THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
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 FIVE CITIES' SEWERAGE MASTER PLAN ①SRI JAYAWARDENAPURA KOTTE

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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
M/P	Master Plan
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	Water Quality Index 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 (M/P) for the entire country. The M/P identifies 15 priority cities and explains the process used to select the following five cities to be covered by the City Sewerage M/P.

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

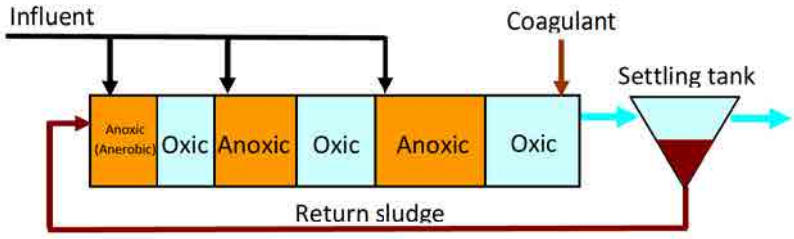
Chapter 2 examines the environmental and socio-economic conditions of the target area for sewerage development in Sri Jayawardenapura Kotte MC. It then describes the necessity of the Sewerage Project. 96% of the households have septic tanks. Increasing levels of BOD, ammonia, and coliform bacteria have been detected in the lake surrounding the National Parliament, indicating the deterioration of water quality caused by human activities. A sewerage system would treat wastewater efficiently and would protect and improve water quality. The mean household income in Colombo district where Sri Jayawardenapura Kotte is located is higher than the national average. The sewer charges should be affordable and therefore the sewerage system would be sustainable.

Chapter 3 sets out the basic conditions for the preparation of the sewerage plan for Sri Jayawardenapura Kotte MC. The plan is to serve 198,000 people in Sri Jayawardenapura Kotte MC and adjacent areas (3,392 ha) by, 2046. The maximum daily wastewater flow will be 35,000 m^3.

Chapter 4 describes the sewerage facility plan and design. The sewer route and locations of pumping stations and the sewage treatment plant (STP) are shown in Figure 1. Given the limited area available, the wastewater treatment would be a step-feed biological nutrient removal process (**Figure 2**) developed in Japan, which achieves high nitrogen removal with a relatively small footprint. Sludge generated by the wastewater treatment process will be dewatered with a screw press machines and then composted.

Source: JET

Figure 1 Map of Sewer System Plan in Sri Jayawardenapura Kotte



Source: JET

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

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

Chapter 6 estimates the project costs at approximately 44.1 billion JPY (excluding tax), and the annual maintenance cost, 0.39 billion JPY as shown in **Table 1**.

Table 1.1-1 Estimated Project Cost

		Amount		Total Amount	Total Amount
		L.C. (LKR)	F.C. (JPY)	LKR	JPY
1	Construction Cost				
	A Sri Jayawardenapura Kotte STP (Q=35,000m3/day)	4,887,272,727	5,644,800,000	12,218,181,818	9,408,000,000
	B Trunk Sewer & Pump Station	3,884,573,000	4,878,220,000	10,219,925,000	7,869,338,000
	C Branch Sewer & Pump Station	7,079,587,000	3,522,960,000	11,654,860,000	8,974,242,000
	D House Connection	4,950,000,000	0	4,950,000,000	3,811,500,000
	Sub-total of 1(A-D)	20,801,432,727	14,045,980,000	39,042,966,818	30,063,080,000
2	Administration cost	2,700,000,000	0	2,700,000,000	2,079,000,000
3	Consulting cost	1,354,000,000	3,129,000,000	5,417,636,000	4,171,580,000
4	Physical contingency for construction cost	1,309,000,000	773,000,000	2,312,896,000	1,780,930,000
5	Price escalation for construction cost	5,381,000,000	1,419,000,000	7,223,857,000	5,562,370,000
6	Land acquisition and compensation	-	-	-	-
7	Interest during construction	0	323,000,000	419,481,000	323,000,000
8	Front-end Fee	0	84,000,000	109,091,000	84,000,000
9	Tax and duty	9,861,000,000	0	9,861,000,000	7,592,970,000
	Sub-total of (2-9)	20,605,000,000	5,728,000,000	28,043,961,000	21,593,850,000
	Total including Tax and Duty	41,406,432,727	19,773,980,000	67,086,926,000	51,656,933,000
	Total excluding Tax and Duty	31,545,432,727	19,773,980,000	57,225,926,000	44,063,963,000
	Eligible Portion (1, 3, 4, 5 and 7)	28,845,432,727	19,689,980,000	54,416,835,000	41,900,963,000
	Non-Eligible Portion (2, 6, 8 and 9)	12,561,000,000	84,000,000	12,670,091,000	9,755,970,000

Source: JET

Chapter 7 proposes two sewage tariff schemes to recover the maintenance cost. Type 1 tariff is calculated to cover the maintenance cost for the sewerage system in Sri Jayawardenapura Kotte, while Type 2 is calculated based on the sewerage systems operated by NWSDB. Type-1 is calculated to be 46.97 LKR/m^3, and Type-2, 42.34 LKR/m^3, both are lower than the limits of affordability estimated by the World Bank (WB). The construction cost will be borne by the central government.

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

Chapter 9 concludes that the need for sewerage services in Sri Jayawardenapura Kotte MC the administrative capital of Sri Lanka, is of very high priority. The population served by the sewer system is projected to be significant. The planned treatment is an advanced process that removes nitrogen and phosphorus, which will have a significant positive impact on water quality. A site for the sewage treatment plant is available and a sludge disposal site is already operating. Therefore, Sri Jayawardenapura Kotte MC is selected for a F/S to prepare the project for Japanese financial assistance.

To implement the proposed project in a timely manner, early acquisition of sites necessary for the sewage treatment plant and pumping stations is recommended. , it is proposed that The F/S should include basic site investigations such as a geotechnical survey, to make sure that project cost estimation can be made accurately and to avoid cost over-run.

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 increased 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 had urban sewerage coverage. A considerable amount of untreated wastewater is discharged into the ocean, rivers, and streams, causing problems related to hygiene and environmental degradation.

The national policy formulated in 2010 (Source: Department of National Planning, 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. NWSDB sets the objective to achieve 7.0% sewerage coverage by 2020.

The Government committed to developing the Strategic M/P 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 water environment. The Government sought assistance from Japan. The Japanese government accepted the request and subsequently JICA (JICA) signed the Record of Discussions (R/Ds) on this project with the Sri Lankan side in August 2015 and was assigned to carry out a study and formulate the Strategic M/P.

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

(1) Purpose

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

(2) Outputs

- Strategic Sewerage M/P for Sri Lanka
- City Sewerage M/P for priority cities
- Feasibility Studies (F/S) for selected cities
- 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) and can be found in Section I of this Report. The M/P aims to improve the overall water environment through the development of sewerage systems and improvement of on-site sanitation facilities. 79 major cities in the country were evaluated using the following six criteria. An approach to the sewerage system development was proposed.

