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 ⑤DEHIWALA MOUNT LAVINIA

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JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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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

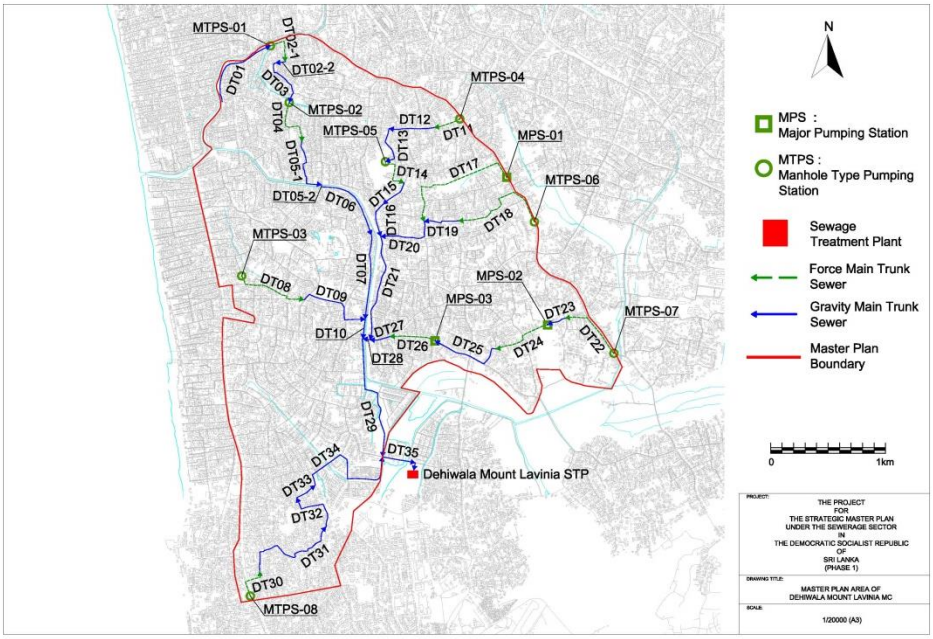
Chapter 1 describes the Project background and objectives and the Strategic Sewerage Master Plan for the entire country. The Master Plan identifies 15 priority cities and explains the process used to select the following five cities to be covered by the City Sewerage Master Plan:

- 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 Dehiwala-Mount Lavinia and the need for a sewerage system. Increasing levels of Biochemical Oxygen Demand (BOD), ammonia, phosphorus, and coliform are detected in rivers in the area, indicating the deterioration of water quality due to human activities. The average household income for the area is higher than the national average, therefore the city should be able to collect enough revenue from sewage charges to make the proposed system sustainable. 97% of the households have septic tanks. The sewerage system will treat the wastewater more efficiently, contributing to better protection and improvement of water quality.

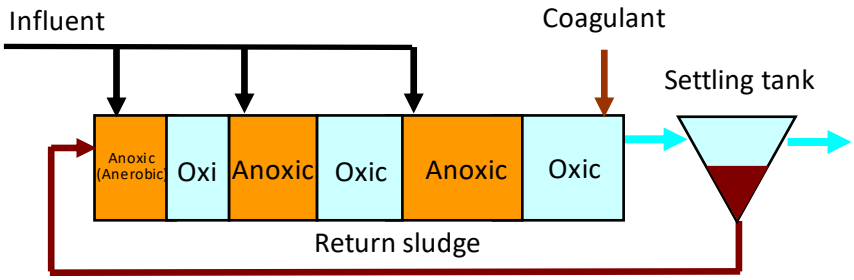
Chapter 3 sets out the basic conditions for the preparation of the sewerage plan. The system will be achieved by 2046, serving the city of Dehiwala-Mount Lavinia with an area of 981 ha. The served population is estimated to be 106,100 and that the maximum daily wastewater flow will be 20,000 m^3.

Chapter 4 describes the sewerage facility plan and design. The sewer route and locations of pumping stations and sewage treatment plant (STP) are shown in **Figure 1**. The treatment plant uses a step-feed biological nutrient removal process (**Figure 2**) developed in Japan, to achieve high nitrogen removal with a relatively small STP size. The process can also be operated to remove phosphorus. Sludge generated will be dewatered with screw press machines and then composted.



Source: JET

Figure 1: Map of Sewer System in Dehiwala-Mount Lavinia



Source: JET

Figure 2: (Three stage) Step-feed Biological Nutrient Removal Process

Chapter 5 proposes that NWSDB should deliver sewerage services in Dehiwala-Mount Lavinia. Since NWSDB is already providing water supply services, there will be savings in administrative costs such as bill collection. Training programs at the NWSDB Training Centre can be expanded to provide OJT to develop the skills required.

Chapter 6 estimates the costs required for the development of the sewerage system. As shown in **Table 1**, the total project cost is estimated at approximately 19.2 billion Japanese Yen (JPY) (not including tax), with an annual maintenance cost of 0.22 billion JPY.

Table 1 Estimated Project Cost

			Amount		Total Amount	Total Amount
			L.C. (LKR)	F.C. (JPY)	LKR	JPY
1	Construction Cost					
	A	Dehiwala Mount Lavinia STP (Q=20,000m3/day)	2,792,727,273	3,225,600,000	6,981,818,182	5,376,000,000
	B	Trunk Sewer & Pump Station	2,319,693,000	2,022,846,000	4,946,765,000	3,809,010,000
	C	Branch Sewer & Pump Station	2,003,645,000	715,050,000	2,932,281,000	2,257,857,000
	D	House Connection	2,652,500,000	0	2,652,500,000	2,042,425,000
	Sub-total of 1(A-D)		9,768,565,273	5,963,496,000	17,513,364,182	13,485,292,000
2	Administration cost		1,184,000,000	0	1,184,000,000	911,680,000
3	Consulting cost		465,000,000	1,022,000,000	1,792,273,000	1,380,050,000
4	Physical contingency for construction cost		605,000,000	336,000,000	1,041,364,000	801,850,000
5	Price escalation for construction cost		2,343,000,000	587,000,000	3,105,338,000	2,391,110,000
6	Land acquisition and compensation		-	-	-	-
7	Interest during construction		0	164,000,000	212,987,000	164,000,000
8	Front-end Fee		0	37,000,000	48,052,000	37,000,000
9	Tax and duty		4,286,000,000	0	4,286,000,000	3,300,220,000
	Sub-total of (2-9)		8,883,000,000	2,146,000,000	11,670,013,000	8,985,910,000
	Total including Tax and Duty		18,651,565,273	8,109,496,000	29,183,378,000	22,471,201,000
	Total excluding Tax and Duty		14,365,565,273	8,109,496,000	24,897,378,000	19,170,981,000
	Eligible Portion (1, 3, 4, 5 and 7)		13,181,565,273	8,072,496,000	23,665,326,000	18,222,301,000
	Non-Eligible Portion (2, 6, 8 and 9)		5,470,000,000	37,000,000	5,518,052,000	4,248,900,000

Source: JET

Chapter 7 explains the two types of sewage tariff for recovering the maintenance cost. Type 1 is based on the system in Sri Jayawardenapura Kotte and is calculated to be 52.01 LKR/m^3. Type 2 is for sewerage systems operated by NWSDB and is calculated to be 43.56 LKR/m^3. Both are within the ability to pay (ATP) as estimated by the World Bank (WB). The construction cost will be borne by the central government and will not be part of the cost recovery.

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

Chapter 9 concludes that the sewerage service in Dehiwala-Mount Lavinia will make a significant positive impact on the protection and improvement of the local water environment. However, as the site for the STP has not been identified, further steps will not be taken to conduct a F/S in 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 to 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 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/D)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 which would 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. The M/P outlines the 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-(5)] presents the Sewerage M/P for Dehiwala-Mount Lavinia 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 Dehiwala-Mount Lavinia MC. The sewerage service area and the conditions for implementing the project are identified.

CHAPTER 2 EXISTING CONDITIONS

2.1 ENVIRONMENTAL AND NATURAL CONDITIONS

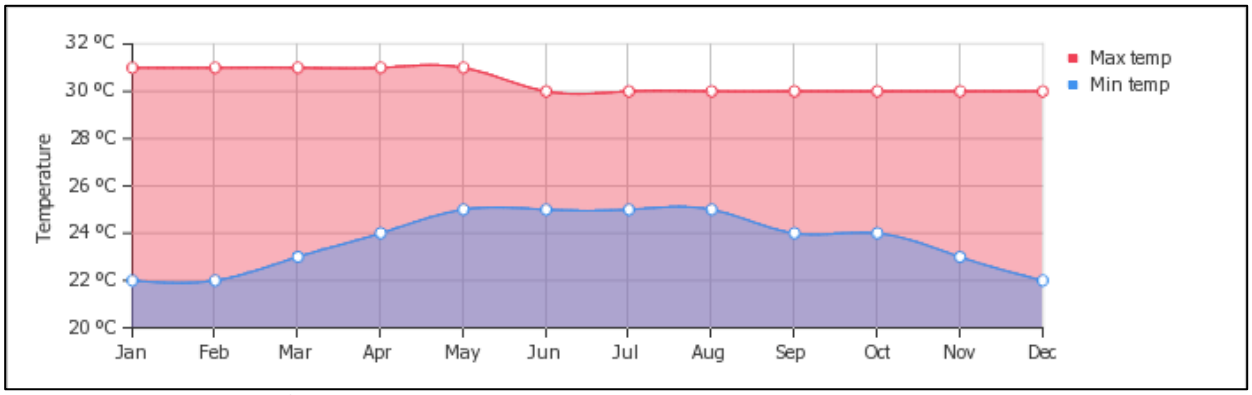
2.1.1 Climate

(1) General

Dehiwala-Mount Lavinia MC and surrounding areas are within the Wet/Low Country Zone, distributed largely in Gampaha and Colombo districts, which receive the lowest rainfall in the Western Province. The mean annual rainfall is over 1,700 mm, with a relative dry period from December to mid-March.

(2) Temperature

Dehiwala-Mount Lavinia MC has an average annual temperature of 27.5 °C, with little variation throughout the year. The temperature profile is shown in **Figure 2.1-1**.

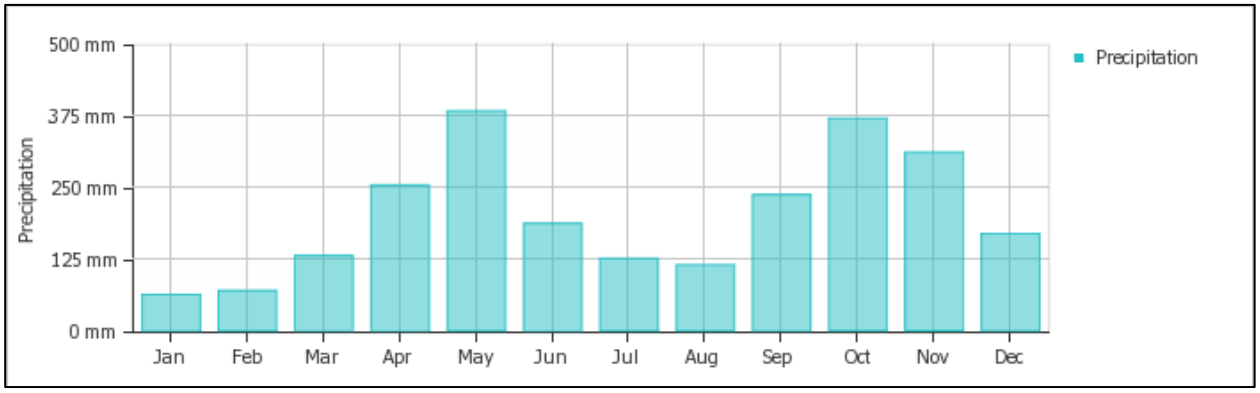


Source: JET, using Department of Meteorology data

Figure 2.1-1 Average Monthly Maximum and Minimum Temperatures

(3) Precipitation

Dehiwala-Mount Lavinia MC area receives an average annual rainfall of 2000 to 3000 mm, mainly during the southwest monsoon season. Precipitation profile is shown in **Figure 2.1-2**.

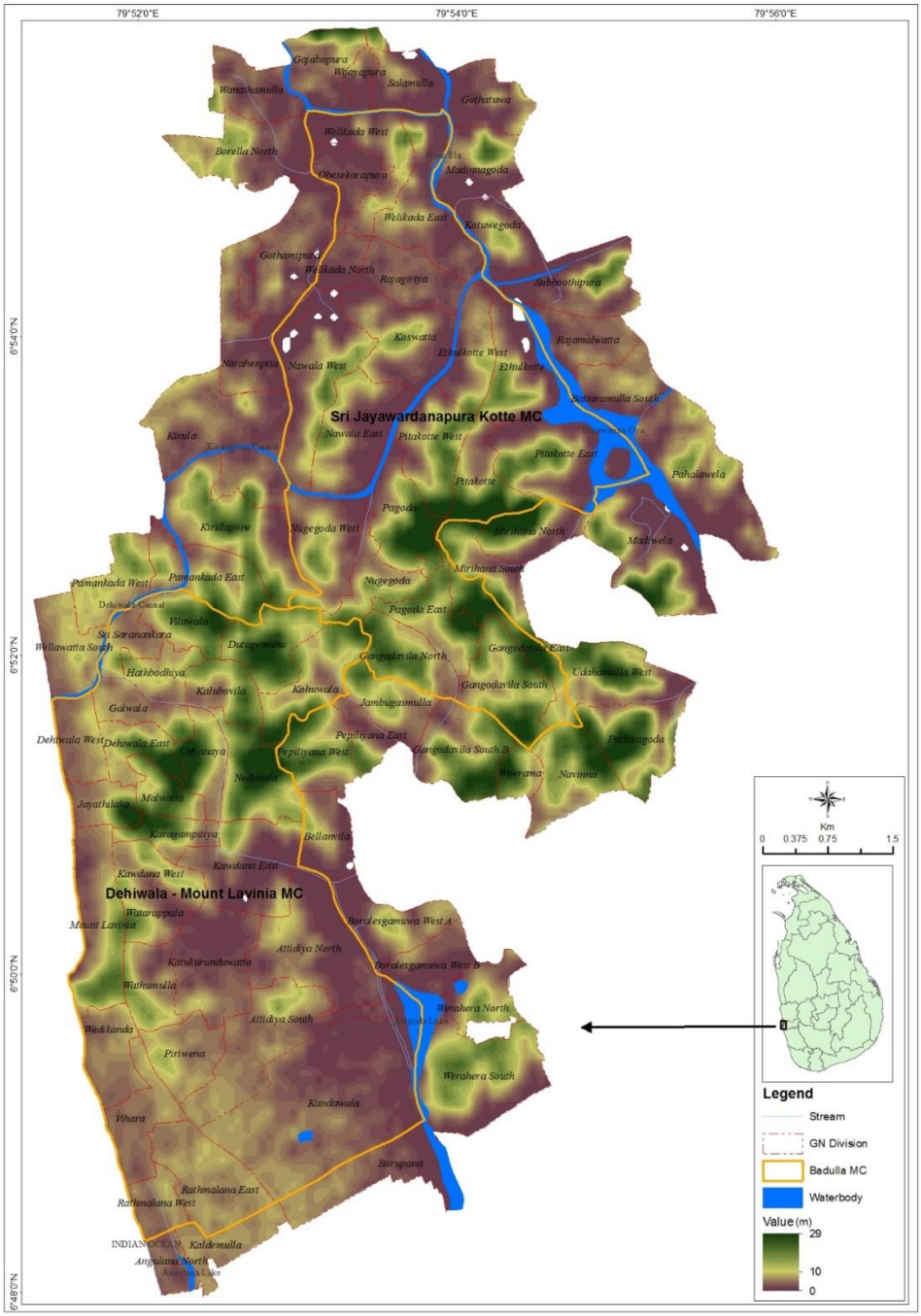


Source: JET, using Department of Meteorology data

Figure 2.1-2 Average Monthly Precipitation

2.1.2 Geography

Dehiwala-Mount Lavinia MC located in the Western Province, is the largest suburb of Colombo, situated immediately south of the city centre. The area is bounded on one side by Mount Lavinia Beach and hills made up of lateritic soil on the other. Elevation of the area is shown in **Figure 2.1-3**.

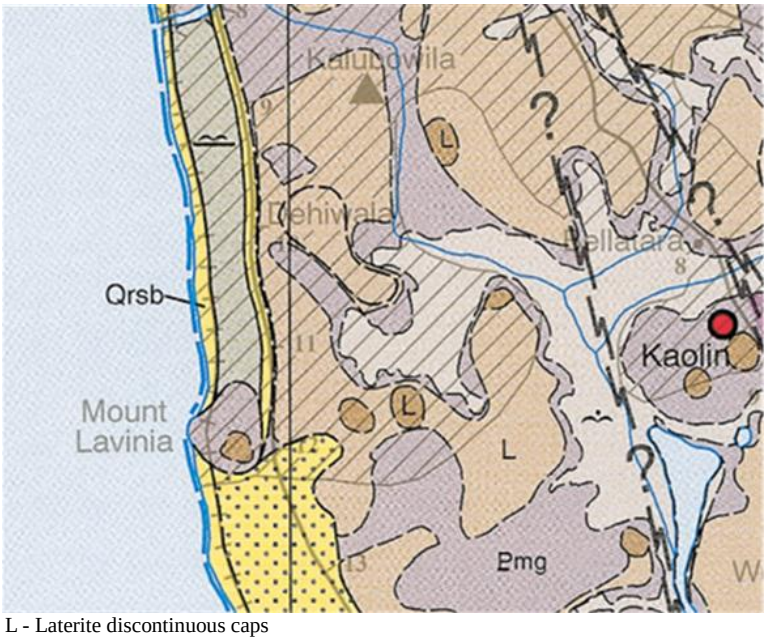


Source: Survey Department of Sri Lanka

Figure 2.1-3 Elevation of Dehiwala–Mount Lavinia MC

2.1.3 Geology

The area is in the Highland Complex. The major rock types are granulite facies rocks, such as gneisses, sillimanite-graphite gneisses, quartzite, marbles. Some charnokites, granitic gneisses, garnet biotite gneisses are also present. The landward bed rock is covered by a dense layer of lateritic soil of varying thickness. The main geologic features are summarized in **Figure 2.1-4**.



L - Laterite discontinuous caps
Pmg - undifferentiated Proterozoic gneiss
Pmgk - undifferentiated charnockitic gneiss
Qrsb - beach Sand
Source: Geological Surveys and Mines Bureau

Figure 2.1-4 Geology of the Project Area

2.1.4 Hydrology

The Dehiwala Canal on the northern boundary separates Dehiwala-Mount Lavinia MC from Colombo Municipal Council (CMC). The canal system is important for conveying surface drainage and flood waters. There are extensive wetlands around the Weras Ganga and Bolgoda Lakes. These and other water bodies such as the Belanwila and Attidiya Marshes, are noted for their biodiversity and flood detention capacity.

2.1.5 Surface Water Quality and Quantity

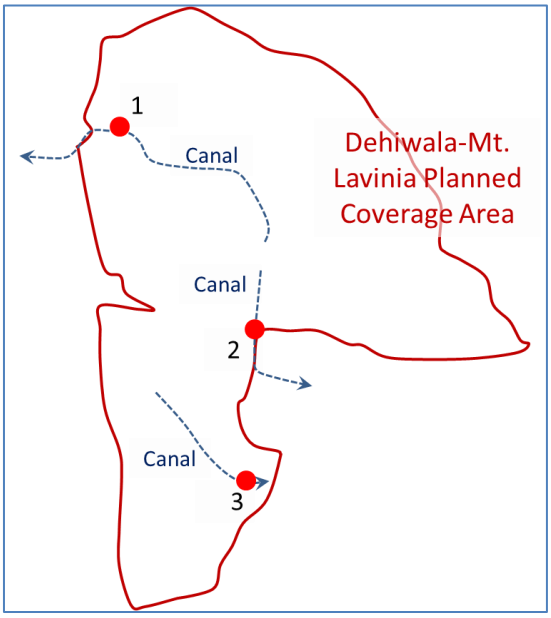
(1) Water Quality

Water quality at sampling stations (1-3) in Dehiwala–Mount Lavinia is shown in **Table 2.1-1**. The locations of sampling stations are shown in **Figure 2.1-5**.

Table 2.1-1 Water Quality (Dehiwala-Mt. Lavinia)

Dehiwala-Mt. Lavinia		1	2	3	Criteria
pH	-	7.2	7.2	7.1	-
Temperature	^{o}C	29.4	29.1	28.9	-
Odor	-	Objectionable	Objectionable	Objectionable	ND
Color	mg Pt/L	<15	22	32	100
EC	uS/cm	382	353	452	700
Turbidity	NTU	22	11	25	-
Total Suspended Solids (TSS)	mg/l	38	34	55	40
TDS	mg/l	270	250	320	-
DO	mg/l	Nil	0.9	Nil	5
BOD	mg/l	50	38	34	4
COD	mg/l	51	41	41	15
Nitrate	mg/l	0.29	0.66	0.44	10
Ammonia	mg/l	2.96	1.94	1.26	0.59
Total Phosphorus (T-P)	mg/l	0.17	0.58	0.62	-
PO_4^{3-} - P	mg/l	0.08	0.35	0.43	0.4
Cl	mg/l	28.7	30.2	34	600
Total Nitrogen (T-N)	mg/l	3.27	2.64	1.74	-
Fecal Coliform	/100ml	100	700	$14x10^2$	$1x10^3$
Total Coliform	/100ml	$157x10^4$	$3x10^6$	$167x10^4$	$1x10^4$

*) Over the criteria
Source: JET



Source: JET

Figure 2.1-5 Water Sampling Locations

The criteria for evaluating water quality are based on "Revised Ambient Water Quality Standards". The values are chosen from Category C (Fish and Aquatic Life Water) for normal environmental standards. In case values are not set for Category C, lowest values from Category D, E and F are used.

The concentration of TSS, DO, BOD, COD, ammonia, phosphate, fecal and total coliform, were measured and shown to be higher than the standards. Therefore, all sampling locations are polluted because of the discharge from the city.

(2) Effects of Implementing a Sewerage System

Sewage treatment should reduce the TSS currently at 35 mg/L. DO values will be improved by aeration in the reactor tank. BOD will be reduced because of organic decomposition in the activated sludge process. Ammonia will be oxidised by aerobic bacteria to nitrates. Faecal and total coliform will be decreased by chlorination.

The effect of pollution load reduction can be measured by BOD. If wastewater discharged upstream of the sampling stations are all treated at the STP (target value: 20 mg BOD/L), BOD load will be reduced by approximately 57%.

Thus, introduction of a sewerage system will improve the water environment in Dehiwala-Mt. Lavinia.

(3) Water Quantity

The flow rates at the sampling stations 1, 2 and 3 on 27th August 2016 are shown below.

Table 2.1-2 Water Quantity (Dehiwala-Mt. Lavinia)

Station	Flow Rate (m^3/s)	Incremental Flow (%)	Date
1	0.088	n.a.	27-08-2016
2	0.035	n.a.	
3	0.004	n.a.	

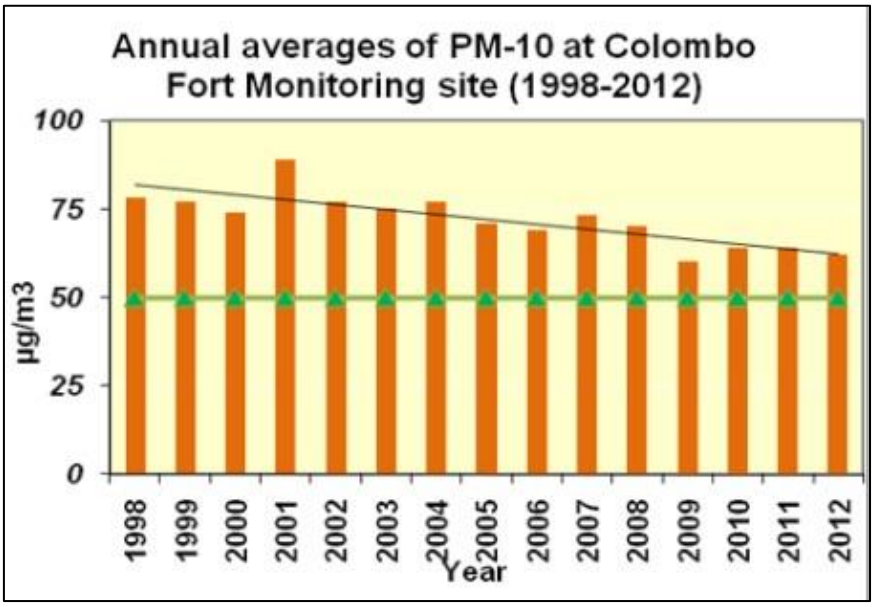
Source: JET

2.1.6 Environmental Quality

(1) Air Quality

In Sri Lanka, there is only one station that monitors ambient air quality on a continuous basis; it is located at Colombo Fort and has been in operation since 1997. The annual average of PM10 indicates that the pollution level has been relatively stable within the range 70-80 $\mu g/m^3$ from 1998 to 2012 (refer to **Figure 2.1-6**). This is higher than the limit of 50 $\mu g/m^3$ identified in WHO guidelines.

Vehicle and industry emissions are the major contributors to poor air quality in Dehiwala-Mount Lavinia MC. Heavy vehicles along Galle Road and side roads, and trains contribute to high levels of pollutants, such as dust, particulate matter and smoke. Air quality further deteriorates during peak hours when traffic is heavy and congested. Sewage and solid wastes thrown in the canals produce foul odours, especially during dry weather when water level is low.



Source: CEA

Figure 2.1-6 PM10 Levels Observed in the Project Area

(2) Noise and Vibration

Ambient noise and vibration levels are as expected for urban areas with industrial, commercial, and public institutions. Heavy traffic along Galle Road and other roads during peak hours as well as at night and trains contribute to the high noise and vibration levels.

2.1.7 Protected Areas

The Colombo Flood Detention Area Wetlands (approximately 1200 ha) are a large network of freshwater marshes, open waterways, lakes, and paddy fields scattered across metropolitan Colombo. 399 ha of the wetlands is state owned and protected. The remaining 800 ha is privately owned paddy fields.

(1) Bellanwila-Attidiya Sanctuary/Weras Ganga

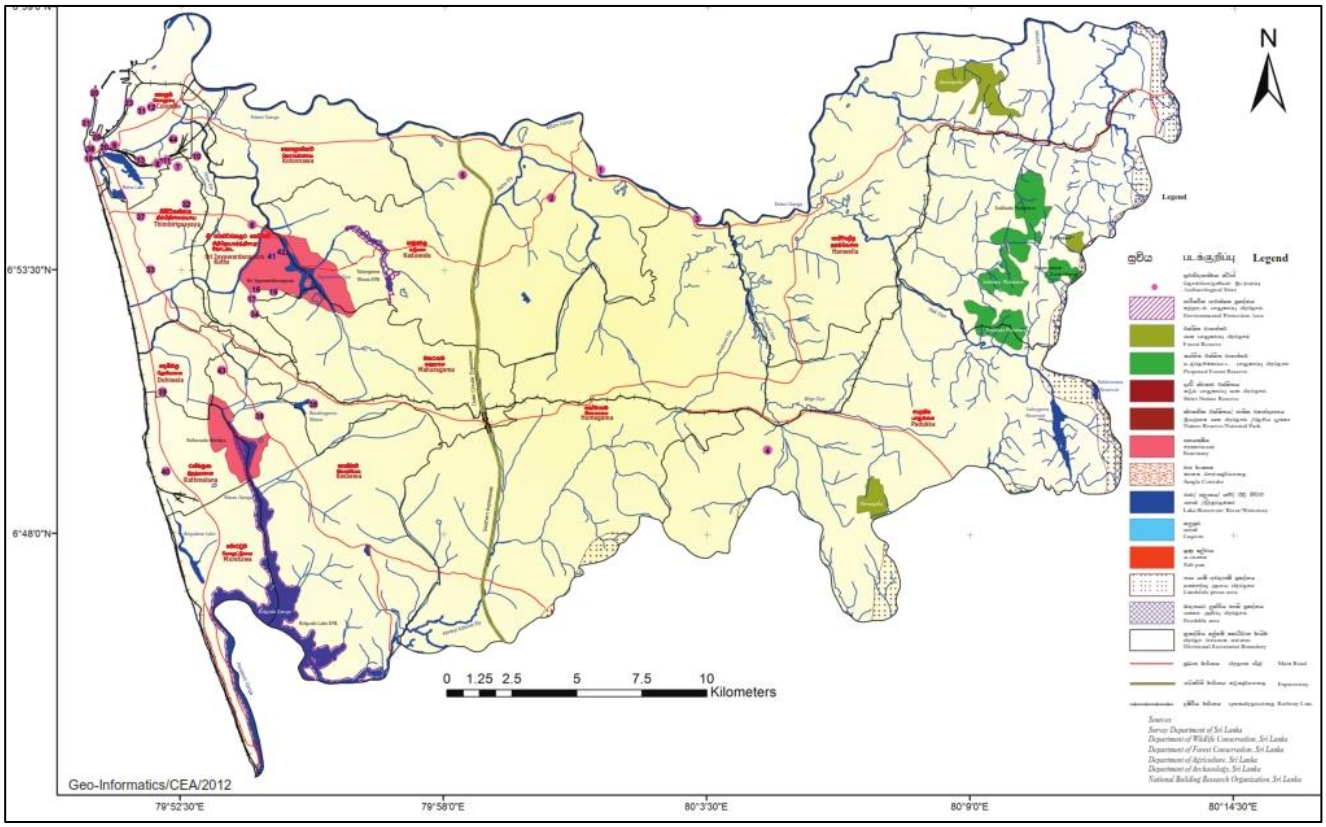
Bellanwila-Attidiya Sanctuary (BAS), listed in the directory of Asian wetlands by the IUCN (1989), is a sanctuary under the Fauna and Flora Protection Ordinance by Gazette Extraordinary No. 620/9 of 25th July 1990. It is also designated as an Important Bird Area by Birdlife International (www.birdlife.org, accessed 7/8/2009). Bellanwila-Attidiya Sanctuary is situated in the upper catchments of the Bolgoda river basin.

(2) Diyawanna Oya Wetland

Diyawanna Oya wetland is located close to Dehiwala-Mt. Lavinia MC. It is a man-made canal system on the left bank of the lower valley of Kelani River in the Colombo District. Kolonnawa marsh, Heen-ela marsh, and Kotte marsh function as the main catchment of this system and act as flood detention zones for the City of Colombo. They provide other functions, such as recreation area, food and fodder production, and habitat for wildlife.

(3) Buffer Zone

A set of sensitive areas has been declared under the CEA regulations. These sensitive zones can be considered as buffer zones for the natural and man-made protected areas. Any development activities within these zones are subjected to close monitoring by CEA and relevant authorities. These sensitive areas have been mapped by CEA and the map of Colombo District is given in **Figure 2.1-7**.



Source:CEA

Figure 2.1-7 Environmentally Sensitive Areas in the Colombo District

2.1.8 Fauna and Flora

Fauna and flora of the general area as documented in literature and site surveys are summarized in **Table 2.1-3** and **Table 2.1-4** Further investigation is necessary to determine the fauna and flora specific to the Project sites.

