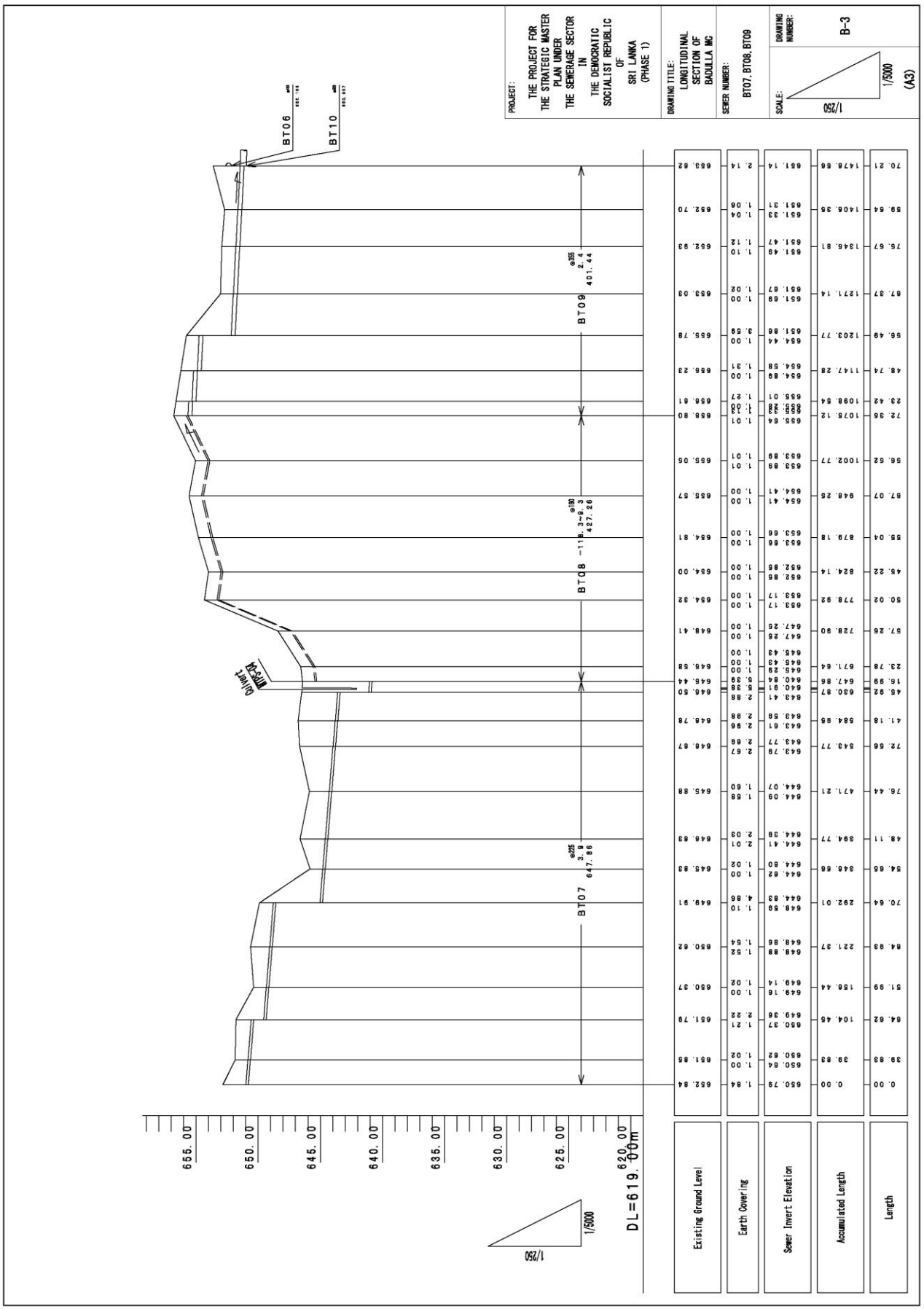
SEWER DESIGN CALCULATIONS

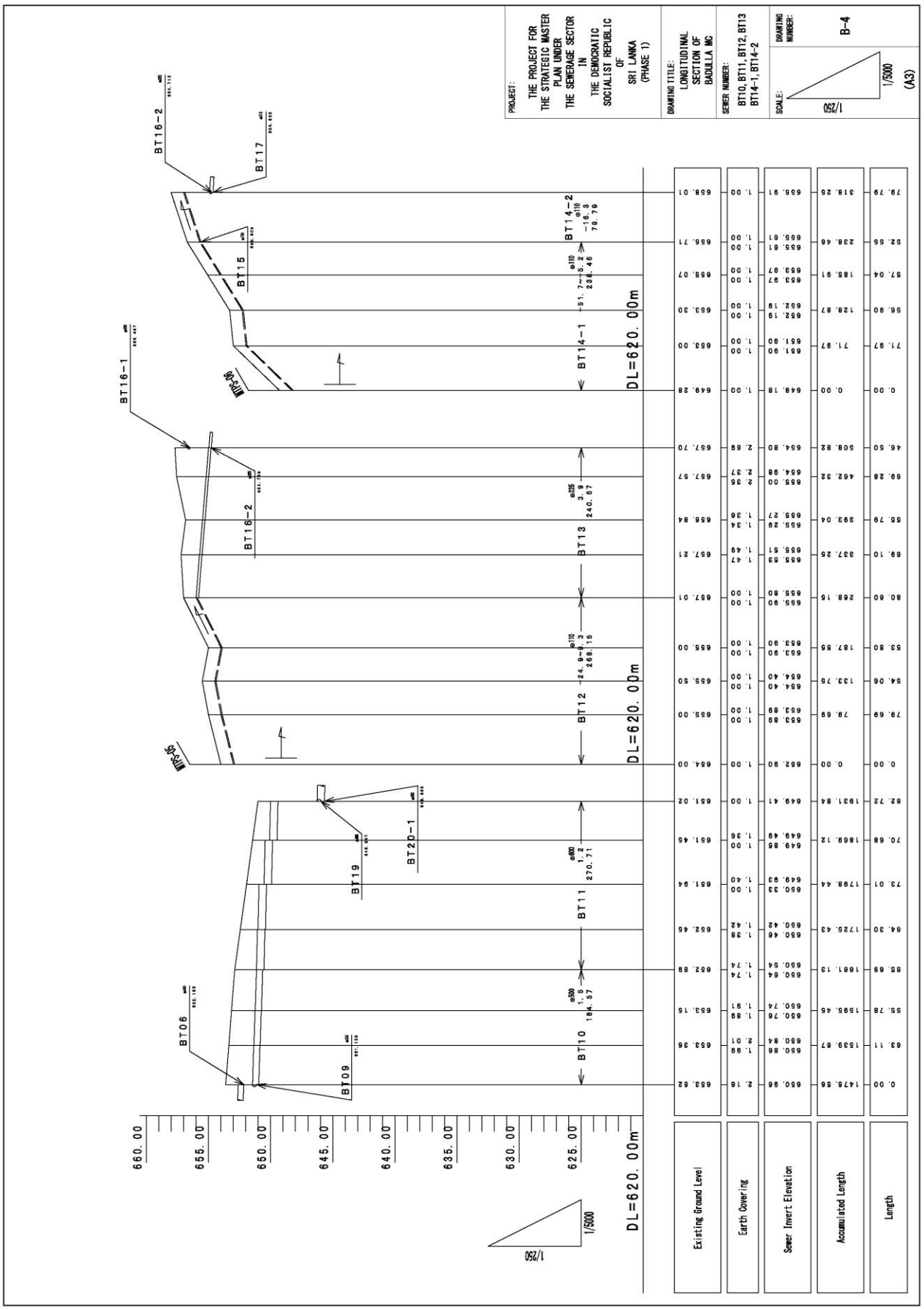
Master Plan Area	Unit Sewer Water ($m^3/s/ha$)	Legend	P
Badulla MC	0.000474	◎:Main Sewer	P_ 1