- Urbanization
- Sanitation
- Urban development

- Sustainability of sewerage service
- Water environment
- Maturity of sewerage project plan

15 cities are designated as priorities for the implementation of sewerage systems to achieve the 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 of the 15 priority cities are selected for the development of sewerage M/Ps 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 sewerage services.

The five cities selected are:

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

The Report (Section II-(4)) presents the Sewerage M/P for Sri Jayawardenapura Kotte MC as part of the Project's Output (2).

1.2 OBJECTIVES AND SCOPE

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

CHAPTER 2 EXISTING CONDITIONS

2.1 EXISTING ENVIRONMENTAL CONDITIONS/NATURAL CONDITIONS

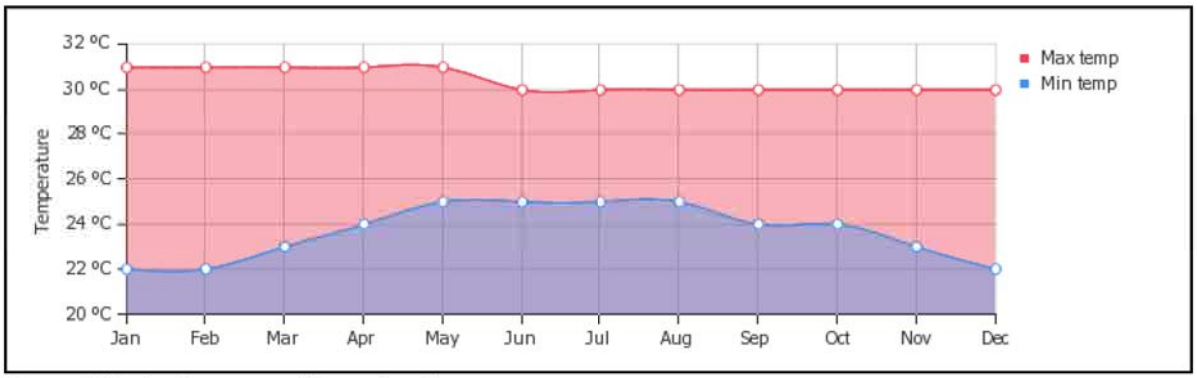
2.1.1 Climate

(1) General

The Sri Jayawardenapura Kotte Municipal Council (SJKMC) area and its surroundings are classified as wet low country zone, sub category WL3, according to the agro-ecological classification system. The WL3 agro-ecological region distributed largely in Gampaha and Colombo districts, receives the lowest rainfall in the Western Province. The mean annual rainfall is over 1,700 mm. There is a relative dry period from December to mid-March.

(2) Temperature

There is very little variation in temperature throughout the year. The monthly temperatures are summarized in **Figure 2.1-1** The average annual temperature is 300C.

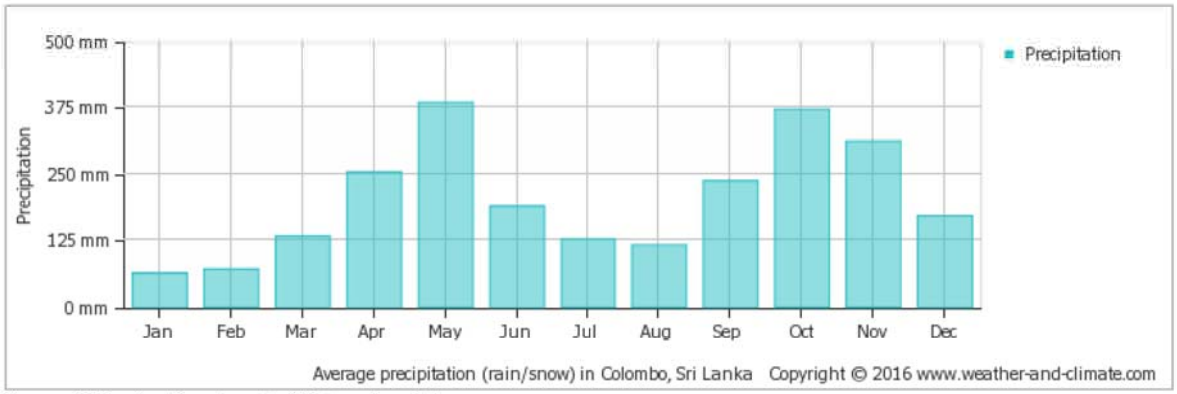


Source: JET, using Department of Meteorology data

Figure 2.1-1 Average Monthly Minimum and Maximum Temperatures

(3) Precipitation

Sri Jayawardenapura Kotte gets a significant amount of rain during the year, receiving the most precipitation in May and October. A maximum of 377 mm can be recorded in May. Monthly precipitation is summarized in **Figure 2.1-2**.