Table 2.1-3 Fauna in the Project Area

Class	Type	Taxa		Significant Species (common name)	Conservation Status (IUCN 3.1)
		Family	Species		
Birds		Megalaimidae		*Megalaima zeylanica* (Brownheaded barbet)	LC
				Megalaima flavifrons (Yellow-fronted barbet)	LC
		Alcedinidae		*Halcyon smyrnensis* (White-throated kingfisher)	LC
				Pelargopsis capensis (Stork-billed kingfisher)	LC
		Cuculidae		*Centropus sinensis* (Greater coucal)	LC
		Psittaculidae		*Psittacula krameri* (Rose-ringed parakeet)	LC
		Ardeidae		*Ardeola grayii* (Indian pond heron)	LC

				Dupetor flavicollis (Black bittern)	LC
		Columbidae		*Ducula aenea* (Green imperial pigeon)	LC
				Columba livia (Rock dove)	LC
		Picidae		*Picus chlorolophus* (Lesser yellownape)	LC
		Accipitridae		*Spilornis cheela* (Crested serpend eagle)	LC
				Haliaeetus leucogaster (White-bellied sea eagle)	LC
		Anhingidae		*Anhinga melanogaster* (Oriental darter)	NT
		Phalacrocoracidae		*Phalaerocorox fuscicollis* (Indian cormorant)	LC
		Rallidae		*Rallus striatus* (Slaty-breasted rail)	LC
Amphibians		Bufonidae		*Duttaphrynus melanostictus* (Asian toad)	LC
		Dicroglossidae		*Euphlyctis cyanophlyctis* (Indian skipper frog)	LC
				Euphlyctis hexadactylus (Green pond frog)	LC
				Hoplobatrachus crassus (Jerdon's frog)	LC
		Rhacophoridae		*Philautus popularis* (Common shrub frod)	LC
		Microhylidae		*Microhyla rubra* (Marrow-mouthed frog)	LC
		Ranidae		*Hylarana gracilis* (Gravenhorst's frog)	LC
		Rhacophoridae		*Polypedates cruciger* (Sri Lanka whipping frog)	LC
Reptiles	Lizards	Agamidae		*Calotes calotes* (Common green forest lizard)	NA
				Calotes versicolor (Oriental garden lizard)	NA
		Gekkonidae		*Gehyra mutilata* (Four-clawed gecko)	NA
				Hemidactylus parvimaculatus (Spotted house gecko)	NA
				Hemidactylus frenatus (Common house gecko)	NA
		Varanidae		*Varanus bengalensis* (Bengal monitor lizard)	LC
				Varanus salvator (Asian water monitor)	LC
	Snakes	Colubridae		*Ptyas mucosa* (oriental ratsnake)	LC
				Oligodon sublineatus (Kukri snake)	LC
				Sibynophis subpunctatus (Black-headed snake)	LC
				Xenochrophis asperrimus (Sri Lankan keelback)	LC
Mammals	Bats	Pteropodidae		*Pteropus giganteus* (Indian flying fox)	LC
		Vespertilionidae		*Kerivoula picta* (Painted bat)	LC
		Herpestidae		*Herpestes brachyurus* (Short-tailed mongoose)	LC
				Herpestes edwardsii (Indian grey mongoose)	LC
	Rodents	Muridae		*Bandicota bengalensis* (Lesser bandicoot rat)	LC
				Bandicota indica (Greater bandicoot rat)	LC
				Rattus rattus (Black rat)	LC
		Sciuridae		*Funambulus palmarum* (Indian palm squirrel)	LC
				Hystrix indica (Indian Crested porcupine)	LC
Fish		Osphronemidae		*Trichogaster pectoralis* (Snakeskin gourami)	LC
		Cichlidae		*Oreochromis mossambicus* (Mozambique tilapia)	NT
				Etroplus suratensis (Green chromide)	LC
		Anabantiade		*Anabus testudineus* (Climbing perch)	NA
		Bagridae		*Mystus vittatus* (Striped sward catchfish)	LC
		Heteropneustidae		*Heteropneustes fossilis* (Asian stinging cathish)	LC
		Loricariidae		*Pterygoplichthys multiradiatus* (Sailfish catfish)	NA
		Cobitidae		*Lepidocephalichthys thermalis* (Spiny loach)	LC
		Cyprinidae		*Puntius chola* (Swamp barb)	LC
				Puntius bimaculatus (Redside barb)	NA

Sources: :
Manamendraarachchi and Adikari (2014)
IUCN Redlist
JET

Legend: IUCN 3.1 scale

Dom: Domesticated
Def: Data deficient
NA: Data not available

Table 2.1-4 Flora in the Project Area

Taxa		Significant Species (common name)	Conservation Status (IUCN 3.1)
Family	Species		
Moraceae		*Ficus religiosa* (Bodhi tree)	LC
Putranjivaceae		*Drypete sepiaria* (Weera)	LC
Sapotacceae		*Manilkara hexandra* (Palu)	LC
Asteraceae		*Vernonia zeylanica* (Ironweed)	LC
Apocynaceae		*Willughbeia cirrhifera*	VU
Anacardiaceae		*Mangifera indica* (Mango)	None
		Spondias dulcis (Ambarella)	None
		Annona reticulate (Custard apple)	None
		Plumeria rubra (Frangipani)	None
		Phyllanthus myrtifolius (Mousetail plant)	None
		Alstonia macrophylla (Hard milkwood)	lc
		Leucaena leucocephala (white leadtree)	None
		Musa x paradisaca (Plantains)	None
		Tecoma stans (Trumpetbush)	None
		Macaranga indica	None
		Swietenia mahogany	
		Ludwigia decurrens (Willow primrose)	LC
		Lygodium spp. (Climbing fern)	
Salviniaceae		*Salvinia molesta* (Kariba weed)	LC
		Ipomoea aquatic (Kankun)	LC
		Cyclosorus interaptus (Swamp shield-fern)	None
		Eichhornia crassipes (Water hyacinth)	None
		Cerbera odollam (Suicide tree)	None
		Cyperus pilosus	
		Hibiscus tiliaceus (Beach Hibiscus)	LC
		Colocasia esculenta	
		Panicum repens (Torpedograss)	None
		Leersia Hexandra (Southern cutgrass)	LC
		Rhyncospora sp	
		Eleocharis sp	
		Brachiaria sp	
		Bacopa sp	
		Phragmites karka	
		Annona glabra (Swamp apple)	
		Cerbera manghas (Sea mango)	
		Syzygium sp	
		Melastoma sp	
		Lantana camara (Big sage)	

Source:
Egodawatta and Warnasooriya (2014)
Manamendraarachchi and Adikari (2014)
Munashingha et al., (2009)
Dharmasena, (1993)
Wijerathna and Baladurage
IUCN Redlist
JET

Legend: IUCN 3.1 scale

Dom: Domesticated
Def: Data deficient
NA: Data not available

2.2 SOCIAL CONDITIONS

2.2.1 Administration

Dehiwala-Mount Lavinia MC was established in 1959 to promote, public health and welfare, development of sanitation infrastructures and amenities of the city. The city area lies within Dehiwala DSD and Ratmalana DSD in the Colombo District, in the Western Province. The total area of the Dehiwala-Mount Lavinia MC is 21 km^2, consisting of 29 wards. Dehiwala DSD, Ratmalana DSD and

Colombo District are 8 km^2, 13 km^2 and 699 km^2 respectively, while the Western Province is 3,684 km^2 . The District has 15 km^2 of forested and the Province has 195 km^2. The District has 23 km^2 of inland water and the Western Province has 91 km^2.

2.2.2 Population and Demography

According to the Census and Statistics Department of Sri Lanka, the population density of Dehiwala-Mount Lavinia MC is 8,784 persons per km^2, compared to 3,487 per km^2 in Colombo District, and 1,652 per km^2 in Western Province. In 2012, the population for Dehiwala-Mount Lavinia MC was 184,468, while the populations were 88,962 (51.77%) in Dehiwala DSD and 95,506 (48.23%) in Ratmalana DSD. The population Figures and gender distribution, obtained from the Grama Niladari Division, are tabulated below.

Table 2.2-1 Population in Dehiwala-Mount Lavinia MC Area

Name of GND	Total	Male		Female	
		No	%	No	%
Dehiwala DSD					
Sri Saranankara	6,367	3,111	49	3,256	51
Vilawala	6,334	3,095	49	3,239	51
Dutugemunu	4,806	2,388	50	2,418	50
Kohuwala	5,475	2,567	47	2,908	53
Kalubovila	5,517	2,674	48	2,843	52
Hathbodhiya	6,228	3,049	49	3,179	51
Galwala	5,671	2,814	50	2,857	50
Dehiwala West	5,184	2,499	48	2,685	52
Dehiwala East	6,767	3,262	48	3,505	52
Udyanaya	5,914	2,891	49	3,023	51
Nedimala	9,058	4,356	48	4,702	52
Malwatta	3,543	1,714	48	1,829	52
Jayathilaka	4,374	2,108	48	2,266	52
Karagampitiya	5,633	2,826	50	2,807	50
Kawdana East	8,091	3,847	48	4,244	52
Dehiwala DSD Total	88,962	43,201	49	45,761	51
Ratmalana DSD					
Mount Lavinia	8,373	4,255	51	4,118	49
Kawdana West	6,624	3,199	48	3,425	52
Watarappala	6,311	3,116	49	3,195	51
Wathumulla	4,608	2,210	48	2,398	52
Katukurunduwatta	12,166	5,944	49	6,222	51
Attidiya North	8,854	4,284	48	4,570	52
Attidiya South	7,683	3,686	48	3,997	52
Piriwena	5,018	2,380	47	2,638	53
Wedikanda	7,585	3,635	48	3,950	52
Vihara	6,443	3,097	48	3,346	52
Rathmalana West	5,736	2,847	50	2,889	50
Rathmalana East	6,564	3,408	52	3,156	48
Kandawala	9,541	4,725	50	4,816	50
Ratmalana DSD Total	95,506	46,786	49	48,720	51
MC Total	184,468	89,987	49	94,481	51

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

2.2.3 Health and Diseases

The prevalence of chronic illnesses in the Colombo 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

	Under 15 years	15-24 years	25-59 years	60 and older
Colombo District	3.3%	2.4%	20.7%	63.4%
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 in Colombo District is lower than than the national average for the age group 15 – 24 years, but higher for other age categories. The prevalence of diabetes and high blood pressure among those 15 years and older is also higher than the national average.

Table 2.2-3 Prevalence of Diabetes and High Blood Pressure

	Diabetes	High Blood Pressure
Colombo District	11.2%	11.9%
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 and Ethnicity

The population in Colombo District is predominantly Buddhist, with relatively equal distributions in the Hindu, Islamic and Christian faiths as shown in **Table 2.2-4**.

Table 2.2-4 Population by Religion

Buddhist	Hindu	Islam	Roman Catholic	Other Christian	Other	Colombo District Total
1,631,659	185,944	274,267	162,701	67,405	2,324	2,324,300
70.2%	8.0%	11.8%	7.0%	2.9%	0.1%	100%

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

The majority of the population is Sinhalese.

Table 2.2-5 Population by Ethnic Group

Sinhala	SL Tamil	Indian Tamil	SL Moor	Other	Colombo District Total
1,778,090	234,754	23,243	248,700	37,189	2,324,300
76.5%	10.1%	1.0%	10.7%	1.6%	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 Rate

	% of Poor Households		
	2006/07	2009/10	2012/13
Sri Lanka	12.6	7.0	5.3
Western Province	6.5	3.0	1.5

Source: Census and Statistics Department

2.2.6 History and Culture (Heritage)

From 1412 to 1597 the Dehiwala-Mount Lavinia MC area was part of the Kingdom of Kotte comprised of villages such as Pepiliyana, Nedimala, Attidiya and Kalubowila, while Ratmalana and areas south of Dehiwala was one large span of marshland, and scarcely populated. A list of protected archaeological monuments in Dehiwala-Mount Lavinia MC is shown in **Table 2.2-7**.

Table 2.2-7 Protected Archaeological Monuments in Dehiwala–Mount Lavinia MC

Monument	GND	DSD	Description
Pushparama Vihara, Ratmalana	No. 546 BRatmalana Vihara division	Dehiwala	Ancient image house
Subodharama Purana Vihara	Karagampitiya	Dehiwala	Ancient image house, Sathsathi Mandira, Bana preaching hall, Awasage and relict chamber
Christ Church Cemetery		Ratmalana	The ancient four tombs engravings in the Christian cemetery
Galkissa Samudrasanna Vihara	No. 546-A Wedikanda	Ratmalana	The ancient Buddha shrine
Ratmalana Dewala watta	Ratmalana West	Ratmalana	The ancient Dewale house and other antiques
The ancient two Storied Building of School for blind	Ratmalana town	Ratmalana	The ancient Dewale house and other antiques

Source: Department of Archaeology

2.2.7 Economy

(1) General

In recent years, there has been rapid industrialization in Dehiwala-Mount Lavinia. The extensive commercial activities include restaurants and hotels catering to tourists. Many large-scale industries are also found in Ratmalana/Attidiya to the south. **Table 2.2-8** shows the Gross Domestic Product (GDP) of Western Province covering the Colombo, Gampaha, and Kalutara Districts.

Table 2.2-8 GDP by Sector for Western Province (Current Prices)

Unit: Million Japan Sewage Works Agency (LKR)

No	Sector	2010		2011		2012		2013	
1	Agriculture	75,942	3.0%	92,191	3.2%	93,187	2.9%	91,965	2.5%
2	Industry	802,790	31.9%	966,704	33.4%	1,135,586	35.0%	1,280,355	35.1%
3	Services	1,634,176	65.0%	1,835,532	63.4%	2,015,081	62.1%	2,270,921	62.3%
	GDP	2,512,908	100.0%	2,894,428	100.0%	3,243,854	100.0%	3,643,241	100.0%
	GDP Share Percentage	44.8		44.2		42.8		42.0	

Source: CBSL Annual Report 2014

Western Province, including Greater Colombo (GC), contributes about 42 to 44% of the national GDP. The service industry generates 60 to 65% (national average: 56.8%) of the total GDP of the Province. The industrial sector's share of the total GDP of the Province is only 30 to 35% (national average: 32.5%).

(2) Tourism

Dehiwala–Mount Lavinia is one of the top tourist destinations in the country, blessed with a beautiful long beach lined with a lot of restaurants, hotels, in addition to a zoological garden. There are a lot of apartments for domestic and foreign tourists. **Table 2.2-9**, **Figure 2.2-1** and **Figure 2.2-2** show the tourist numbers at the Dehiwala Zoological Garden and the revenue for the past 4 years.

Table 2.2-9 Number of Visitors to the Zoological Gardens and Revenue from Entrance Fees

Year	2011	2012	2013	2014
No. of Foreign Visitors	**20,446**	**21,188**	**27,120**	**28,823**
No. of Local Visitors	**1,689,755**	**1,412,062**	**1,429,322**	**1,249,562**
Total No. of Visitors	**1,710,201**	**1,433,250**	**1,456,442**	**1,278,385**
Revenue: Foreign Visitors (LKR)	**24,717,750**	**25,108,000**	**34,521,500**	**46,895,300**
Revenue: Local Visitors (LKR)	**130,922,050**	**110,039,210**	**112,079,300**	**98,383,110**
Total Revenue (LKR)	**155,639,800**	**135,147,210**	**146,600,800**	**145,278,410**

Source: Annual Statistical Reports- Sri Lanka Tourism Development Authority (Annual Reports of 2011,2012,2013,2014)

Most of the visitors were local tourists. There has been a slight drop in local tourists while the number of foreign visitors has been increasing for the same period. In 2014, there were at least 1,278,000 tourists to the Dehiwala Zoo. While the total revenue from admission fees has been decreasing, the amount for 2014 is still significant at 145 million LKR. Tourists also contribute to revenues of hotels, restaurants, transportation, souvenir shops, and related businesses. The total tourism revenues can be quite substantial.

The establishment of a sewerage system will preserve the water environment along the seashore and contribute to the continuous growth of the tourism industry and the economy of the area.

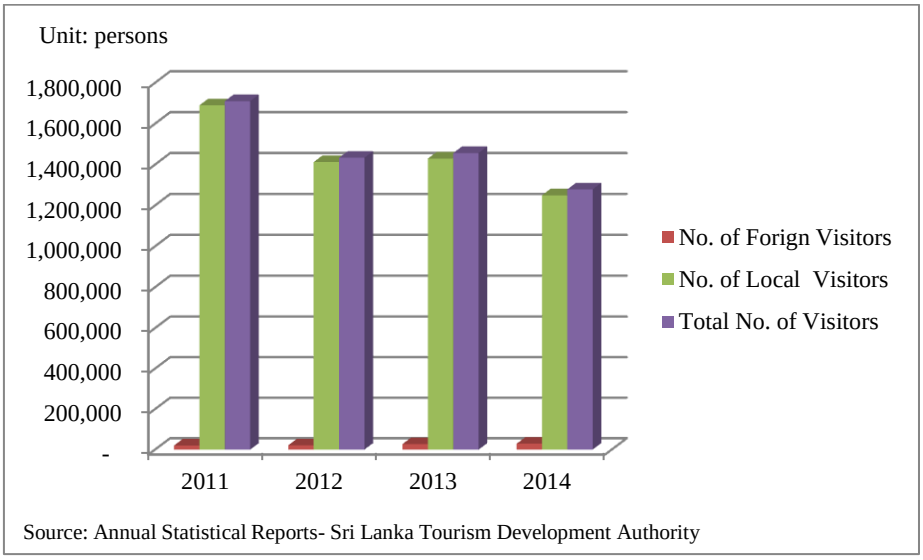


Figure 2.2-1 Dehiwala Zoological Garden Tourist Arrivals

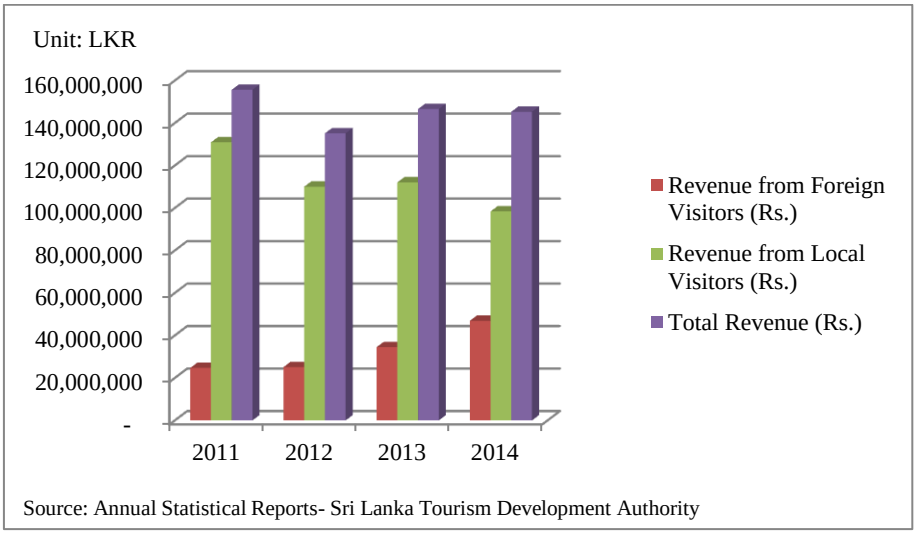


Figure 2.2-2 Dehiwala Zoological Garden Tourism Revenue

(3) Household Income

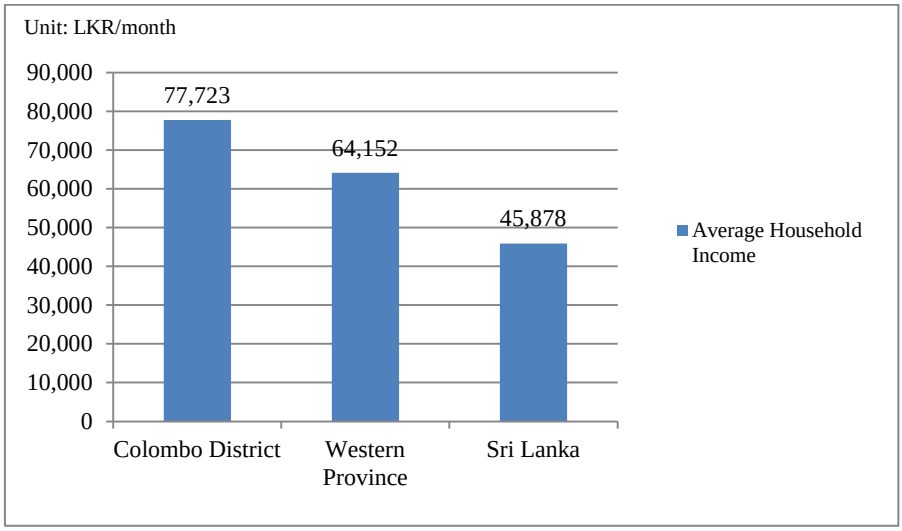
Average household income data are available from "Household Income and Expenditure Survey 2012/2013", some of which are presented in and **Figure 2.2-3**. The average monthly household income in Colombo District was 77,723 LKR in 2012/13. Most household income came from wage/salaries (37.4%). Household income is higher than the national average (41% lower) and 17.5% higher than that in Western Province. In Dehiwala-Mount Lavinia, the design of a sewage tariff should take into consideration households' ATP.

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

Unit: LKR/month

No.	Sector	Colombo District	%
1	Average Household Income	77,723	
2	Per capita	19,346	
3	Ave. No. of Income Receivers	1.9	
4	Wage/ Salaries	29,860	37.4%
5	Agricultural Activities	708	0.9%
6	Non-Agricultural Activities	19807	24.8%
7	Other Cash Income	8811	11.0%
8	Income by Adhoc Gain	6271	7.9%
9	Non-Monetary Income	12266	15.4%
10	Income in Kind	2078	2.6%

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 2.2-3 Comparison of Monthly Household Income

2.2.8 Land Use

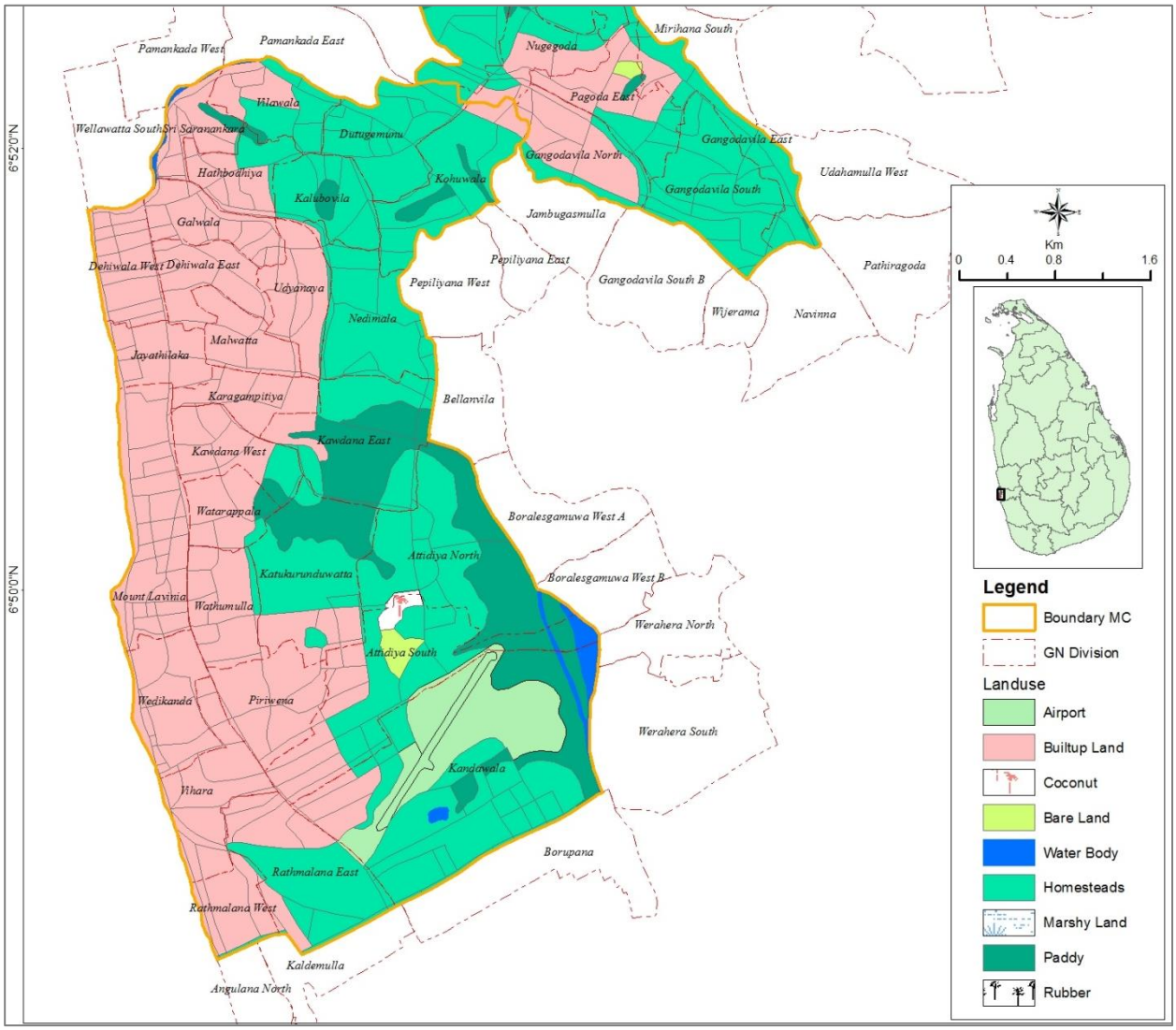
Land use in Colombo district is shown in **Table 2.2-11**. Land use in Dehiwala-Mount Lavinia MC area is monitored and managed with GIS mapping, as shown in **Figure 2.2-4**.

Table 2.2-11 Land Use in Colombo District

ඉඩම් ස්වභාවය Nature of land	භූමි ප්‍රමාණය (හෙක්ටයාර) Area (Hec)	ප්‍රතිශතය Percentage (%)
01.අස්වද්දන ලද කුඹුරු` - Asweddumized paddy land		
1. වාරිමාර්ග - Irrigated	1971.3	2.8
11.අහස්දියෙන් - Rainfed	5737.5	8.2
02.තේ - Tea	67.2	0.1
03. රබර් - Rubber	16558.0	23.6
04. පොල් - Coconut	2928.6	4.2
05. කුරුදු- Cinnamon	152.8	0.2
06. වෙනත් වගාවන් - Other crops	418.4	0.6
07.වනාන්තර- Forests		0.0
1. ඝන වනාන්තර - Dense forests	1237.4	1.8
11. විවෘත වනාන්තර - Open forests	8.0	0.0
111. වගා කරන ලද වනාන්තර - Planted forests	618.3	0.9
08.ලදු කැළෑ හා හේන - Grass lands/Chena	584.1	0.8
09. වගුරු හා කඩොලාන කැළෑ - Marshes and Mangroves	2226.2	3.2
10.ගෙවතු - Home gardens	19154.4	27.3
11.ජලාශ - Reservoirs	1705.9	2.4
12.ගොඩනැගිලි- Building	11199.0	16.0
13වැලි හා ගල් පර - Sand and Mountain	58.8	0.1
14. ඔබ්බු කිරීම් හා අත්හරින ලද ඉඩම් - Abandoned land	598.4	0.9
15.වෙනත් (පූජා භූමි, මාර්ග,සුසාන භූමි ආදිය)	4917.8	7.0
Other (sacred places, roads,cemetery etc)		
එකතුව - Total	70141.9	100.0

Source: District Land use Planning Office

Almost all Dehiwala-Mount Lavinia is developed (**Figure 2.2-4**). The paddy fields will be replaced by a recreation zone, according to UDA's zoning plan (**Figure 2.2-5**).



Source: Survey Department of Sri Lanka

Figure 2.2-4 Land Use in Dehiwala-Mount Lavinia MC

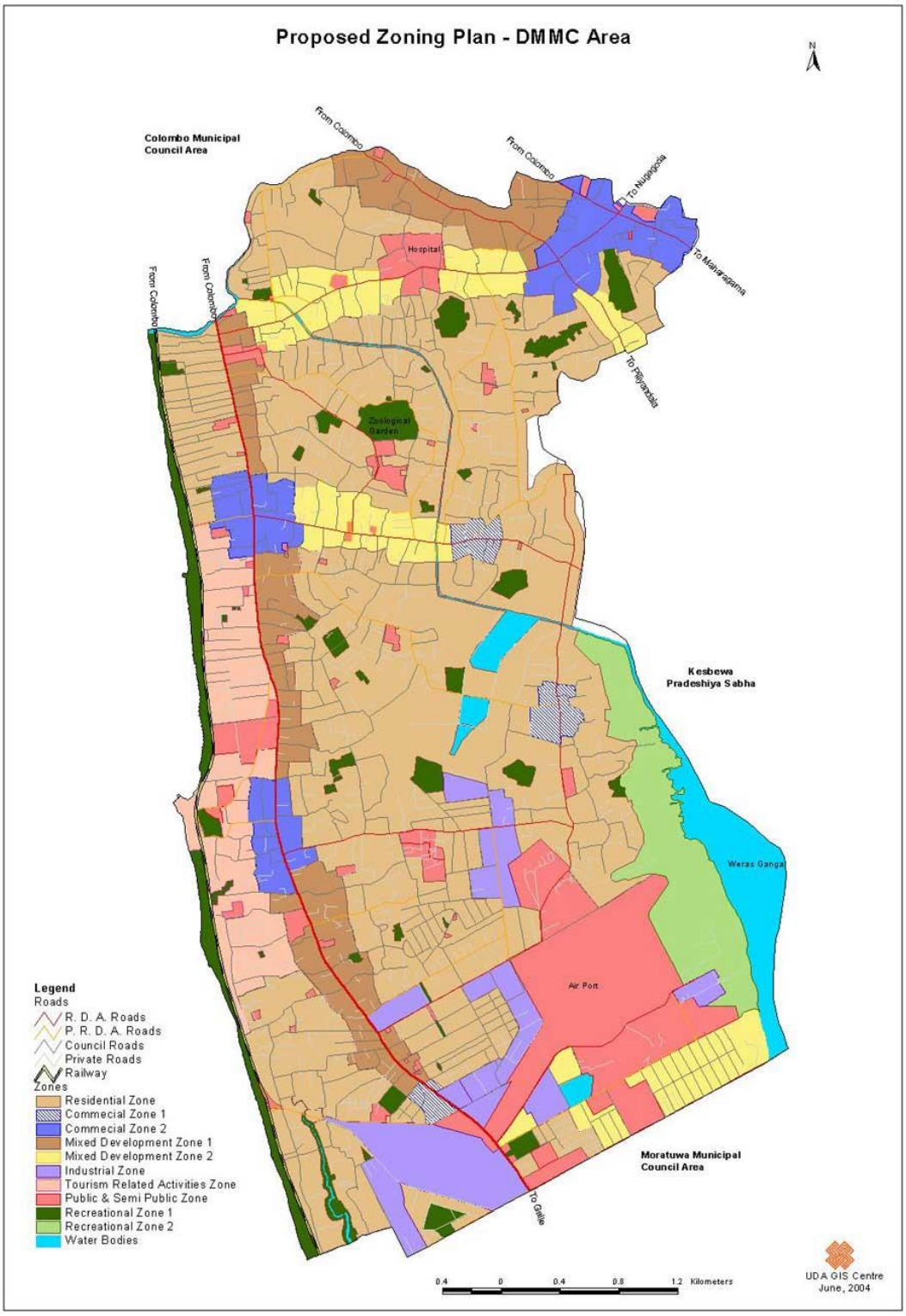


Figure 2.2-5 Land Use Plan for Dehiwala-Mount Lavinia MC

2.2.9 Water Supply and Sanitation

(1) Water Supply

Table 2.2-12 shows the access to drinking water by source. Dehiwala-Mount Lavinia MC has a 100% access to piped water supply which serves 57,600 households and businesses. Some households choose to use communal water taps and tube wells.

Table 2.2-12 Access to Water by Source in Dehiwala-Mount Lavinia MC Area

No.	Name of GND	GND 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
Dehiwala DSD																
1	Sri Saranankara	538C	1,546	32	2	-	1,395	81	28	-	5	-	-	-	2	1
2	Vilawala	537	1,512	41	2	-	1,342	69	25	-	-	-	-	-	32	1
3	Dutugemunu	537A	1,246	79	-	-	1,129	15	22	-	1	-	-	-	-	-
4	Kohuwala	537B	1,482	92	3	-	1,345	35	4	-	-	-	-	-	3	-
5	Kalubovila	538	1,397	89	3	-	1,167	123	9	-	4	-	-	-	1	1
6	Hathbodhiya	538B	1,566	60	-	-	1,446	50	8	-	-	-	-	-	2	-
7	Galwala	538A	1,365	12	-	-	1,320	13	13	-	3	-	-	-	4	-
8	Dehiwala West	540A	1,464	7	-	-	1,213	6	238	-	-	-	-	-	-	-
9	Dehiwala East	540	1,692	20	2	-	1,599	34	25	-	2	-	3	-	4	3
10	Udyanaya	536A	1,443	39	-	2	1,316	70	14	-	1	-	-	-	-	1
11	Nedimala	536	2,407	100	14	2	2,147	120	14	-	8	-	-	-	1	1
12	Malwatta	539/42A	923	38	3	-	866	6	5	-	-	5	-	-	-	-
13	Jayathilaka	540B	1,116	7	-	-	1,000	57	48	-	-	-	-	-	4	-
14	Karagampitiya	539/42	1,391	45	8	-	1,290	35	11	-	-	-	-	-	-	2
15	Kawdana East	539/42B	2,141	116	6	1	1,911	81	20	-	6	-	-	-	-	-
Dehiwala DSD Total			22,691	777	43	5	20,486	795	484	-	30	5	3	-	53	10
Ratmalana DSD																
1	Mount Lavinia	541	2,195	18	1	1	2,034	66	44	-	6	-	-	-	3	22
2	Kawdana West	539/42C	1,667	45	3	-	1,569	17	27	-	1	-	-	-	3	2
3	Watarappala	544	1,591	76	2	1	1,312	39	155	-	1	-	-	-	2	3
4	Wathumulla	544A	1,330	57	2	1	1,246	3	10	-	1	-	-	-	9	1
5	Katukurunduwatta	545A	3,034	67	8	-	2,761	126	50	-	5	-	-	-	10	7
6	Attidiya North	543	2,314	191	7	1	1,775	247	73	-	5	-	-	-	5	10
7	Attidiya South	543B	2,052	185	4	2	1,617	118	38	-	2	-	-	77	9	-
8	Piriwena	545	1,354	62	-	-	1,108	53	124	-	1	-	-	-	6	-
9	Wedikanda	546A	2,021	21	-	-	1,821	130	40	-	3	-	-	-	6	-
10	Vihara	546B	1,598	5	-	-	1,443	113	28	-	3	-	-	-	4	2
11	Rathmalana West	546	1,412	16	7	-	1,015	300	69	-	2	-	-	-	-	3
12	Rathmalana East	546C	1,695	2	4	-	1,258	364	66	-	-	-	-	-	-	1
13	Kandawala	543A	2,310	64	11	1	1,863	339	22	-	2	-	-	5	2	1
Ratmalana DSD Total			24,573	809	49	7	20,822	1,915	746	-	32	-	-	82	59	52
MC			4,7264	1,586	92	12	4,1308	2,710	1,230	0	62	5	3	82	112	62

Source: Census of Population and Housing 2012, DCS

Piped water consumption is shown in **Table 2.2-13**. The supply system is not keeping up with growing

demand, causing problems such as inadequate water pressure during peak periods. Water supply volume needs to be augmented accordingly.