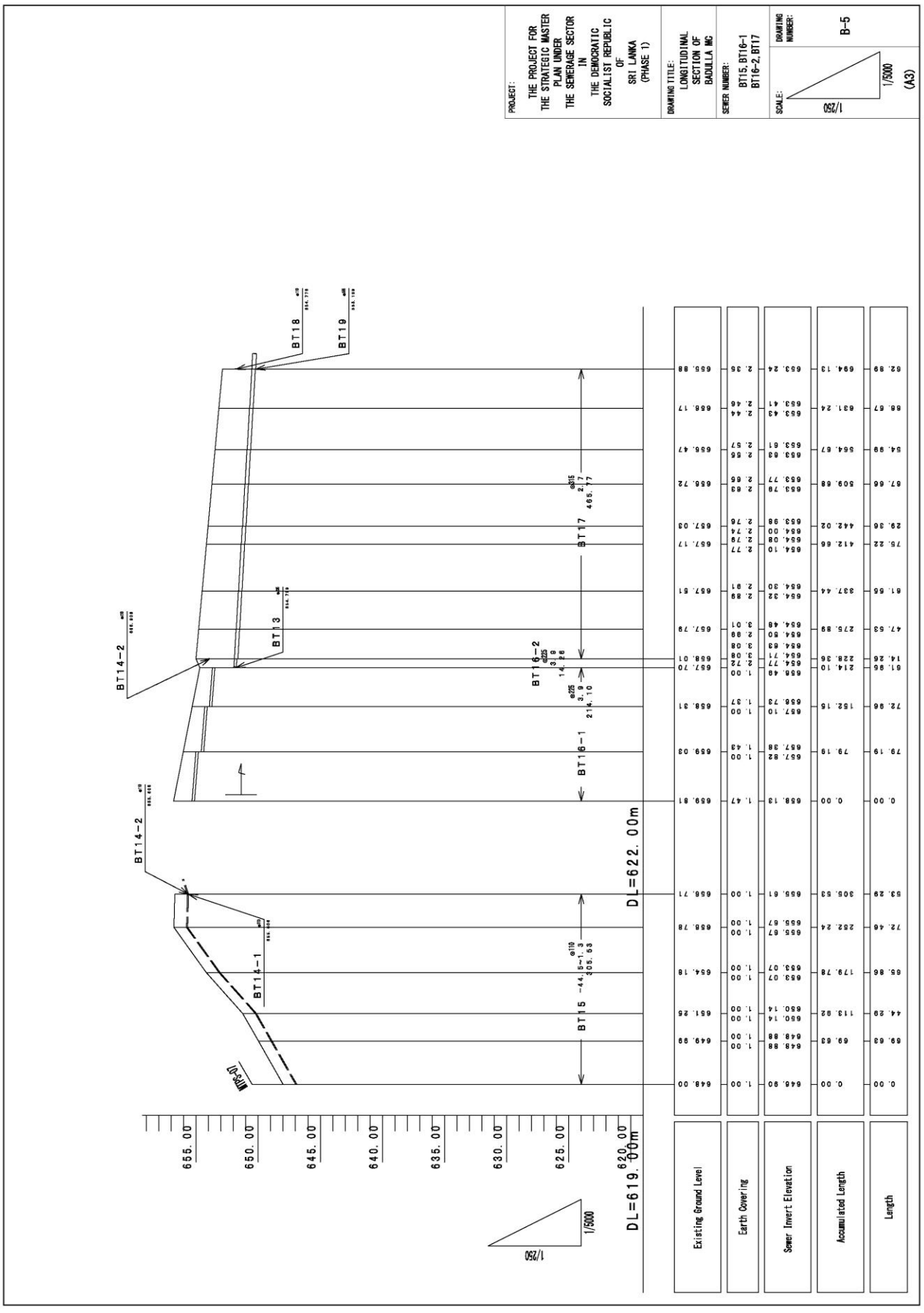
Line No.	Catchment Area		Length	Design Outflow			Design Sewer Line							Note
				Sewer Water Outflow		Total Outflow	Dia (Internal Diameter)	Slope	V	Cap	Existing Ground Level	Sewer Invert Elevation	Earth Covering	
	Area	Accumulated Area	Accumulated Length	Area Input	Point Input						Upper / Lower	Upper / Lower	Upper / Lower	
	(ha)	(ha)	(m)	(m^3/s)	(m^2/s)	(m^3/s)	(mm)	(‰)	(m/s)	(m^3/s)	(m)	(m)	(m)	
			305				HDPE				656.00	654.896	1.00	From MTPS-01
BT01-1 ◎	10.32	10.32	305	0.005		0.005	⊙ 110		Force Main		664.38	663.273	1.00	
			84				HDPE				664.38	661.074	3.09	
BT01-2 ◎	0.45	10.77	389	0.005		0.005	⊙ 225	3.90	0.65	0.021	661.96	660.747	1.00	To BT03-1
			116				HDPE				659.90	655.743	3.94	
BT02-1 ◎	14.70	14.70	116	0.007		0.007	⊙ 225	3.90	0.65	0.021	655.98	654.767	1.00	To MTPS-02
			175				HDPE				655.98	652.538	3.32	From MTPS-02
BT02-2 ◎	9.26	23.96	291	0.011		0.011	⊙ 125		Force Main		661.96	660.841	1.00	
			150				HDPE				661.96	660.661	1.00	From BT01-2 and BT02-2
BT03-1 ◎	1.85	36.58	538	0.017		0.017	⊙ 315	2.70	0.68	0.043	662.77	660.238	2.23	
			172				GRP				662.77	660.120	2.24	From BT03-1 and BT04-2
BT03-2 ◎	2.01	81.57	841	0.039		0.039	⊙ 400	1.80	0.70	0.088	660.85	659.444	1.00	To BT05
			438				HDPE				653.10	649.801	3.00	
BT04-1 ◎	40.45	40.45	438	0.019		0.019	⊙ 315	2.70	0.68	0.043	651.93	648.520	3.11	To MTPS-03
			232				HDPE				651.93	648.520	3.26	From MTPS-03
BT04-2 ◎	2.53	42.98	669	0.020		0.020	⊙ 160		Force Main		662.77	661.616	1.00	To BT03-2
			512				GRP				660.85	659.286	1.16	From BT03-2
BT05 ◎	8.20	89.77	1352	0.043		0.043	⊙ 400	1.80	0.70	0.088	658.00	656.594	1.00	
			105				GRP				658.00	655.130	2.41	
BT06 ◎	5.55	95.32	1457	0.045		0.045	⊙ 450	1.70	0.74	0.118	653.62	652.163	1.00	To BT10
			648				HDPE				652.84	650.792	1.84	
BT07 ◎	9.32	9.32	648	0.004		0.004	⊙ 225	3.90	0.65	0.021	646.44	640.839	5.39	To MTPS-04
			428				HDPE				646.44	645.288	1.00	From MTPS-04
BT08 ◎	33.08	42.40	1076	0.020		0.020	⊙ 160		Force Main		656.80	655.639	1.01	
			402				HDPE				656.80	655.333	1.13	
BT09 ◎	4.17	46.57	1477	0.022		0.022	⊙ 355	2.40	0.70	0.055	653.62	651.139	2.14	
			185				GRP				653.62	650.957	2.16	From BT06 and BT09
BT10 ◎	5.87	147.76	1662	0.070		0.070	⊙ 500	1.50	0.74	0.146	652.89	650.639	1.74	
			271				GRP				652.89	650.539	1.74	
BT11 ◎	9.21	156.97	1932	0.074		0.074	⊙ 600	1.20	0.75	0.213	651.02	649.412	1.00	To BT20-1
			269				HDPE				654.00	652.896	1.00	From MTPS-05
BT12 ◎	14.74	14.74	269	0.007		0.007	⊙ 110		Force Main		657.01	655.902	1.00	
			241				HDPE				657.01	655.797	1.00	
BT13 ◎	3.19	17.93	509	0.008		0.008	⊙ 225	3.90	0.65	0.021	657.70	654.799	2.69	To BT16-2
			239				HDPE				649.28	648.175	1.00	From MTPS-06
BT14-1 ◎	6.23	6.23	239	0.003		0.003	⊙ 110		Force Main		656.71	655.606	1.00	
			80				HDPE				656.71	655.605	1.00	From BT15
BT14-2 ◎		11.15	386	0.005		0.005	⊙ 110		Force Main		658.01	656.906	1.00	
			306				HDPE				648.00	646.896	1.00	From MTPS-07
BT15 ◎	4.92	4.92	306	0.002		0.002	⊙ 110		Force Main		656.71	655.605	1.00	To BT14-2
			215				HDPE				659.81	658.126	1.47	
BT16-1 ◎	2.56	2.56	215	0.001		0.001	⊙ 225	3.90	0.65	0.021	657.70	656.487	1.00	
			15				HDPE				657.70	654.769	2.72	From BT13 and BT16-1
BT16-2 ◎		20.49	523	0.010		0.010	⊙ 225	3.90	0.65	0.021	658.01	654.713	3.08	
			466				HDPE				658.01	654.632	3.08	From BT14-2 and BT16-2
BT17 ◎	9.38	41.02	989	0.019		0.019	⊙ 315	2.70	0.68	0.043	655.88	653.235	2.35	To BT19
			343				HDPE				650.82	649.716	1.00	From MTPS-08
BT18 ◎	9.00	9.00	343	0.004		0.004	⊙ 110		Force Main		655.88	654.776	1.00	
			383				HDPE				655.88	653.199	2.34	From BT17 and BT18
BT19 ◎	5.55	55.57	1372	0.026		0.026	⊙ 355	2.40	0.70	0.055	651.02	645.947	4.74	
			244				GRP				651.02	645.665	4.75	From BT11 and BT19
BT20-1 ◎	2.90	215.44	2176	0.102		0.102	⊙ 600	1.20	0.75	0.213	647.34	645.313	1.42	
			34				GRP				647.34	643.000	3.94	
BT20-2 ◎		215.44	2209	0.102		0.102	⊙ 400	0.00	0.00	0.000	646.96	643.000	3.55	
			44				GRP				646.96	645.110	1.24	
BT20-3 ◎		215.44	2253	0.102		0.102	⊙ 600	1.20	0.75	0.213	647.36	645.037	1.72	To MPS-01
			246				HDPE				649.68	648.467	1.00	
BT21 ◎	4.27	4.27	246	0.002		0.002	⊙ 225	3.90	0.65	0.021	647.36	646.147	1.00	To MPS-01
			537				HDPE				647.36	646.019	1.00	From MPS-01
BT22-1 ◎		219.71	2789	0.104		0.104	⊙ 355		Force Main		658.67	657.330	1.00	
			167				GRP				658.67	654.864	3.20	
BT22-2 ◎		219.71	2956	0.104		0.104	⊙ 600	1.20	0.75	0.213	650.92	649.312	1.00	To BT25
			458				HDPE				668.29	666.273	1.80	
BT23 ◎	7.12	7.12	458	0.003		0.003	⊙ 225	3.90	0.65	0.021	651.37	650.157	1.00	
			188				HDPE				651.37	650.137	1.02	
BT24 ◎	0.96	8.08	645	0.004		0.004	⊙ 225	3.90	0.65	0.021	650.92	649.366	1.34	
			191				GRP				650.92	648.867	1.34	From BT22-2 and BT24
BT25 ◎	7.21	235.00	3147	0.111		0.111	⊙ 700	1.00	0.76	0.293	646.67	644.961	1.00	To STP

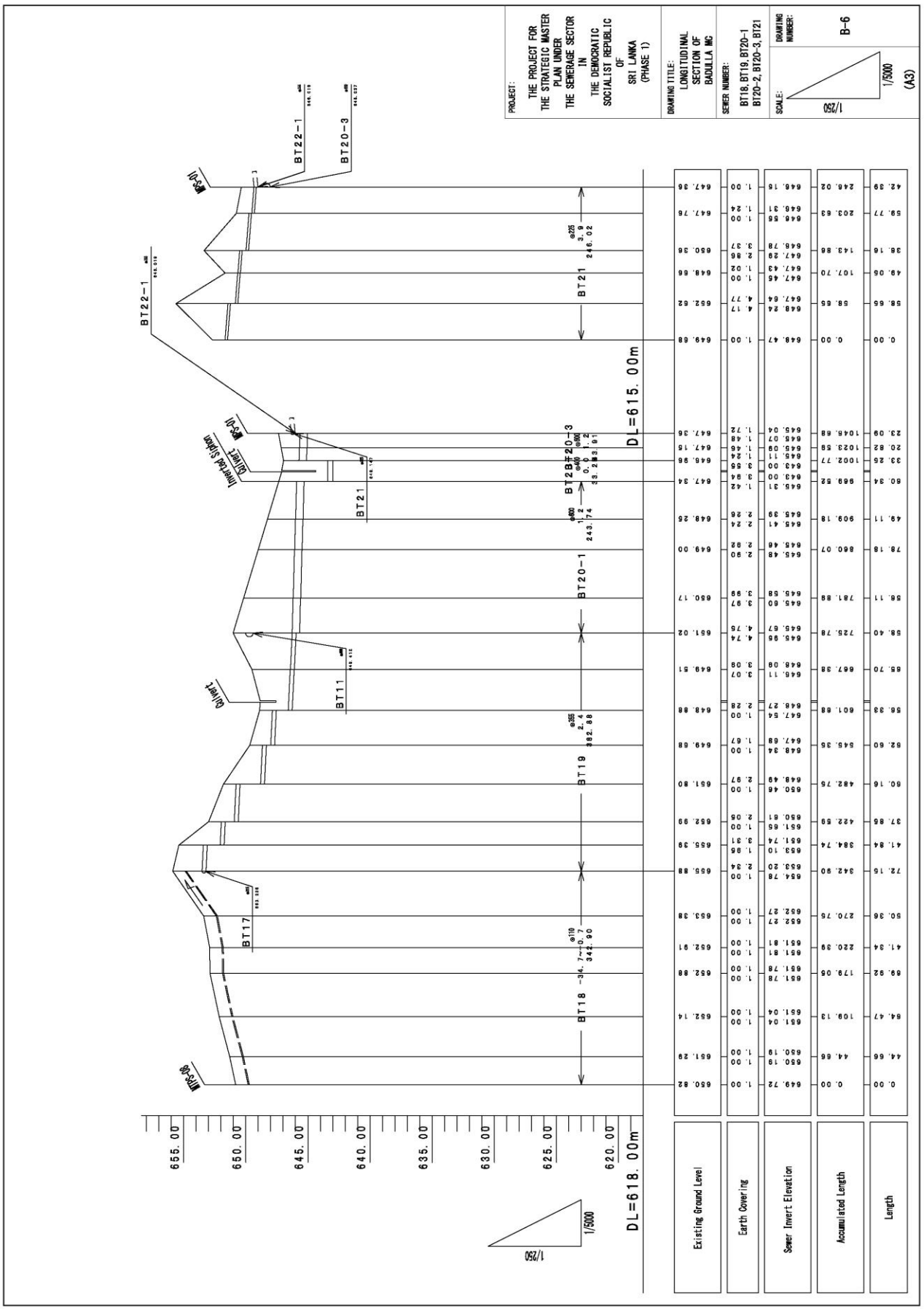

PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF BADULLA MC
SEWER NUMBER:
BT01-1, BT01-2, BT02-1
BT02-2, BT03-1, BT03-2
SCALE:
1/250
1/5000
DRAWING NUMBER:
B-1
(A3)
BT05
BT04-2
BT01-2
BT03-2
BT03-1
BT02-2
BT02-1
BT01-2
BT01-1
MTR-02
Culvert
MTR-01
DL=625.00m
DL=627.00m
665.00
660.00
655.00
650.00
645.00
640.00
635.00
630.00
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length