Source: JET, using Department of Meteorology data

Figure 2.1-2 Average Monthly Precipitation

2.1.2 Topography

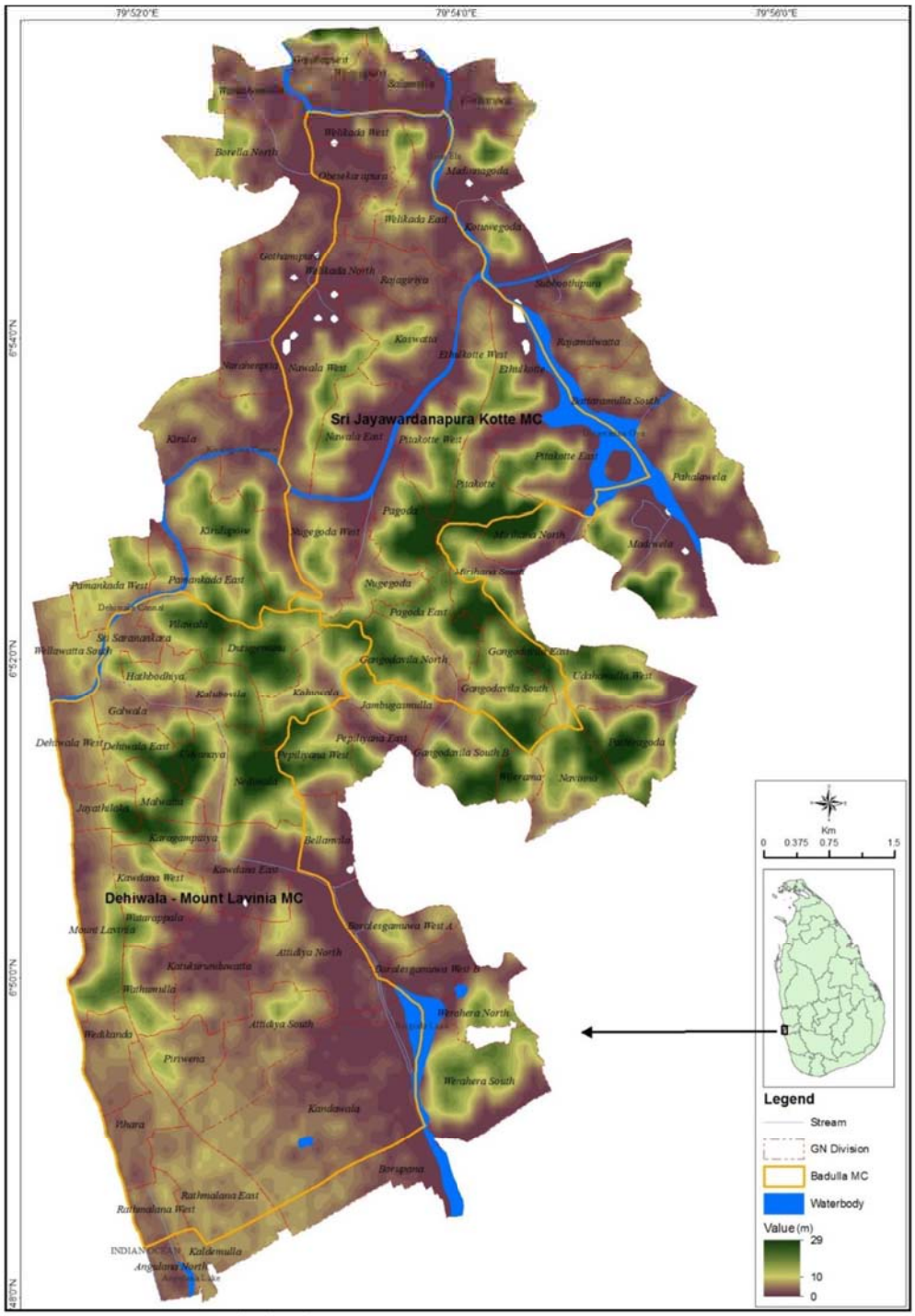
The Sri Jayawardenapura Kotte MC area has a mix of land and water bodies. The extent of marshlands is summarized in **Table 2.1-1** Sri Jayawardenapura Kotte MC covers 17 km^2 and has 10 wards. The area is bordered by Heen Ela to the north, a branch of Diyawanna Oya to the South, Kaduwela MC to the East, and Maharagama UC to the west.

Table 2.1-1 Percentage of Marshlands in Sri Jayawardenapura Kotte MC area

Ward No.	Name	Extent Total (ha)	Extend Marshland (ha)	%. of Marshland
1	Rajagiriya West	122	32	26.2
2	Rajagiriya East	120	25	20.8
3	Welikada	206	79	38.3
4	Nawala	321	58	18.1
5	Ethul Kotte	165	53	32.1
6	Pita Kotte	270	86	31.8
7	Pagoda	142	21	14.8
8	Nugegoda North	69	7	10.0
9	Nugegoda South	76	0	0
10	Gangodawila	213	0	0
	Total			**21.2**

Source: Survey Department of Sri Lanka

Marsh lands exist in all wards except Nugegoda South and Gangodawila and act as water retention areas during the southwest monsoon from May to August. The area has great biodiversity and provides a good living environment.

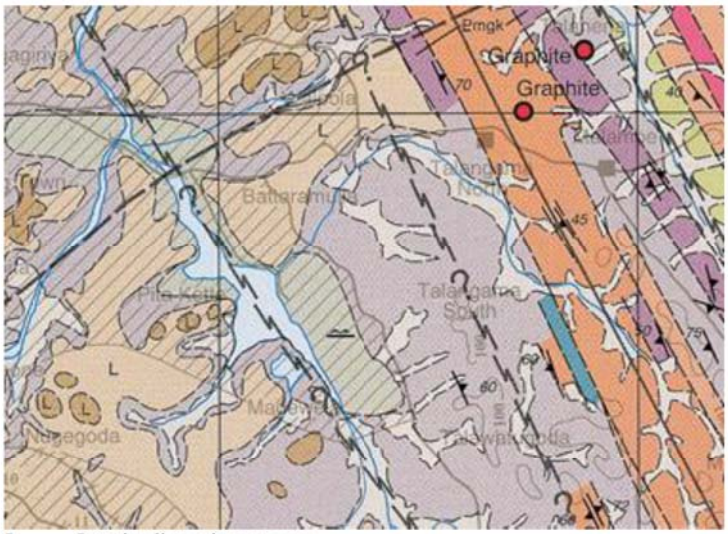


Source: Survey Department of Sri Lanka

Figure 2.1-3 Elevation Map of the Sri Jayawardenapura Kotte MC Area

2.1.3 Geology

The area is in the Highland Complex. Therefore, the major rock types are the granulite facies rocks such as gneisses, sillimanite-graphite gneisses, quartzite, marbles, and some charnokites. Granitic gneisses, Garnet biotite gneisses are also present. The bedrock is well covered by a dense layer of lateritic soil of varying thickness and rock out-crops are scarce. A geologic map of the area is shown in **Figure 2.1-4**.