Table 2.2-13 Water Consumption for 2013-2015

Unit: m^3/year

	2013	**2014**	**2015**
Households	11,584,470	11,794,176	12,304,450
Commercial and Industrial	1,298,161	1,416,786	1,515,378
Institutional	274,601	286,811	303,745
Others	154,214	150,155	155,773
Total	13,311,446	13,647,928	14,279,346

Source: National Water Supply & Drainage Board (NWSDB)

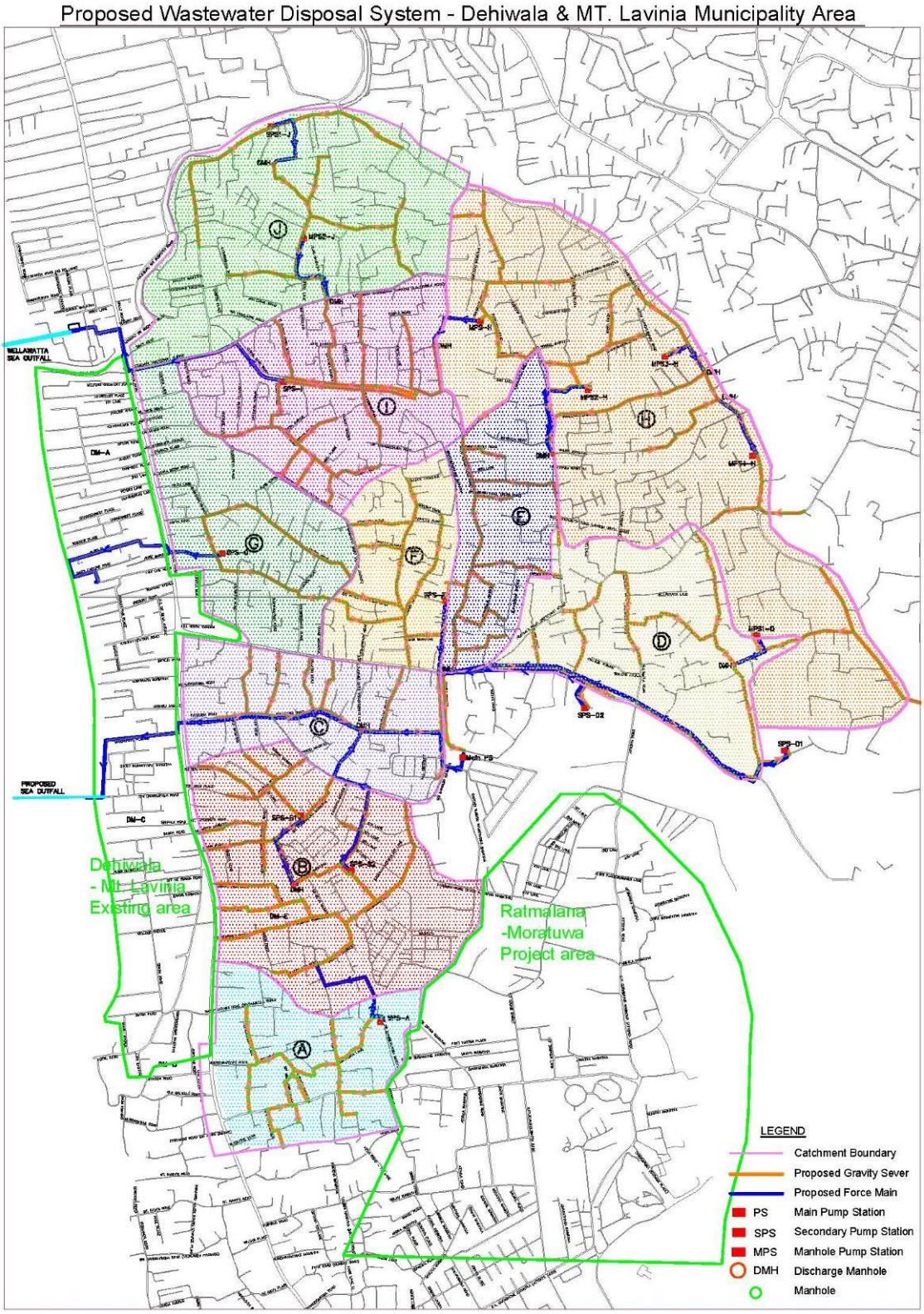
(2) Sanitation

Table 2.2-14 shows the distribution of sanitation facilities in Dehiwala-Mount Lavinia MC. Approximately 97% of the households have water sealed toilets (i.e. with traps to block odour) connected to septic tanks.

Sewer reticulation is only available in two areas (**Figure 2.2-6**). One sewer area extends from the coastal area in Mount Lavinia to Wellawatte (circled in green on the left). The other is Mount Lavinia GN encompassing the Mount Lavinia intersection and sections along Galle Road up to the bridge over Dehiwala Canal. It was developed by Asian Development Bank (ADB)'s GC Wastewater Management Project and has been in operation since 1987 (shaded in green).

Only a small portion of the wastewater generated in Dehiwala-Mount Lavinia MC is collected in the existing piped system, and this wastewater is discharged to the ocean without treatment.

A sewer system development plan proposed by the private sector envisions reinforcing the existing sewage collection network and developing a collection system in other areas.



Source: NWSDB

Figure 2.2-6 Sewerage Development Plan Proposed by the Private Sector - Dehiwala-Mount Lavinia MC

Table 2.2-14 Access to Sanitation in Dehiwala-Mount Lavinia MC Area

No.	Name of GND	Total	Water Seal Toilet	Pour Flush Toilet (Not Water Trap	Direct Pit	Other	Not Using Toilet
Dehiwala DSD							
1	Sri Saranankara	1,546	1,501	5	38	2	0
2	Vilawala	1,512	1,413	21	76	2	0
3	Dutugemunu	1,246	1,202	15	29	0	0
4	Kohuwala	1,482	1,399	5	78	0	0
5	Kalubovila	1,397	1,336	36	25	0	0
6	Hathbodhiya	1,566	1,563	0	1	1	1
7	Galwala	1,365	1,358	6	1	0	0
8	Dehiwala West	1,464	1,463	0	1	0	0
9	Dehiwala East	1,692	1,669	11	10	0	2
10	Udyanaya	1,443	1,420	15	8	0	0
11	Nedimala	2,407	2,356	25	24	0	2
12	Malwatta	923	920	2	1	0	0
13	Jayathilaka	1,116	1,056	3	57	0	0
14	Karagampitiya	1,391	1,356	9	26	0	0
15	Kawdana East	2,141	2,099	15	27	0	0
Dehiwala DSD Total		22,691	168	22,111	402	5	5
Ratmalana DSD							
1	Mount Lavinia	2,195	2,179	3	12	0	1
2	Kawdana West	1,667	1,663	3	0	0	1
3	Watarappala	1,591	1,584	5	2	0	0
4	Wathumulla	1,330	1,327	2	1	0	0
5	Katukurunduwatta	3,034	2,941	88	4	1	0
6	Attidiya North	2,314	2,218	36	59	1	0
7	Attidiya South	2,052	2,002	47	3	0	0
8	Piriwena	1,354	1,330	8	14	0	2
9	Wedikanda	2,021	1,977	8	34	1	1
10	Vihara	1,598	1,510	1	83	1	3
11	Rathmalana West	1,412	1,405	0	7	0	0
12	Rathmalana East	1,695	1,633	30	1	30	1
13	Kandawala	2,310	2,125	29	154	1	1
Ratmalana DSD Total		24,573	260	23,894	374	35	10
MC		47,264	428	46,005	776	40	15

Source: Census of Population and Housing 2012, DCS

2.2.10 Solid Waste Collection and Disposal

Dehiwala-Mount Lavinia MC generates 175 tons of waste per day. Per capita waste generation is 933 grams per day. Waste generated from households and commercial facilities is collected by the MC or private operators and disposed of at the Karadiyana dump site.

Medical waste from the Colombo South Teaching Hospital in Kalubowila and some healthcare centres undergoes special processing before being disposed of at the Karadiyana dump site. **Figure 2.2-7**Figure 2.2-7 shows the disposal site and composting facility.

Sauce: JET

Figure 2.2-7 Karadiyana Disposal Site (left) and Composting Facility (right)

2.3 NEED FOR THE PROJECT

As stated in its 2010 national policy, Sri Lanka aims to achieve 100% access to adequate sanitation by 2025, through the development of on and off-site sanitation facilities. NWSDB's service plan sets the 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, coverage of piped sewerage remains at 2.4% in Sri Lanka. Elsewhere, wastewater is treated on-site, typically by septic tanks, most are not working properly in Dehiwala-Mount Lavinia due to high population density. Local water bodies have high levels of BOD, ammonia, phosphorus, and coliform from wastewater discharges (See 2.1.5).

Sewage collection and treatment is necessary to preserve and improve water quality.

CHAPTER 3 PLANNING BASIS FOR SEWERAGE SYSTEM

3.1 SANITATION PROVISION

In March 2013, NWSDB, with the country's financial support, prepared the "Proposal for Extension of Piped Sewerage Coverage for Dehiwala-Mt. Lavinia MC Area". Targeting year 2040, the proposal suggests using 1.7 km of 1,500 mm diameter HDPE pipe to discharge wastewater into the sea, in lieu of providing treatment. The served population would be the population for 2013 as forecast in the 2001 census. However, according to the 2012 census, the population projection was overestimated. Population is a key determinant for sewer system planning. Therefore, the M/P has prepared a set of general assumptions, incorporating the 2012 census data and the broader target area, drawing on the above proposal.

3.1.1 Target Year

According to "NWSDB Design Manual D7 Wastewater Collection, Treatment, Disposal & Re-Use 2012", the design period for collection networks, pumping stations, STP, and effluent disposal and utilization systems is 30 years. Therefore, 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 the sewage volume calculation matrix.

Table 3.1-1 Design Basis for Estimating Sewage Flow

Item	Value	Remarks
Per capita water consumption	120 lpcd	
Domestic Flow	80%	of water consumption
Non-domestic Flow	30%	of Domestic Flow
Average Dry Weather Flow (ADWF)	Domestic + Non-domestic flow	
Daily maximum dry weather flow	1.15 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: PDWF + Infiltration
Planning of Pumping Station: Hourly Maximum Dry Weather Flow + Infiltration
Source: JET

(2) Trunk Sewers

a. Hydraulic Calculation for Trunk Sewers

The Manning formula is used for the hydraulic calculation of gravity sewers, and the Hazen William formula is used for force mains (pressurized flow).

Manning Formula

$Q = A \times V$, $V = 1/n \times R^{2/3} \times S^{1/2}$

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

$Q = A \times V$, $V = 0.84935 \times C \times R^{0.63} \times S^{0.54}$

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 Cover
1.0 m

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

f. Pipe Materials

Table 3.1-3 Sewer 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 type of pumping stations. They are manhole type pumping station (MTPS) or major pumping station (MPS). The Ceylon Electricity Board (CEB) requires that the electrical demand at a pumping facility be 42 kVA or less where transformers are not provided. Where the electrical demand exceeds 42 kVA, transformers are 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

Types 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:

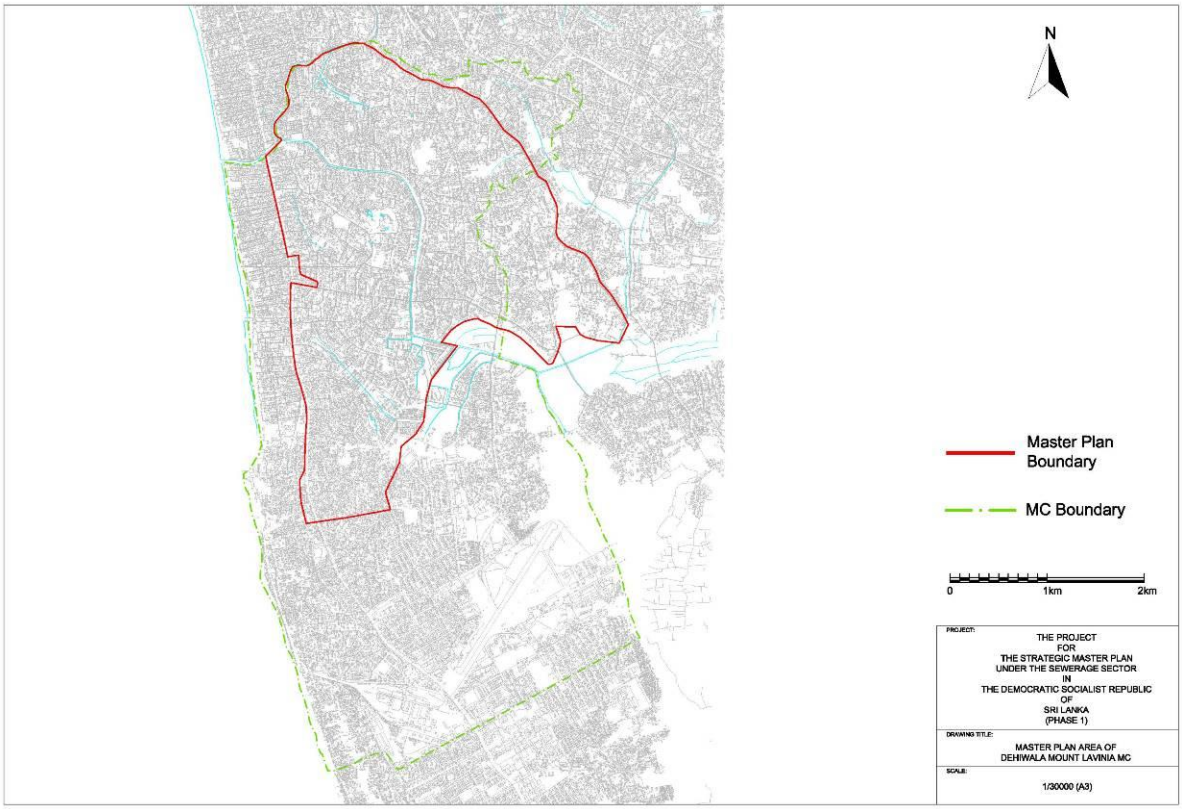
- influent sewage quality and effluent discharge standards
- land availability

- construction and O&M cost
- ease of operation and maintenance (O&M)

3.1.3 Sewerage Service Area Selection

The sewerage service area in the Master Plan includes:

- developed and almost fully developed and populated areas by the target year of 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
- adjacent city areas where these can be cost effectively included



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

Figure 3.1-1 M/P Area in Dehiwala-Mt. Lavinia

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	S/No.	GND No.	GND
1	**Dehiwala DSD**		2	**Ratmalana DSD**	
1.1	538C	Sri Saranankara	2.1	539/42C	Kawdana West
1.2	537	Vilawala	2.2	544	Watarappola
1.3	537A	Dutugemunu	2.3	544A	Wathumulla
1.4	537B	Kohuwala	2.4	545A	Katukurunduwatta
1.5	538	Kalubowila	3	**Kesbewa DSD**	
1.6	538B	Hathbodhiya	3.1	535	Pepiliyana West
1.7	538A	Galwala	3.2	535A	Bellanwila
1.8	540	Dehiwala East	3.3	535B	Divulpitiya West
1.9	536A	Udyanaya			
1.1	536	Nedimala			
1.11	539/42A	Malwatta			
1.12	539/42	Karagampitiya			
1.13	539/42B	Kawdana East			

Source: JET based on data of DCS

3.1.4 Sewage Flow

Rate of population increase in the project area and planned population is calculated as shown in Section 1 **APPENDIX 12**. The sewage volume to be treated is calculated as shown in **Table 3.1-6**. Detailed calculation sheets are attached in **APPENDIX 1**.

Table 3.1-6 Design Sewage Flow

M/P Area (ha)	Item	2046	Remarks	
981	a Population	106,100		
	b Water Consumption (l/d/cap)	120		
	c Return factor (%)	80		
	d Domestic Flow (m^3/d)	10,186	d = a x b x c	
	e Non-Domestic Flow (m^3/d)	3,056	e = d x 30%	
	f Point Source (m^3/d)	-		
	g Infiltration (m^3/d)	2,648	g = (d + e + f) x 20%	
	h Daily Average Flow (m^3/d)	15,890	h= d + e + f + g	
	i Daily Maximum Flow (m^3/d)	17,876	i = (d + e + f) x 1.15 + g	For STP design
	j Hourly Maximum Flow (m^3/d)	23,835	j = (d + e + f) x 1. 6+ g	For PS design
	k Peak Flow (m^3/d)	42,374	k= (d + e + f) x 3.0+ g	For Sewer design

3.1.5 Influent Sewage Quality

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

Table 3.1-7: Design Sewage Quality

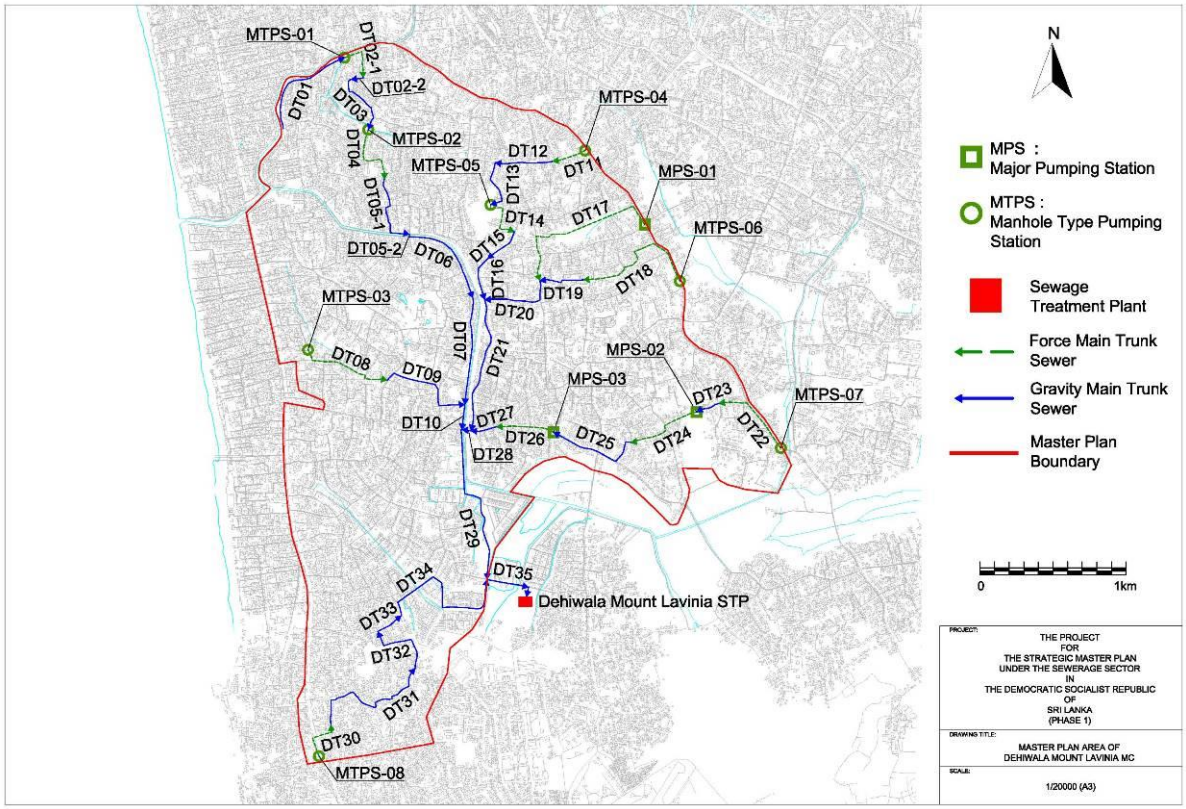
Parameter	Influent Sewage
	Design
BOD_5	240
COD	600
TSS	160
T-N	45
T-P	6

Unit: mg/L
Source: JET

CHAPTER 4 PRELIMINARY PLAN AND DESIGN OF THE SEWERAGE SYSTEM

4.1 GENERAL LAYOUT

The proposed sewerage development plan for Dehiwala-Mt. Lavinia 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 Dehiwala-Mt. Lavinia

4.2 SEWAGE COLLECTION FACILITIES

The design of the NWSDB 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	147,150m	Including Force Main
	Sub-Total (Branch Sewer)		147,150m	
Trunk Sewer	225mm	HDPE Pipe	1,149m	
	280mm	HDPE Pipe	85m	
	315mm	HDPE Pipe	855m	
	355mm	HDPE Pipe	1,262m	
	400mm	GRP Pipe	1,958m	Pipe Jacking (110m)
	450mm	GRP Pipe	714m	Pipe Jacking (153m)
	500mm	GRP Pipe	662m	Pipe Jacking (57m)
	600mm	GRP Pipe	2,758m	Pipe Jacking (885m)
	700mm	GRP Pipe	1,649m	Pipe Jacking (1,192m)
	1000mm	GRP Pipe	1,133m	Pipe Jacking (671m)
	1200mm	GRP Pipe	290m	Pipe Jacking (290m)
	110mm	HDPE Pipe	557m	Force Main
	125mm	HDPE Pipe	305m	Force Main
	160mm	HDPE Pipe	1,893m	Force Main
	180mm	HDPE Pipe	1,741m	Force Main
	225mm	HDPE Pipe	469m	Force Main
	250mm	HDPE Pipe	529m	Force Main
	315mm	HDPE Pipe	400m	Force Main
	Sub-Total (Trunk Sewer)		18,409m	Sub-Total (Pipe Jacking) 3,358m
Total	Branch Sewer + Trunk Sewer		165,559m	
	Crossing: Railway Crossing (None), River Crossing (4 locations)			

*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 1.7 m^3/min	40 m	2+(1)	land requirement is about 0.08 ha
MPS-02	Approximately 3.5 m^3/min	25 m	2+(1)	land requirement is about 0.08 ha
MPS-03	Approximately 5.2 m^3/min	20 m	2+(1)	land requirement is about 0.08 ha
MTPS-01	Approximately 0.9 m^3/min	20 m	1+(1)	
MTPS-02	Approximately 2.7 m^3/min	20 m	1+(1)	
MTPS-03	Approximately 1.7 m^3/min	30 m	1+(1)	
MTPS-04	Approximately 0.2 m^3/min	10 m	1+(1)	
MTPS-05	Approximately 1.5 m^3/min	30 m	1+(1)	
MTPS-06	Approximately 1.2 m^3/min	40 m	1+(1)	
MTPS-07	Approximately 1.2 m^3/min	30 m	1+(1)	
MTPS-08	Approximately 0.3 m^3/min	15 m	1+(1)	

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

4.2.3 Service/House Connections

It is projected that there will be approximately 26,500 households by 2046. This is based on the 2046 population of 106,000 people and an average family size of four people, reported in the Household Income and Expenditure Survey 2012/13 issued by the DCS.

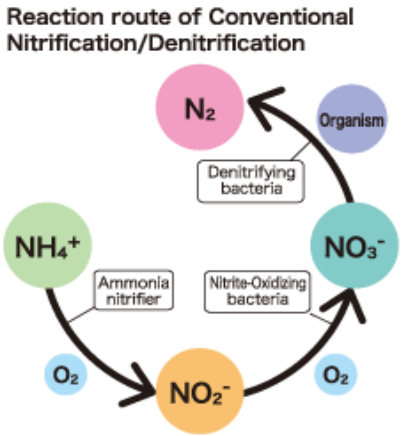
4.3 SEWAGE TREATMENT FACILITY

4.3.1 Treatment Method

(1) Compliance with the Allowable Discharge Limits

The effluent of NWSDB shall comply with the allowable discharge limits. The allowable discharge limit is being amended and the draft amendment is available to the public, although it is not yet gazetted. The effluent quality shall comply with the amended discharge limits. The draft amendment of allowable discharge limits are shown in **APPENDIX 4**. The allowable limits for organic substances will not be changed much. Those for heavy metals will become stricter. The newly introduced item which is likely to have considerable influence on sewage treatment is the allowable limit for nitrate, which is 10 mg/L as NO_3-N.

Figure 4.3-1 shows the reaction cycle of nitrogen during the biological wastewater treatment. Ammoniac nitrogen and a portion of organic nitrogen is converted into nitrite and then to nitrate through nitrification carried out by ammonia oxidizing bacteria (AOB) as well as nitrite oxidizing bacteria (NOB). Nitrate produced should be reduced through denitrification to less than 10 mg/L to meet the allowable discharge limit. Nitrification naturally progresses under high wastewater temperature conditions in Sri Lanka. Suppression of nitrification reaction is therefore not easy and is not considered to be a realistic option. The treatment process should have biological denitrification ability. Denitrification can be integrated into activated sludge processes relatively easily, but is more difficult for biofilm processes and stabilization ponds.



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

Figure 4.3-1 Nitrogen Cycle

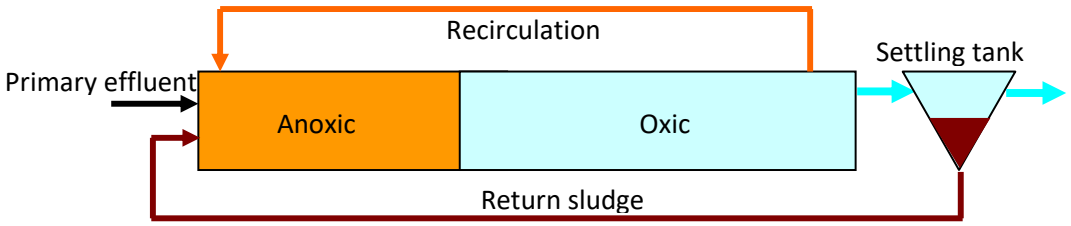
(2) Selection of Treatment Process for Estimating Land Requirements

The projected daily maximum sewage inflow rate is 20,000 m^3/d , requiring a mid-scale facility. The commonly used OD process is for small-scale STPs and therefore not suitable.

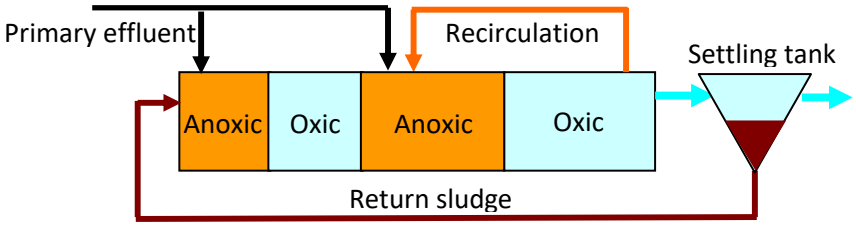
Considering that nitrogen removal by denitrification is required, biological nutrient removal (BNR) is used for estimating land requirement. There are many variations of BNR process. Activated-sludge BNR system can be designed in many configurations. Common features include anaerobic zones for the release of stored phosphorus, anoxic zones for denitrification, and oxic zones for oxidation of

organic material, nitrification, and phosphorus uptake. Recirculation typically is included to return nitrified mixed liquor from the oxic zone to the anoxic zones for denitrification. **Figure 4.3-2** shows some examples of commonly used BNR process.

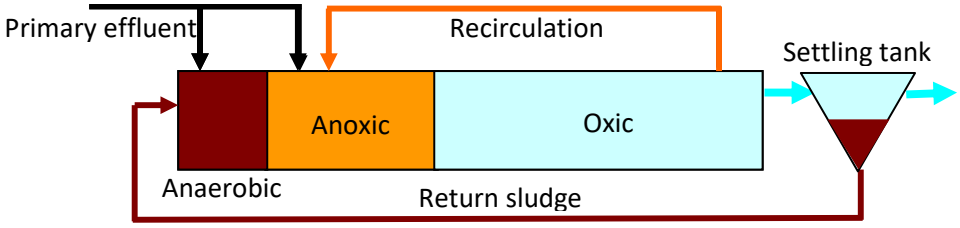
MLE (Modified Ludzack-Ettinger) process : N removal



Multi stage step-feed BNR process (Two-stage) : N removal



A_2O (Anaerobic-Anoxic-Oxic) process : N, P removal



Source: JET

Figure 4.3-2 Examples of BNR Process

There are many variations and proprietary BNR processes. A BNR process with a biofilm carrier in the nitrification (oxic) zone has recently become more popular. Nitrifying biomass in the reactor is increased by the introduction of biofilm carrier, resulting in a shorter hydraulic retention time (HRT) in the nitrification zone, potentially reducing the space required.

Information on the site conditions is necessary for the final determination of the treatment process. Since the STP site is not yet decided, the following discussion on treatment process is in general terms only.

4.3.2 Sewage Treatment Process

(1) Required Treatment Level

The design influent wastewater quality and target effluent quality values are shown in **Table 4.3-1**. The influent and effluent quality used are the same as proposed for Sri Jayawardenapura Kotte MC.

Table 4.3-1 Design Quality of Influent and Effluent

Inflow		Effluent	
		Tolerance limit	Design target value
BOD_5	240	30	15
COD	600	250	75
TSS	160	50	15
T-N	45	-	-
TKN	-	150	2.5
NH_4-N	-	50	2.5
NO_3-N	-	10	10
T-P	6	-	3
Soluble-P	-	5	2

(mg/L)

Source: JET

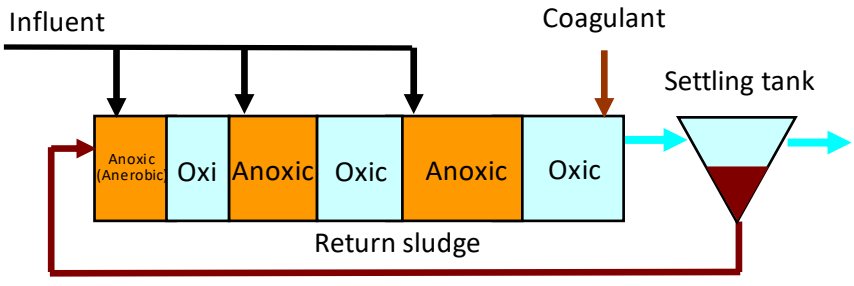
(2) Treatment Process

The selected BNR process must satisfy the following conditions:

1) effluent must meet the design target values
2) treatment facility must be accommodated within the identified site.
3) process must minimize maintenance cost

BNR systems used to be configured in a plug-flow regime with the system influent and return activated sludge (RAS) flows directed to the beginning of the tanks. More recently, adaptations are made to use step-aeration. Step-feed BNR configurations can remove high levels of nutrients with reduced tank volume.

A three-stage step-feed BNR process is the preferred treatment process (**Figure 4.3-3**).



Source: JET

Figure 4.3-3 Three-stage Step-feed BNR Process

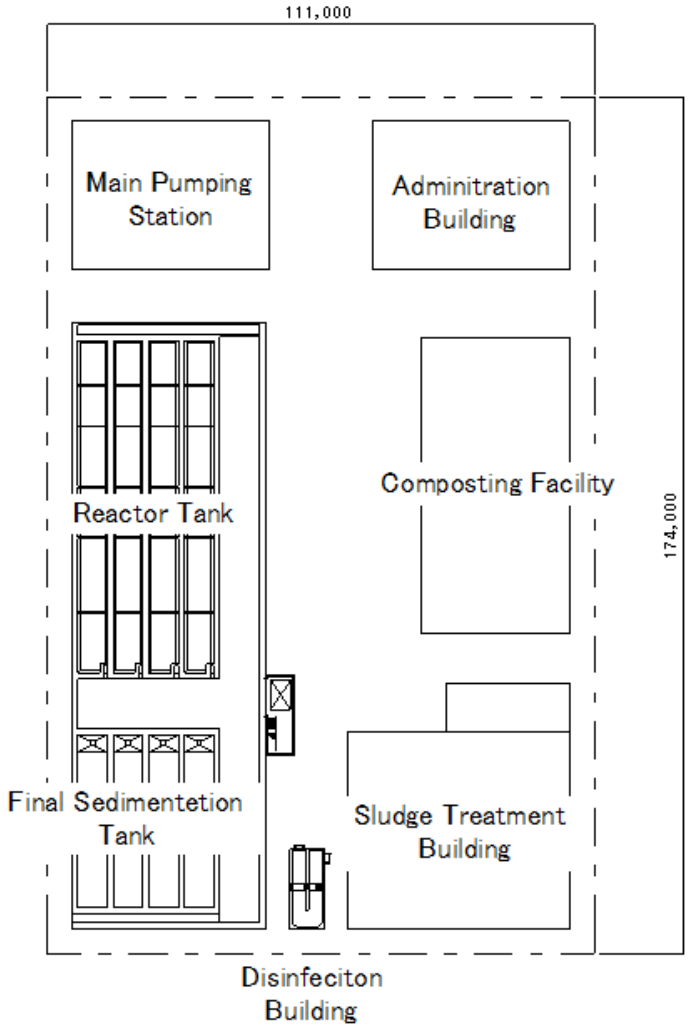
Equal amounts of influent is introduced to each denitrification tank. The capacity of each tank is determined so that each stage would have the same biomass amount.