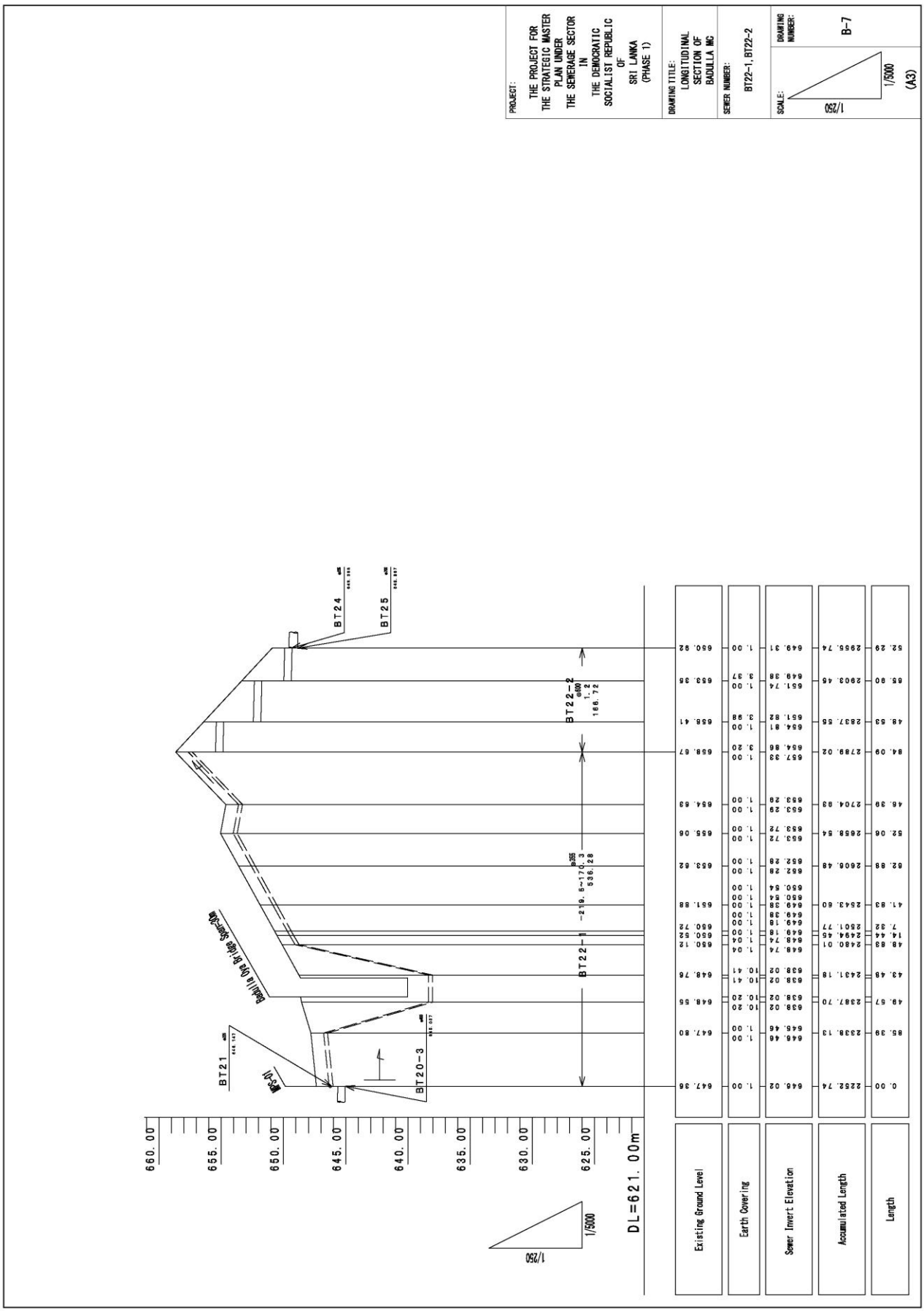

PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF BADULLA MC
SEWER NUMBER:
BT04-1, BT04-2 BT05, BT06
SCALE:
1/250
1/5000
(A3)
DRAWING NUMBER:
B-2
BT10
BT09
BT06
BT05
BT04-2
BT04-1
BT03-2
BT03-1
DL=627.00m
DL=625.00m
665.00
660.00
655.00
650.00
645.00
640.00
635.00
630.00
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length

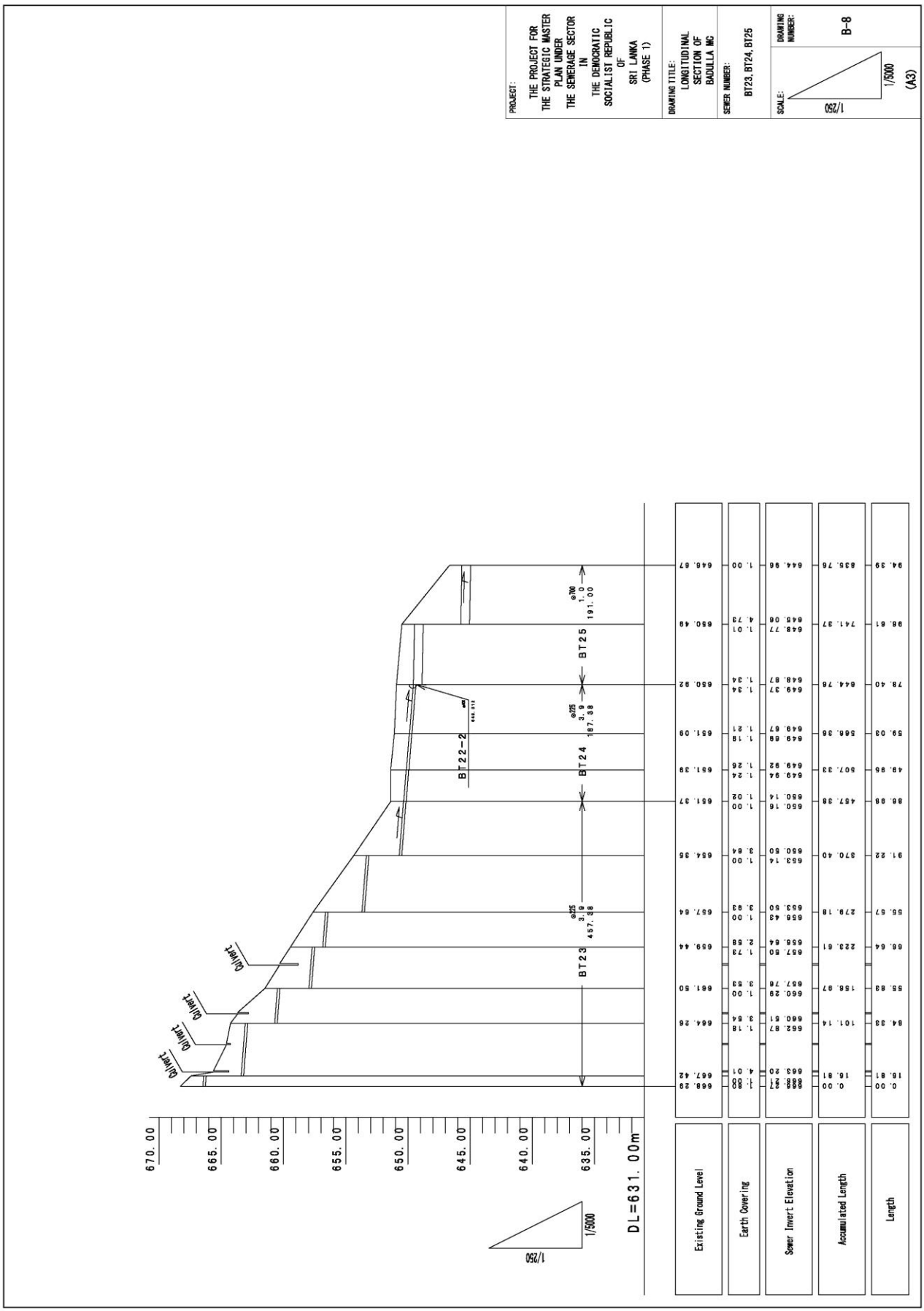

PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE: LONGITUDINAL SECTION OF BADULLA MC
SEWER NUMBER: BT07, BT08, BT09
SCALE: 1/5000 1/250 (A3)
DRAWING NUMBER: B-3
BT06
BT10
BT09
BT08
BT07
Culvert
655.00
650.00
645.00
640.00
635.00
630.00
625.00
620.00
DL=619.00m
1/5000
1/250
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length


PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF BADULLA MC
SEWER NUMBER:
BT10, BT11, BT12, BT13
BT14-1, BT14-2
SCALE:
1/250
1/5000
(A3)
DRAWING NUMBER:
B-4
BT16-2
BT17
BT15
BT14-2
BT14-1
BT16-1
BT16-2
BT13
BT12
BT20-1
BT19
BT11
BT06
BT09
BT10
DL=620.00m
660.00
655.00
650.00
645.00
640.00
635.00
630.00
625.00
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length


PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF BADULLA MC
SEWER NUMBER:
BT15, BT16-1
BT16-2, BT17
SCALE:
1/250
1/5000
(A3)
DRAWING NUMBER:
B-5
BT18
BT19
BT13
BT14-2
BT16-2
BT16-1
BT17
BT14-2
BT14-1
BT15
MH5-07
DL=622.00m
DL=619.00m
655.00
650.00
645.00
640.00
635.00
630.00
625.00
620.00
1/250
1/5000
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length


PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE: LONGITUDINAL SECTION OF BADULLA MC
SEWER NUMBER: BT18, BT19, BT20-1 BT20-2, BT20-3, BT21
SCALE: 1/5000 (A3) 1/250
DRAWING NUMBER: B-6
DL=615.00m
DL=618.00m
Inverted Siphon
Drop Manhole
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length


PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF BADULLA MC
SEWER NUMBER:
BT22-1, BT22-2
SCALE:
1/250
1/5000
(A3)
DRAWING NUMBER:
B-7
BT24
BT25
BT22-2
BT22-1
BT20-3
BT21
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length
660.00
655.00
650.00
645.00
640.00
635.00
630.00
625.00
DL=621.00m
1/250
1/5000


PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF BADULLA MC
SEWER NUMBER:
BT23, BT24, BT25
SCALE:
1/250
1/5000
(A3)
DRAWING NUMBER:
B-8
BT23
BT24
BT22-2
BT25
DL=631.00m
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length

APPENDIX 4: Draft Amendment of Tolerance Discharge Limits

Schedule III

Tolerance limit values for the discharge of wastewaters or effluents (industrial / domestic) from a prescribed activity into the inland surface waters

No.	*Parameter*	*Unit, type of limit*	*Tolerance limit values for Inland surface waters*
1.	Total suspended solids	mg/1, max.	50
2.	Total dissolved solids	mg/1, max.	1000
3.	pH at ambient temperature	-	6.0 – 8.5
4.	Biochemical oxygen demand (BOD_5 in 5 days at 20^0 C)	mg/1,max.	30
5.	Temperature at the point of discharge	^{0}C, max.	Ambient water temperature ± 5 or 40 whichever is lesser
6.	Oils and greases	mg/1,max.	10
7.	Phenols (as C_6H_5OH)	mg/1,max.	1.0
8.	Chemical oxygen demand (COD)	mg/1,max.	250
9.	Colour (Maximum spectral absorption coefficient)	Wave length range 436 nm, (Yellow range) 525 nm, (Red range) 620 nm, (blue range)	 $7m^{-1}$ $5m^{-1}$ $3m^{-1}$
10.	Dissolved phosphates (as P)	mg/1,max.	5

11.	Total Kjeldhal nitrogen (as N)	mg/1,max.	150
12.	Ammoniacal nitrogen (as N)	mg/1,max.	50
13.	Nitrate (as N)	mg/1,max.	10
14.	Cyanide (as CN)	mg/1,max.	0.05
15.	Total residual chlorine (as Cl_2)	mg/1,max.	0.5
16.	Chlorides (as Cl)	mg/1,max.	400
17.	Fluorides (as F)	mg/1,max.	2.0
18.	Sulphides (as S)	mg/1,max.	0.5
19.	Arsenic, total (as As)	mg/1,max.	0.05
20.	Cadmium, total (as Cd)	mg/1,max.	0.03
21.	Chromium, total (as Cr)	mg/1,max.	0.05
22.	Chromium, hexavalent (as Cr^{6+})	mg/1,max.	0.01
23.	Copper, total (as Cu)	mg/1,max.	0.05
24.	Iron, total (as Fe)	mg/1,max.	3.0
25.	Lead, total (as Pb)	mg/1,max.	0.05
26.	Mercury, total (as Hg)	mg/1,max.	0.001
27.	Nickel, total (as Ni)	mg/1,max.	0.2
28.	Selenium, total(as Se)	mg/1,max.	0.05
29.	Zinc, total (as Zn)	mg/1,max.	2.0
30.	Silver, total (as Ag)	mg/1,max.	0.035
31.	Pesticides (Total)	mg/1,max.	0.005
32.	Surfactants (Total)	mg/l, max.	5.0
33.	Faecal coliform	MPN/100ml, max.	150