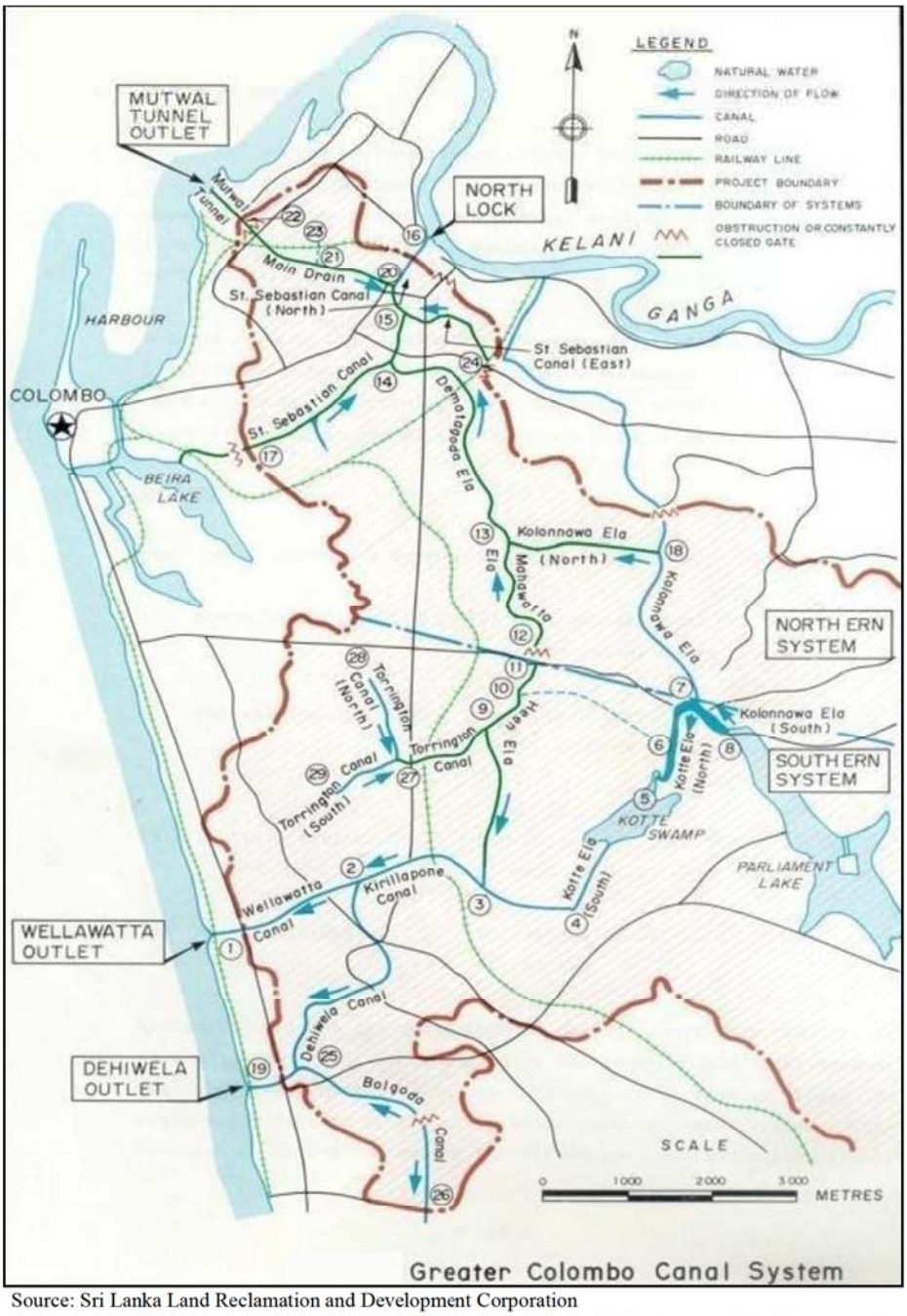


L Laterite discontinuous caps
Pmg undifferentiated Proterozoic gneiss
Source: Geology Survey and Mines Bureau

Figure 2.1-4 Regional Geology

2.1.4 Hydrology

A map of the Colombo canal system is given in **Figure 2.1-5** The network of canals and marshes in the region is important for flood discharge. The drainage catchment of 99 km^2 slopes from southeast to northwest. Heen Ela marsh (Nawala), Kotte swamp where the Kolonnawa canal starts and the Diyawannawa marsh are the main retention areas connected to the system. The Parliament Lake (Diyawanna Oya) is the headwater boundary of the Colombo canal system. Water flowing north from these retention areas is routed through Kolonnawa Ela and Dematagoda Ela and discharged to the Kelani River via the North Lock. Water flowing south and west is routed through Kotte Ela, Nawala Ela and Kirulapone Ela and discharged to the sea from the Wellawatta canal and the Dehiwala canal outfalls.



Source: Sri Lanka Land Reclamation and Development Corporation

Figure 2.1-5 Drainage Network and Surface Water Bodies in the Project Area

2.1.5 Surface Water Quality and Quantity

(1) Water Quality

The locations of sampling stations (1-5) for establishing water quality in Sri Jayawardenapura Kotte were selected for ease of sampling. The location of sampling stations is shown in **Figure 2.1-6**.

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

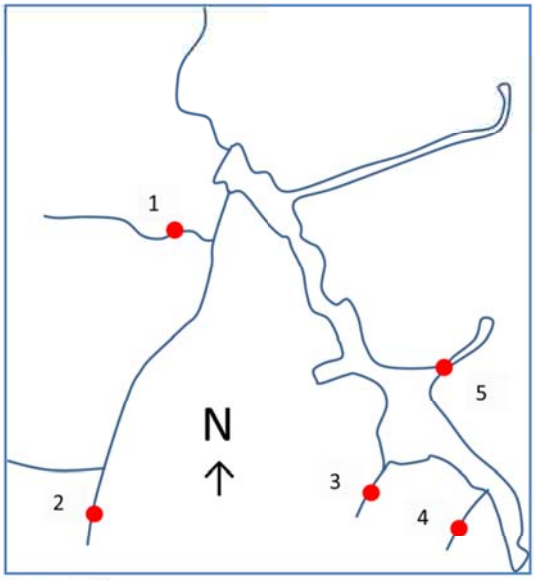
values are not available for Category C, the lowest values from Category D, E and F are used.

The result of water quality analysis is shown in Table 2.1-2.

Table 2.1-2 Surface Water Quality (Sri Jayawardenapura Kotte)

Sri Jayawardenapura Kotte		1	2	3	4	5	Criteria
pH	-	7.6	7.4	7.2	7.3	7.6	-
Temperature	°C	32.6	29.7	30.3	31.2	30.5	-
Odor	-	!	-	!	!	-	ND
Color	mg Pt/L	<15	<15	40	23	16	100
EC	uS/cm	317	177	343	298	281	700
Turbidity	NTU	35	6	12	11	136	-
Total Suspended Solids (TSS)	mg/l	52	23	64	48	43	40
TDS	mg/l	220	130	250	210	200	-
DO	mg/l	7	5.1	8.2	4.1	7.8	5
BOD	mg/l	8	4.8	4	4	7.6	4
COD	mg/l	26	27	22	18	24	15
Nitrate	mg/l	0.51	0.81	0.52	0.56	0.52	10
Ammonia	mg/l	0.18	4.9	2.2	1.9	1.35	0.59
Total Phosphorus (T-P)	mg/l	0.14	0.28	0.3	0.24	0.25	-
PO_4^{3-} - P	mg/l	0.08	0.18	0.21	0.17	0.15	0.4
Cl	mg/l	39.9	12.2	30.2	26.2	26.2	600
Total Nitrogen (T-N)	mg/l	0.74	5.78	2.74	2.5	1.95	-
Fecal Coliform	/100ml	64	800	84	100	304	$1x10^3$
Total Coliform	/100ml	$158x10^2$	$18x10^4$	$3x10^4$	$15x10^4$	$6x10^4$	$1x10^4$