This process configuration, offers the following advantages:

1) High nitrogen removal efficiency (about 80%) can be achieved with a much smaller recirculation ratio (0.5Q).
2) Return activated sludge is enough thus internal recirculation in each stage is not required.
3) Reactor HRT can be reduced to less than 10 hours which is small enough for the process to fit the selected site.

(3) General Layout

Figure 4.3-4 shows the typical layout of a STP using the three-stage step-feed BNR process. The required area is about 2 ha.



Source: JET

Figure 4.3-4 4.3-4: Draft Layout of the Treatment Plant

(4) Main Unit Processes

1) Screen and grit chamber

Screening is the first operation at STP. Screening removes objects such as rags, paper, plastics and metals to prevent damage and clogging of downstream equipment, piping, and appurtenances. Grit includes sand, gravel, cinder, or other heavy solid materials that are "heavier" (higher specific gravity) than the organic biodegradable solids in the wastewater. Grit also includes eggshells, bone chips, seeds, and coffee grounds. Removal of grit prevents abrasion and wear of mechanical equipment, deposition in pipelines and channels, and accumulation in aeration basins. Grit removal follows screening and precedes aeration.

The treatment plant will accept septage from areas that will not be covered by the sewerage network for the foreseeable future. Septage should be separately and carefully processed to remove coarse materials and sand before entering the aeration tanks. Since the plant has no primary settling tank to provide dilution, the amount of septage that can be accepted should not exceed 0.5% of the influent flow volume.

2) Primary settling tank

Typically, the next stage in treatment would be primary sedimentation where sewage flows through large primary sedimentation tanks or primary clarifiers. The tanks are used to settle organic solids while grease and oils rise to the surface and are skimmed off. Approximately 60% of suspended solids and 35% of BOD removal efficiency can be achieved at this stage.

Primary sedimentation tanks are omitted to save space and reduce land requirements. Sewage will flow directly to the BNR process.

3) Reactor

Wastewater flows into the BNR reactor tanks, which is the main part of the process. The total HRT of the reactor is estimated to be 9.5 hours. Influent is divided equally into three and step-fed into each anoxic tank. Aerobic decomposition of organic substances and nitrification takes place in the oxic tanks. Return activated sludge which contains nitrate is sent to the first anoxic tank where denitrification takes place (nitrate is converted to nitrogen, N_2). The organic substances required for denitrification is supplied by influent wastewater.

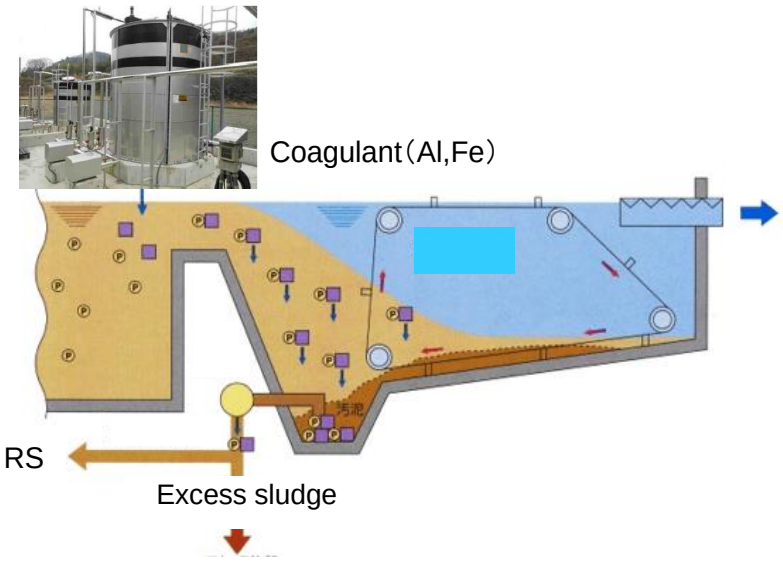
Biological phosphorous removal is the uptake of phosphorus by phosphorus-accumulating organisms (PAOs). These micro-organisms are settled out in the clarifier as activated sludge. While the actual uptake of phosphorus occurs under aerobic conditions, PAOs must first be conditioned by exposure to volatile fatty acids (VFA) under anaerobic conditions. The anaerobic cell is integrated in the first anoxic tank.

While good aeration is all that is needed for phosphorus uptake to occur, the aerobic uptake of phosphorus is dictated by the amount of VFA stored and energy/phosphorus released in the anaerobic zone. Therefore, success is primarily determined by influent wastewater quality and the amount of VFA that is present proportion to the amount of phosphorus to be removed.

Biological phosphorous removal is expected to some extent however, simultaneous chemical precipitation is added to the third stage to ensure that target P concentrations are met. Coagulant is added directly into the mixed liquor at the end of the third stage in the oxic tank. Mixing and coagulation take place in the oxic tank and phosphorous is precipitated with the activated sludge in the

final settling tank. The coagulant dosing equipment is minimal (only a coagulant storage tank and a dosing pump are required).

Figure 4.3-5. shows the principle of the simultaneous precipitation method.



Source: JET

Figure 4.3-5 Principle of Simultaneous Precipitation

4) Final settling tank

The mixed liquor flows into the settling tank and is retained for 3.4 hours at the overflow rate of 25 $m^3/m^2/d$. Solid-liquid separation takes place there. 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 first stage anoxic tank to keep the process going and the excess is sent to thickening and dewatering.

5) Disinfection

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.

4.3.3 Odour Control

The possible odour emission points are:

- septage receiving facility
- grit chamber
- reactor tank
- sludge treatment process

The septage receiving facility, grit chamber and sludge treatment process are the main odour emission

points. Odour from the reactor tank is usually not very offensive. Necessity of deodorization process depends on the environmental condition near the STP.

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

Odour control options are as follows:

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

Soil bio-filter is a simple method but periodical soil turnover is required for efficient odour reduction. If intensive odour control is required, activated carbon is necessary.

4.3.4 Sludge Treatment and Disposal

(1) Characteristics of Waste Sludge Produced

The waste activated sludge (WAS) from the STP is estimated to be 20 t/d. This sludge when dewatered will have a moisture content of 80%, corresponding to 4 DSt/d. The WAS has a high protein content which is the main component of the biomass. This is aerobically stabilized due to the long solids retention time (SRT). Odour emission therefore is generally much less than primary sludge.

If waste sludge becomes anaerobic in the storage tank, phosphorus will be released to the supernatant which is returned to the BNR reactor and will impose an additional load. Therefore, rapid processing from the storage tank is desirable.

(2) Sludge Treatment

1) Thickening

Sludge thickening normally refers to the process of reducing free water content. Thickening is an important process because it reduces the volume of sludge that is sent to the dewatering process. Gravity thickening works best for primary sludge and is not very effective for WAS. Mechanical thickening is more efficient. The commonly used mechanical methods are: dissolved air floatation (DAF), centrifugation, gravity belt thickener and screw press. Detailed considerations will be described in the F/S.

2) Anaerobic Digestion

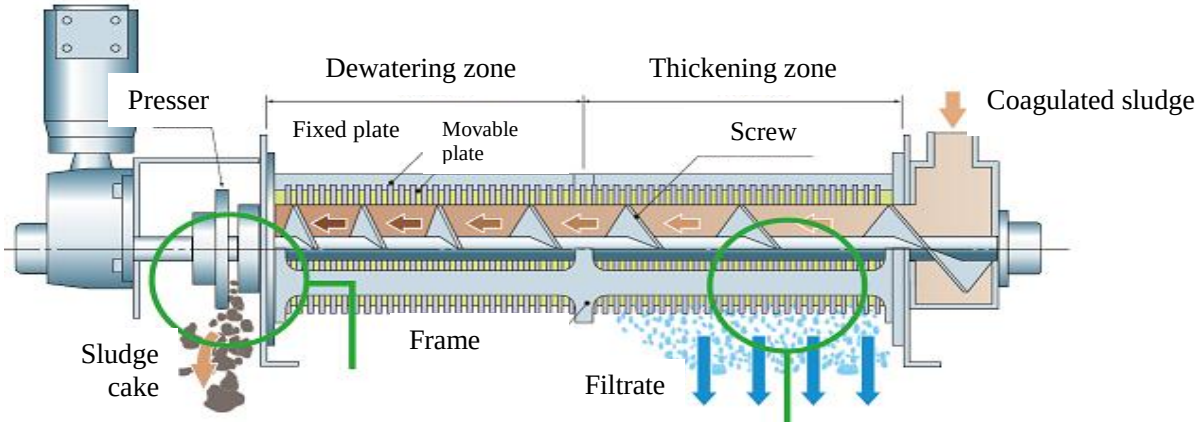
Anaerobic digestion is not considered in the sludge treatment process because it doesn't work well for waste activated sludge alone.

3) Dewatering

Dewatering refers to the reduction of floc-bound and capillary water content of sludge. Sludge dewatering is required at the STP prior to disposal. Since dewatering processes differ significantly in their ability to reduce water content, the sludge disposal method will generally have a major influence on the dewatering process that is most suitable.

The commonly used dewatering machines are: filter belt press, screw press and centrifuge. These machines require sludge conditioning by polymer coagulant prior to dewatering. Screw press 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.

A diagram of a screw press is shown in **Figure 4.3-6**.

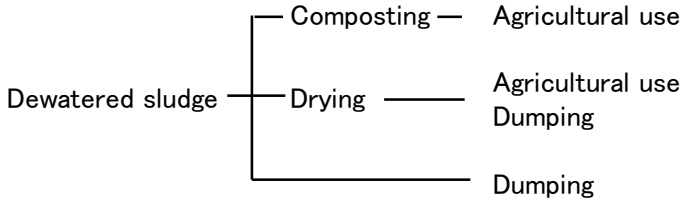


Source: Japan NWSDB Construction Association

Figure 4.3-6 Diagram of Pressurized Screw Press

(3) Sludge Disposal

There are several options for the final disposal of waste sludge, as shown in **Figure 4.3-7**.



Source: JET

Figure 4.3-7 Sludge Disposal Options

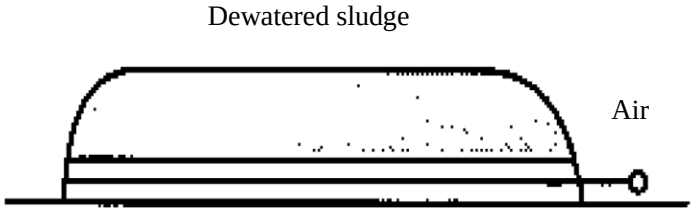
Nitrogen and phosphorus in sewage sludge contains essential nutrients for plants, ideal for use as compost or other agricultural purpose. In sludge composting, some organic materials are usually added to the dewatered sludge to adjust the moisture content and C/N ratio as pre-conditioning. Organic substances are decomposed and stabilized in the composting process.

During composting, fermentation temperature will rise to over 65℃ destroying pathogenic bacteria in the process. Matured compost has no offensive odour. Composting is preferable to drying and dumping excess sludge, since it recycles the nutrient and is more hygienic. However, strict quality control especially for heavy metals and education of users is essential.

There are various sludge composting processes. The simplest is pile composting shown in **Figure 4.3-8**. Dewatered sludge is piled on a flat concrete bed after adjusting its moisture content to around 60% by adding some organic materials such as sawdust, rice hulls, straw, bark or composted sludge. It usually takes 10-14 days for the first stage fermentation. The second stage fermentation takes 1 to 3 months

before the compost is mature . Since space at the STP site is likely to be limited, dewatered sludge should be sent to a composting plant located elsewhere.

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



Source: JET

Figure 4.3-8 Pile Composting

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

4.4 ON-SITE FACILITIES AND SEPTAGE MANAGEMENT

4.4.1 On-site Facilities

Wastewater will not be collected from coastal areas of Dehiwala-Mount Lavinia. Septic tanks will be the main solution to improve wastewater treatment in this area. The design, construction, and maintenance of septic tanks should comply with Sri Lank Standards 745 Part II: 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 of Septic Tanks

Periodic maintenance is important for the facility to function sustainably. Therefore, users and owners should be aware of the following precautions:

(i) Sludge removal

A septic tank requires sludge removal at regular intervals. When filled with sludge and scum, the tank should be partially 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 of at the NWSDB to be constructed.

(ii) Access Cover

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

(iii) Mosquitoes

To prevent mosquito breeding, the septic tank must be kept tightly closed. Vents must be covered 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 and solid matter should be cleared from the access cover, using a long and suitably flexible stick.

CHAPTER 5 INSTITUTIONAL ARRANGEMENTS FOR IMPLEMENTATION

The implementation of sewerage systems requires planning, design, construction, and eventually operating and maintaining. Capacity development at NWSDB, relevant regional support centres (RSC), 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 are at the planning stage.

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

Municipalities	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

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 out-sourced to NWSDB, while sewer pipe maintenance will be conducted by the MC.

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

The ownership and the implementation structure of the sewerage works can be different and must be determined by each municipality.

5.1.2 Public Works in Dehiwala–Mount Lavinia MC

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

Table 5.1-2 Public Works in Dehiwala–Mount Lavinia MC

Water works	Responsible organization		NWSDB、RSC Western South
	Water supply schemes		14
	Blanch offices		14
	Planning & Desiging		Engineer 2, Technical 3, Others 3
	WTP	Full scale	0
		Partial scale	2
		Out-sourcing	Care taker works and adding Chlorine
	Laboratory		2
		Out-sourcing	no
	Meter reading		15
	Charge collection		5
		Out-sourcing	no
Solid waste management	Responsible organization		MC Health department
	Works		Door to Door collection in houses and buisness places including sweeping roads and clean small side drains.
	Type of tasks	Planning & Designing	Implementing
		Construction	no
		O&M	Implementing
	Financing sources		Service charge, MC budget, Government subsidy (for labourers salary) , Western Povince Council subsidy.
	Service charge		For business
	Dumping site	Location	Karadiana dumping site. Ownered by WMA
		Capacity	
	Collection	Method	Door to Door collection
		Vehicles	Compactors=15, Drum trucks=8, tractors=25, container currier=2
	Staff	Supervisor	1
		PHI	3
		Upper level labor	10
		Labors	90
	Out-sourcing		no
On-site sanitation	Responsible organization		MC Health department
	Type of tasks	Planning & Designing	Implementing
		Construction	Implementing
		O&M	Implementing
	No. of septic tanks	At present	78,734 (all houses)
		Future	-
	Financing sources		Service charge, MC budget
	Services	Installation	Property /land owner or House holder
		Approval	MC PHI (public health inspector)
		Supervisor	MC PHI (public health inspector)
	Sludge removal	Frequency	Depending on situation
		Procedure	By gully sucker
		Sludge disposal site	Sewage pumping station in Mt. Lavinia
	Service charge	Installation	By Property /land owner or House holder
		Sludge disposal	Domestic=Rs.1968.50, Business places=Rs.5606.40
	Staff	PHI	1
		Labors	21
	Out-sourcing		no
Road construction and maintenance works	Responsible organization		MC
	Works		D & E roads
	Type of tasks	Planning & Designing	Implementing
		Construction	Implementing
		O&M	Implementing
	Financing sources		MC budget
	Staff	Engineer	2
		Technical officer	3
		Others	48
	Out-sourcing	Details	-
		Type of contract	-
Storm water management	Responsible organization		MC
	Works		Mainly cleaning of blockages
	Type of tasks	Planning & Designing	Implementing
		Construction	Implementing
		O&M	Implementing
	Existing drainage system		Main canals 10km, Road side drains 125km
	Financing sources		MC budget
	Staff	Engineer	1
		Technical officer	1
		Others	75
	Out-sourcing		-

Source: MC

Water works in the MC are owned, operated and implemented by NWSDB, Western South RSC.

The MC provides all the other public works services from planning to O&M without outsourcing. The water tariff covers the expenses for water supply and the MC budget and government subsidies are used to cover the costs of providing the other services.

Owners manage on-site sanitation facilities and the MC takes care of sludge removal and disposal and bills the owners for the service.

5.1.3 Organizational Options for Implementing Sewerage Works

5 options are prepared for implementing the 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 & Design	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- NWSDB
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 system is owned by MC 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 charge.

B) Experience and knowledge

NWSDB has many experienced engineers and skilled labourers working in RSC North Central and managing the MC's water works. The Greater Colombo Sewerage (GCS) Office, organized under the 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 Dehiwala-Mount Lavinia MC to ensure a smooth start-up and operation.

Therefore, Options 1 or 2 are preferred for implementing the sewerage works in Dehiwala-Mount Lavinia MC.

5.2 ORGANIZATION FOR IMPLEMENTATION

To organize the implementation of the sewerage works in Dehiwala-Mount Lavinia MC, detailed roles of NWSDB, relevant RSC and MC must be defined. **Table 5.2-1** shows the roles of each party from planning to O&M under the preferred implementation structures, i.e. Options 1 and 2.

Table 5.2-1 Roles of NWSDB and MC at Various Implementation Stages of Sewerage Works

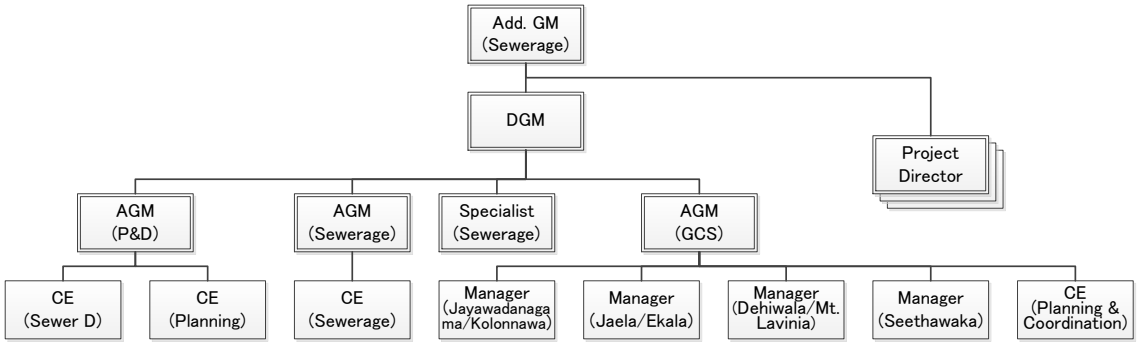
Option-1		Implementation Stage			
		Planning	Design	Construction	O&M
NWSDB	Tasks	Supervision Decision of STP site and others	Supervision	Supervision	O&M of sewerage works Consideration of out-sourcing
	Staff	* Technical Team	* PD under DGM * Staff in Project Management Units (PMU)	⇒	* Staff in STP * 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		Implementation stage			
		Planning	Design	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 shown in **Figure 5.2-1**. When the sewerage projects are implemented in the GC and regional areas, engineering tasks in planning, design, construction and O&M will increase.

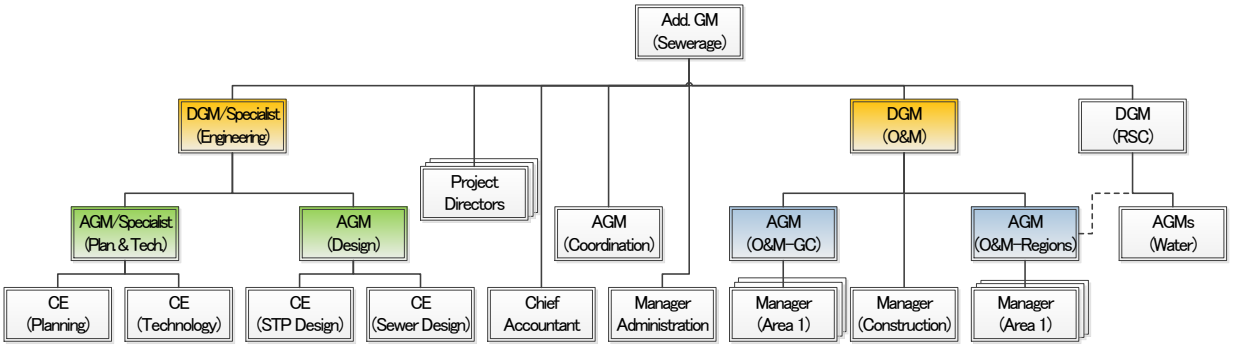


Source: JET

Figure 5.2-1 Organization Chart of NWSDB Sewerage Department

Some reorganization of the sewerage department will be required to cope with the increase of tasks as shown in **Figure 5.2-2**.

Tasks of Deputy General Manager (DGM) will be split into DGM/Specialist (Engineering) and DGM (O&M). Although planning and design are now conducted by AGM (P&D), those will be split into AGM (Plan & Tech.) and AGM (Design). To cope with the increase of sewerage projects in regional areas, AGM (O&M-Regionals) will be established in addition to AGM (O&M-GC).

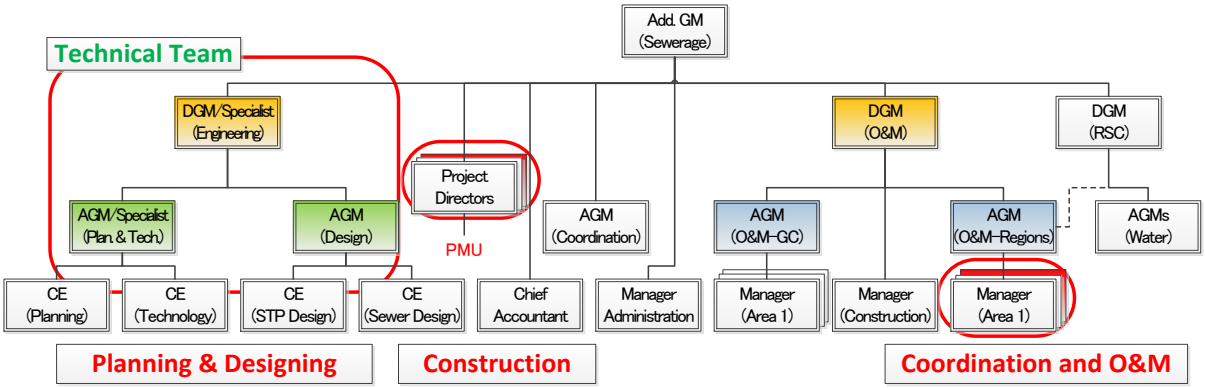


Source: JET

Figure 5.2-2 Proposed Reorganization of 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 consultant team. At the construction stage, a Project Director (PD) will be added under 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 RCS to coordinate the O&M of STP and sewer networks.



Source: JET

Figure 5.2-3 NWSDB Sewerage Department Responsibilities for Project Tasks

5.2.2 Organization of RSC Western South

In the Dehiwala–Mount Lavinia area, AGM (O&M-GC) is responsible for all aspects of sewerage system including customer services. RSC Western South has no direct involvement in managing the sewerage works in the MC. However, because the sewerage service charge is added to the water bill which is collected by the RSC, some strengthening of the RSC organization will be needed for the increase in workload in. billing, collecting, and accounting.

5.2.3 Organization of Dehiwala–Mount Lavinia MC

Dehiwala-Mount Lavinia 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 the 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 the 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 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 importance especially when many new staff with almost no experience will be hired. Training seminars and OJT are mandatory.

(1) NWSDB Training Centre

The Training Centre is not offering many technical programs on sewerage systems. As a large number of 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.

(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 STP staff at commissioning. Staff should also be dispatched to other STPs for 6 months to 1 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 Systems

	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 Western South 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 sewerage systems 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 office of PMU 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 sites.

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 cost is presented in **APPENDIX 6**.

Project cost is estimated with the following conditions.

Construction Cost	:	Estimated with price level at January, 2017
Consulting cost	:	Estimated with price level at January, 2017
Consulting period	:	2019～2024
Construction period	:	2021～2024
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 24.9 billion LKR (19.2 billion JPY), excluding 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	Dehiwala Mount Lavinia STP (Q=20,000m3/day)	2,792,727,273	3,225,600,000	6,981,818,182	5,376,000,000
	B	Trunk Sewer & Pump Station	2,319,693,000	2,022,846,000	4,946,765,000	3,809,010,000
	C	Branch Sewer & Pump Station	2,003,645,000	715,050,000	2,932,281,000	2,257,857,000
	D	House Connection	2,652,500,000	0	2,652,500,000	2,042,425,000
	Sub-total of 1(A-D)		9,768,565,273	5,963,496,000	17,513,364,182	13,485,292,000
2	Administration cost		1,184,000,000	0	1,184,000,000	911,680,000
3	Consulting cost		465,000,000	1,022,000,000	1,792,273,000	1,380,050,000
4	Physical contingency for construction cost		605,000,000	336,000,000	1,041,364,000	801,850,000
5	Price escalation for construction cost		2,343,000,000	587,000,000	3,105,338,000	2,391,110,000
6	Land acquisition and compensation		-	-	-	-
7	Interest during construction		0	164,000,000	212,987,000	164,000,000
8	Front-end Fee		0	37,000,000	48,052,000	37,000,000
9	Tax and duty		4,286,000,000	0	4,286,000,000	3,300,220,000
	Sub-total of (2-9)		8,883,000,000	2,146,000,000	11,670,013,000	8,985,910,000
	Total including Tax and Duty		18,651,565,273	8,109,496,000	29,183,378,000	22,471,201,000
	Total excluding Tax and Duty		14,365,565,273	8,109,496,000	24,897,378,000	19,170,981,000
	Eligible Portion (1, 3, 4, 5 and 7)		13,181,565,273	8,072,496,000	23,665,326,000	18,222,301,000
	Non-Eligible Portion (2, 6, 8 and 9)		5,470,000,000	37,000,000	5,518,052,000	4,248,900,000

Source: JET

6.1.2 Operation and Maintenance (O&M) Cost

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

Table 6.1-2 Estimated O&M Cost

	Total Amount (LKR/year)	Total Amount (JPY/year)
Dehiwala Mount Lavinia	285,644,000	220,636,000

Source: JET

6.2 MULTI-PHASED CONSTRUCTION

Construction should be conducted in phases because of the size of the project - service area of 981 ha and cost of 24.9 billion LKR (19.2 billion JPY).

The total project cost for phased construction would be higher than the estimated cost shown above. The extra cost will depend on the number of phases and timing.

CHAPTER 7 FINANCIAL PLAN

7.1 FINANCIAL CONDITION OF DEHIWALA–MOUNT LAVINIA MUNICIPAL COUNCIL

Table 7.1-1 shows the financial situation of the Dehiwala–Mount Lavinia MC. Basically, total expenditures of Dehiwala–Mount Lavinia MC must be covered by its incomes. Any surplus or deficit is rolled over to the next year.

Dehiwala–Mount Lavinia MC, as other MCs, pays the salaries of central government staff who work at the MC and gets reimbursed on this amount annually through a central to provincial government budgetary transfer, under "Revenue, Grant & Reimbursement". The MC also receives grants as a part of the project cost, as shown under "Capital Receipt and Grants".

Table 7.1-1 Summary of Incomes & Expenditures of Dehiwala–Mount Lavinia MC

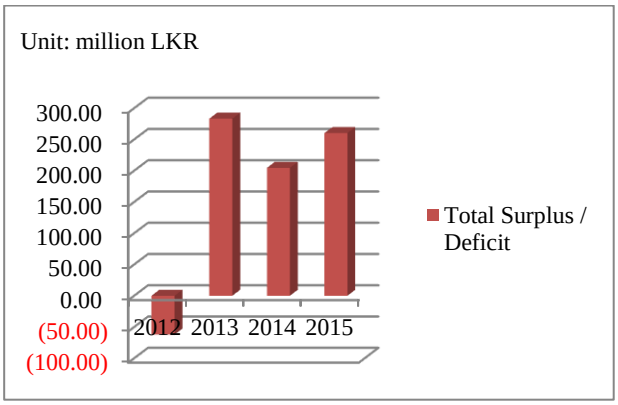
Unit: million LKR

Year		2012	2013	2014	2015
Revenue					
	Assessment Rates	156.53	382.00	339.88	364.51
	Rent	16.24	18.34	16.97	17.30
	License Fees	15.24	26.43	39.03	25.81
	Charges for Services	39.58	55.11	63.54	66.80
	Warrant Cost/Fine	26.34	31.35	33.61	35.88
	Stamp Duty	0.00	0.00	0.00	0.00
	Court Fines	0.00	0.00	0.00	0.00
	Other Revenue	193.28	291.43	319.88	252.40
	Total	**447.21**	**804.66**	**812.91**	**762.70**
Expenditure					
	Personal Emoluments	493.97	523.48	591.57	743.71
	Travelling Expenses	5.09	6.96	6.09	5.06
	Supplies & Equipment	126.96	154.88	98.96	84.51
	Repairs to Capital Assets	48.29	48.34	247.49	112.14
	Transport	143.11	128.28	151.25	134.87
	Interest & Dividends	5.36	6.85	7.37	6.62
	Grants	16.69	15.36	14.74	19.03
	Pensions Gratuity	11.48	9.21	10.28	10.08
	Total	**850.95**	**893.36**	**1,127.75**	**1,116.02**
Actual Revenue over Recurrent Expenditure		-403.74	-88.70	-314.84	-353.32
Revenue Grants & reimbursements		371.30	412.24	612.34	665.79
Capital Receipts & Grants		21.12	30.82	0.44	2.50
Capital Expenditure		50.72	71.18	93.38	54.80
Total Surplus / Deficit		**-62.04**	**283.18**	**204.56**	**260.17**

Source: Dehiwala - Mount Lavinia MC

Dehiwala–Mount Lavinia MC has been recording annual surpluses since 2013 after reflecting salary reimbursement and capital grant. The surplus has been stable at around 200 to 300 million LKR (**Figure 7.1-1**). The MC has had negative balances in the past (**Figure 7.1-2**). As shown in **Figure 7.1-3**, "Revenue Grants & Reimbursement" amounts were substantial and increasing. Except for 2012, these amounts (371 to 666 million LKR) were much larger than the negative balance of the recurrent account (-89 to -353 million LKR). As shown in **Figure 7.1-4**, the size of the capital account balances (capital receipts minus capital expenditure) were relatively small (-30 to -93 million LKR). From 2013 to 2015, the "Revenue Grants & Reimbursement" amounts covered the losses of recurrent accounts and capital accounts.

The financial condition of Dehiwala–Mount Lavinia MC is excellent because of the control over recurrent expenditure and modest capital expenditure.



Source: JET, based on Dehiwala - Mount Lavinia MC data

Figure 7.1-1 Trend of Total Surplus (deficits) for Dehiwala-Mount Lavinia MC

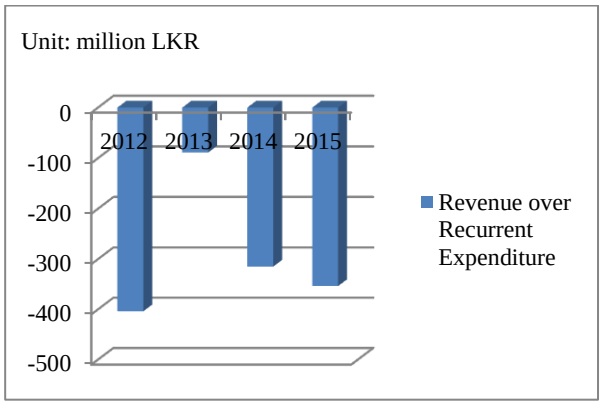
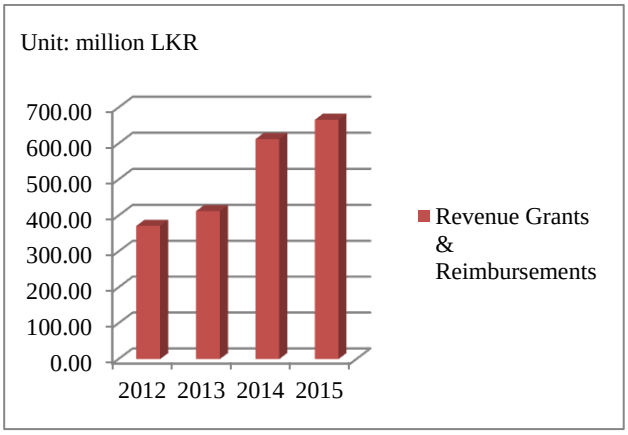
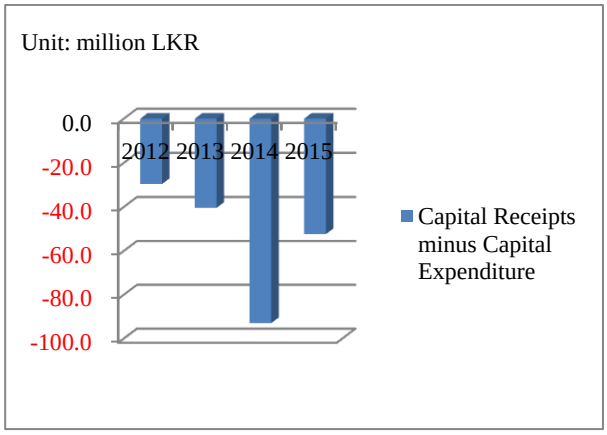


Figure 7.1-2 Trend of Revenue minus Recurrent Expenditure for Dehiwala-Mount Lavinia MC



Source: JET, based on Dehiwala - Mount Lavinia MC data

Figure 7.1-3 Trend of Revenue Grants & Reimbursements for Dehiwala-Mount Lavinia MC



Source: JET, based on Dehiwala - Mount Lavinia MC data

Figure 7.1-4 Trend of Capital Receipts minus Capital Expenditure for Dehiwala-Mount Lavinia 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 the 100% of the debt service (capital & interest) for sewerage projects.