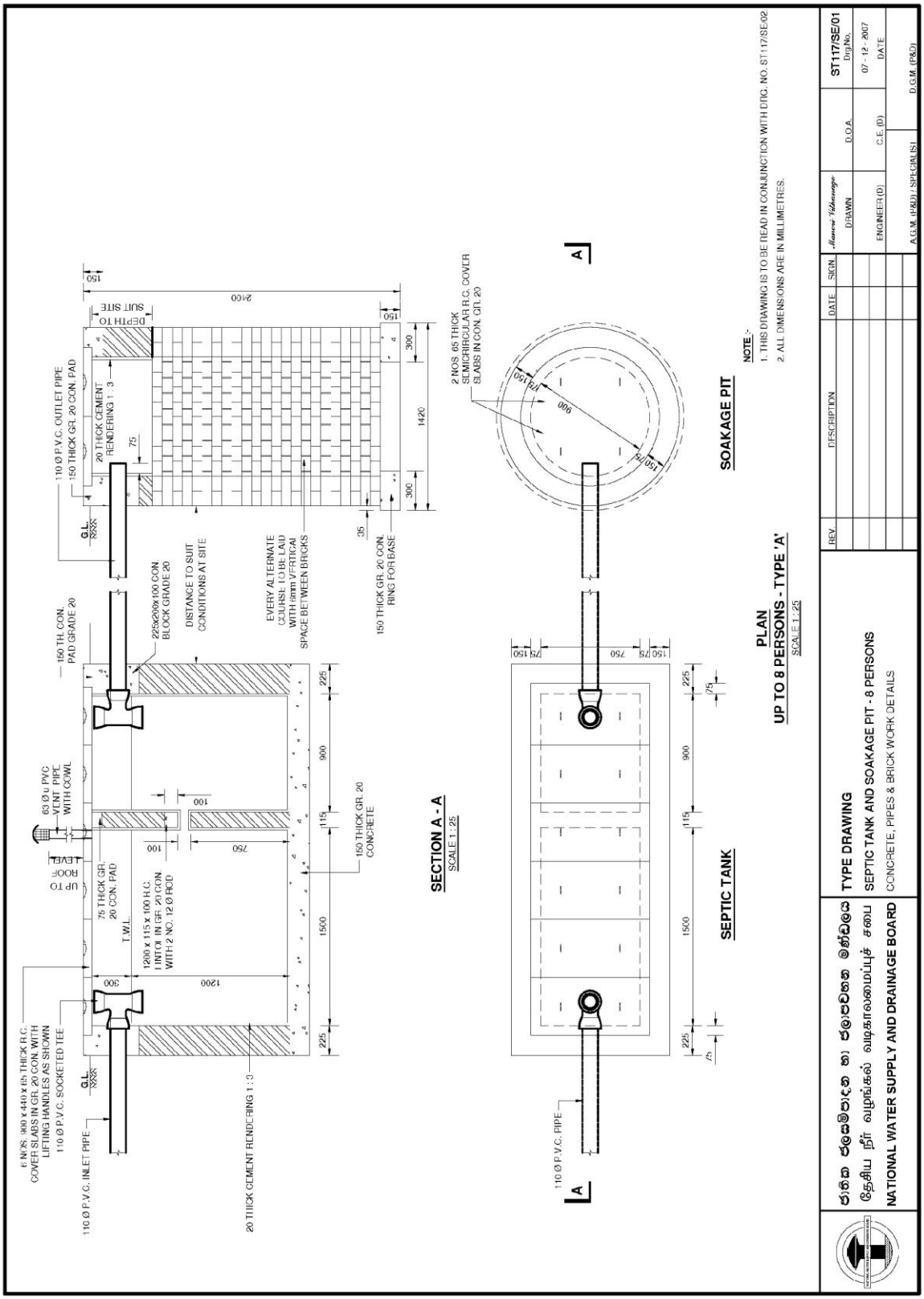
		mg/l, max.	250
34.	Sulphates (as S)		
35.	Radio Active Material:		
	(a) Alpha emitters	micro curie/ml, max	10^{-8}
	(b) Beta emitters	micro curie/ml, max	10^{-7}

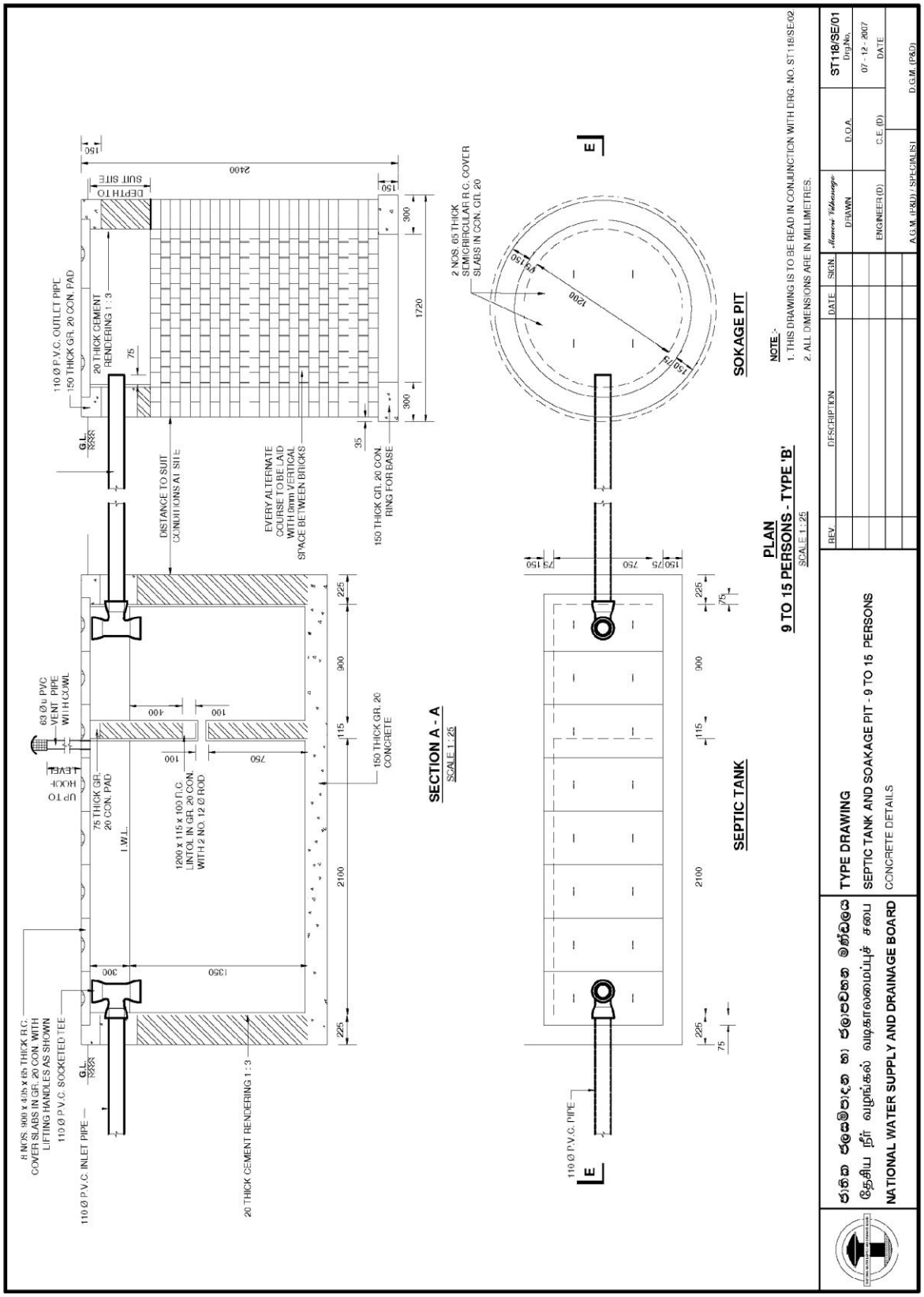
Note 1: All efforts should be made to remove unpleasant odour as practicable as possible.

Note 2: These limit values are based on the premise that for inland surface water the dilution factor may be at least 1:8. In an event where the dilution factor is found to be less, the limit values in the Schedule should be adjusted on a proportional basis so as to give rise to more stringent limit values.

Note 3: The above mentioned general standards and criteria should cease to apply with regard to a particular industry when industry specific standards and criteria are stipulated for that industry.

APPENDIX 5: General Layout of Septic Tank




SECTION A - A
SCALE 1 : 25
PLAN
9 TO 15 PERSONS - TYPE 'B'
SCALE 1 : 25
SOKAGE PIT
SEPTIC TANK
NOTE :-
1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH DRG. NO. ST118/SE/02
2. ALL DIMENSIONS ARE IN MILLIMETRES.
TYPE DRAWING
SEPTIC TANK AND SOAKAGE PIT - 9 TO 15 PERSONS
CONCRETE DETAILS
NATIONAL WATER SUPPLY AND DRAINAGE BOARD
ST118/SE/01
07 - 12 - 2007
D.G.M. (P&D)