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



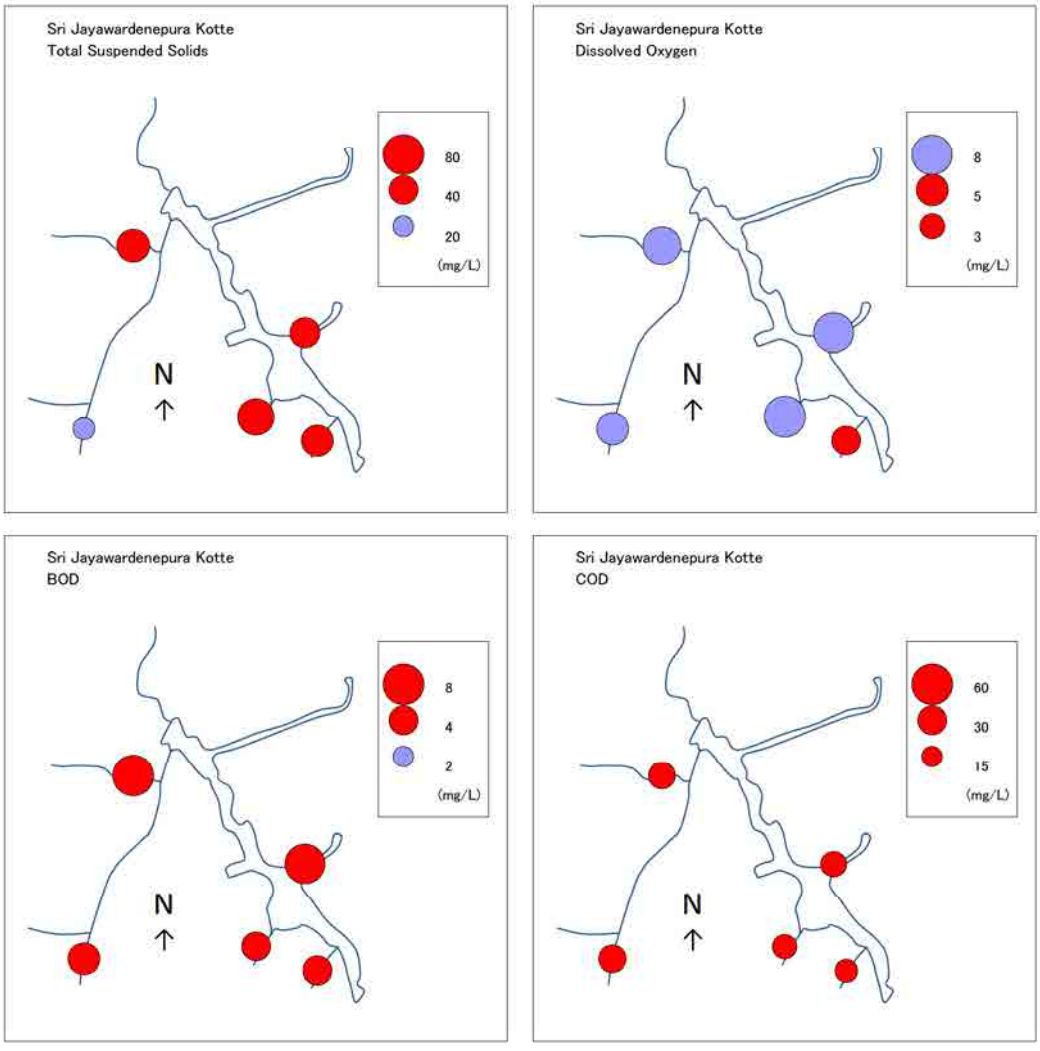
Source: JET

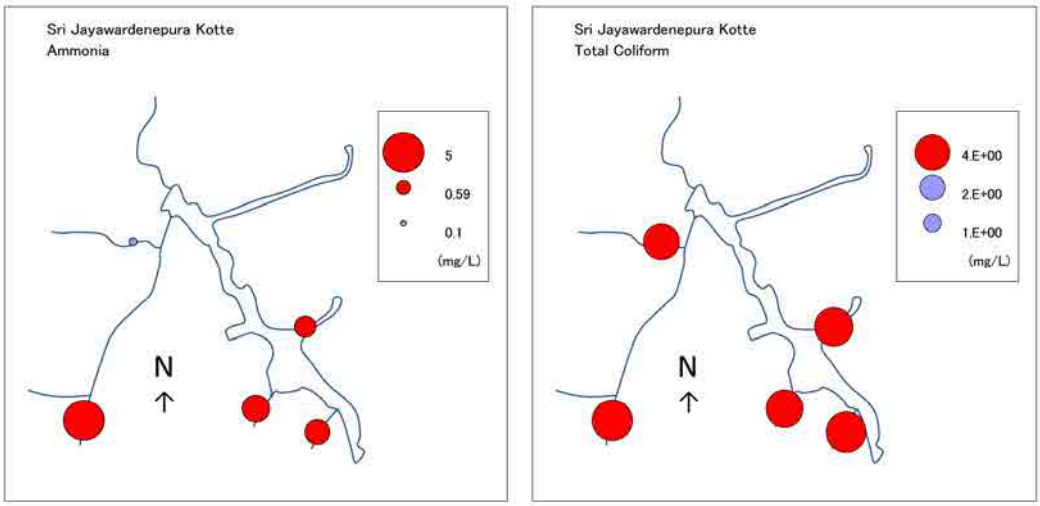
Figure 2.1-6 Water Sampling Locations

Results for TSS, DO, Biochemical Oxygen Demand (BOD), COD, ammonia, and total coliform at all sampling locations exceed standard values.

Sampling stations 1 and 2 are in tidal streams, 3 and 4 are inflows into the lake, while 5 is in the static part of the lake. Water quality parameters that indicate pollution are depicted in **Figure 2.1-7** The figure indicates two important aspects:

- TSS, BOD, COD, ammonia, and total coliform, indicate pollution from wastewater sources at all sampling locations.
- dissolved oxygen levels are relatively good at all locations despite the pollution load. Only water flowing into the lake (station 4) does not meet the standard value of 5 mg/L.





*) Red indicators show the values are above the criteria
Source: JET

Figure 2.1-7 Water Pollution in Sri Jayawardenapura Kotte

(2) Potential Impact of a Sewerage System

As shown in the above figures, high levels of TSS, DO, BOD, COD, ammonia, and total coliform are observed in Sri Jayawardenapura Kotte indicating pollution from wastewater sources. The TSS values are much higher than 40 mg/L set in the standards. The target effluent discharge for the proposed STP is set at 35 mg/L, therefore it is expected that TSS in the receiving water body will be reduced significantly by the development of a STP.

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

Total coliform will be reduced by disinfection with chlorine. Thus, the introduction of a sewerage system will improve the water environment in Sri Jayawardenapura Kotte MC.

(3) Water Quantity

Figure 2.1-6 shows the sampling stations in the Sri Jayawardenapura Kotte drainage system. Sampling stations 1 and 2 are at larger rivers where flow rates are difficult to measure. The direction of flow is not stable because of tidal influence. Station 3 and 4 are upstream of the lake and not influenced by tides but the flow is too small to measure. Station 5 is in a static area of the lake where there is no flow.