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

Therefore, it is recommended to apply the following cost burden principle for sewerage service in Sri Lanka:

- 100% of construction cost shall be borne by the central government. 100% grant to NWSDB or the MC.

- O&M costs shall be covered by the sewage tariff which will be implemented incrementally.
- Small-scale replacements shall be covered by the NWSDB's or the MC's own budget, but large-scale ones will be conducted as projects covered by the central government.

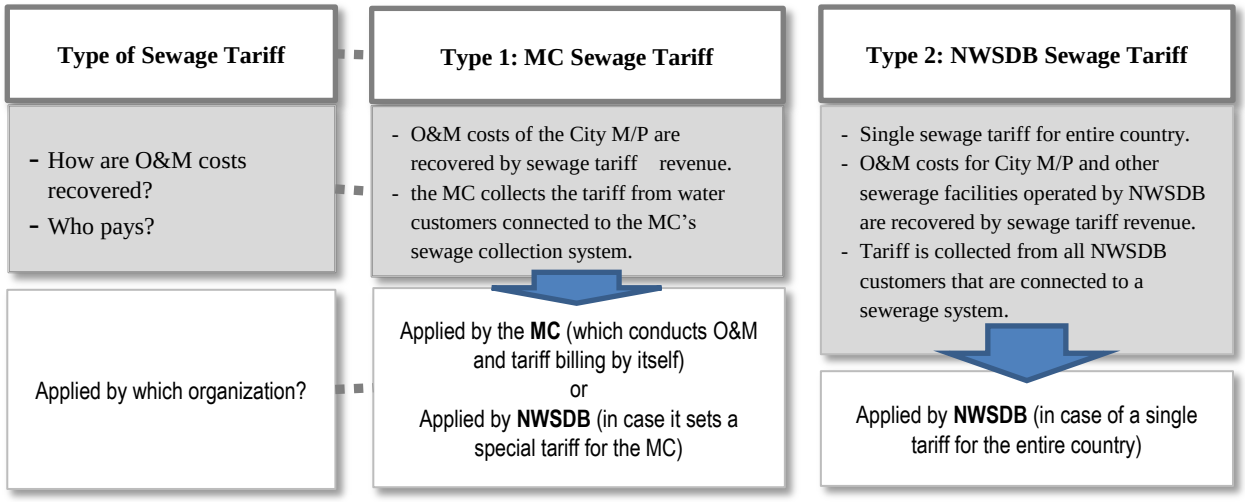
Therefore, the sewage tariff is structured to cover the only the O&M costs of the sewerage facilities.

7.2.2 Sewage Tariffs

(1) Two Types of Proposed 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 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, nation-wide 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) Tariff 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 amount of water they consume.

(3) Sewage Tariff Proposed by the 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. The tariff would be implemented in increments scheduled for 2019 and 2022 (Strategic M/P, Section 7.3.1). The sewage tariff to cover the O&M costs of each City M/P 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 Tariff Implementation Schedule

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 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 an 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 Type 1 and Type 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: the MC does the O&M and the billing or NWSDB sets a special tariff for the MC

Table 7.2-1 Calculation of Type 1 Sewage Tariff for Dehiwala–Mount Lavinia MC

No.	Items	Unit	Description	Amount
1	Annual O&M costs	LKR/year	Total	285,643,689
2	Expected profit (10%) (=1x10%)	LKR/year	Total	28,564,369
3	**O&M costs with profit** (=1+2)	LKR/year	**Total**	**314,208,058**
4	Sewage Flow	m^3/day	Domestic Flow	10,186
		m^3/day	Non-Domestic Flow	3,056
		m^3/year	Total	4,833,330
5	Sewage Return Factor	%		80.0
6	**Water Consumption Volume** *1	m^3/year	**Total**	**6,041,663**
7	**Sewage tariff** (=3/6)	LKR/m^3		**52.01**

Note: *1; Water consumption volume is calculated by dividing the estimated sewage flow by (Sewage return factor/100).".
Source: JET

(2) Type 2: NWSDB National Sewage Tariff

Table 7.2-2 Calculation of Type 2 Sewage Tariff (3rd Increment) for Dehiwala–Mount Lavinia MC

Items	Unit	Description	Amount
Operating Expense	LKR	Existing (2015)*1	410,282,866
		New facilities (City M/P)*2	285,643,689
		Total	**695,926,555**
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**	509,540,035
Expected Profit (5%)	LKR	**Total**	25,477,002
O/M costs after subtraction plus profit	LKR	**Total**	**535,017,037**
Water Consumption Volume of Sewerage Customers	m^3/year	Existing (2015)	6,240,008
		New facilities (City M/P)	6,041,663
		Total	**12,281,671**
Sewage tariff	LKR	-	**43.56**

Note: *1; based on actual cost data for 2015 for O&M costs of the existing sewerage facilities with operational costs of head office.
*2; For City M/P, based on maximum O&M costs at full capacity.
*3; based on a 3 year average, 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

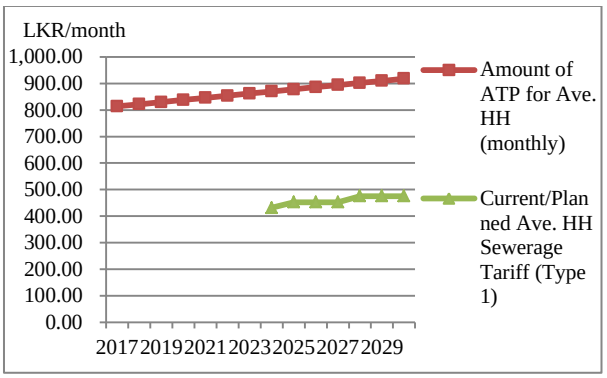
If the City M/P is implemented, the NWSDB sewage tariff would be 43.56/m^3. LKR (third increment), when the STP operation reaches full capacity.

7.2.5 Affordability and Ability to Pay

The following 3 assumptions are made in the analysis of household ATP:

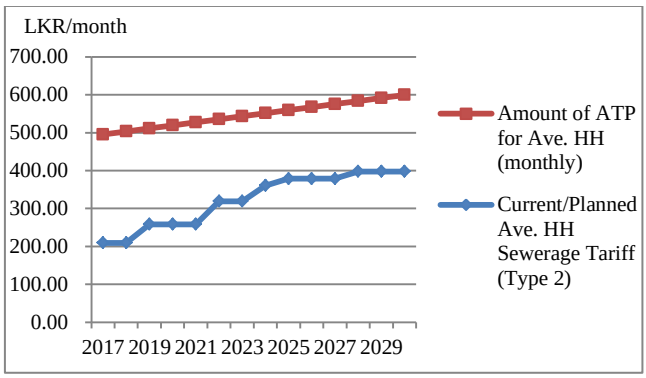
- third tariff increment is set for 2024
- trend of household income increase shall continue
- increase in sewage tariff for domestic, commercial, and industrial customers should be the same. If the increase for commercial and industrial customers is higher than that of domestic customers, monthly charge 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 Colombo 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 1% of average household income, based on International Bank for Reconstruction and Development (IBRD) WB estimate.



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

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

As shown in **Figure 7.2-3**, the monthly household sewage charge (Type 1) is 50 to 53% of the ATP which is well within the households' ATP. The high average household income in the Colombo District is reflected by the high level of affordability in this MC.

As shown in **Figure 7.2-4**, the monthly household sewage charge (Type 2) at 42% to 68% of the household ATP, 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 55% 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 = 55% of the following water supply tariffs

Items	Unit	Description	Amount
Operating Expense	LKR	Existing (2015)*1	410,282,866
		New facilities (City M/P)*2	285,643,689
		Total	**695,926,555**
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**	509,540,035
Expected Profit (5%)	LKR	**Total**	25,477,002
O/M costs after subtraction plus profit	LKR	**Total**	**535,017,037**
Water Consumption Volume of Sewerage Customers	m^3/year	Existing (2015)	6,240,008
		New facilities (City M/P)	6,041,663
		Total	**12,281,671**
Sewage tariff	LKR	-	**43.56**

Note: *1; based on actual cost data for 2015 for O&M costs of the existing sewerage facilities with operational costs of head office.
*2; For City M/P, based on maximum O&M costs at full capacity.
*3; based on a 3 year average, 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

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; 75%
- Government hospital; 75%
- 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 revisions must be well-coordinated.

The third tariff increment should be implemented in 2024. By then the water supply tariff will have almost certainly been increased. In such a case, the percentages applied to the water tariff (55% of domestic water tariff in **Table 7.2-3**) would be lower.

7.3 FINANCIAL PLAN CONCLUSION

A) The financial condition of Dehiwala–Mount Lavinia MC is excellent.
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, and implemented in increments
   - 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.
C) Type 1 sewage tariff is calculated to recover O&M costs from revenue collected from the customers in the MC area; Type 2 recovers the total O&M costs of the sewerage business of NWSDB including the O&M costs of City M/P, from revenue NWSDB collects from all its sewerage customers.
D) Type 1 sewage tariff for the MC is estimated at 52.01/m^3 LKR
E) Type 2 sewage tariff for NWSDB is estimated at 43.56/m^3 LKR
F) Both sewage tariff charges are within (68%) of the household ATP.
G) The latest average household income data should be used for the 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 (Section I of this report). No regulations specific to or published by Dehiwala-Mount Lavinia 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 Dehiwala-Mount Lavinia MC could not be found. The national agreements are compiled 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 is 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 odors	P/C	D	No impacts are expected during construction.
	O	B-/B+	B-: Odor will be generated at the STP during operation. B+: Improved sewerage collection and environmental conditions will reduce offensive odors in the Project area.
8 Geographical features	P/C	C-	Impacts are unknown and require investigation.

Item	Evaluation		Reason
	O	D	No impacts are expected during operation.
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 labor 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 STUDY

8.6.1 Purpose

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

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 that are identified as the survey proceeds should also be included.

8.6.3 Target Areas

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

8.6.4 Target Periods

Target periods are the stages of planning, execution, and operation of the completed Project.

8.6.5 Contents and Methodology for the ESC Study

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

Table 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, hearing 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, hearing 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, hearing 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, hearing 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, hearing 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, hearing 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, hearing 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, hearing 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, hearing 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: Hearing 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: Hearing 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: Hearing 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: Hearing 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: Hearing survey of concerned parties, data collection.	In progress (M/P, F/S stage)
23	Children's Rights	P/C	C-	Study: Child labor laws. Method: Hearing survey of concerned parties, relevant laws and	In progress (M/P, F/S, EIA stage)

				regulations.	
		O	C+	Study: Water borne diseases and children Method: Hearing 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, hearing survey of concerned parties.	In progress (M/P, F/S, EIA stage)
		O	C+	Study: Impacts of pollution on heritage sites. Method: Hearing 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, hearing 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, hearing 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, hearing surveys of concerned parties	

Source: JET

8.6.6 Prediction and Evaluation of Impacts

Prediction and evaluation of the 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, EMP will determine how to mitigate the impacts, and EMoP will identify steps to be taken by relevant authorities to ensure that mitigation measures are effectively implemented. Execution plan, frequency of measures, lead organization, support for the organization, and budget should be provided for EMP and EMoP.

8.6.8 Stakeholder Consultation

Consultations with UNI and NGO were conducted at the start of the Project to understand the needs and attitudes in the area, and to confirm the relevance of the Project. Details on 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 EMP. EMP will be implemented through EMoP. EMP development is not appropriate at this stage. Draft versions of 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 conducted according to the schedule shown in **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			Dehiwala-Mount Lavinia 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 Survey

CHAPTER 9 CONCLUSION AND RECOMMENDATION

9.1 F/S IMPLEMENTATION

Dehiwala-Mount Lavinia borders Colombo MC and Sri Jayawardenapura Kotte is the administrative capital of Sri Lanka. The sewerage system will serve a population of significant size. The local water bodies have high levels of BOD, ammonia, phosphorus, and total coliform because of wastewater discharge. The sewerage system will provide cost efficient wastewater treatment and is necessary to preserve and improve water quality.

A site for the NWSDB has not been identified. Selection of a site and land acquisition will likely take a long time. Therefore, Dehiwala-Mount Lavinia is not selected for the F/S.

9.2 CONCLUSION AND RECOMMENDATION

The development of a sewerage system in Dehiwala-Mount Lavinia will have a significant impact on the preservation and improvement of local water environment. However, a site for the NWSDB must be identified before the next step in the planning process can be taken.

APPENDICES

APPENDICES

APPENDIX 1: Dehiwala – Mt. Lavinia Waste Water Flow Calculation

DEHIWALA MOUNT LAVINIA - WASTE WATER FLOW CALCULATION

Water Consumption 120 lpcd
Domestic Waste Water Flow 80 % of Domestic Water Consumption
Non- Domestic Waste Water Flow 30 % of Domestic Waste Water Flow
Infiltration 20 % of (Domestic + Non - Domestic) Waste Water Flow

S/No.	GND No.	GND	Population 2001	Population 2012	Population 2046	% covered	Population 2046 in covered area	Domestic Water Consumption (cum/d)	Domestic Waste Water Flow (cum/d)	Non - Domestic Waste Water Flow (cum/d)	(Domestic + Non-Domestic) Waste Water Flow(cum/d)	Infiltration (cum/d)	Total waste Water Flow (cum/d)	
1	**Dehiwala DSD**													
1.1	538C	Sri Saranankara	6781	6367	6367	100%	6367	764	611	183	795	159	954	
1.2	537	Vilawala	8477	6334	6334	100%	6334	760	608	182	790	158	949	
1.3	537A	Dutugemunu	5941	4806	4806	50%	2403	288	231	69	300	60	360	
1.4	537B	Kohuwala	7508	5475	5475	50%	2738	329	263	79	342	68	410	
1.5	538	Kalubowila	5755	5517	5517	100%	5517	662	530	159	689	138	826	
1.6	538B	Hathbodhiya	6740	6228	6228	100%	6228	747	598	179	777	155	933	
1.7	538A	Galwala	6263	5671	5671	100%	5671	681	544	163	708	142	849	
1.8	540	Dehiwala East	7039	6767	6767	100%	6767	812	650	195	845	169	1013	
1.9	536A	Udyanaya	6283	5914	5914	100%	5914	710	568	170	738	148	886	
1.1	536	Nedimala	9442	9058	9058	100%	9058	1087	870	261	1130	226	1357	
1.11	539/42A	Malwatta	4604	3543	3543	100%	3543	425	340	102	442	88	531	
1.12	539/42	Karagampitiya	6115	5633	5633	100%	5633	676	541	162	703	141	844	
1.13	539/42B	Kawdana East	8344	8091	8091	60%	4855	583	466	140	606	121	727	
		Sub Total 1	89292	79404	79404		71027	8523	6819	2046	8864	1773	10637	
2	**Ratmalana DSD**							0	0	0	0	0	0	
2.1	539/42C	Kawdana West	6972	6624	6624	100%	6624	795	636	191	827	165	992	
2.2	544	Watarappola	6908	6311	6311	100%	6311	757	606	182	788	158	945	
2.3	544A	Wathumulla	6186	4608	4608	80%	3686	442	354	106	460	92	552	
2.4	545A	Katukurunduwatta	11925	12166	12535	65%	8148	978	782	235	1017	203	1220	
		Sub Total 2	31991	29709	30078		24769	2972	2378	713	3091	618	3709	
3	**Kesbewa DSD**									0				
3.1	535	Pepiliyana West	5263	5039	5039	100%	5039	605	484	145	629	126	755	
3.2	535A	Bellanwila	3576	3413	3413	100%	3413	410	328	98	426	85	511	
3.3	535B	Divulpitiya West	2645	2631	2631	70%	1842	221	177	53	230	46	276	
		SubTotal 3	11484	11083	11083		10294	1235	988	296	1285	257	1542	
		Grand Total	132767	120196	120565		106090	12731	10185	3055	13240	2648	15888	

GND's where population incresed from 2001 -2012

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

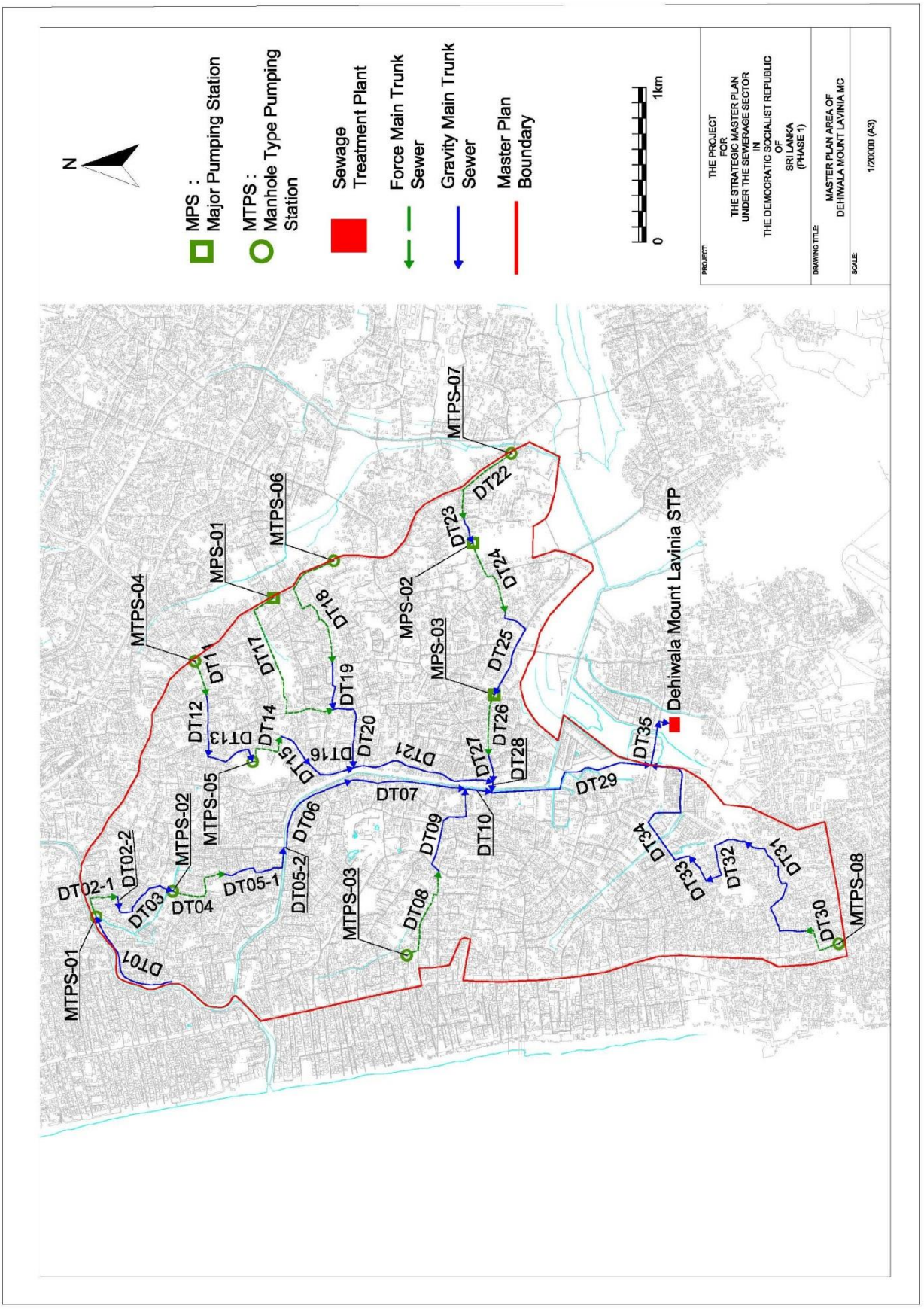
***Average of 1-year measurement

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^{0}C		6.6	6.93	6.7	6.2	6.9	6.2	7.3	6.42	7.4
Total Suspended Solids at 104^{0}C	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.

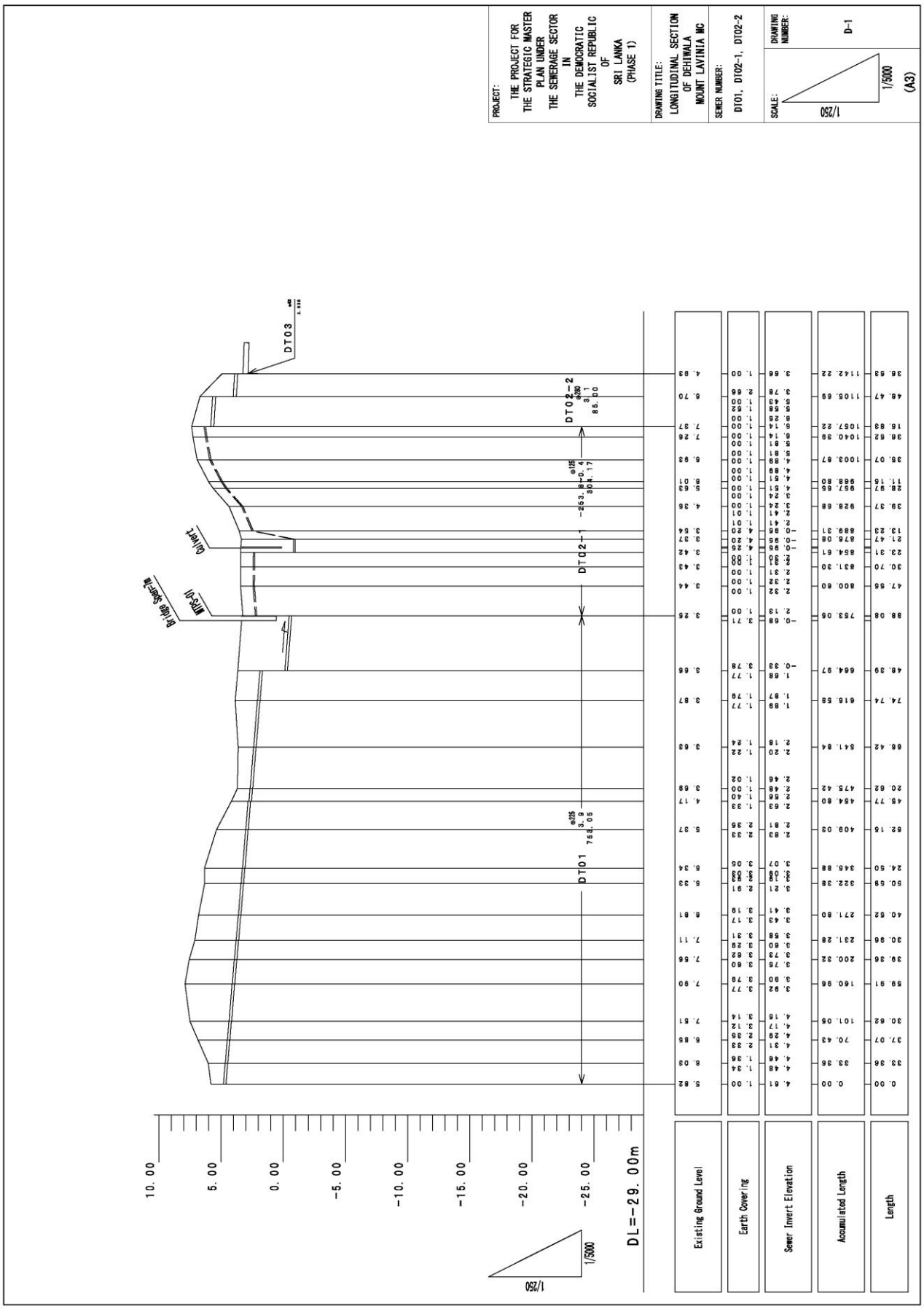
APPENDIX 3: Layout Plan, Sewer Design Calculations and Longitudinal Cross Section