APPENDIX 6:Detail of Project Costs and Annual Fund Requirement

1USD=	145	LKR	
1USD=	112	YEN	
1LKR	0.770	YEN	

Badulla Master Plan Area = 235 ha

	Item Description	Spec	Unit	Quantity	Unit Price		Amount		Total Amount	Total Amount
					L.C.	F.C.	L.C.	F.C.		
					LKR	JPY	LKR	JPY	LKR	JPY
1	**Construction Cost**									
A	**STP**									
A1	**STP**									
	Badulla STP (Q=4,000m3/day)	About 2400 USD/m3	Ls	1			558,545,455	645,120,000	1,396,363,636	1,075,200,000
	Sub-total of A						**558,545,455**	**645,120,000**	**1,396,363,636**	**1,075,200,000**
B										
B1	**Trunk Sewer**									
	Supply and install of HDPE OD225	Depth : not exceeding 1.5m	m	633	2,800	3,800	1,773,000	2,407,000	4,899,000	3,772,000
	Supply and install of HDPE OD225	Depth : not exceeding 2.0m	m	192	3,900	4,200	750,000	807,000	1,798,000	1,385,000
	Supply and install of HDPE OD225	Depth : not exceeding 2.5m	m	263	4,400	4,200	1,155,000	1,103,000	2,587,000	1,992,000
	Supply and install of HDPE OD225	Depth : not exceeding 3.0m	m	361	5,400	4,500	1,950,000	1,625,000	4,060,000	3,127,000
	Supply and install of HDPE OD225	Depth : not exceeding 3.5m	m	158	5,500	4,500	869,000	711,000	1,792,000	1,380,000
	Supply and install of HDPE OD225	Depth : not exceeding 4.0m	m	336	6,400	4,800	2,153,000	1,615,000	4,250,000	3,273,000
	Supply and install of HDPE OD225	Depth : not exceeding 4.5m	m	143	6,500	4,800	929,000	686,000	1,820,000	1,401,000
	Supply and install of HDPE OD315	Depth : not exceeding 2.0m	m	85	4,100	7,200	348,000	611,000	1,142,000	879,000
	Supply and install of HDPE OD315	Depth : not exceeding 2.5m	m	127	4,400	7,200	561,000	917,000	1,752,000	1,349,000
	Supply and install of HDPE OD315	Depth : not exceeding 3.0m	m	294	5,400	7,600	1,587,000	2,233,000	4,487,000	3,455,000
	Supply and install of HDPE OD315	Depth : not exceeding 3.5m	m	547	5,400	7,600	2,951,000	4,154,000	8,346,000	6,426,000
	Supply and install of HDPE OD355	Depth : not exceeding 1.5m	m	264	3,100	8,700	818,000	2,296,000	3,800,000	2,926,000
	Supply and install of HDPE OD355	Depth : not exceeding 2.0m	m	56	4,200	9,000	237,000	507,000	895,000	689,000
	Supply and install of HDPE OD355	Depth : not exceeding 2.5m	m	172	4,400	9,000	758,000	1,550,000	2,771,000	2,134,000
	Supply and install of HDPE OD355	Depth : not exceeding 3.0m	m	63	5,400	9,300	338,000	582,000	1,094,000	842,000
	Supply and install of HDPE OD355	Depth : not exceeding 3.5m	m	104	5,400	9,300	559,000	963,000	1,810,000	1,393,000
	Supply and install of HDPE OD355	Depth : not exceeding 4.0m	m	67	6,400	9,600	431,000	647,000	1,271,000	979,000
	Supply and install of GRP/FRP ND400	Depth : not exceeding 1.5m	m	393	3,800	22,700	1,492,000	8,913,000	13,067,000	10,062,000
	Supply and install of GRP/FRP ND400	Depth : not exceeding 2.0m	m	56	4,900	23,000	276,000	1,294,000	1,957,000	1,507,000
	Supply and install of GRP/FRP ND400	Depth : not exceeding 2.5m	m	115	7,300	23,000	840,000	2,646,000	4,276,000	3,293,000
	Supply and install of GRP/FRP ND450	Depth : not exceeding 2.5m	m	35	9,300	28,800	328,000	1,016,000	1,647,000	1,269,000
	Supply and install of GRP/FRP ND450	Depth : not exceeding 4.0m	m	70	12,700	29,600	884,000	2,061,000	3,561,000	2,742,000
	Supply and install of GRP/FRP ND500	Depth : not exceeding 2.0m	m	66	7,400	28,800	486,000	1,892,000	2,943,000	2,266,000
	Supply and install of GRP/FRP ND500	Depth : not exceeding 2.5m	m	119	8,000	28,800	951,000	3,424,000	5,398,000	4,156,000
	Supply and install of GRP/FRP ND600	Depth : not exceeding 1.5m	m	227	6,400	34,000	1,454,000	7,726,000	11,488,000	8,846,000
	Supply and install of GRP/FRP ND600	Depth : not exceeding 2.0m	m	87	7,800	34,500	682,000	3,015,000	4,598,000	3,540,000
	Supply and install of GRP/FRP ND600	Depth : not exceeding 2.5m	m	60	12,000	34,500	724,000	2,082,000	3,428,000	2,639,000
	Supply and install of GRP/FRP ND600	Depth : not exceeding 3.0m	m	49	13,700	34,900	673,000	1,714,000	2,899,000	2,232,000
	Supply and install of GRP/FRP ND600	Depth : not exceeding 3.5m	m	101	14,000	34,900	1,411,000	3,519,000	5,981,000	4,605,000
	Supply and install of GRP/FRP ND600	Depth : not exceeding 4.0m	m	144	15,700	35,300	2,262,000	5,086,000	8,867,000	6,828,000
	Supply and install of GRP/FRP ND700	Depth : not exceeding 1.5m	m	97	8,200	42,400	792,000	4,096,000	6,111,000	4,706,000
	Supply and install of HDPE OD110	Depth : not exceeding 1.5m	m	1,539	600	1,000	923,000	1,539,000	2,922,000	2,250,000
	Supply and install of HDPE OD125	Depth : not exceeding 1.5m	m	150	600	1,200	90,000	180,000	324,000	249,000
	Supply and install of HDPE OD125	Depth : not exceeding 3.5m	m	24	1,800	1,200	44,000	29,000	82,000	63,000
	Supply and install of HDPE OD160	Depth : not exceeding 1.5m	m	645	800	2,000	516,000	1,291,000	2,193,000	1,688,000
	Supply and install of HDPE OD160	Depth : not exceeding 3.5m	m	13	1,700	2,000	23,000	27,000	58,000	45,000
	Supply and install of HDPE OD355	Depth : not exceeding 1.5m	m	394	1,200	10,000	473,000	3,944,000	5,595,000	4,308,000
	Supply and install of HDPE OD400	Depth : not exceeding 4.0m	m	33	1,800	12,800	60,000	426,000	613,000	472,000
	Supply and install of HDPE OD225(PJ)	Depth : not exceeding 10m	m	121	30,700	233,849	3,705,000	28,223,000	40,358,000	31,076,000
	Supply and install of HDPE OD355(PJ)	Depth : not exceeding 10m	m	58	32,000	254,100	1,869,000	14,839,000	21,140,000	16,278,000
	Supply and install of GRP/FRP ND400(PJ)	Depth : not exceeding 10m	m	119	35,600	275,814	4,235,000	32,811,000	46,847,000	36,072,000
	Supply and install of GRP/FRP ND600(PJ)	Depth : not exceeding 10m	m	56	38,500	379,302	2,160,000	21,283,000	29,800,000	22,946,000
	Supply and install of GRP/FRP ND700(PJ)	Depth : not exceeding 10m	m	94	40,600	479,710	3,832,000	45,280,000	62,637,000	48,231,000
	Supply and install of HDPE OD355(PJ)	Depth : not exceeding 10m	m	142	32,000	254,100	4,540,000	36,052,000	51,361,000	39,548,000
	Temporary road reinstatementAsphalt concete	Add 10% of pipeline(W=1.2)	m2	11,715	2,000	0	23,430,000	0	23,430,000	18,041,000
	Permanent road reinstatementAsphalt concete	Add 10% of pipeline(W=1.2)	m2	11,715	4,910	0	57,520,000	0	57,520,000	44,290,000
B2	**Pump Station**									
	Manhole Type Pumping Station		pc	8	22,000,000	0	176,000,000	0	176,000,000	135,520,000
	Major Pumping Station		pc	1	570,000,000	0	570,000,000	0	570,000,000	438,900,000
	Sub-total of B						**880,842,000**	**257,822,000**	**1,215,675,000**	**936,070,000**
C	**Branch Sewer**									
C1										
	Supply and install of HDPE OD225	Depth : not exceeding 2.5m	m	35,250	4,400	4,200	155,100,000	148,050,000	347,373,000	267,477,000
	Temporary road reinstatementAsphalt concete	Add 10% of pipeline(W=1.2)	m2	46,530	2,000	0	93,060,000	0	93,060,000	71,656,000
	Permanent road reinstatementAsphalt concete	Add 10% of pipeline(W=1.2)	m2	46,530	4,910	0	228,462,000	0	228,462,000	175,916,000
	Manhole Type Pump		pc	2	1,000,000	6,930,000	2,000,000	13,860,000	20,000,000	15,400,000
	Sub-total of C						**478,622,000**	**161,910,000**	**688,895,000**	**530,449,000**
D	**House Connection**									
D1										
	House Connection		HH	5,800	100,000	0	580,000,000	0	580,000,000	446,600,000
	Sub-total of D						**580,000,000**	**0**	**580,000,000**	**446,600,000**
	Sub-total of 1						**2,498,009,455**	**1,064,852,000**	**3,880,933,636**	**2,988,319,000**
2	Administration cost						303,000,000	0	303,000,000	233,310,000
3	Consulting cost						378,000,000	701,000,000	1,288,390,000	992,060,000
4	Physical contingency for construction cost						152,000,000	58,000,000	227,325,000	175,040,000
5	Price escalation for construction cost						540,000,000	92,000,000	659,481,000	507,800,000
6	Land acquisition and compensation									
7	Interest during construction						0	31,000,000	40,260,000	31,000,000
8	Front-end Fee						0	9,000,000	11,688,000	9,000,000
9	Tax and duty						1,082,000,000	0	1,082,000,000	833,140,000
	Sub-total of (2-9)						**2,455,000,000**	**891,000,000**	**3,612,143,000**	**2,781,350,000**
	Total including Tax and Duty						**4,953,009,455**	**1,955,852,000**	**7,493,077,000**	**5,769,669,000**
	Total excluding Tax and Duty						**3,871,009,455**	**1,955,852,000**	**6,411,077,000**	**4,936,529,000**
	Eligible Portion (1, 3, 4, 5 and 7)						**3,568,009,455**	**1,946,852,000**	**6,096,389,000**	**4,694,219,000**
	Non-Eligible Portion (2, 6, 8 and 9)						**1,385,000,000**	**9,000,000**	**1,396,688,000**	**1,075,450,000**

APPENDIX 7: Detail of Annual Fund Requirement

Annual Fund Requirement of Badulla MC

Base Year for Cost Estimation: Jan, 2017 — FC & Total: million JPY
Exchange Rates: LKR = JPY 0.77 — LC : million LKR
Price Escalation: FC: 1.6% LC: 3.8%
Physical Contingency: 5%
Physical Contingency for Consultant: 5%

Annual Fund Requirement of Badulla MC

Item	Total			2017			2018			2019			2020		
	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
A. ELIGIBLE PORTION															
Ⅰ) Procurement / Construction	1,215	3,189	3,671	0	0	0	0	0	0	0	0	0	0	0	0
STP	645	559	1,075	0	0	0	0	0	0	0	0	0	0	0	0
Trunk Sewer	258	881	936	0	0	0	0	0	0	0	0	0	0	0	0
Branch Sewer	162	479	530	0	0	0	0	0	0	0	0	0	0	0	0
House Connection	0	580	447	0	0	0	0	0	0	0	0	0	0	0	0
Base cost for JICA financing	1,065	2,498	2,988	0	0	0	0	0	0	0	0	0	0	0	0
Price escalation	92	540	508	0	0	0	0	0	0	0	0	0	0	0	0
Physical contingency	58	152	175	0	0	0	0	0	0	0	0	0	0	0	0
Ⅱ) Consulting services	701	378	992	0	0	0	0	0	0	187	83	251	165	65	215
Base cost	629	309	867	0	0	0	0	0	0	173	73	229	150	55	192
Price escalation	39	51	78	0	0	0	0	0	0	6	6	10	7	7	12
Physical contingency	33	18	47	0	0	0	0	0	0	9	4	12	8	3	10
Total (Ⅰ + Ⅱ)	1,916	3,567	4,663	0	0	0	0	0	0	187	83	251	165	65	215
B. NON ELIGIBLE PORTION															
a Procurement / Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Base cost for JICA financing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Price escalation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Physical contingency	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
b Land Acquisition	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Base cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Price escalation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Physical contingency	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
c Administration cost	0	303	233	0	0	0	0	0	0	0	16	13	0	14	11
d VAT	0	908	699	0	0	0	0	0	0	0	49	38	0	42	32
e Import Tax	0	174	134	0	0	0	0	0	0	0	17	13	0	15	12
Total (a+b+c+d+e)	0	1,385	1,067	0	0	0	0	0	0	0	82	63	0	71	54
TOTAL (A+B)	1,916	4,953	5,730	0	0	0	0	0	0	187	165	314	165	135	269
C. Interest during Construction	31	0	31	0	0	0	0	0	0	0	0	0	0	0	0
Interest during Construction(Const.)	30	0	30	0	0	0	0	0	0	0	0	0	0	0	0
Interest during Construction (Consul.)	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
D. Front End Fee	9	0	9	0	0	0	0	0	0	9	0	9	0	0	0
GRAND TOTAL (A+B+C+D)	1,957	4,953	5,770	0	0	0	0	0	0	197	165	324	165	135	269
E. JICA finance portion incl. IDC (A + C)	1,947	3,567	4,694	0	0	0	0	0	0	187	83	251	165	65	215

Item	2021			2022			2023			2024			2025			2026			2027		
	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
A. ELIGIBLE PORTION																					
Ⅰ) Procurement / Construction	274	700	813	436	1,138	1,312	443	1,181	1,352	62	170	194	0	0	0	0	0	0	0	0	0
STP	148	128	247	232	201	387	232	201	387	32	28	54	0	0	0	0	0	0	0	0	0
Trunk Sewer	59	203	215	93	317	337	93	317	337	13	44	47	0	0	0	0	0	0	0	0	0
Branch Sewer	37	110	122	58	172	191	58	172	191	8	24	27	0	0	0	0	0	0	0	0	0
House Connection	0	133	103	0	209	161	0	209	161	0	29	22	0	0	0	0	0	0	0	0	0
Base cost for JICA financing	245	575	687	383	899	1,076	383	899	1,076	53	125	149	0	0	0	0	0	0	0	0	0
Price escalation	16	92	87	32	184	174	38	226	212	6	37	35	0	0	0	0	0	0	0	0	0
Physical contingency	13	33	39	21	54	62	21	56	64	3	8	9	0	0	0	0	0	0	0	0	0
Ⅱ) Consulting services	95	51	134	105	79	166	149	100	226	0	0	0	0	0	0	0	0	0	0	0	0
Base cost	85	42	117	92	63	141	129	76	188	0	0	0	0	0	0	0	0	0	0	0	0
Price escalation	6	7	11	8	13	18	13	19	28	0	0	0	0	0	0	0	0	0	0	0	0
Physical contingency	5	2	6	5	4	8	7	5	11	0	0	0	0	0	0	0	0	0	0	0	0
Total (Ⅰ + Ⅱ)	369	751	947	541	1,217	1,478	592	1,281	1,578	62	170	194	0	0	0	0	0	0	0	0	0
B. NON ELIGIBLE PORTION																					
a Procurement / Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Base cost for JICA financing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Price escalation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Physical contingency	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
b Land Acquisition	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Base cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Price escalation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Physical contingency	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
c Administration cost	0	62	47	0	96	74	0	102	79	0	13	10	0	0	0	0	0	0	0	0	0
d VAT	0	185	142	0	288	222	0	307	237	0	38	29	0	0	0	0	0	0	0	0	0
e Import Tax	0	34	26	0	49	38	0	54	41	0	6	4	0	0	0	0	0	0	0	0	0
Total (a+b+c+d+e)	0	280	215	0	433	333	0	464	357	0	56	43	0	0	0	0	0	0	0	0	0
TOTAL (A+B)	369	1,031	1,163	541	1,650	1,811	592	1,745	1,935	62	226	237	0	0	0	0	0	0	0	0	0
C. Interest during Construction	2	0	2	6	0	6	11	0	11	11	0	11	0	0	0	0	0	0	0	0	0
Interest during Construction(Const.)	2	0	2	6	0	6	10	0	10	11	0	11	0	0	0	0	0	0	0	0	0
Interest during Construction (Consul.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D. Front End Fee	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GRAND TOTAL (A+B+C+D)	371	1,031	1,165	547	1,650	1,818	602	1,745	1,946	74	226	248	0	0	0	0	0	0	0	0	0
E. JICA finance portion incl. IDC (A + C)	371	751	950	547	1,217	1,484	602	1,281	1,589	74	170	205	0	0	0	0	0	0	0	0	0