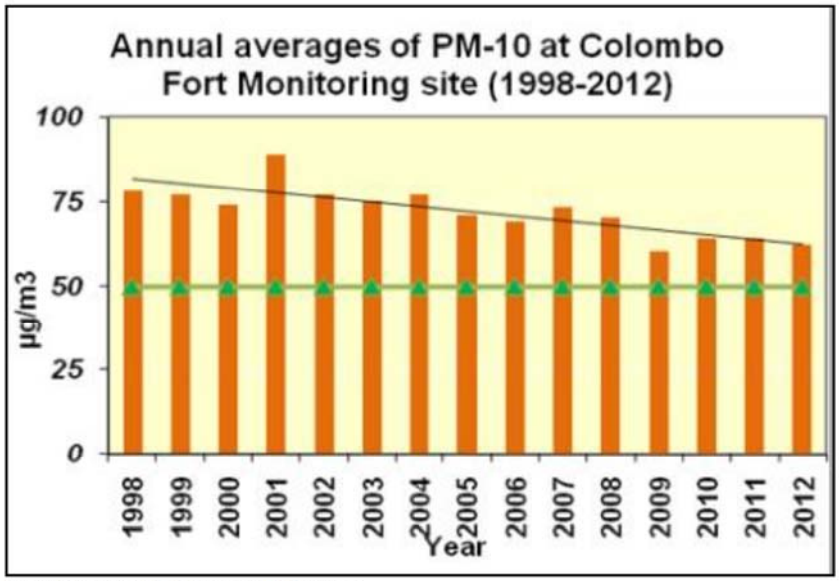
2.1.6 Environmental Quality

(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 70-80 $\mu g/m^3$ from 1998 to 2012 (refer to **Figure 2.1-8**). This is higher than the limit of 50 $\mu g/m^3$ identified in WHO guidelines.

Major contributors to air pollution in the Sri Jayawardenapura Kotte MC area are vehicle and industry emissions. Heavy traffic along the main roads (High level road: Kirulapona – Delkanda section, Sri Jayawardenapura Mawatha: Borella-Rajagiriya-Battaramulla section) and other roads, and train movements in the Project area also contribute to elevated levels of pollutant emissions.

Foul odours from the canals, especially during dry weather when water levels are low, come from sewage discharges and rotting solid wastes thrown in the water.



Source: Central Environmental Authority

Figure 2.1-8 PM10 Levels Observed in the Area

(2) Noise/Vibration

Ambient noise and vibration levels are as expected for an area with urban, industrial, commercial, and public institutions. Trains and heavy traffic on most roads day and night all contribute to high noise and vibration levels.

2.1.7 Protected Areas

Wetlands of the Project area are shown in **Figure 2.1-9**.

(1) Sri Jayawardenapura Sanctuary

Diyawanna Oya has lots of aquatic birds. A part of the Diyawanna Oya is designated as the Sri Jayawardenapura Sanctuary under the Fauna and Flora Protection Ordinance (Gazette Extraordinary No. on 09.01.1985). The sanctuary of 449.2 ha, is home to many endemic birds, butterflies, dragonflies, and mammals native to Sri Lanka and Asian Wetlands. Some endemic and some threatened floral species, common to an inland wetland, made up niches in the habitat. The newly constructed 18 hectares Beddagana Wetland Park, is in the Sri Jayewardenepura Sanctuary.

(2) Diyawanna Oya Wetland

A large part of the Diyawanna Oya wetland is located in the Sri Jayawardenapura Kotte MC. It is a man-made canal system on the left bank of the lower valley of the Kelani River in the Colombo district, Western province of Sri Lanka (6 52' 55" - 6 55' 45" N and 79 52' 35" - 79 55' 15" E). Kolonnawa marsh, Heen-ela marsh and Kotte marshes function as the main catchment of this system. These areas (400 ha) function as the main drainage system and flood detention zones of Colombo city. The importance of the Diyawanna Oya wet lands is threefold: (1) they provide a good recreational environment; (2) a source of income for inhabitants, from fishing, cattle grazing, collecting reeds, rushes, and fuel wood; and (3) provide important hydrological function and serve as refuge for fauna and flora.

(3) Colombo Flood Detention Area Wetlands

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

(4) Thalangama Tank Environmental Protection Area

Thalangama Tank and its surrounding areas are protected under the National Environmental Act by the Gazette Extraordinary No. 1487/10 dated 5th March 2007. This EPA is located about 2 km from the MC boundary.