SEWER DESIGN CALCULATIONS

Master Plan Area	Unit Sewer Water ($m^3/s/ha$)	Legend	P
Dehiwala Mount Lavinia MC	0.000500	◎: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^3/s)	(m^3/s)	(mm)	(‰)	(m/s)	(m^3/s)	(m)	(m)	(m)	
			753				HDPE				5.82	4.607	1.00	
DT01 ◎	12.93	12.93	753	0.006		0.006	⊙ 225	3.90	0.65	0.021	3.25	−0.675	3.71	To MTPS-01
			305				HDPE	Force Main			3.25	2.130	1.00	From MTPS-01
DT02-1 ◎	14.50	27.43	1058	0.014		0.014	⊙ 125				7.37	6.250	1.00	
			85				HDPE				7.37	5.584	1.52	
DT02-2 ◎		27.43	1143	0.014		0.014	⊙ 280	3.10	0.67	0.033	4.93	3.664	1.00	
			448				GRP				4.93	2.838	1.69	
DT03 ◎	45.72	73.15	1590	0.037		0.037	⊙ 400	1.80	0.70	0.088	3.93	1.063	2.46	To MTPS-02
			469				HDPE	Force Main			3.93	2.712	1.01	From MTPS-02
DT04 ◎	17.34	90.49	2059	0.045		0.045	⊙ 225				11.41	10.197	1.00	
			535				GRP				11.41	8.179	2.62	
DT05-1 ◎	60.43	150.92	2593	0.075		0.075	⊙ 600	1.20	0.75	0.213	3.43	−0.105	2.93	
			18				HDPE	Inverted Siphon			3.43	−1.200	4.29	
DT05-2 ◎		150.92	2611	0.075		0.075	⊙ 355				3.54	−1.200	4.40	
			674				GRP				3.54	−0.305	3.14	
DT06 ◎	87.44	238.36	3284	0.119		0.119	⊙ 700	1.00	0.76	0.293	9.15	−1.099	9.54	
			741				GRP				9.15	−1.119	9.56	
DT07 ◎	20.70	259.06	4025	0.130		0.130	⊙ 700	1.00	0.76	0.293	2.41	−1.979	3.68	To DT10
			642				HDPE	Force Main			7.69	6.509	1.01	From MTPS-03
DT08 ◎	53.02	53.02	642	0.027		0.027	⊙ 180				19.21	18.037	1.00	
			691				GRP				19.21	17.802	1.00	
DT09 ◎	13.72	66.74	1333	0.033		0.033	⊙ 400	1.80	0.70	0.088	2.41	1.004	1.00	
			173				GRP				2.41	−2.009	3.71	
DT10 ◎	0.80	326.60	4198	0.163		0.163	⊙ 700	1.00	0.76	0.293	3.60	−2.242	5.13	To DT29
			237				HDPE	Force Main			15.44	14.332	1.00	From MTPS-04
DT11 ◎	5.64	5.64	237	0.003		0.003	⊙ 110				20.51	19.403	1.00	
			395				HDPE				20.51	18.960	1.34	
DT12 ◎	5.70	11.34	632	0.006		0.006	⊙ 225	3.90	0.65	0.021	12.03	10.817	1.00	
			378				HDPE				12.03	8.451	3.28	
DT13 ◎	27.52	38.86	1010	0.019		0.019	⊙ 315	2.70	0.68	0.043	6.60	5.301	1.00	To MTPS-05
			360				HDPE	Force Main			6.60	5.446	1.00	From MTPS-05
DT14 ◎	9.63	48.49	1369	0.024		0.024	⊙ 160				15.42	14.262	1.01	
			271				HDPE				15.42	13.214	1.87	
DT15 ◎	3.20	51.69	1639	0.026		0.026	⊙ 355	2.40	0.70	0.055	13.15	11.078	1.74	
			313				GRP				13.15	10.996	1.75	
DT16 ◎	4.19	55.88	1952	0.028		0.028	⊙ 400	1.80	0.70	0.088	6.80	5.381	1.01	To DT21
			1099				HDPE	Force Main			6.55	5.365	1.01	From MPS-01
DT17 ◎	55.84	55.84	1099	0.028		0.028	⊙ 180				19.52	18.348	1.00	To DT20
							⊙							
			952				HDPE	Force Main			4.44	2.377	1.91	From MTPS-06
DT18 ◎	37.79	37.79	952	0.019		0.019	⊙ 160				20.45	19.297	1.00	
			311				HDPE				20.45	18.176	1.98	
DT19 ◎	2.72	40.51	1262	0.020		0.020	⊙ 315	2.70	0.68	0.043	19.52	16.105	3.12	To DT20
			517				GRP				19.52	15.937	3.13	From DT17 and DT19
DT20 ◎	17.62	113.97	1779	0.057		0.057	⊙ 450	1.70	0.74	0.118	6.80	4.519	1.82	
			939				GRP				6.80	4.369	1.82	
DT21 ◎	25.79	195.64	2891	0.098		0.098	⊙ 600	1.20	0.75	0.213	4.80	0.939	3.25	To DT28
			582				HDPE	Force Main			2.46	1.296	1.01	From MTPS-07
DT22 ◎	40.50	40.50	582	0.020		0.020	⊙ 160				5.74	4.587	1.00	
			167				HDPE				5.74	4.441	1.00	
DT23 ◎	1.15	41.65	749	0.021		0.021	⊙ 315	2.70	0.68	0.043	1.52	0.221	1.00	To MPS-02
			529				HDPE	Force Main			1.52	0.282	1.00	From MPS-02
DT24 ◎	74.50	116.15	1278	0.058		0.058	⊙ 250				11.84	10.603	1.00	
			662				GRP				11.84	10.327	1.01	
DT25 ◎	22.97	139.12	1939	0.070		0.070	⊙ 500	1.50	0.74	0.146	4.05	1.330	2.21	To MPS-03
			400				HDPE	Force Main			4.05	2.746	1.01	From MPS-03
DT26 ◎	33.37	172.49	2338	0.086		0.086	⊙ 315				14.47	13.171	1.00	
			179				GRP				14.47	12.453	1.41	
DT27 ◎	0.76	173.25	2517	0.087		0.087	⊙ 600	1.20	0.75	0.213	4.80	3.192	1.00	
			62				GRP				4.80	−1.142	5.23	
DT28 ◎	5.20	374.09	2952	0.187		0.187	⊙ 700	1.00	0.76	0.293	3.60	−1.203	4.09	
			1133				GRP				3.60	−2.542	5.13	
DT29 ◎	72.93	773.62	5330	0.387		0.387	⊙ 1000	0.70	0.81	0.634	2.13	−3.735	4.85	To DT35
			320				HDPE	Force Main			6.27	5.159	1.01	From MTPS-08
DT30 ◎	9.23	9.23	320	0.005		0.005	⊙ 110				12.35	11.243	1.00	
			975				HDPE				12.35	8.555	3.46	
DT31 ◎	40.10	49.33	1294	0.025		0.025	⊙ 355	2.40	0.70	0.055	1.81	−0.721	2.19	
			508				GRP				1.81	−0.803	2.21	
DT32 ◎	31.07	80.40	1801	0.040		0.040	⊙ 400	1.80	0.70	0.088	2.71	−2.346	4.65	
			197				GRP				2.71	−2.396	4.65	
DT33 ◎	16.53	96.93	1998	0.048		0.048	⊙ 450	1.70	0.74	0.118	1.76	−2.791	4.09	
			1106				GRP				1.76	−2.941	4.09	
DT34 ◎	110.45	207.38	3104	0.103		0.103	⊙ 600	1.20	0.75	0.213	2.13	−4.689	6.21	
			290				GRP				2.13	−5.289	6.20	From DT29 and DT34
DT35 ◎		981.00	5620	0.490		0.490	⊙ 1200	0.60	0.84	0.955	5.20	−5.463	9.45	To STP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SEWER NUMBER:
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SCALE:
1/250
1/5000
DRAWING NUMBER:
D-1
(A3)
DT03
DT02-2
DT02-1
DT01
MTRS-01
Railway Station
Canal
10.00
5.00
0.00
-5.00
-10.00
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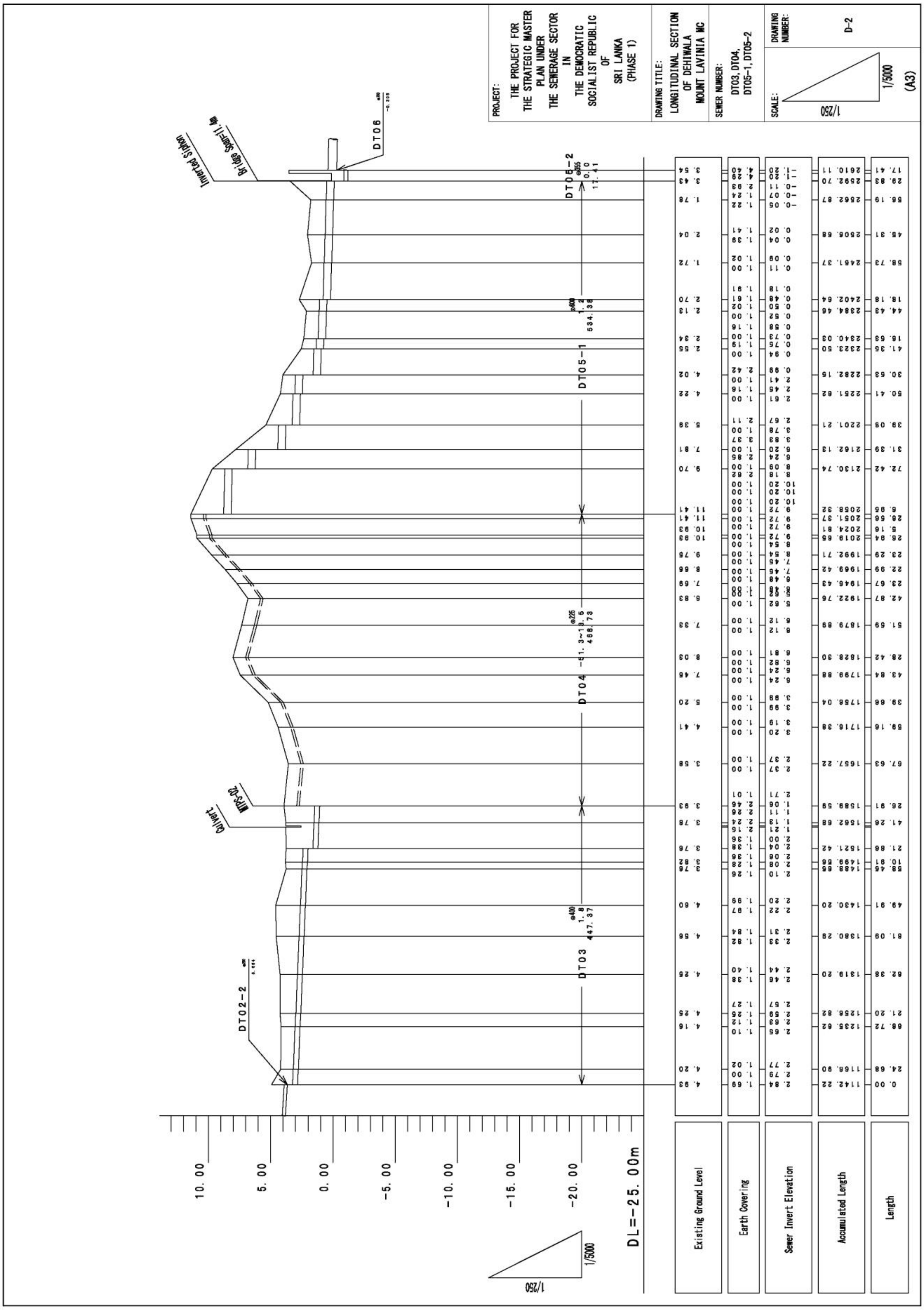
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length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SCALE:
1/250
1/5000
(A3)
DRAWING NUMBER:
D-2
DT02-2
DT03
DT04
DT05-1
DT05-2
DT06
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Bridge
Culvert
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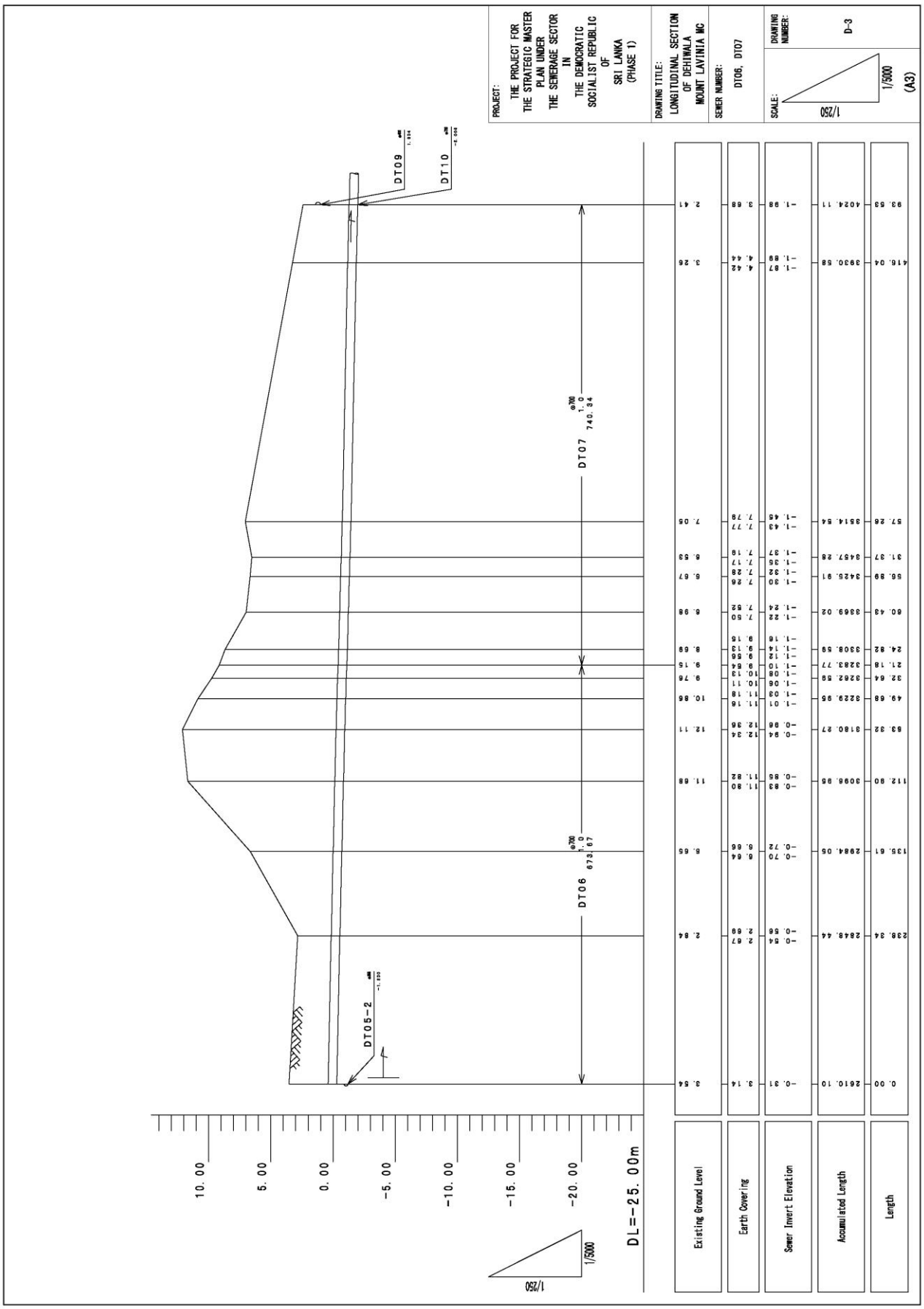
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length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SCALE:
1/250
1/5000
DRAWING NUMBER:
D-3
(A3)
DT09
DT10
DT07
DT06
DT05-2
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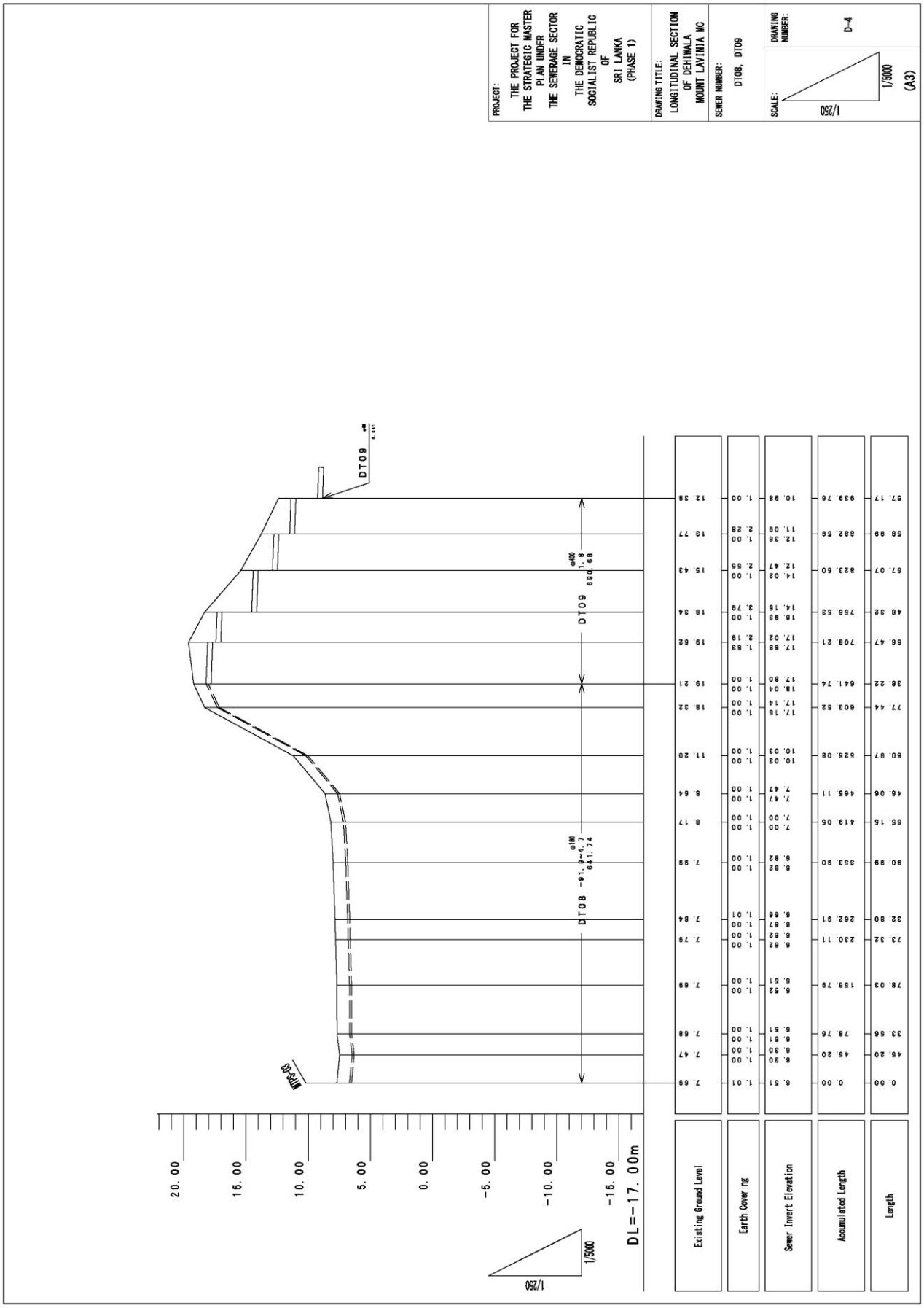
5.00
0.00
-5.00
-10.00
-15.00
-20.00
DL=-25.00m
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length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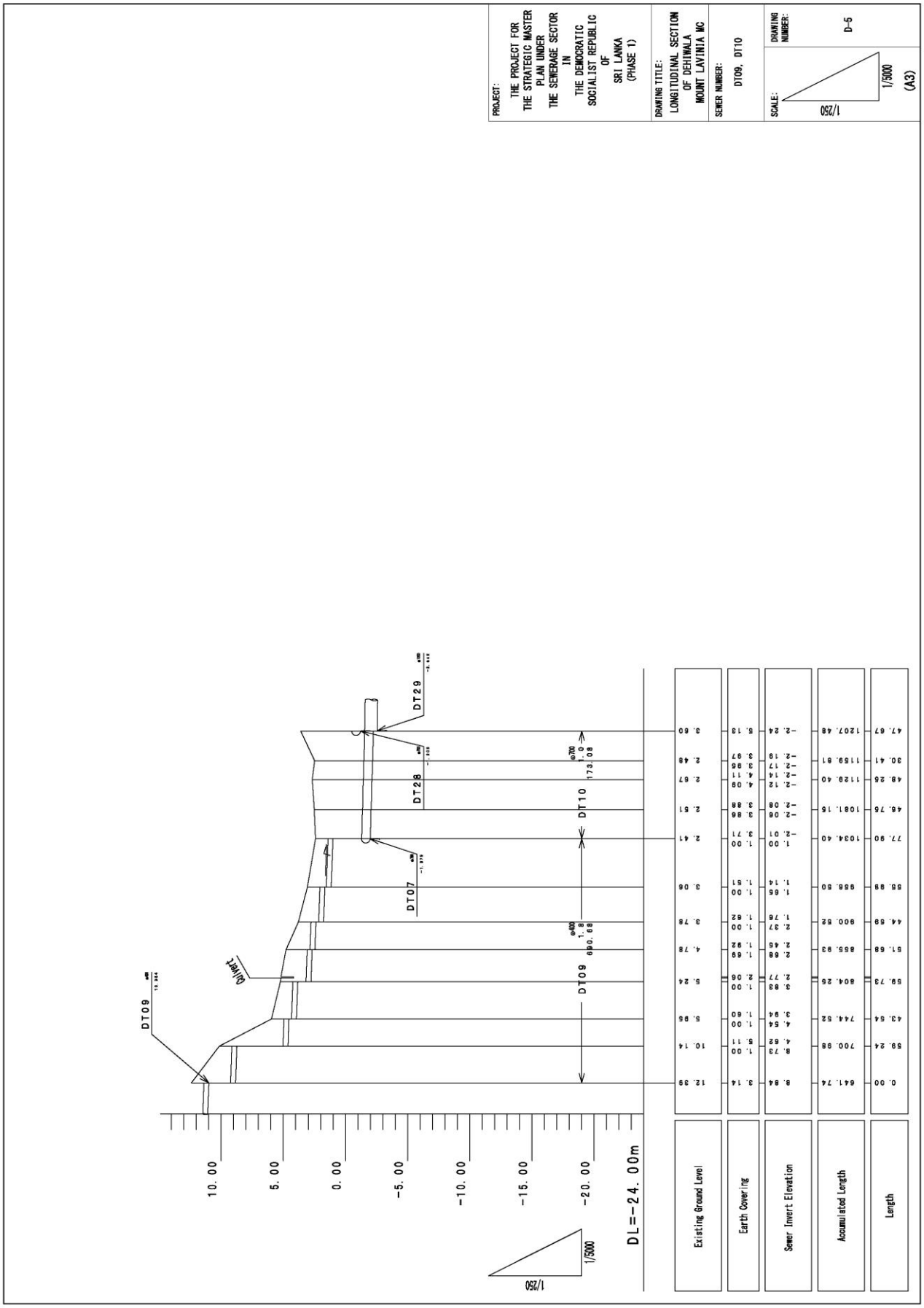
DT08, DT09
SCALE:
1/250
1/5000
DRAWING NUMBER:
D-4
(A3)
DT09
DT09 ø400 1.8 690.68
DT08 -81.9~4.7 ø180 641.74
MH5-69
DL=-17.00m
20.00
15.00
10.00
5.00
0.00
-5.00
-10.00
-15.00
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length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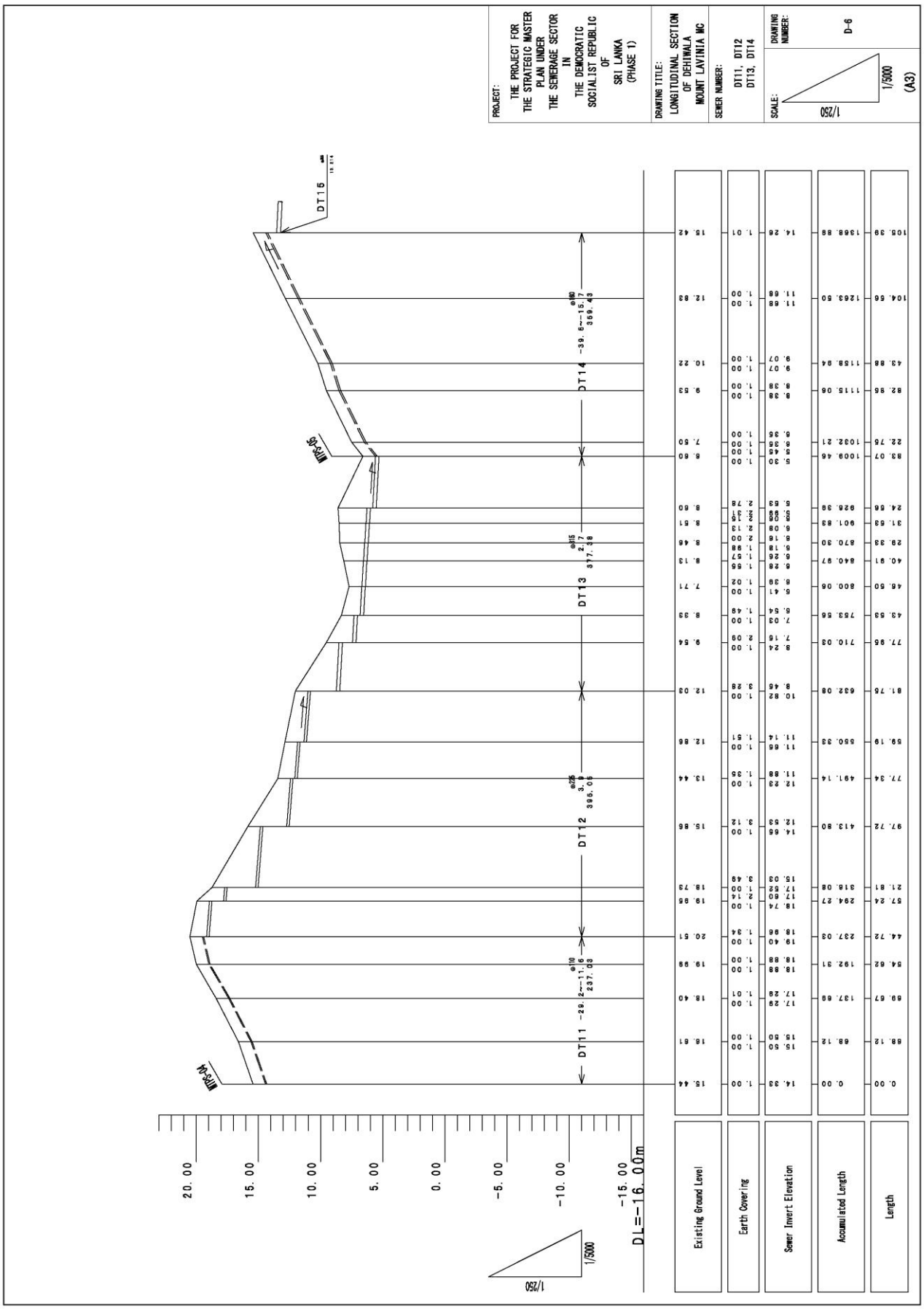
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF DEHIWALA MOUNT LAVINIA MC
SEWER NUMBER:
DT09, DT10
SCALE:
1/250
1/5000
DRAWING NUMBER:
D-5
(A3)
DT09
DT07
DT28
DT29
DT10
DL=-24.00m
10.00
5.00
0.00
-5.00
-10.00
-15.00
-20.00
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length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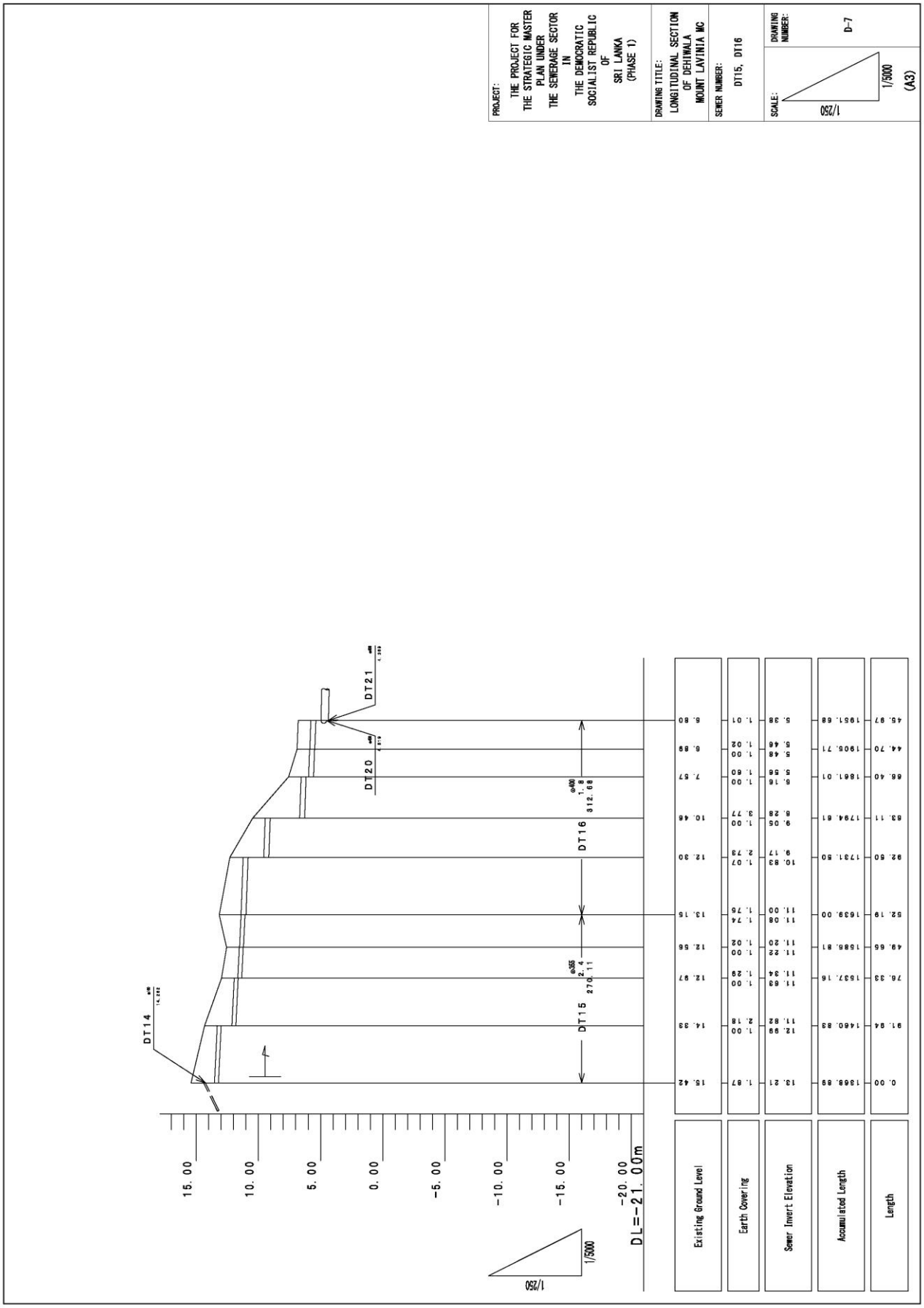
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF DEHIWALA MOUNT LAVINIA MC
SEWER NUMBER:
DT11, DT12
DT13, DT14
SCALE:
1/250
1/5000
DRAWING NUMBER:
D-6
(A3)
MH-S4
MH-S5
DT11
DT12
DT13
DT14
DT15
DL=-16.00m
20.00
15.00
10.00
5.00
0.00
-5.00
-10.00
-15.00
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length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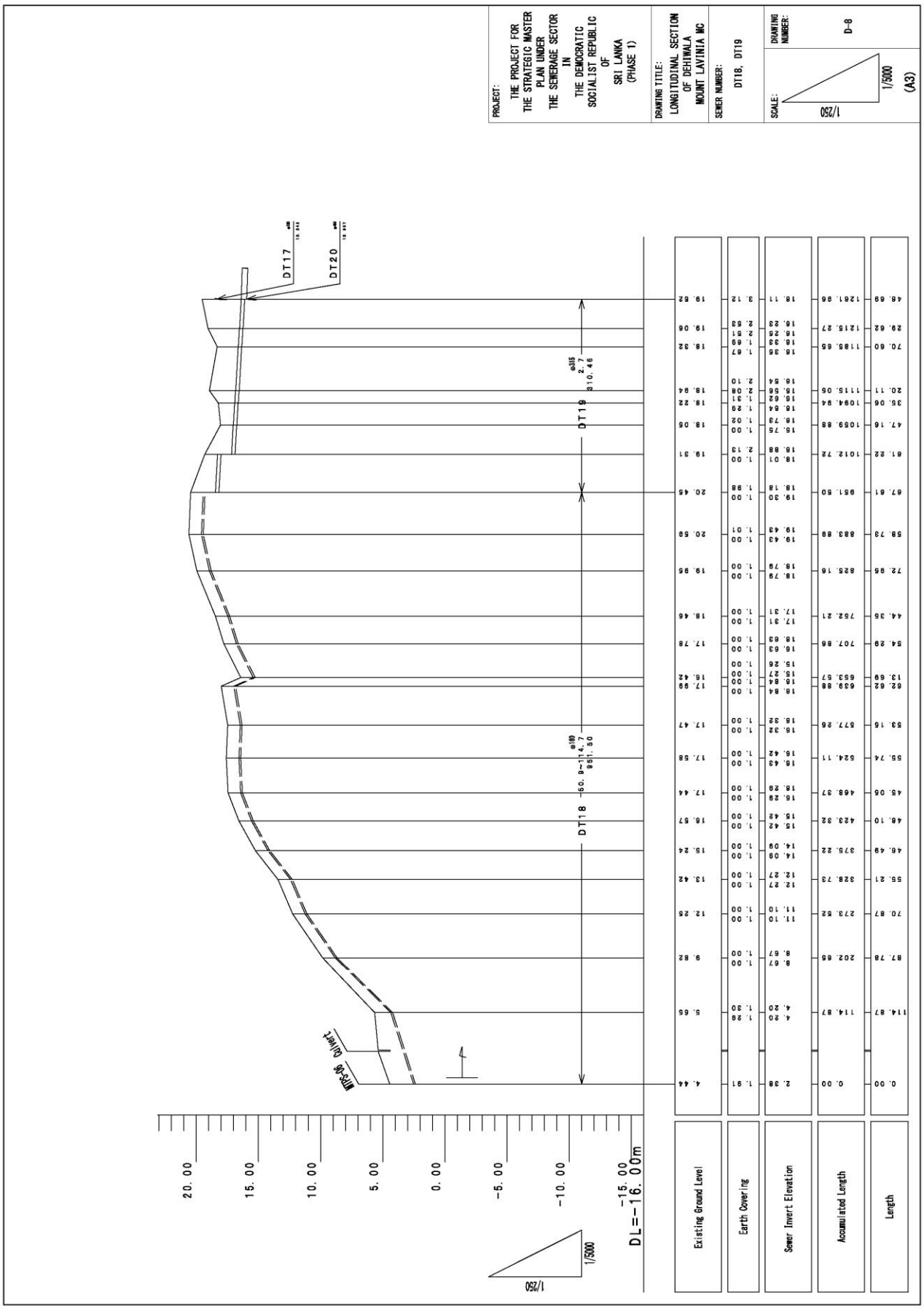
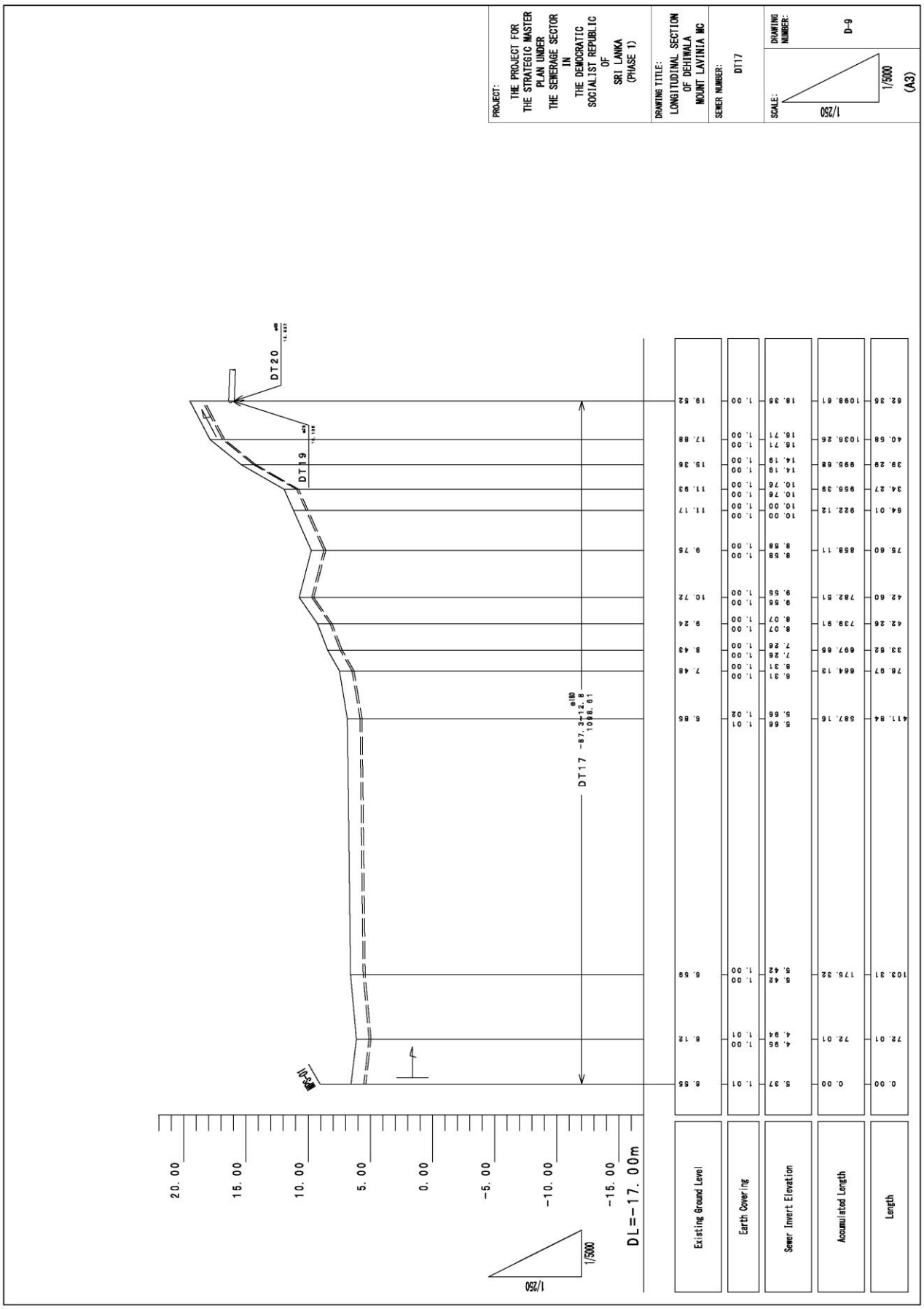
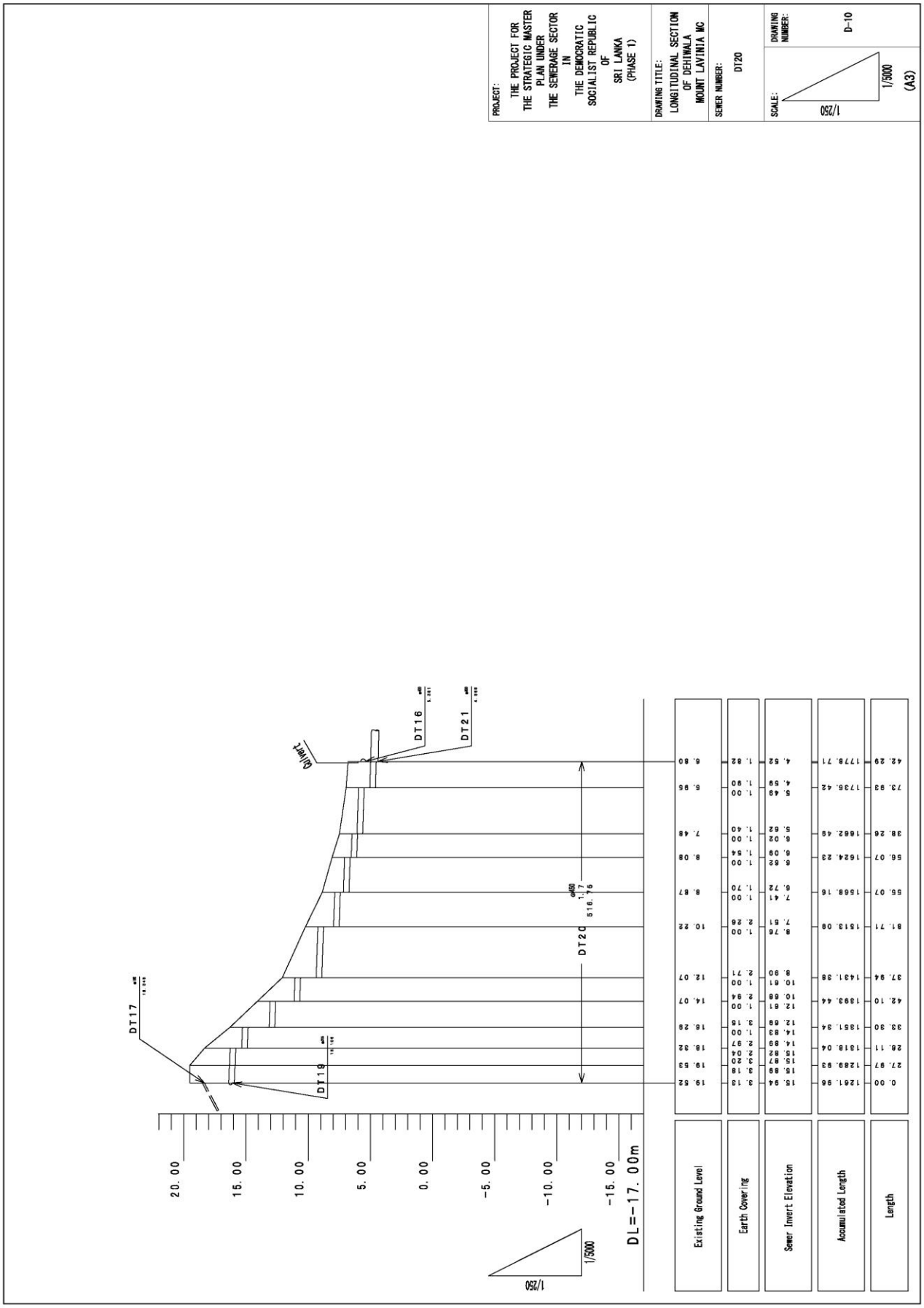
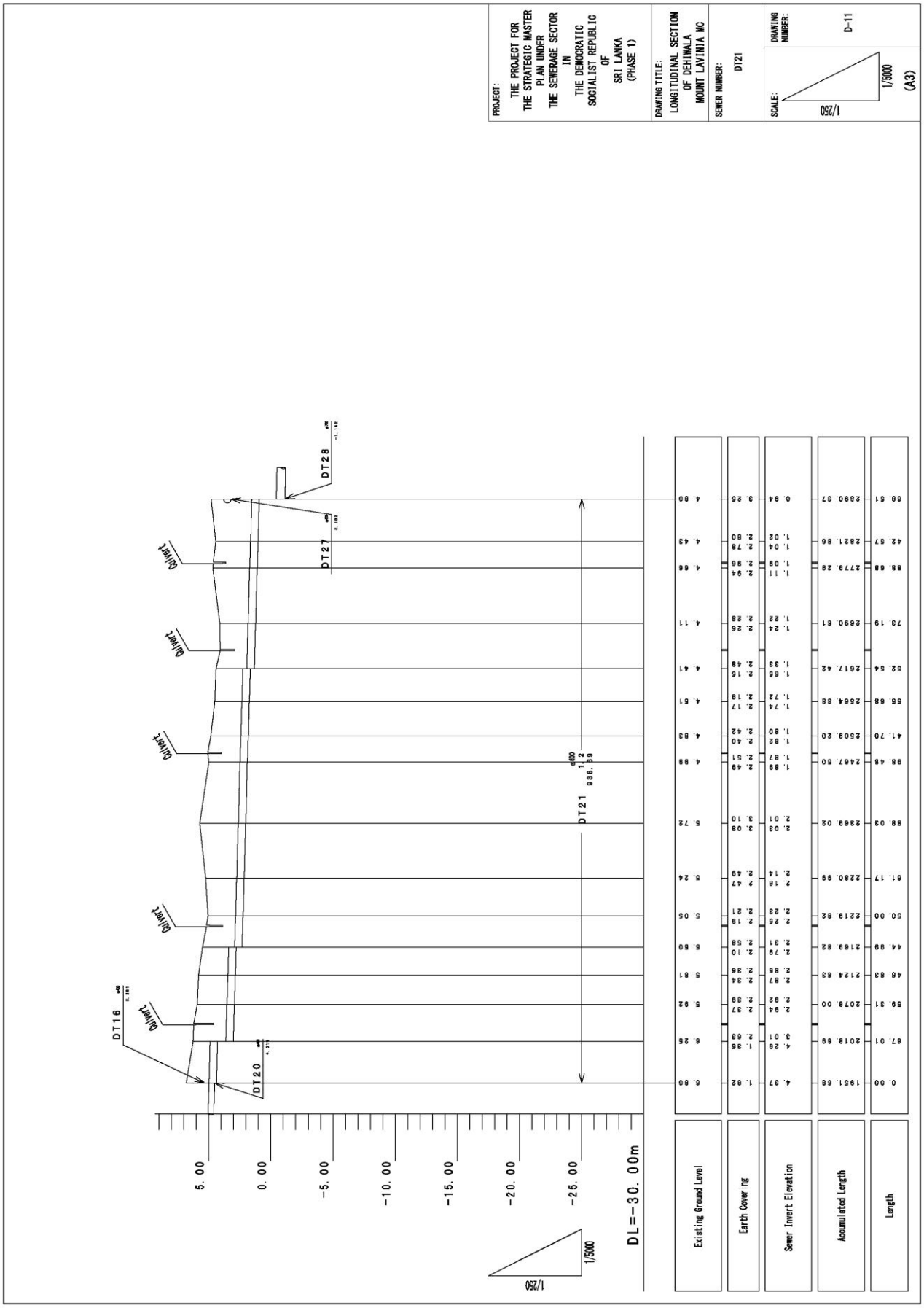
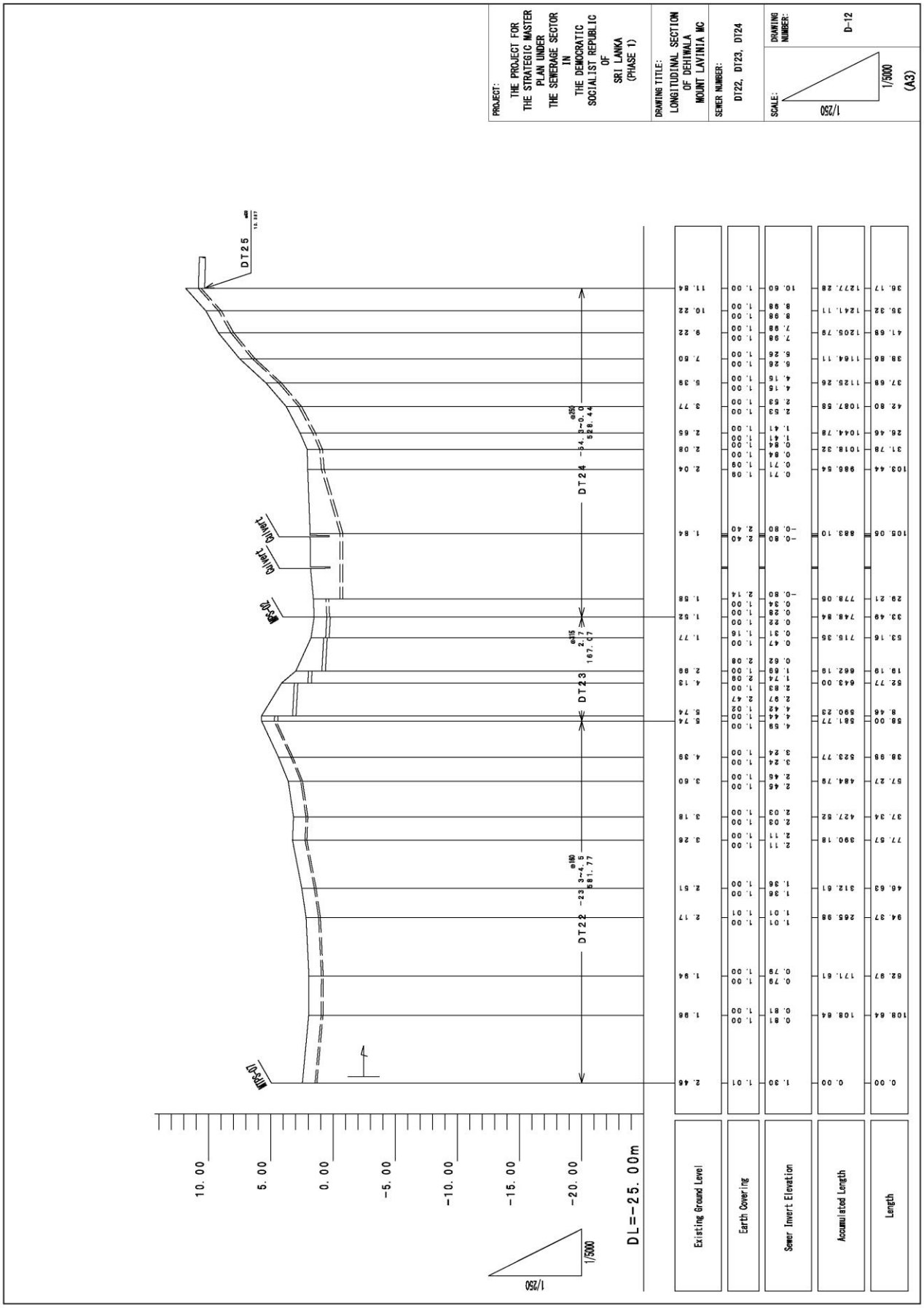
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF DEHIWALA MOUNT LAVINIA MC
SEWER NUMBER:
DT15, DT16
SCALE:
1/250
1/5000
(A3)
DRAWING NUMBER:
D-7
DT14
DT15
DT16
DT20
DT21
15.00
10.00
5.00
0.00
-5.00
-10.00
-15.00
-20.00
DL=-21.00m
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length