APPENDIX 8: Breakdown of Operating Expenditure

Moratuwa Ratmalana - 8119

Type of Expenditure	Moratuwa Ratmalana WWTP	Moratuwa Ratmalana Distribution Network	Moratuwa (Soysapura)	Total
Salary			21,586,000.00	21,586,000.00
Utility Cost	9,460,008.00	3,300,000.00	103,000.00	12,863,008.00
Chemical Cost	383,000.00	-		383,000.00
Repair and Maintanance Cost	810,050.00	142,950.00	1,271,000.00	2,224,000.00
Establishment Cost	862,000.00	-	1,115,000.00	1,977,000.00
Security and Rent Cost	1,162,000.00	2,324,000.00	1,121,000.00	4,607,000.00
Total	**12,677,058.00**	**5,766,950.00**	**25,196,000.00**	**43,640,008.00**

Soysapura — Treatment Plant and Network
Present, Inflow, 5000m3/d (RS/m3/d/year) — 39.13 LKR/m3/day
Capacity, 17000m3/d (RS/m3/d/year)

			Total Amount (LKR)
Sri Jayawardanapura Kotte MC	35000	m3/d -> 35000 x 39.13 x 365 =	499,876,455
Anuradhapura MC	14000	m3/d -> 1400 x 39.13 x 365 =	199,950,582
Badulla MC	4000	m3/d -> 4000 x 39.13 x 365 =	57,128,738
Nuwara Eliya MC	4700	m3/d -> 4700 x 39.13 x 365 =	67,126,267
Dehiwala-Mt Lavinia MC	20000	m3/d -> 20000 x 39.13 x 365 =	285,643,689

APPENDIX 9: Regulations and Organizations Related to ESC

In Sri Lanka, various environmental legislations and standards are in force pertaining to wastewater collection, treatment, and disposal practices in order to safeguard the environment. It should be noted that many number of statutes exist which deal with this subject directly or indirectly. The most important legislations and standards are;

- National Environmental Act No. 47 of 1980 and No. 56 of 1988 and its amendments
- Tolerance limits for the discharge of industrial waste in to inland surface waters
- Tolerance limits for industrial effluents discharged on land for irrigation purpose
- Tolerance limits for industrial and domestic effluents discharged into marine coastal areas
- Tolerance limits for discharge of effluents into public sewers with central treatment plants
- Hazardous Waste Disposal
- Air Quality and Offensive Odor
- Noise and Vibration
- Marine Pollution Prevention Act no 59 of 1981
- Coast Conservation Act No. 57 of 1981 amended by Act No 64 of 1988 and its amendments
- Flood Protection Ordinance No 4 of 1924
- Land development Ordinance of 1935
- Nuisance Ordinance No. 15 of 1862 as amended by act No 57 of 1946
- State Land Ordinance No 8 of 1947
- Soil Conservation Act No 25 of 1951
- Urban Development Authority Law No 41 of 1978
- Mahaweli Authority of Sri Lanka Act No 23 of 1979
- Municipal Councils Ordinance No 29 of 1947 amended by act no 61 of 1981
- Fauna and Flora Protection Ordinance No 2 of 1987
- Agrarian Services Act No 58 of 1979 amended by Act No. 4 of 1991
- Irrigation Ordinance No 32 of 1946, amended by No 48 of 1968 and by No 13 of 1994
- Forest Ordinance No 16 of 1907 as amended by Act No 23 of 1995

1.1 Approvals Required for a Sewerage Project

The proposed Project and each of its subprojects will be in full concurrence with legal requirements of the relevant Government Ministries and agencies.

Central Environmental Authority (CEA)
Approval of CEA under EIA regulations is required for the implementation of any "Prescribed Project" and valid Environmental Protection License (EPL) is required to discharge effluents in to the environment.

Coast Conservation and Coastal Resources Management Department (CC&CRMD - Commonly known as CCD)
Approval of the Director General of CC&CRMD is required for any development activity to be carried out within the Coastal Zone as defined under Coast Conservation Act.

Local Authority (LA) (Municipal Councils, Urban Councils or Pradeshiya Sabha)
To carryout construction activities of the project, the approval of relevant Local Authority must be obtained.

Mahaweli Authority of Sri Lanka (MASL)
As the responsible agency for Mahaweli River, the MASL has been vested with the authority of granting permission for development works in the Mahaweli River and its reservation. Moreover, MASL is also a Project Approving Agency Gazette under the NEA.

Road Development Authority (RDA), Provincial Road Development Authority (PRDA)
If the project activities require to lay pipelines along provincial or national roads, the approval of PRDA or RDA is required.

Department of Archaeology

It is the state agency responsible for conservation of archaeological artefacts and structures of historical interest whether lying or hidden beneath the surface of the ground or in any water/lake. Any development project on such land will have to be permitted by the Director General of Archaeology.

The Forest Department
The Forest Department in its role as statutory custodian of state forests and lands and the plantation of new forests, has been vested with powers so as to not granting permission for any development activity within any land declared, proposed or defined under the Forest Ordinance.

The Department of Wild Life Conservation
The Department of Wild Life Conservation has been vested with the powers as to not grant permission for development projects which are proposed to be located within, or within a 1 mile radius of National Reserves declared under the Fauna and Flora Protection Ordinance without carrying out EIA.

Department of Agrarian Development
Filling of any paddy cultivation land is envisaged for the construction of sewerage treatment plants, laying of pipelines or related structures, approval of the Department, of Agrarian Development is required.

Urban Development Authority (UDA)
If the development activities of the proposed project are within an area declared under UDA law, approval of UDA is required.

1.2 EIA Procedure Under NEA

Environmental Impact Assessment (EIA) is the general process of finding the impacts on natural and social environments and proposing preventive or minimising measures to enhance positive impacts. The broader legal framework for the EIA process in Sri Lanka was laid down by the amendments made to NEA in 1988 through the National Environmental (Amendment) Act No. 56 of 1988. The provision relating to EIA is contained in Part IV C of the National Environmental Act. Regulations pertaining to this process are published in Government Gazette Extraordinary No.772/72 dated 24th June 1993 and in several subsequent amendments. The procedure stipulated in the Act for the approval of projects provides for the submission of two types of reports: Initial Environmental Examination (IEE) report or EIA report. Such reports are required in respect of "prescribed projects" included in EIA regulations.

The EIA process is implemented through designated Project Approving Agencies (PAAs). A list of line ministries and agencies that are designated as PAAs is depicted in Government Gazette (Extra Ordinary) No. 859/14 dated February 13, 1995. The PAA's are basically responsible for the administration of the EIA process under NEA, which includes but not limited to:

- Subject all prescribed projects to IEE/EIA requirements
- Ensure and guide proper scoping process for IEEs/EIAs
- Draft Term of Reference (ToR) for IEEs/EIAs
- Establish, conduct and participate in Technical Evaluation and reviews during and after IEE/EIA report preparation
- Ensure public notification of availability of EIA for public review
- Evaluate the comments received from the public and other agencies
- Establish appropriate mitigatory measures and ensure that they are incorporated in the approval conditions
- Ensure implementation of the conditions through effective monitoring
- Obtain concurrence of the CEA prior to taking decision on the EIA report.

In order to obtain environmental approval for a prescribed project, the project proponent should submit either an IEE report or an EIA report as required by the PAA. Determination of whether an IEE or EIA is required for a proposed prescribed project is based on an assessment of the likely significance of the impacts of the proposed project on the environment. EIAs, rather than IEEs, are required for prescribed projects that are likely to have significant impacts. Determination of Significance is based on the consideration of both context and intensity of the potential impacts.

In the event that an EIA is required, the PAA in consultation with CEA is responsible for subjecting the preliminary information submitted by the project proponent to environmental scoping, in order to set the Terms of Reference (TOR) for the EIA within 30 days from the date of acknowledging receipt of the preliminary information. The TOR is prepared by a scoping committee comprising experts in the relevant field, appointed by the PAA. In developing the TOR, the EIA regulations provide for the PAA to consider the views of state agencies and the public.

Upon submission of the EIA report by the project proponent, the PAA is required to determine whether issues referred to in the TOR have been addressed and notify the proponent of any inadequacies within 14 days. In the event any inadequacies are identified, the project proponent is required to make necessary amendments and resubmit the report. Once accepted, in addition to the EIA being forwarded to the CEA by the PAA, notice is also placed in a national newspaper published daily in Sinhala, Tamil and English languages inviting the public to make written comments, if any, to the PAA within 30 days from the date of first appearance of the notice. According to the legislation, public consultation is mandatory is only at this stage of the EIA process. Informal consultation with Non-Governmental Organisations (NGOs), interested groups and civil society may occur during early stages of environmental studies depending on the type of project and public interest in the project. The notification would specify the times and places at which the EIA would be available to the public. As a minimum the report would be available at the CEA, PAA and in appropriate government agencies in the project area. The environmental regulations have provisions for public hearings on the project although it is not mandatory. The PAA can use its discretion and hold a public hearing if it would be in the interest of the public. The PAA is required to forward all comments, either written or raised during any public hearing, to the project proponent for review and response within 6 days of completion of the public comment period. The project proponent is required to respond to all such comments in writing to the PAA.

The Technical Evaluation Committee (TEC) appointed by the PAA would then evaluate the EIA and require the project proponent to respond to any queries raised by the TEC. The TEC would also evaluate the adequacy of the project proponent's response to any comments raised during the public comments period. Upon completion of the evaluation of the TEC, the PAA with the concurrence of the CEA would either grant approval for the implementation of the proposed project subject to specified conditions or refuse approval for implementation of the project, with reasons for doing so. This decision must be made within 30 days of the receipt of responses from the project proponent. The PAA is required to specify a period within which the approved project should be completed. In the event the proponent is unable to complete the project within the specified period, written permission for an extension has to be obtained from the PAA, 30 days prior to the expiration date.