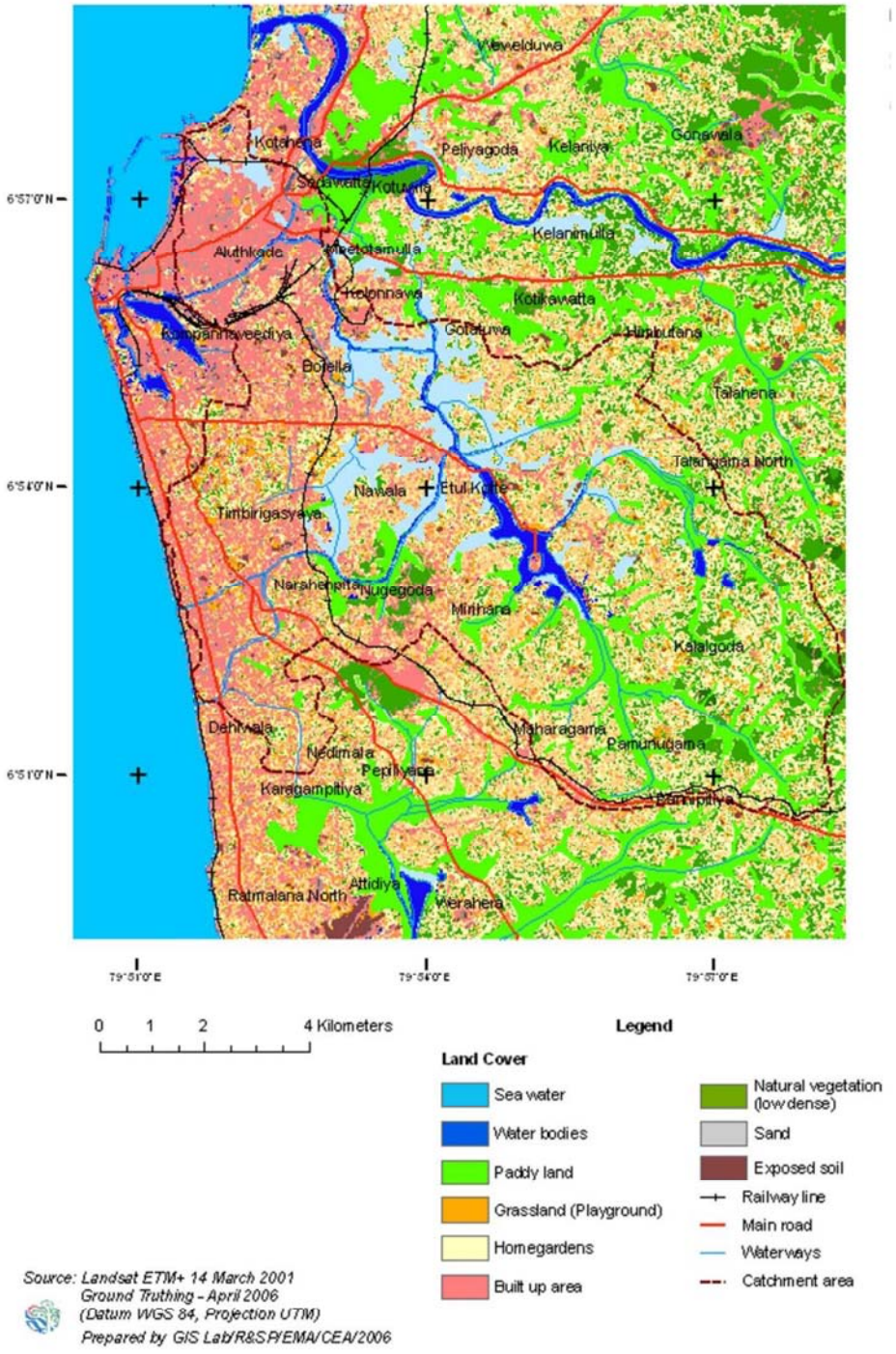


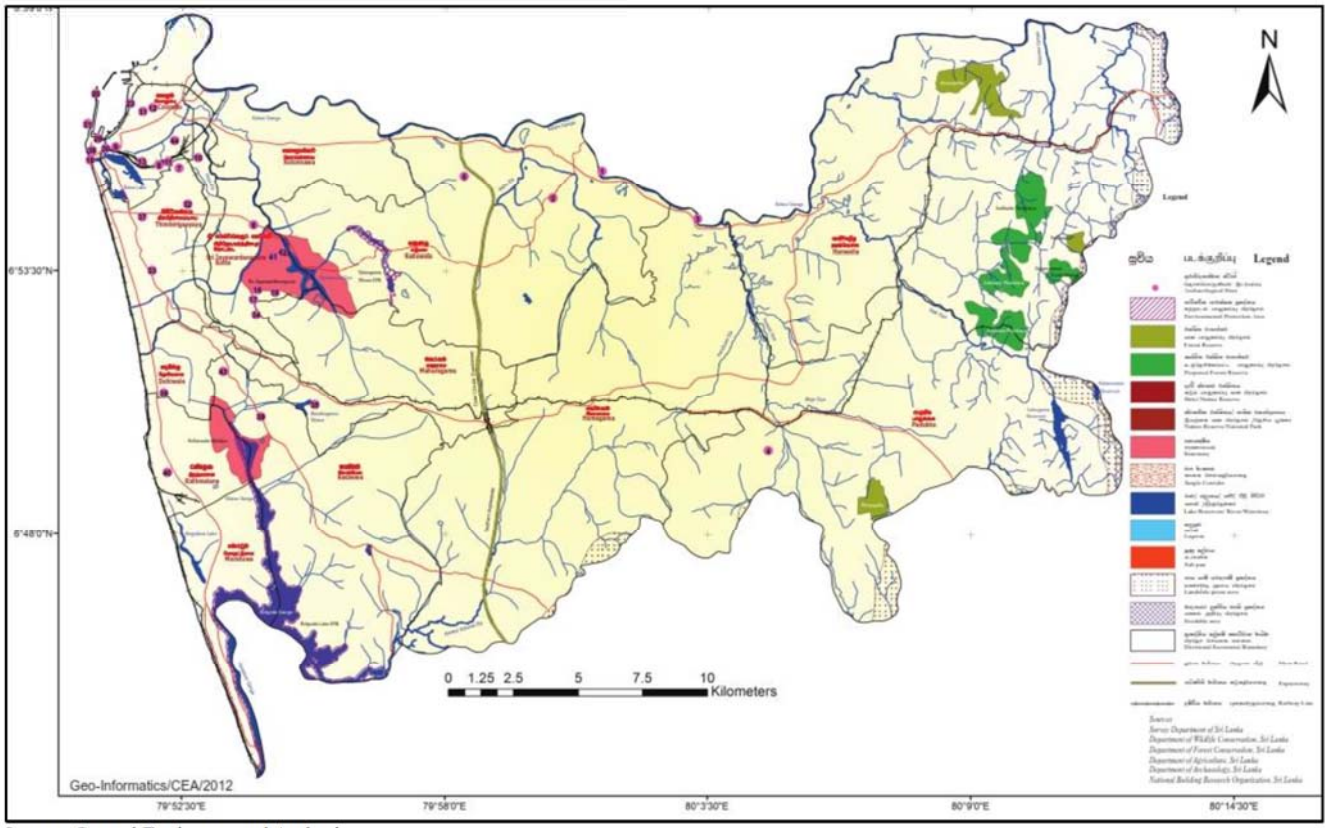
Figure 2.1-9 Colombo Flood Detention Area

(5) Buffer Zone

A set of sensitive areas has been declared under the CEA regulations. These sensitive zones can be considered as buffer zones for each natural and manmade protected area. Any development activities within these zones are subject to close monitoring by CEA and each of the relevant authorities.

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

These sensitive areas have been mapped by CEA and the map of Colombo District is given in **Figure 2.1-10**.



Source: Central Environmental Authority

Figure 2.1-10 Environmentally Sensitive Areas in the Colombo District

2.1.8 Fauna and Flora

Fauna and flora of the general Sri Jayawardenapura Kotte area are identified through literature review and site surveys. The findings 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 site.

Table 2.1-3 Survey of Fauna in the Project Area

Class	Type	Taxa Family		*Significant Species* (common name)	Conservation Status (IUCN 3.1)
Birds		Columbidae		*Ducula aenea* (Green imperial pigeon)	LC
				Columba livia (Rock dove)	LC
		Picidae		*Picus chlorolophus* (Lesser yellownape)	LC
		Anhingidae		*Anhinga melanogaster* (Oriental darter)	NT
		Phalacrocoracidae		*Phalaerocorox fuscicollis* (Indian cormorant)	LC
		Rallidae		*Rallus striatus* (Slaty-breated rail)	LC
		Alcedinidae		*Halcyon smyrnensis* (White-throated kingfisher)	LC
				Pelargopsis capensis (Stork-billed kingfisher)	LC
		Ardeidae		*Mesophoyx intermedia* (Intermediate egret)	NA
				Ardeola grayii (Indian pond heron)	LC
				Dupetor flavicollis (Black bittern)	LC
		Accipitridae		*Spilornis cheela* (Crested serpend eagle)	LC
				Haliaeetus leucogaster (White-bellied sea eagle)	LC
		Megalaimidae		*Megalaima zeylanica* (Brownheaded barbet)	LC
				Megalaima flavifrons (Yellow-fronted barbet)	LC
		Cuculidae		*Centropus sinensis* (Greater coucal)	LC
		Psittaculidae		*Psittacula krameri* (Rose-ringed parakeet)	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
		Hystricidae		*Hystrix indica* (Indian crested porcupine)	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		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
		Colubridae		*Ptyas mucosa* (oriental ratsnake)	LC
				Oligodon sublineatus (Kukri snake)	LC
				Sibynophis subpunctatus (Black-headed snake)	LC
				Xenochrophis asperrimus (Sri Lankan keelback)	LC
Fish		Osphronemidae		*Trichogaster pectoralis* (Snakeskin gourami)	LC