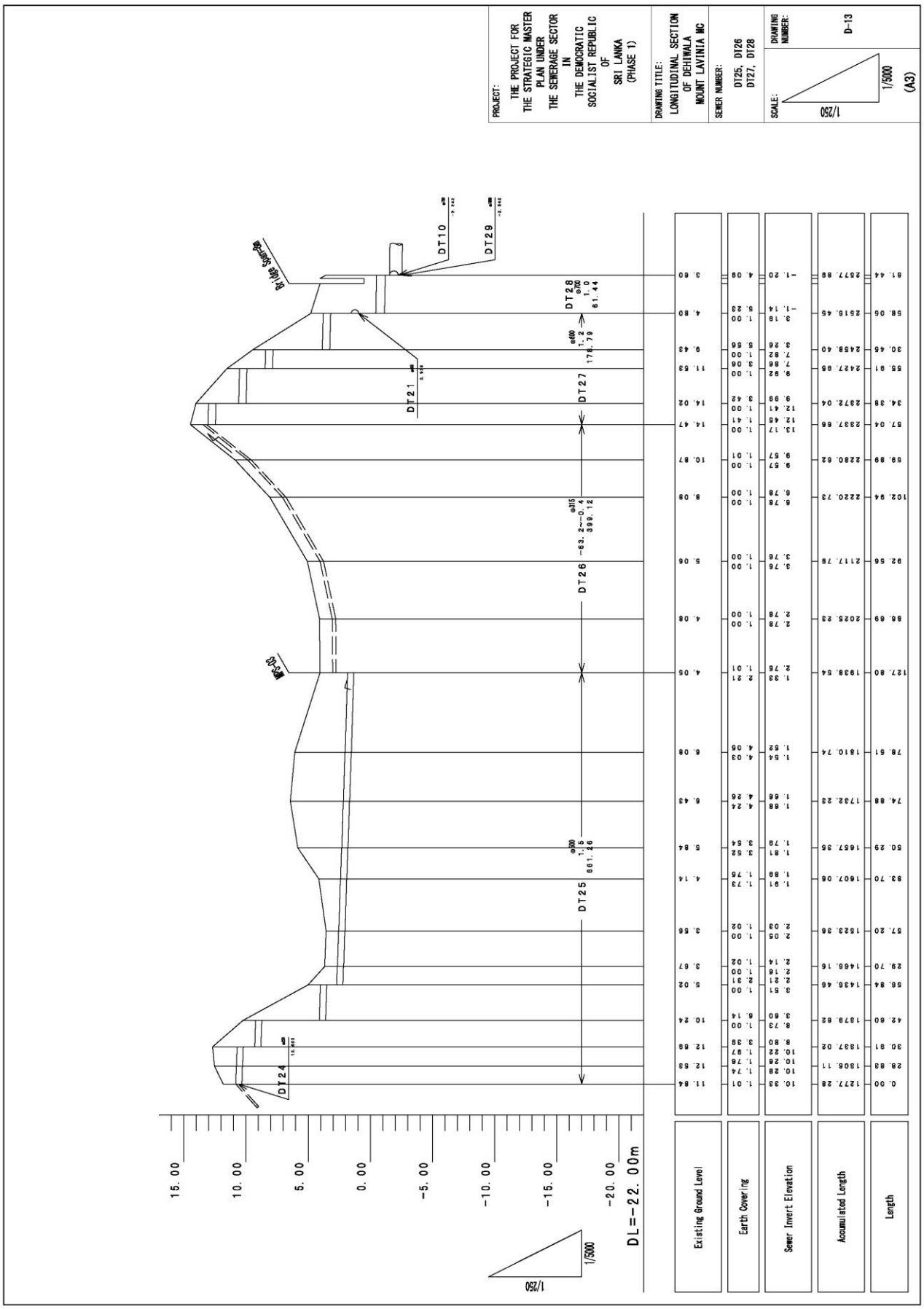

PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF DEHIWALA MOUNT LAVINIA MC
SEWER NUMBER:
DT18, DT19
SCALE:
1/250
1/5000
DRAWING NUMBER:
D-8
(A3)
DT17
DT20
DT19
DT18
RTPS-06 Outlet
DL=-16.00m
20.00
15.00
10.00
5.00
0.00
-5.00
-10.00
-15.00
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length

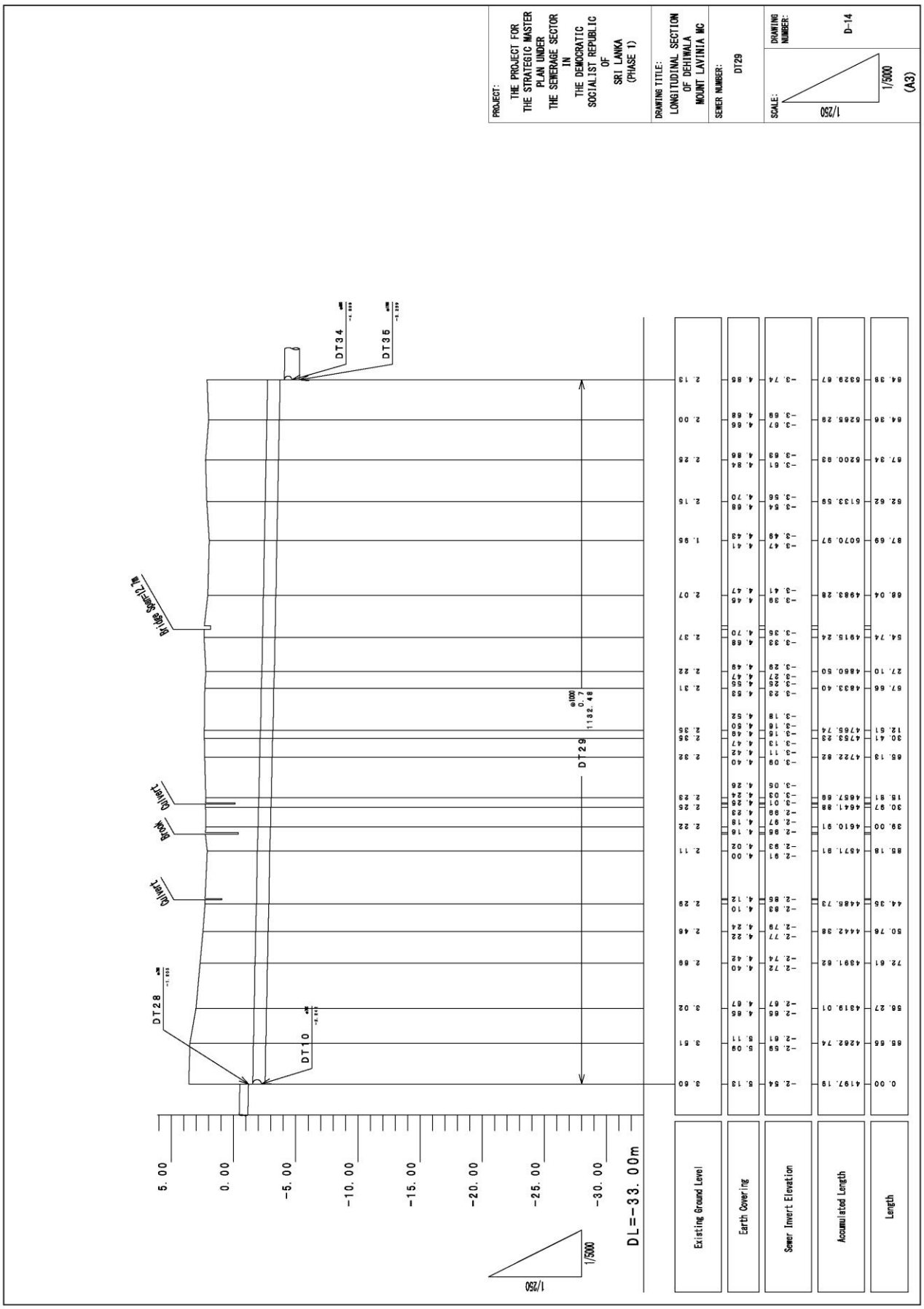

PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF DEHIWALA MOUNT LAVINIA MC
SEWER NUMBER:
DT17
SCALE:
1/250
1/5000
DRAWING NUMBER:
D-9
(A3)
DT20
DT19
DT17 -87.3+12.8
DL=-17.00m
20.00
15.00
10.00
5.00
0.00
-5.00
-10.00
-15.00
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length

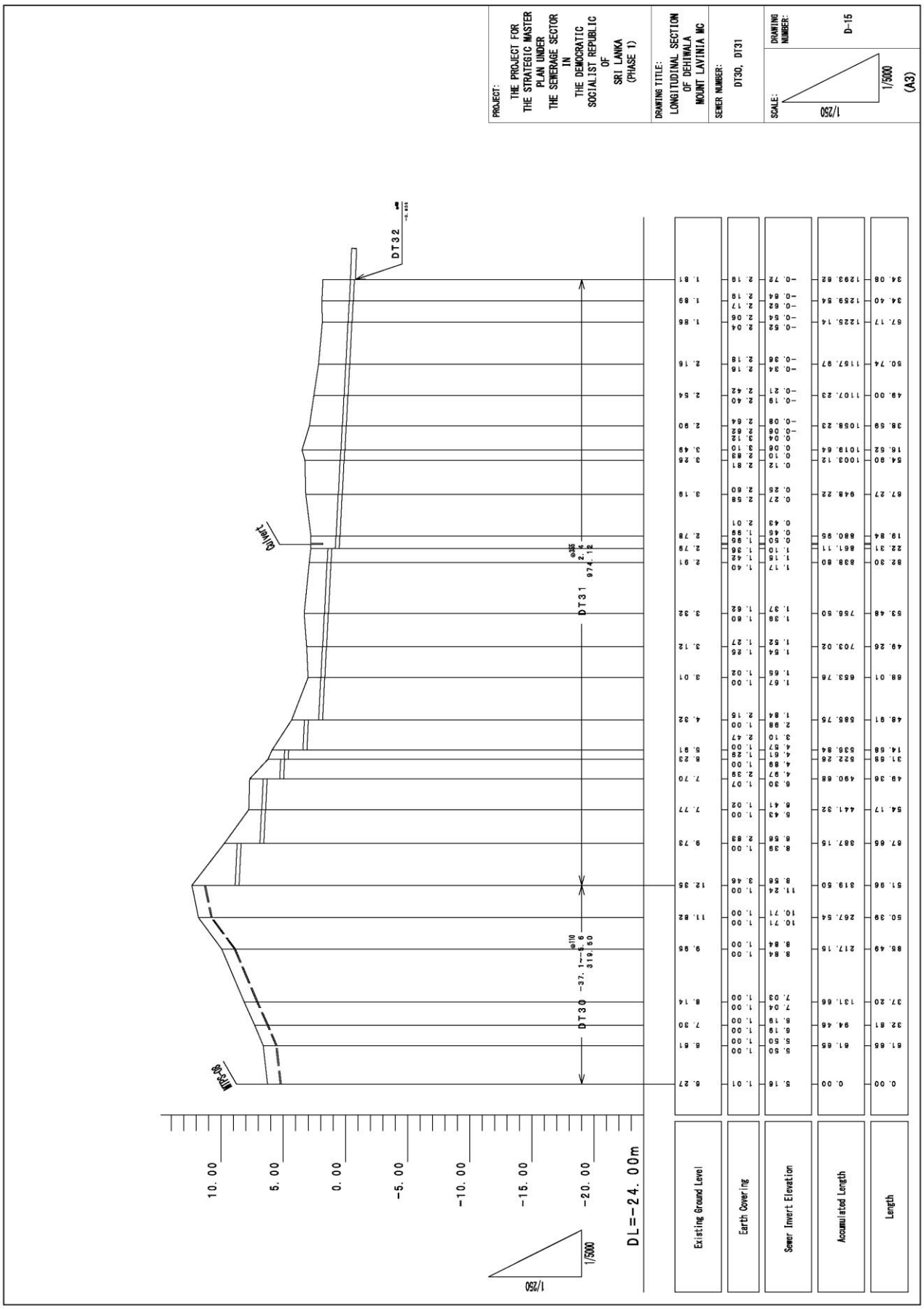

PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF DEHIWALA MOUNT LAVINIA MC
SEWER NUMBER:
DT20
SCALE:
1/250
1/5000
(A3)
DRAWING NUMBER:
D-10
DT16
DT21
DT17
DT19
DT20
OUTFALL
DL=-17.00m
20.00
15.00
10.00
5.00
0.00
-5.00
-10.00
-15.00
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length

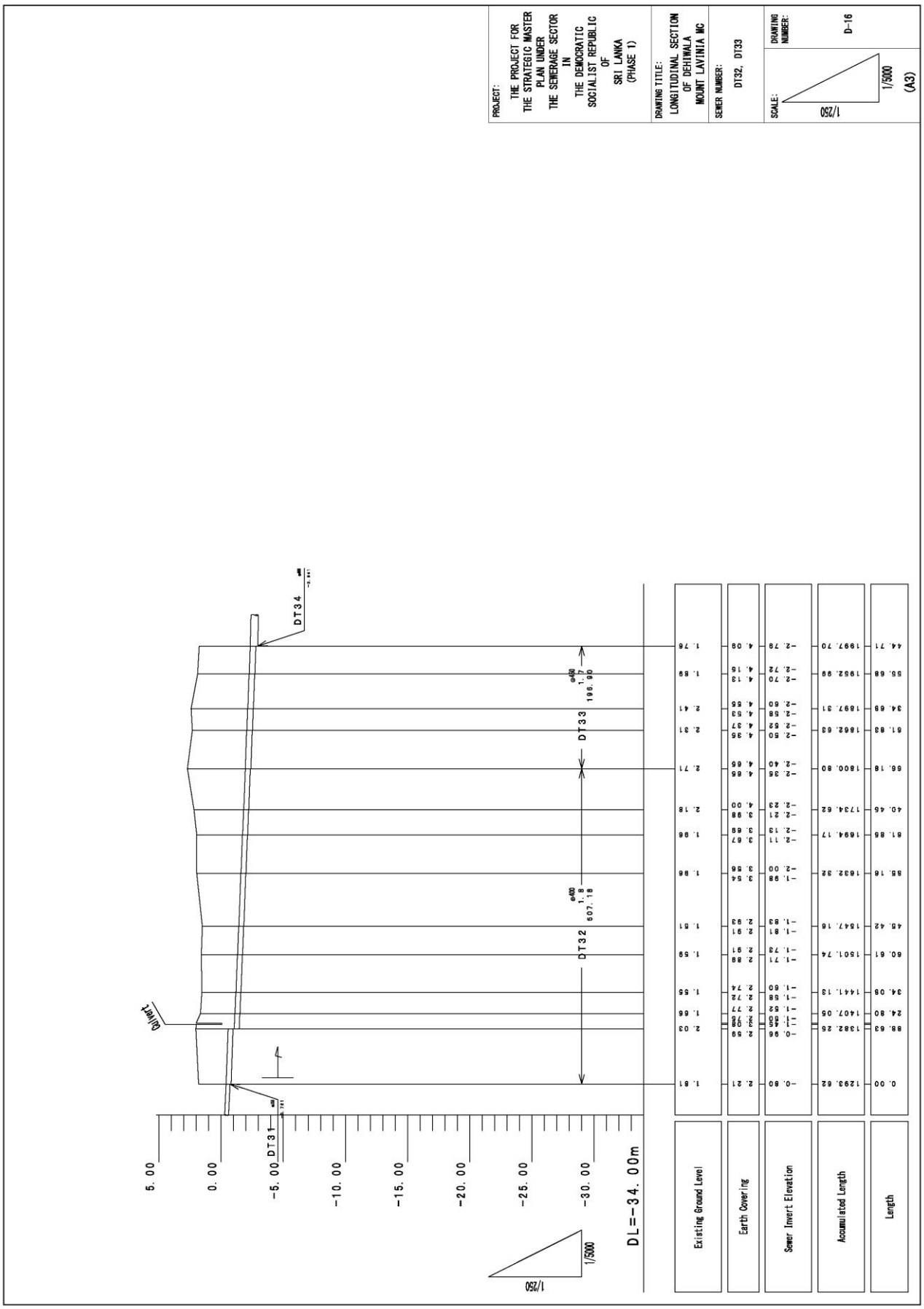

PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF DEHIWALA MOUNT LAVINIA MC
SEWER NUMBER:
DT21
SCALE:
1/250
1/5000
DRAWING NUMBER:
D-11
(A3)
DT28
DT27
DT21
DT20
DT16
Outlet
5.00
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
DL=-30.00m
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length

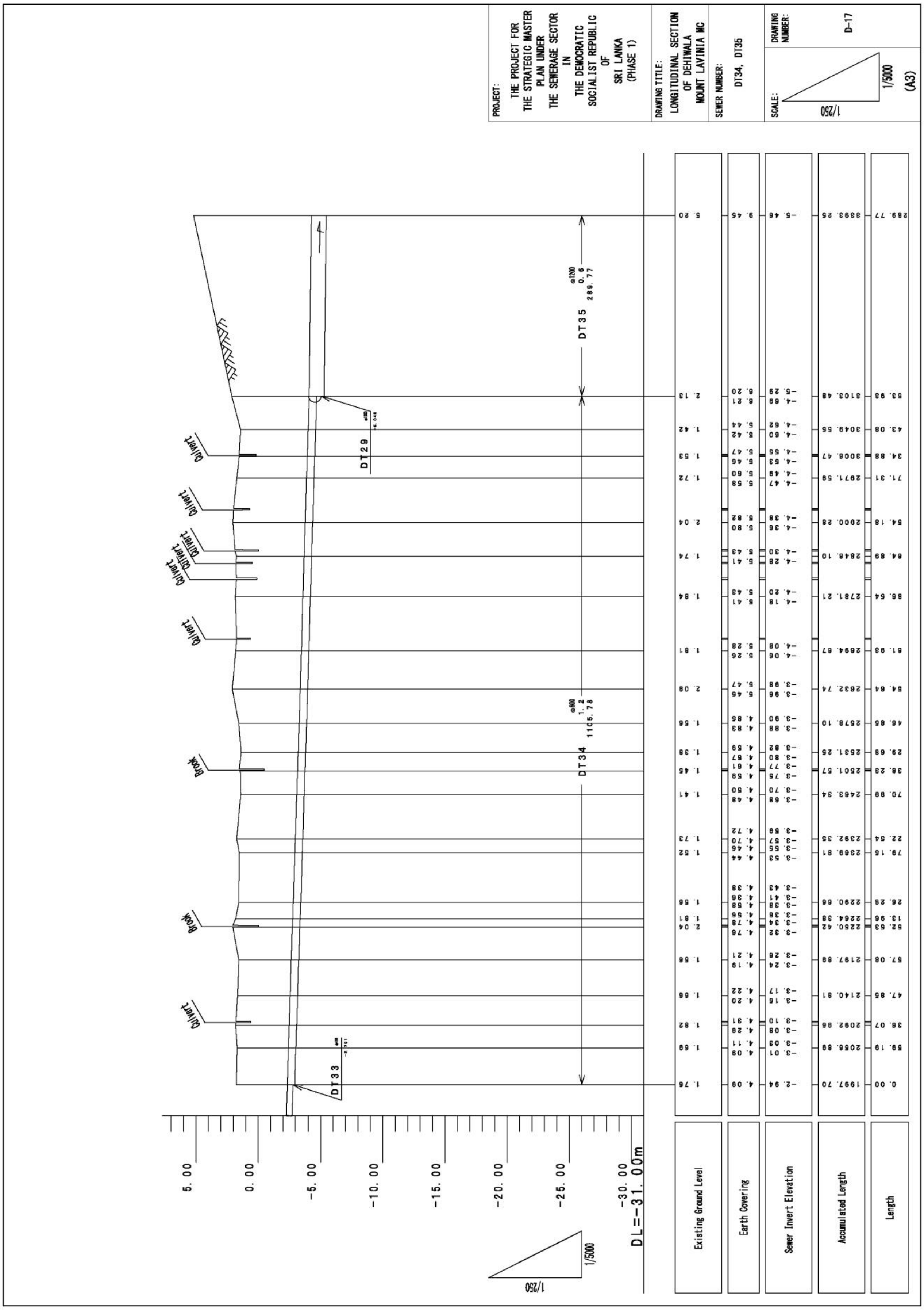

PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF DEHIWALA MOUNT LAVINIA MC
SEWER NUMBER:
DT22, DT23, DT24
SCALE:
1/250
1/5000
DRAWING NUMBER:
D-12
(A3)
DT25
DT24
DT23
DT22
MH-S-01
MH-S-02
Culvert
Culvert
DL=-25.00m
10.00
5.00
0.00
-5.00
-10.00
-15.00
-20.00
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 DEHIWALA MOUNT LAVINIA MC
SEWER NUMBER:
DT25, DT26
DT27, DT28
SCALE:
1/250
1/5000
DRAWING NUMBER:
D-13
(A3)
DT10
DT29
DT28
DT21
DT27
DT26
DT25
DT24
Bridge Section
MP6-03
DL=-22.00m
15.00
10.00
5.00
0.00
-5.00
-10.00
-15.00
-20.00
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 DEHIWALA MOUNT LAVINIA MC
SEWER NUMBER:
DT29
DRAWING NUMBER:
D-14
SCALE:
1/250
1/5000
(A3)
DT34
DT35
DT28
DT10
DT29
φ1000
0.7
1182.48
5.00
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
-30.00
DL=-33.00m
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 DEHIWALA MOUNT LAVINIA MC
SEWER NUMBER:
DT30, DT31
SCALE:
1/250
1/5000
DRAWING NUMBER:
D-15
(A3)
DT32
DT31
DT30
MH5-48
DL=-24.00m
10.00
5.00
0.00
-5.00
-10.00
-15.00
-20.00
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 DEHIWALA MOUNT LAVINIA MC
SEWER NUMBER:
DT32, DT33
SCALE:
1/250
1/5000
DRAWING NUMBER:
D-16
(A3)
DT34
DT33
DT32
DT31
DRAIN
5.00
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
-30.00
DL=-34.00m
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 DEHIWALA MOUNT LAVINIA MC
SEWER NUMBER:
DT34, DT35
DRAWING NUMBER:
D-17
SCALE:
1/250
1/5000
(A3)
DT35
DT34
DT29
DT33
Culvert
Brook
DL=-31.00m
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/l,max.	150
12.	Ammoniacal nitrogen (as N)	mg/l,max.	50
13.	Nitrate (as N)	mg/l,max.	10
14.	Cyanide (as CN)	mg/l,max.	0.05
15.	Total residual chlorine (as Cl_2)	mg/l,max.	0.5
16.	Chlorides (as Cl)	mg/l,max.	400
17.	Fluorides (as F)	mg/l,max.	2.0
18.	Sulphides (as S)	mg/l,max.	0.5
19.	Arsenic, total (as As)	mg/l,max.	0.05
20.	Cadmium, total (as Cd)	mg/l,max.	0.03
21.	Chromium, total (as Cr)	mg/l,max.	0.05
22.	Chromium, hexavalent (as Cr^{6+})	mg/l,max.	0.01
23.	Copper, total (as Cu)	mg/l,max.	0.05
24.	Iron, total (as Fe)	mg/l,max.	3.0
25.	Lead, total (as Pb)	mg/l,max.	0.05
26.	Mercury, total (as Hg)	mg/l,max.	0.001
27.	Nickel, total (as Ni)	mg/l,max.	0.2
28.	Selenium, total(as Se)	mg/l,max.	0.05
29.	Zinc, total (as Zn)	mg/l,max.	2.0
30.	Silver, total (as Ag)	mg/l,max.	0.035
31.	Pesticides (Total)	mg/l,max.	0.005
32.	Surfactants (Total)	mg/l, max.	5.0
33.	Faecal coliform	MPN/100ml, max.	150