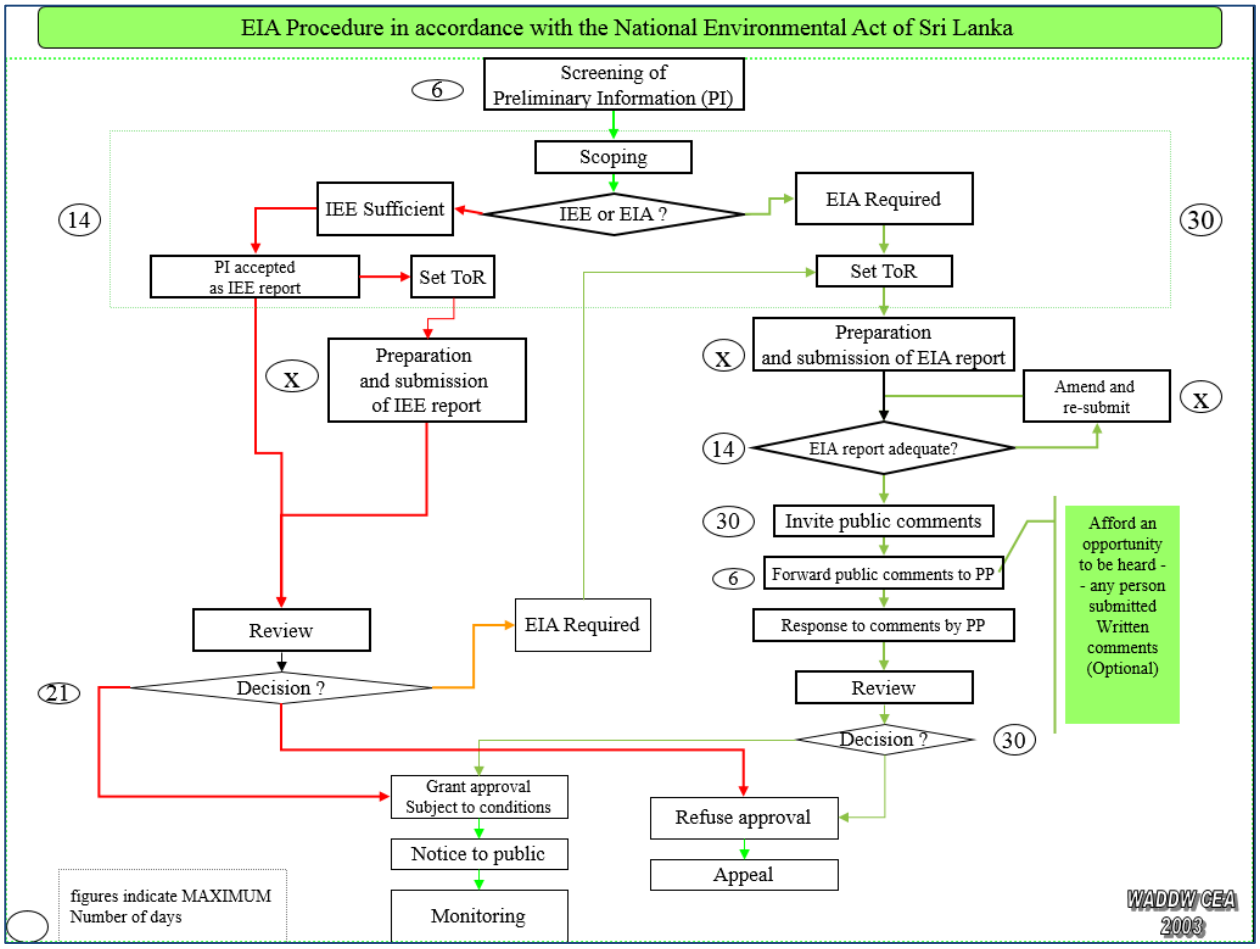
Upon review of the preliminary information provided by the project proponent (PP), if the PAA determines that the project would have no long-term adverse environmental impacts, an IEE would be considered adequate. Under such circumstances, the proponent will be required to submit a detailed IEE for review and approval by the PAA. The IEE will identify potential environmental and social issues and the complexity of possible remedial actions. Upon reviewing the IEE, if the TEC identifies any substantial environmental issues that may arise as a result of the proposed project, the proponent will be required to undertake a detailed EIA. The IEE review process is similar to the EIA review process, except for the level of detail and analysis involved, which is proportionate to the anticipated environmental and social impacts. The IEE is not required by law to be opened for the public for comments and does not go through the public consultation process.

Projects Subject to EIA

According to the EIA regulations, "Sewerage Treatment" is not a prescribed activity requiring an IEE/EIA. However, "Laying of gas and liquid (excluding water) transfer pipelines of length exceeding 1 kilometre" is a prescriber activity. However, any project or undertaking irrespective of their magnitude, if located partly or wholly within an environmental sensitive area, will become a prescribed project requiring approval under the EIA regulations. Environmental sensitive areas are defined as;

- Any erodible area declared under the Soil Conservation Act (1951, 1953);
- 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);
- Any reservation beyond the Full Supply Level of a reservoir;
- Any archaeological reserve, ancient or protected monument as defined or declared under the Antiquities Ordinance (1965);

- Any area declared under the Botanic Gardens Ordinance (1928, 1973);
- Areas within, or less than 100m from the boundaries of any area declared under the National Heritage and Wilderness Act (1988): the Forest Ordinance;
- Areas within, or less than 100m from the boundaries of any area declared as a Sanctuary under the Fauna and Flora Protection Ordinance (1937);
- 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;
- 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.



Source: Central Environmental Authority

Figure A8-1: Procedure for obtaining Environmental Clearance

APPENDIX 10: Comparison with JICA Guidelines

There are some gaps between the current Sri Lankan Regulations and JICA Guideline, but they are rather insignificant. The governmental laws pay less attention to the social impacts than JICA Guidelines. Thus, the preparing of the Resettlement Action Plan (RAP) is not mandatory. The 30 day term for public comment that the government stipulates differs greatly from the recommended 120-day JICA policy. Although JICA's guidelines suggest that the project proponents should disclose information related to it, under the Sri Lanka's legislation, the responsibility of information disclosure is incurred not by the project proponent but by the PAA.

Table: Comparison of JICA and Sri Lankan Policies and Guidelines

Item	JICA Guidelines	Sri Lankan Policies and Regulations
EIA / IEE Process	At the scoping stage and EIA draft report stage, the project proponent has to hold stakeholder meetings in the area to explain the contents. The comments should be reflected in the plan. EIA reports / RAP will be disclosed 120 days prior to concluding the agreement documents.	Stakeholders are provided an opportunity to comment in the scoping stage. The stakeholders are usually related governmental organizations (not local community/general public). The stakeholders and public can submit queries and comments on the EIA draft report. The comments should be addressed in the final report. EIA reports will be opened for 30 days for public comments.
Environmental Checklist	A check list is provided for each sector. These items should be included in the EIA report.	The PAA shall prepare terms of reference for an EIA. No specific checklist is provided.
Involuntary Resettlement Process	The project proponent is obliged to prepare a RAP. If number of resettled household is small (e.g. one household), the RAP can be simplified one. The RAP is prepared as part of the EIA Report.	In case that the number of resettled households is 20 or more, the NIRP requires a RAP.
Compensation for land resettlement	Full replacement cost must be applied as much as possible.	The Land Acquisition Act (LAA) provides for the payment of compensation on the basis of "market value" which is defined as the "amount which the land might be expected to have realized if sold by a willing seller in the open market as a separate entity". The National Involuntary Resettlement Policy (NIRP) recommends that compensation for loss of land, structures, other assets and income should be based on full replacement cost and should be paid promptly together with transaction costs.
Compensation for non-registered residents	All residents before the cut-off-date are eligible.	The LAA does not have any provisions on this issue. The NIRP recommends that affected persons who do not have documented title to land should receive fair and just treatment.
Grievance redress mechanism	The project proponent is obliged to have a grievance redness mechanism.	The LAA provides a limited grievance redress mechanism whereby certain grievances of the affected persons relating to compensation can be referred to the Board of Review established under the LAA. The NIRP recommends the establishment of an internal monitoring system by project executing agencies to monitor the implementation of RAPs and handling of grievances. Grievances redress mechanism formally instituted by the project authorities with the support of the Divisional Secretaries of the project area.

APPENDIX 11: International Commitments related to ESC

International Commitments

A list of Environment-related International Conventions, Protocols, and Treaties is given in **Table**.

Table: List of Environment-related International Conventions, Protocols, and Treaties

No	Environment-Related International Conventions, Protocols, and Treaties
1	International Plant Protection Convention (Rome, 1951)
2	Plant Protection Agreement for the South East Asia and Pacific Region (Rome, 1956)
3	Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar, 1971)
4	Convention Concerning the Protection of the World Cultural and Natural Heritage (Paris, 1972)
5	Convention on International Trade in Endangered Species of Wild Fauna and Flora (Washington, 1973)
6	Convention on Conservation of Migratory Species (Bonn, 1979)
7	Vienna Convention for the Protection of the Ozone Layer (Vienna, 1985)
8	Montreal Protocol on Substances that Deplete the ozone Layer (Montreal 1987)
9	United Nations Framework Convention on Climate Change (New York, 1992)
10	Convention on Biological Diversity (Rio De Janeiro, 1992)
11	International Convention to Combat Desertification (Paris 1994)
12	United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa (Paris, 1994)
13	Kyoto protocol to the United Nations Framework Convention on Climate Change (Kyoto, 1997)
14	Cartagena protocol on Biosafety to the Convention on Biological Diversity (Cartagena, 2003)
15	Convention on Conservation of Migratory Species (Bonn, 1979)

APPENDIX 12: Record of Consultation with Public and Authorities

Record of Meeting/Discussion

Date:	02/05/2016	**Time**:	from	10:30	to	12:00	
Venue:	CEA Director of EIA office						

Attendants

Name	Position	Department/Organization
Name		
Kanthi De Silva	Director of EIA	CEA
JICA Experts (Name)		
Koji KIMURA	Deputy Team Leader	JET
Yudai TADAKI	Environmental and Social Consid.	JET
Ranjith Warusamana	Deputy Team Leater (Local expert)	JET (Local expert)
Ms. KPP Dharmasena	Chief Engineerg (P&D - Sewerage)	NWSDB

Main Subject:
1. Verify CEA requirments for environmental and social studies at each stage of the project
2. Acquire documentation/guidelines related to requirements

Topic	Contents of Discussion	Conclusion
1	By JET: General introduction of current project (Presented: IC/R presentation). JET understanding is environmental studies are required at each stage, as follows 1) National M/P: SEA required 2) Priority Cities M/P: IEE required 3) F/S for final two cities: EIA or IEE required.	
2	CEA response: SEA is not required for any stage. SEA is performed generally to determine the type of project to select. Since the current project is already defined as a sewerage project, no study is required. Furthermore, any environmental evaluation undertaken at this stage will not be considered or accepted as an SEA by CEA. There is no law or procedure for SEA.	
3	Requirements for IEE/EIA: IEE/EIA will NOT be required at the Cities M/P stage. EIA will be required for approval of the F/S for each of the selected cities. The TOR for the EIA can be issued based on the Project Proposal submitted to CEA at the the Cities M/P stage for preparation of coming EIA for the F/S.	
4	Minitry of Land is responsible for the Resettlement Action Plan.	
	Documents: SEA for water reources and irrigation development in Sri Lanka, TOR	

Actions to be taken	by Whom	until When

Record of Meeting/Discussion

Date:	02/11/2016	**Time**:	from	15:30	to	16:30	
Venue:	CEJ office						

Attendants

Name	Position	Department/Organization
Name		
Mr. Hemantha Withanage	Executive director	CEJ
JICA Experts (Name)		
Koji KIMURA	Deputy Team Leader	JET
Yudai TADAKI	Environmental and Social Consid.	JET
WADD Wijesooriya	Director	EMAC
Buddhika De Silva	Director	EMAC

Main Subject:
1. To make known the JET's intention to perform M/P for the Project, and its contents.
2. To collect thoughts and opinions regarding the Project and apply them for its implementation

Topic	Contents of Discussion	Conclusion
1	By JET: General introduction of current project (Presented: IC/R presentation).	
2	CEJ: Kaduwela may be an interesting location for sewerage project. a) High domestic sewerage needs: direct dumping of domestic sewerage to Kelani River, complaints of itchiness and reactions to bathing in river, etc b) Highly industrialized: industrial effluent and solid waste in Kelani river c) Water treatment plant located downstream is affected by pollution at Kaduwela. Many other water and land pollution issues were discussed	
3	CEJ and JET will further consult each other as the Project progresses.	
4		
	Documents: Kelani River Edatabase.pdf Content-Kelani River industrial pollution 2015 Kelani River industrial pollution	

Actions to be taken	by Whom	until When

Record of Meeting/Discussion

Date:	02/11/2016	**Time**:	from	14:00	to	15:00	
Venue:	Office of Professor Jayathunge, Faculty of Science, University of Colombo						

Attendants

Name	Position	Department/Organization
Name		
Prof. Amaramalee Jayathunge	Prof. Zoology	Faculty of Science, University of Colombo
JICA Experts (Name)		
Koji KIMURA	Deputy Team Leader	JET
Yudai TADAKI	Environmental and Social Consid.	JET
WADD Wijesooriya	Director	EMAC
Buddhika De Silva	Director	EMAC

Main Subject:
1. To make known the JET's intention to perform M/P for the Project, and its contents.
2. To collect thoughts and opinions regarding the Project and apply them for its implementation

Topic	Contents of Discussion	Conclusion
1	By JET: General introduction of current project (Presented: IC/R presentation).	
2	Prof. Jayathunge's response: Odor issues should be controlled. The extent of industrial and medical waste water included in the study, or treated at the waste water treatment plant should be discussed.	
3	Prof. Jayathunge will be leaving the department due to retirement. She will appoint others to participate in the consultations, from chemistry and biology backgrounds.	
4		

Actions to be taken	by Whom	until When

APPENDIX 13: Draft EMP and EMoP

Mitigation Measures

Mitigation measures proposed with respect to the stages of: (i) planning and design (ii) construction and (iii) operation is given in **Table 1**.

Table 1: Environmental Impact – Mitigation Matrix

Environmental Impact / Issue	Mitigation Measure	Implementing Organization	Responsible Organization
Planning and Design Phase			
Site Selection	▪ Site selection process shall avoid land acquisition and involuntary resettlement where possible, including impacts on vulnerable persons. ▪ Locate sewage pipelines within the right of ways of roads to eliminate acquisition of new land. ▪ Avoid locating sewage pumping stations and wet wells within close proximity of any inhabited areas, sensitive sites such as hospitals, schools, temples, etc. to minimize nuisance impacts from odor, rodents, etc. as much as possible	Consultant/ NWSDB	NWSDB
Overall Environmental Management	▪ An Environmental Management Plan shall be prepared and implemented.	Consultant/ NWSDB	NWSDB
Discharge standards	▪ The design will specify the guidelines for the proper handling and disposal of waste to predetermined authorized disposal sites;	Consultant/ NWSDB	NWSDB
Archaeological resources	▪ Consult the relevant records of national and/or local archaeological agencies regarding the archaeological potential of proposed sites of STP, pumping stations, and main sewers, to ensure that these are located in areas where there is a low risk of chance finds.	Consultant/ NWSDB	NWSDB
Public utilities	▪ Telephone lines, electric poles and wires, and water pipes (old) existing within right-of-way (ROW) require shifting without disruption to services.	Consultant/ NWSDB	NWSDB
Traffic	▪ In order to limit the disruption to the neighborhood and traffic flow, coordinate with NWSDB to provide guidance to the organization of construction works. ▪ The design will specify the handling and transportation of construction materials and equipment.	Consultant/ NWSDB	NWSDB
Safety	▪ The design will include guidelines for site safety which will include specific requirements for physical division (fence), where necessary, of the construction site from passing pedestrians, children at play, vehicles, and any other people at risk. ▪ The design will include guidelines for workers' safety on site and the safety of visitors. Bills of quantities and technical description of works will include needed safety equipment.	Consultant/ NWSDB	NWSDB
Construction Phase			
Soil erosion and sedimentation	▪ Careful planning of construction activities that lead to heavy erosion, to avoid heavy rainy seasons ▪ Remove waste soil as soon as it is excavated, by loading directly onto trucks; ▪ The work, permanent or temporary shall consist of measures to control soil erosion, sedimentation and water pollution. Typical measures include the use of berms, dikes, sediment basins, fiber mats, mulches, grasses, slope drains and other devices. ▪ Adequate compaction of filled surfaces on completion and progressive re-vegetation of all disturbed areas as quickly as possible ▪ Protection of drainage channels with berms (i.e. ridge or embankment bordering channel) to prevent overspill ▪ Sedimentation traps will be constructed to reduce suspended solids before water is discharged to water bodies where applicable. ▪ All debris and residual spoil material including any excess earth will be disposed only at designated locations. ▪ The debris and spoil material will be disposed in such a manner that (i) watercourses and drainage paths are not blocked; (ii) the disposed material will not be washed away by floods and (iii) will not be a nuisance to the public.	Contractor	Consultant/ NWSDB
Transport of earth material	▪ Vehicles will be properly maintained to ensure the good running conditions and those which are not in suitable condition will be replaced. ▪ Provide covers during transportation	Contractor	Consultant/ NWSDB

Environmental Impact / Issue	Mitigation Measure	Implementing Organization	Responsible Organization
Dust Control	▪ Enclosing or covering the construction site in order to control the dust dispersion. ▪ Protecting stockpiles from water and wind erosion; ▪ Using a water truck for dust suppression on all exposed areas ▪ Establishing and enforcing vehicle speed limits to minimize dust generation; ▪ Use tarpaulins to cover loose material when transported to and from the site. ▪ Locating stockpiles away from sensitive receptors; ▪ Loaded haul trucks travelling to and from the site having loads leveled to avoid spillage; ▪ Carrying out progressive rehabilitation of cleared land;	Contractor	Consultant/ NWSDB
Burrow pits	▪ Eligible contractor/s who are operating burrow pits with necessary approvals / permits, will only be selected. ▪ Noise, dust and related safety issues during loading, transportation and unloading will be controlled to meet` the standards and norms	Contractor	Consultant/ NWSDB
Construction Waste Disposal	▪ System to collect waste cement slurry will be provided to avoid contamination of drainage paths. ▪ Wastewater from washing of equipment used for concrete mixing and transporting of concrete will be disposed safely. ▪ All discarded and used oil and grease will be collected, stored and disposed (reuse / sell). ▪ All potentially water polluting chemicals and oils will be stored (a) at locations sufficiently away from watercourses and storm water drainage paths and (b) in a manner that would minimize chances of spillage. ▪ Minimize the oil and chemical spillages during operation and properly maintain the equipment and machinery. ▪ Debris and spoil will be disposed of only to designated places in such a manner that (i) waterways and drainage paths are not blocked, and (ii) the disposed material will not be washed away by heavy storm water flows.	Contractor	Consultant/ NWSDB
Drainage issues	▪ STP site should be located on the high ground to avoid water ingress ▪ Natural drain paths should not be disturbed during any construction activity	Contractor	Consultant/ NWSDB
Noise and vibration	▪ Temporary noise barriers / screens will be placed. ▪ All construction work will be carried out during day time as much as possible and work will be stopped after 6 pm. ▪ Workers involved in high noise generating activities (such as compacting, concrete/cement mixing operations using the mixers) and handling high noise generating machinery and equipment will be provided with ear plugs or mufflers. ▪ To the extent possible, attempts will be made to use equipment and machinery that produce low noise levels ▪ Proper and regular maintenance and/or servicing of equipment and machinery will be carried out.	Contractor	Consultant/ NWS&DB
	Operational phase		
Impacts on Water Resources	▪ Prevent seepage of polluted water to the ground by applying suitable lining for the ponds, raise the levels of the site and the tanks etc as applicable. ▪ Establish the STP on a sufficient high ground to avoid the flood impact. ▪ Avoid spillages of septage during operation – specially during unloading - and take precautionary measures to prevent mixing septage with storm water drainage system. ▪ As a precautionary step, it is proposed to monitor the ground water quality in the area. ▪ Ensure the disposal of treated effluent to a reed bed (artificial wet-land) with species which suit the climatic and coastal conditions of the area. ▪ Ensure the necessary effluent quality for disposal to inland waters	NWS&DB / MC	NWS&DB / MC / Consultant
Odor from STP	▪ Shielding of the unloading bay to an extend to prevent odorous gases being blown away by the wind ▪ Hydraulic arrangements that would minimize agitation of sewage during the release to the treatment system ▪ Keeping much of the screen channel close to prevent release of gases to air ▪ Establish and properly maintain a thick green belt along the STP site and pumping station where applicable.	NWS&DB / MMC	MMC / NWSDB

Environmental Impact / Issue	Mitigation Measure	Implementing Organization	Responsible Organization
Sludge disposal	▪ Use dewatered sludge as fertilizer. ▪ It is recommended that the sludge be disposed at suitable site such as coconut land or suitable plantation land or through burial in to dug pits.	NWS&DB / MMC	MMC / NWSDB

DRAFT ENVIRONMENTAL MONITORING PLAN

Objective Of Environmental Monitoring Plan

In order to fulfil the following objectives an appropriate Environmental Monitoring Programme (EMoP) will be carried out.

- Check the implementation of mitigatory measures to ensure whether they are in conformity with the requirements
- Ensure that the impact does not exceed legal standards
- Provide timely warnings of potential environmental damages

The EMoP characterizes the proposed mitigation and monitoring actions as a set of tasks. In the EMoP the specific responsibilities on task implementation on the project proponent, the contractor(s), and the regulatory agency (agencies) are assigned. These tasks should be implemented within a specified time/period by the agency responsible and as per the specifications set out in the EMoP.

Environmental monitoring committee

The monitoring programme will be undertaken by a committee and all relevant line agencies, local government bodies and interested parties shall take part in the monitoring activities. An Environmental Monitoring Committee (EMC) consisting of the members from the following agencies shall be set up by CEA.

- Central Environmental Authority
- Municipal Council
- National Water Supply and Drainage Board
- Divisional Secretariat
- RDHS and Anuradhapura General Hospital
- Irrigation Department
- Archaeological Department
- Road Development Authority
- Provincial Road Development Authority
- Sri Lanka Railway
- Department of Forest Conservation
- Department of Wildlife Conservation
- Any other agency deemed necessary by the EMC

Outline of environmental monitoring plan

Environmental Monitoring activities shall take place during Design, Construction and Operation stages of the project. Regular site inspections are required to assess whether the various mitigatory measures suggested are properly implemented and they are effective in achieving the objectives of environmental protection. Outline of the Environmental Monitoring Plan is presented in **Table 2**.
One important aspect of monitoring should be to assess the effectiveness of the mitigation measures suggested, where they are found lacking, appropriate new actions to mitigate any adverse effects should be undertaken. This requires measurements of selected environmental parameters at identified locations and a summary of the measurement schedule proposed is given in **Table 3**.

Table 2: Outline of the Environmental Monitoring Plan

Activity	Expected Negative Impact	Mitigation measures	Responsible for Mitigation	Responsible for Monitoring	Parameters to be monitored	Location	Frequency
Pre-construction stage	Cutting of trees	Permits to be obtained for cutting trees. Cut down of branches wherever possible, rather than cutting the whole tree	Contractor	MC / NWSDB	Number of trees in the project area	Project sites	Before commencing
	Burrowing of earth	Approvals to be obtained	Contractor	MC / NWSDB	Field reports and observations	Project sites	Before commencing
Construction stage	Damages to existing roads	Excavation should be done after studying the design drawings	Contractor	MC / NWSDB	Field reports and observations	Project sites	Once every two months
	Traffic congestion	Implement a proper traffic management plan. Use sign boards and barricaes	Contractor	MC / NWSDB	Field reports and observations	Project sites	Weekly
	Generation of dust	Systemic watering on excavated soil	Contractor	MC / NWSDB	Field reports and observations	Project sites	Once every two weeks
		Using a tarpaulin cover while transporting the materials such as sand, cement and excavated soil	Suppliers	MC / NWSDB	Field report and complaints if any	Off the project site	Weekly
		Taking measures to minimize the dust when loading and unloading the materials	Contractor	MC / NWSDB	Field report and complaints if any	Project site	Weekly
	Increased noise level	Machinery should not produce a noise level above 75db. Relevant equipment should be used to monitor the noise levels	Contractor	MC / NWSDB	Noise reports and complaints if any	Project site	Daily
	Waste generation and camping on the location	Solid waste generated should be disposed properly and removed to appropriate disposal yards	Contractor	MC / NWSDB	Field reports	Project site	Once every three months
	Impacts on existing habitats	No endemic or endangered species are damaged. Cutting of tree should be compensated by planting of more trees around the area	Contractor	MC / NWSDB	Field reports	Project site	Once every six months
Operation and maintenance stage	Sludge generation	Collecting sludge in an underground chamber and proper disposal of it	MC / NWSDB	MC / NWSDB	Maintenance report	Project area	Daily
	Possible negative impacts on water quality and quantity	Water quality and quantity tests to be carried out regularly	MC / NWSDB	MC / NWSDB	Field reports	Project site	Once every month

Table 3: Environmental Monitoring Schedule

Aspect	Parameter	Method	Stage	Frequency	Responsibility	Location
Noise level	Day and Night time Noise level (dB)	Portable noise meter (range 0-120 dB(A))	Pre-construction	Once (Baseline measurement)	Contractor / NWSDB / EMC	At STP site boundary; Sensitive locations along the sewer network; Selected pumping stations;
			Construction	Once a year	Contractor / NWSDB / EMC	
			Operation	Yearly; On complaints	NWSDB / EMC	
Air quality / Odour	SO_2, NO_2, CO, PM_{10}, SPM	Spectrometric method; High volume sampling and Gravimetric analysis	Pre-construction	Once (Baseline measurement)	Contractor / NWSDB / EMC	At STP site; Sensitive locations along the sewer network; Selected pumping stations;
			Construction	Two times	Contractor / NWSDB / EMC	
			Operation	Yearly; On complaints	NWSDB / EMC	
Water Quality	EC, TSS, DO, BOD, COD, pH, Oil and grease, E-coli	Portable water quality meter, Spectrometric method	Pre-construction	Once (Baseline measurement)	Contractor / NWSDB / EMC	Malwathu Oya near STP site - (i) upstream and (ii) downstream; Streams at sensitive locations along the sewer network; Streams at selected pumping stations;
			Construction	Two times	Contractor / NWSDB / EMC	
			Operation	Yearly; On complaints	NWSDB / EMC	