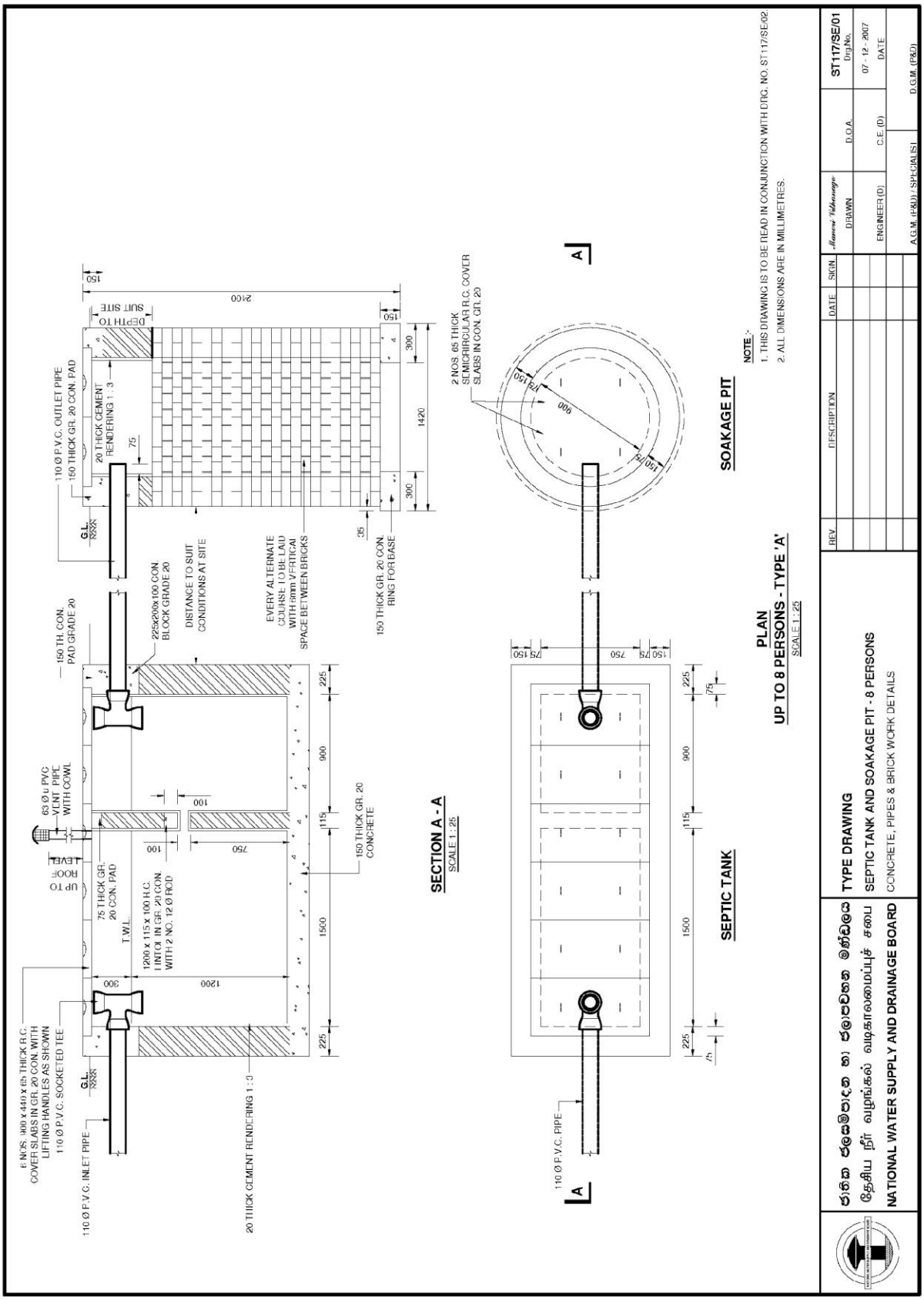
34.	Sulphates (as S)	mg/l, max.	250
35.	Radio Active Material:		
	(a) Alpha emitters	micro curie/ml, max	10^{-8}
	(b) Beta emitters	micro curie/ml, max	10^{-7}

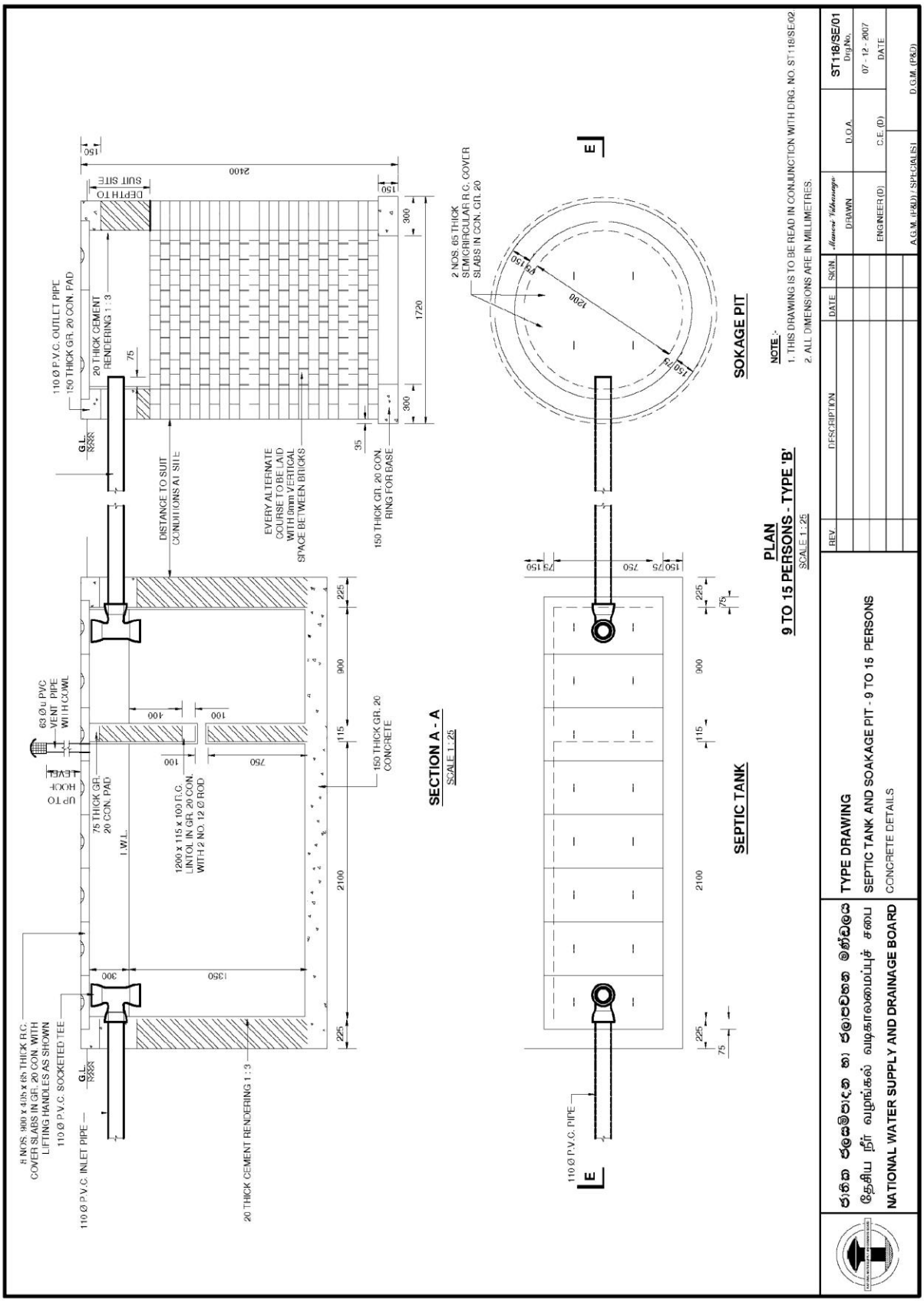
Note 1: All efforts should be made to remove unpleasant odour as practicable as possible.

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
SEPTIC TANK
SOKAGE PIT
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

Dehiwala Mount Lavinia Master Plan Area = 981 ha

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

	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**									
	Dehiwala Mount Lavinia STP (Q=20,000m3/day)	About 2400 USD/m3	Ls	1			2,792,727,273	3,225,600,000	6,981,818,182	5,376,000,000
	Sub-total of A						**2,792,727,273**	**3,225,600,000**	**6,981,818,182**	**5,376,000,000**
B										
B1	**Trunk Sewer**									
	Supply and install of HDPE OD225	Depth : not exceeding 1.5m	m	237	2,800	3,800	663,000	900,000	1,832,000	1,411,000
	Supply and install of HDPE OD225	Depth : not exceeding 2.0m	m	205	3,900	4,200	799,000	860,000	1,916,000	1,475,000
	Supply and install of HDPE OD225	Depth : not exceeding 2.5m	m	105	4,400	4,200	460,000	440,000	1,031,000	794,000
	Supply and install of HDPE OD225	Depth : not exceeding 3.5m	m	383	5,500	4,500	2,109,000	1,725,000	4,349,000	3,349,000
	Supply and install of HDPE OD225	Depth : not exceeding 4.0m	m	218	6,400	4,800	1,397,000	1,048,000	2,758,000	2,124,000
	Supply and install of HDPE OD280	Depth : not exceeding 2.0m	m	48	4,100	6,000	199,000	291,000	577,000	444,000
	Supply and install of HDPE OD280	Depth : not exceeding 3.0m	m	37	5,400	6,300	197,000	230,000	496,000	382,000
	Supply and install of HDPE OD315	Depth : not exceeding 1.5m	m	124	2,900	6,900	358,000	852,000	1,464,000	1,128,000
	Supply and install of HDPE OD315	Depth : not exceeding 2.0m	m	131	4,100	7,200	539,000	947,000	1,769,000	1,362,000
	Supply and install of HDPE OD315	Depth : not exceeding 2.5m	m	363	4,400	7,200	1,595,000	2,611,000	4,986,000	3,839,000
	Supply and install of HDPE OD315	Depth : not exceeding 3.0m	m	113	5,400	7,600	609,000	856,000	1,721,000	1,325,000
	Supply and install of HDPE OD315	Depth : not exceeding 3.5m	m	125	5,400	7,600	673,000	947,000	1,903,000	1,465,000
	Supply and install of HDPE OD355	Depth : not exceeding 1.5m	m	185	3,100	8,700	574,000	1,611,000	2,666,000	2,053,000
	Supply and install of HDPE OD355	Depth : not exceeding 2.0m	m	300	4,200	9,000	1,259,000	2,698,000	4,763,000	3,667,000
	Supply and install of HDPE OD355	Depth : not exceeding 2.5m	m	411	4,400	9,000	1,809,000	3,701,000	6,615,000	5,094,000
	Supply and install of HDPE OD355	Depth : not exceeding 3.0m	m	225	5,400	9,300	1,217,000	2,096,000	3,939,000	3,033,000
	Supply and install of HDPE OD355	Depth : not exceeding 3.5m	m	123	5,400	9,300	663,000	1,142,000	2,146,000	1,653,000
	Supply and install of HDPE OD355	Depth : not exceeding 4.5m	m	17	6,500	9,600	113,000	167,000	330,000	254,000
	Supply and install of GRP/FRP ND400	Depth : not exceeding 1.5m	m	231	3,800	22,700	878,000	5,245,000	7,690,000	5,921,000
	Supply and install of GRP/FRP ND400	Depth : not exceeding 2.0m	m	636	4,900	23,000	3,116,000	14,628,000	22,113,000	17,027,000
	Supply and install of GRP/FRP ND400	Depth : not exceeding 2.5m	m	225	7,300	23,000	1,645,000	5,183,000	8,376,000	6,450,000
	Supply and install of GRP/FRP ND400	Depth : not exceeding 3.0m	m	351	8,500	23,400	2,982,000	8,210,000	13,644,000	10,506,000
	Supply and install of GRP/FRP ND400	Depth : not exceeding 3.5m	m	84	8,700	23,400	731,000	1,967,000	3,286,000	2,530,000
	Supply and install of GRP/FRP ND400	Depth : not exceeding 4.0m	m	321	9,800	23,700	3,145,000	7,606,000	13,023,000	10,028,000
	Supply and install of GRP/FRP ND450	Depth : not exceeding 1.5m	m	74	5,000	28,300	370,000	2,092,000	3,087,000	2,377,000
	Supply and install of GRP/FRP ND450	Depth : not exceeding 2.0m	m	137	6,500	28,800	888,000	3,935,000	5,998,000	4,619,000
	Supply and install of GRP/FRP ND450	Depth : not exceeding 2.5m	m	55	9,300	28,800	512,000	1,586,000	2,572,000	1,980,000
	Supply and install of GRP/FRP ND450	Depth : not exceeding 3.0m	m	153	10,900	29,200	1,667,000	4,466,000	7,467,000	5,750,000
	Supply and install of GRP/FRP ND450	Depth : not exceeding 3.5m	m	98	11,100	29,200	1,090,000	2,867,000	4,813,000	3,706,000
	Supply and install of GRP/FRP ND450	Depth : not exceeding 4.5m	m	45	13,000	29,600	581,000	1,323,000	2,299,000	1,770,000
	Supply and install of GRP/FRP ND500	Depth : not exceeding 1.5m	m	57	5,800	28,300	332,000	1,619,000	2,435,000	1,875,000
	Supply and install of GRP/FRP ND500	Depth : not exceeding 2.0m	m	143	7,400	28,800	1,061,000	4,131,000	6,426,000	4,948,000
	Supply and install of GRP/FRP ND500	Depth : not exceeding 2.5m	m	30	8,000	28,800	238,000	855,000	1,348,000	1,038,000
	Supply and install of GRP/FRP ND500	Depth : not exceeding 3.5m	m	43	13,100	29,200	558,000	1,244,000	2,174,000	1,674,000
	Supply and install of GRP/FRP ND500	Depth : not exceeding 4.0m	m	50	14,700	29,600	739,000	1,489,000	2,673,000	2,058,000
	Supply and install of GRP/FRP ND500	Depth : not exceeding 4.5m	m	281	15,100	29,600	4,246,000	8,323,000	15,055,000	11,592,000
	Supply and install of GRP/FRP ND600	Depth : not exceeding 1.5m	m	227	6,400	34,000	1,455,000	7,731,000	11,495,000	8,851,000
	Supply and install of GRP/FRP ND600	Depth : not exceeding 2.0m	m	144	7,800	34,500	1,123,000	4,965,000	7,571,000	5,830,000
	Supply and install of GRP/FRP ND600	Depth : not exceeding 2.5m	m	426	12,000	34,500	5,114,000	14,703,000	24,209,000	18,641,000
	Supply and install of GRP/FRP ND600	Depth : not exceeding 3.0m	m	416	13,700	34,900	5,698,000	14,515,000	24,549,000	18,902,000
	Supply and install of GRP/FRP ND600	Depth : not exceeding 3.5m	m	380	14,000	34,900	5,326,000	13,278,000	22,570,000	17,379,000
	Supply and install of GRP/FRP ND600	Depth : not exceeding 4.5m	m	279	16,200	35,300	4,525,000	9,861,000	17,331,000	13,345,000
	Supply and install of GRP/FRP ND700	Depth : not exceeding 3.5m	m	238	21,300	44,800	5,077,000	10,678,000	18,945,000	14,587,000
	Supply and install of GRP/FRP ND700	Depth : not exceeding 4.0m	m	47	19,700	44,200	921,000	2,066,000	3,604,000	2,775,000
	Supply and install of GRP/FRP ND700	Depth : not exceeding 4.5m	m	172	20,200	44,200	3,478,000	7,611,000	13,362,000	10,289,000
	Supply and install of GRP/FRP ND1000	Depth : not exceeding 4.5m	m	462	25,600	102,400	11,822,000	47,289,000	73,236,000	56,392,000
	Supply and install of HDPE OD110	Depth : not exceeding 1.5m	m	557	600	1,000	334,000	557,000	1,057,000	814,000
	Supply and install of HDPE OD125	Depth : not exceeding 1.5m	m	269	600	1,200	162,000	323,000	581,000	448,000
	Supply and install of HDPE OD125	Depth : not exceeding 4.5m	m	35	2,000	1,200	69,000	42,000	124,000	95,000
	Supply and install of HDPE OD160	Depth : not exceeding 1.5m	m	1,778	800	2,000	1,422,000	3,556,000	6,040,000	4,651,000
	Supply and install of HDPE OD160	Depth : not exceeding 2.0m	m	115	1,000	2,000	115,000	230,000	414,000	319,000
	Supply and install of HDPE OD180	Depth : not exceeding 1.5m	m	1,740	800	2,500	1,392,000	4,351,000	7,043,000	5,423,000
	Supply and install of HDPE OD225	Depth : not exceeding 1.5m	m	469	900	3,700	422,000	1,734,000	2,674,000	2,059,000
	Supply and install of HDPE OD250	Depth : not exceeding 1.5m	m	320	900	4,800	288,000	1,536,000	2,283,000	1,758,000
	Supply and install of HDPE OD250	Depth : not exceeding 2.5m	m	208	1,600	4,800	334,000	1,001,000	1,634,000	1,258,000
	Supply and install of HDPE OD315	Depth : not exceeding 1.5m	m	399	1,000	7,700	399,000	3,073,000	4,390,000	3,380,000
	Supply and install of GRP/FRP ND400(PJ)	Depth : not exceeding 10m	m	110	35,600	275,814	3,906,000	30,262,000	43,207,000	33,270,000
	Supply and install of GRP/FRP ND450(PJ)	Depth : not exceeding 10m	m	152	37,000	327,404	5,631,000	49,828,000	70,343,000	54,164,000
	Supply and install of GRP/FRP ND500(PJ)	Depth : not exceeding 10m	m	57	37,000	327,404	2,103,000	18,610,000	26,272,000	20,229,000
	Supply and install of GRP/FRP ND600(PJ)	Depth : not exceeding 10m	m	884	38,500	379,302	34,053,000	335,489,000	469,753,000	361,710,000
	Supply and install of GRP/FRP ND700(PJ)	Depth : not exceeding 10m	m	1,191	40,600	479,710	48,365,000	571,455,000	790,514,000	608,696,000
	Supply and install of GRP/FRP ND1000(PJ)	Depth : not exceeding 10m	m	671	85,700	776,622	57,476,000	520,857,000	733,914,000	565,114,000
	Supply and install of GRP/FRP ND1200(PJ)	Depth : not exceeding 10m	m	290	85,700	853,622	24,833,000	247,354,000	346,072,000	266,475,000
	Temporary road reinstatementAsphalt concete	Add 10% of pipeline(W=1.2)	m2	24,289	2,000	0	48,578,000	0	48,578,000	37,405,000
	Permanent road reinstatementAsphalt concete	Add 10% of pipeline(W=1.2)	m2	24,289	4,910	0	119,260,000	0	119,260,000	91,830,000
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	3	570,000,000	0	1,710,000,000	0	1,710,000,000	1,316,700,000
	Sub-total of B						**2,319,693,000**	**2,022,846,000**	**4,946,765,000**	**3,809,010,000**
C	**Branch Sewer**									
C1										
	Supply and install of HDPE OD225	Depth : not exceeding 2.5m	m	147,150	4,400	4,200	647,460,000	618,030,000	1,450,096,000	1,116,574,000
	Temporary road reinstatementAsphalt concete	Add 10% of pipeline(W=1.2)	m2	194,238	2,000	0	388,476,000	0	388,476,000	299,127,000
	Permanent road reinstatementAsphalt concete	Add 10% of pipeline(W=1.2)	m2	194,238	4,910	0	953,709,000	0	953,709,000	734,356,000
	Manhole Type Pump		pc	14	1,000,000	6,930,000	14,000,000	97,020,000	140,000,000	107,800,000
	Sub-total of C						**2,003,645,000**	**715,050,000**	**2,932,281,000**	**2,257,857,000**
D	**House Connection**									
D1										
	House Connection		HH	26,525	100,000	0	2,652,500,000	0	2,652,500,000	2,042,425,000
	Sub-total of D						**2,652,500,000**	**0**	**2,652,500,000**	**2,042,425,000**
	Sub-total of 1						**9,768,565,273**	**5,963,496,000**	**17,513,364,182**	**13,485,292,000**
2	Administration cost						1,184,000,000	0	1,184,000,000	911,680,000
3	Consulting cost						465,000,000	1,022,000,000	1,792,273,000	1,380,050,000
4	Physical contingency for construction cost						605,000,000	336,000,000	1,041,364,000	801,850,000
5	Price escalation for construction cost						2,343,000,000	587,000,000	3,105,338,000	2,391,110,000
6	Land acquisition and compensation									
7	Interest during construction						0	164,000,000	212,987,000	164,000,000
8	Front-end Fee						0	37,000,000	48,052,000	37,000,000
9	Tax and duty						4,286,000,000	0	4,286,000,000	3,300,220,000
	Sub-total of (2-9)						**8,883,000,000**	**2,146,000,000**	**11,670,013,000**	**8,985,910,000**
	Total including Tax and Duty						**18,651,565,273**	**8,109,496,000**	**29,183,378,000**	**22,471,201,000**
	Total excluding Tax and Duty						**14,365,565,273**	**8,109,496,000**	**24,897,378,000**	**19,170,981,000**
	Eligible Portion (1, 3, 4, 5 and 7)						**13,181,565,273**	**8,072,496,000**	**23,665,326,000**	**18,222,301,000**
	Non-Eligible Portion (2, 6, 8 and 9)						**5,470,000,000**	**37,000,000**	**5,518,052,000**	**4,248,900,000**

APPENDIX 7: Detail of Annual Fund Requirement

Annual Fund Requirement of Dehiwala Mount Lavinia

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 Dehiwala Mount Lavinia

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	7,061	12,709	16,847	0	0	0	0	0	0	0	0	0	0	0	0
STP	3,226	2,793	5,376	0	0	0	0	0	0	0	0	0	0	0	0
Trunk Sewer	2,197	2,312	3,978	0	0	0	0	0	0	0	0	0	0	0	0
Branch Sewer	715	2,004	2,258	0	0	0	0	0	0	0	0	0	0	0	0
House Connection	0	2,653	2,042	0	0	0	0	0	0	0	0	0	0	0	0
Base cost for JICA financing	6,138	9,761	13,654	0	0	0	0	0	0	0	0	0	0	0	0
Price escalation	587	2,343	2,391	0	0	0	0	0	0	0	0	0	0	0	0
Physical contingency	336	605	802	0	0	0	0	0	0	0	0	0	0	0	0
Ⅱ) Consulting services	1,022	465	1,380	0	0	0	0	0	0	217	83	280	166	60	212
Base cost	907	372	1,194	0	0	0	0	0	0	200	73	256	151	51	190
Price escalation	66	71	121	0	0	0	0	0	0	6	6	11	7	6	12
Physical contingency	49	22	66	0	0	0	0	0	0	10	4	13	8	3	10
Total (Ⅰ + Ⅱ)	8,083	13,174	18,227	0	0	0	0	0	0	217	83	280	166	60	212
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	1,184	911	0	0	0	0	0	0	0	18	14	0	14	11
d VAT	0	3,551	2,734	0	0	0	0	0	0	0	55	42	0	41	32
e Import Tax	0	735	566	0	0	0	0	0	0	0	20	15	0	15	12
Total (a+b+c+d+e)	0	5,469	4,211	0	0	0	0	0	0	0	92	71	0	70	54
TOTAL (A+B)	8,083	18,643	22,439	0	0	0	0	0	0	217	175	351	166	130	266
C. Interest during Construction	164	0	164	0	0	0	0	0	0	0	0	0	0	0	0
Interest during Construction(Const.)	163	0	163	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	37	0	37	0	0	0	0	0	0	37	0	37	0	0	0
GRAND TOTAL (A+B+C+D)	8,284	18,643	22,640	0	0	0	0	0	0	253	175	388	166	130	267
E. JICA finance portion incl. IDC (A + C)	8,247	13,174	18,392	0	0	0	0	0	0	217	83	280	166	60	212

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	1,226	2,125	2,862	1,794	3,176	4,240	1,823	3,296	4,361	1,852	3,422	4,487	366	691	898	0	0	0	0	0	0
STP	576	499	960	829	718	1,382	829	718	1,382	829	718	1,382	161	140	269	0	0	0	0	0	0
Trunk Sewer	392	413	710	565	595	1,023	565	595	1,023	565	595	1,023	110	116	199	0	0	0	0	0	0
Branch Sewer	128	358	403	184	515	581	184	515	581	184	515	581	36	100	113	0	0	0	0	0	0
House Connection	0	474	365	0	682	525	0	682	525	0	682	525	0	133	102	0	0	0	0	0	0
Base cost for JICA financing	1,096	1,743	2,438	1,578	2,510	3,511	1,578	2,510	3,511	1,578	2,510	3,511	307	488	683	0	0	0	0	0	0
Price escalation	72	280	288	130	515	527	158	629	642	185	749	762	42	170	172	0	0	0	0	0	0
Physical contingency	58	101	136	85	151	202	87	157	208	88	163	214	17	33	43	0	0	0	0	0	0
Ⅱ) Consulting services	130	50	169	164	81	227	143	82	206	202	109	286	0	0	0	0	0	0	0	0	0
Base cost	116	41	148	145	64	194	124	62	172	172	80	233	0	0	0	0	0	0	0	0	0
Price escalation	8	7	13	12	13	22	12	16	24	20	24	39	0	0	0	0	0	0	0	0	0
Physical contingency	6	2	8	8	4	11	7	4	10	10	5	14	0	0	0	0	0	0	0	0	0
Total (Ⅰ + Ⅱ)	1,356	2,175	3,031	1,959	3,257	4,466	1,966	3,378	4,567	2,054	3,531	4,772	366	691	898	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	197	152	0	290	223	0	297	228	0	310	239	0	58	45	0	0	0	0	0	0
d VAT	0	591	455	0	870	670	0	890	685	0	930	716	0	175	135	0	0	0	0	0	0
e Import Tax	0	123	95	0	178	137	0	179	138	0	187	144	0	33	26	0	0	0	0	0	0
Total (a+b+c+d+e)	0	911	701	0	1,338	1,030	0	1,365	1,051	0	1,426	1,098	0	266	205	0	0	0	0	0	0
TOTAL (A+B)	1,356	3,086	3,732	1,959	4,595	5,497	1,966	4,743	5,618	2,054	4,957	5,871	366	957	1,103	0	0	0	0	0	0
C. Interest during Construction	9	0	9	21	0	21	35	0	35	48	0	48	51	0	51	0	0	0	0	0	0
Interest during Construction(Const.)	9	0	9	21	0	21	34	0	34	48	0	48	51	0	51	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)	1,365	3,086	3,741	1,980	4,595	5,518	2,000	4,743	5,653	2,102	4,957	5,919	417	957	1,154	0	0	0	0	0	0
E. JICA finance portion incl. IDC (A + C)	1,365	2,175	3,040	1,980	3,257	4,488	2,000	3,378	4,602	2,102	3,531	4,821	417	691	949	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
Present, Inflow, 5000m3/d (RS/m3/d/year)
Capacity, 17000m3/d (RS/m3/d/year)

Treatment Plant and Network
39.13 LKR/m3/day

			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

Acts and Regulations Relevant to the Implementation of Sewerage Sector Projects

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 Initial Environmental Examination (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.

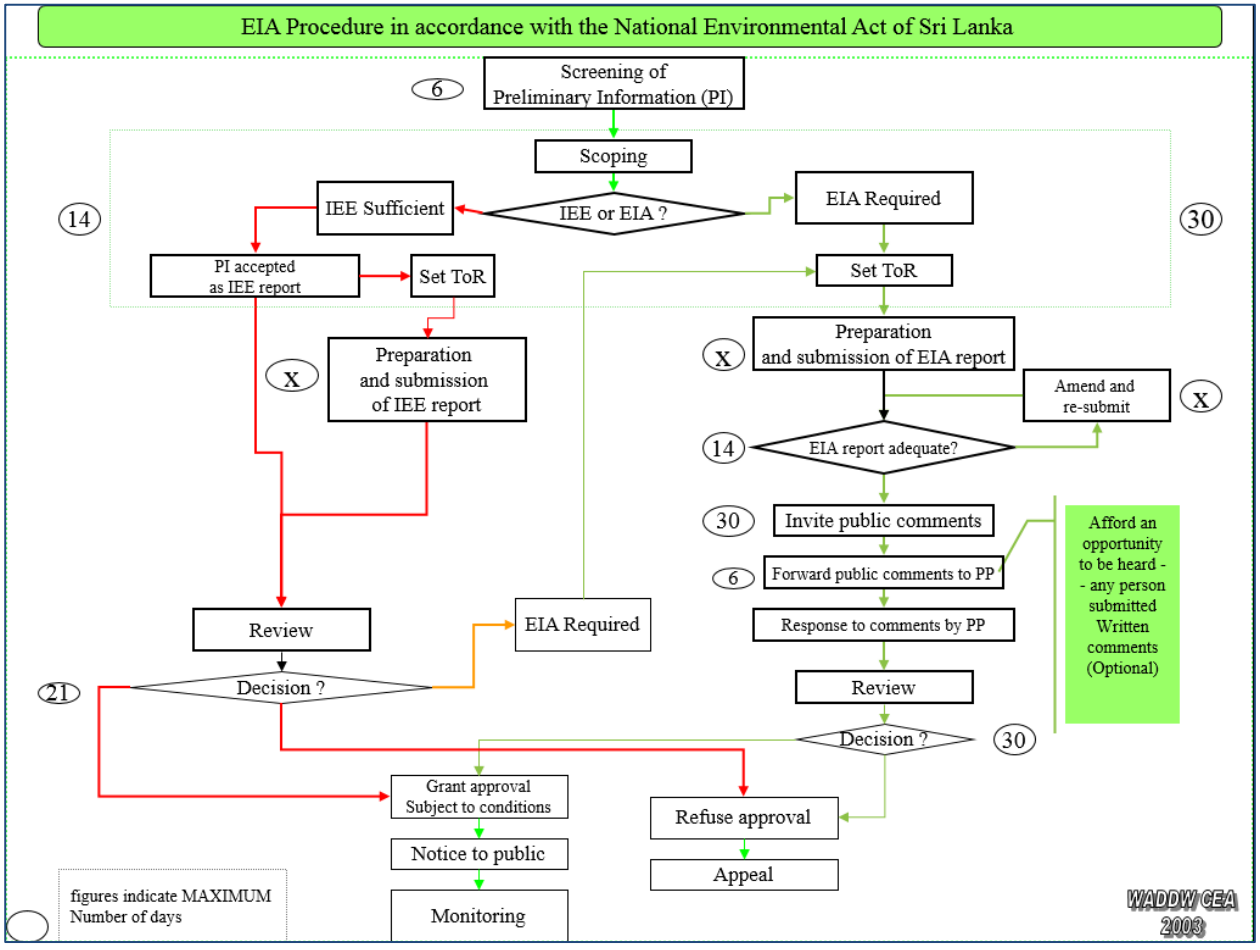
The Technical Evaluation Committee (TEC) appointed by the PAA would then evaluate the EIA and require the project proponent to respond to any queries raised by the TEC. The TEC would also evaluate the adequacy of the project proponent's response to any comments raised during the public comments period. 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 initial environmental examination (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: 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.

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

Date:

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

Date:

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

Date:

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.	Contractor	Consultant/ NWSDB

Environmental Impact / Issue	Mitigation Measure	Implementing Organization	Responsible Organization
	▪ Provide covers during transportation		
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	NWS&DB / MMC	MMC /

Environmental Impact / Issue	Mitigation Measure	Implementing Organization	Responsible Organization
	▪ 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.		NWSDB
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	