		Cichlidae		*Oreochromis mossambicus* (Mozambique tilapia)	NT
		Cichlidae		*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
		Cyprinidae		*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 Survey of Flora in the Project Area

Taxa		*Significant Species* (common name)	Conservation Status (IUCN 3.1)
Family	Species		
Moraceae		*Ficus religiosa* (Bodhi tree)	LC
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
		Muntingia calabura (Capulin)	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 EXISTING SOCIAL CONDITIONS

2.2.1 Administration

SJKMC area is located within Sri Jayawardhanepura-Kotte Divisional Secretariat Division (DSD), Colombo District, in the Western Province of Sri Lanka. In 1985, the national capital was relocated here from Colombo. The national parliament building is located on an island in Lake Diyawanna.

SJKMC was established in 1997 to promote the development of the city and improve public health, welfare and convenience, sanitation, and amenities. Most ministry head offices have already relocated to the city. The SKJMC administrative area covers 17 km^2 and consists of 10 wards.

The administrative area of Colombo District is 699 km^2 and the Western Province is 3,684 km^2. The forested area of the District is 15 km^2 compared to 195 km^2 for the Province. Colombo District has an inland water area of 23 km^2 whereas 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 the SJKMC is 6,300 persons per km^2 compared to 3,487 persons per km^2 in Colombo District and 1,652 persons per km^2 in the Western Province. The population in 2012 for the SJKMC was 107,925. The population figures and gender distribution based on the Grama Niladari Division are tabulated below.

Table 2.2-1 Population in Sri Jayawardenapura Kotte MC Area

Name of GND	Total	Male		Female	
		No	%	No	%
Obsekarapura	11,963	5,925	49.5	6,038	50.5
Welikada West	7,004	3,195	45.6	3,809	54.4
Welikada East	6,749	3,183	47.2	3,566	52.8
Rajagiriya	3,591	1,878	52.3	1,713	47.7
Welikada North	4,834	2,389	49.4	2,445	50.6
Nawala West	4,059	2,032	50.1	2,027	49.9
Koswatta	5,707	2,767	48.5	2,940	51.5
Ethulkotte West	3,371	1,664	49.4	1,707	50.6
Ethulkotte	5,929	2,877	48.5	3,052	51.5
Pitakotte East	3,984	1,912	48.0	2,072	52.0
Pitakotte	3,634	1,753	48.2	1,881	51.8
Pitakotte West	5,301	2,439	46.0	2,862	54.0
Nawala East	5,473	2,573	47.0	2,900	53.0
Nugegoda West	5,627	2,635	46.8	2,992	53.2
Pagoda	5,446	2,537	46.6	2,909	53.4
Nugegoda	3,365	1,678	49.9	1,687	50.1
Pagoda East	5,944	2,902	48.8	3,042	51.2
Gangodavila North	5,352	2,493	46.6	2,859	53.4
Gangodavila South	7,305	3,554	48.7	3,751	51.3
Gangodavila East	3,287	1,606	48.9	1,681	51.1
Total	107,925	51,992	48.2	55,933	51.8

Source: Census of Population and Housing 2012, Department of Census and Statistics

2.2.3 Health/Disease

The prevalence of chronic illnesses by age group in Colombo District and Sri Lanka is given in the following table.

Table 2.2-2 Prevalence of Chronic Illness by Age Group

	Less than 15 years	15-24 years	25-59 years	60 and above
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 slightly higher than the national average for most age groups.

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

The prevalence of diabetes and high blood pressure in Colombo District is higher than the national average.

2.2.4 Religion/Ethnicity

The majority of the population in Colombo District is Sinhala Buddhist.

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

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

A Household Income and Expenditure Surveys (HIES) was carried out by the Census and Statistics Department of Sri Lanka. Poverty rates at the district, province, and national levels are shown in **Table 2.2-6** Poverty levels in the district are less than the provincial and national averages.

Table 2.2-6 Poverty Rates

	Poor HH %		
	2006/07	2009/10	2012/13
Sri Lanka	12.6	7.0	5.3
Western Province	6.50	3.00	1.50
Colombo District	3.90	2.50	1.10

Source: Census and Statistics Department

2.2.6 History and Culture (Heritage)

Historically Sri Lanka had four capitals. The ancient Kingdom of Kotte was centred in Sri Jayawardenapura during the 15th century. The Department of Archaeology has declared many Archaeological Protected Monuments in Sri Jayawardenapura Kotte MC as listed in **Table 2.2-7**.

Table 2.2-7 Archaeological Protected Monuments in Sri Jayawardenapura Kotte MC

Monument	Declared on
Ancient Tunnel at Kotte Ananda Sastralaya	27-Jun-52
Ancient water canal	12-Aug-71
Obeysekera Walawwa	13-Nov-92
Parakumba Pirivena	14-May-71
Pitakotte Raja Maha Vihara	17-May-13
Ancient Rampart - Ethul Kotte ruins	23-Feb-07

Source: JET

2.2.7 Economy

(1) General

Sri Jayawardenapura Kotte MC is the national capital and as such functions mainly as an administrative centre.

Sri Jayawardenapura Kotte MC, Colombo MC, and Dehiwala–Mount Lavinia MC areas are the most urbanized parts of Colombo District. Nugegoda Town is the major commercial centre. All commercial banks and financial companies have head offices or branches in this area. **Table 2.2-8** shows the GDP by industrial sector of Western Province.

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

Unit: Sri Lanka Rupee (LKR) Million

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%
	Provincial GDP	2,512,908	100.0%	2,894,428	100.0%	3,243,854	100.0%	3,643,241	100.0%
	% Share of National GDP	44.8		44.2		42.8		42.0	

Source: CBSL Annual Report 2014

The Western Province, including Greater Colombo (GC), is responsible for 42 to 45% of the national GDP.

The service sector is the largest, is responsible for 60 to 65% (national average: 56.8%) of the total GDP of the Province and the industrial sector 30 to 35% (national average: 32.5%).

(2) Household Income

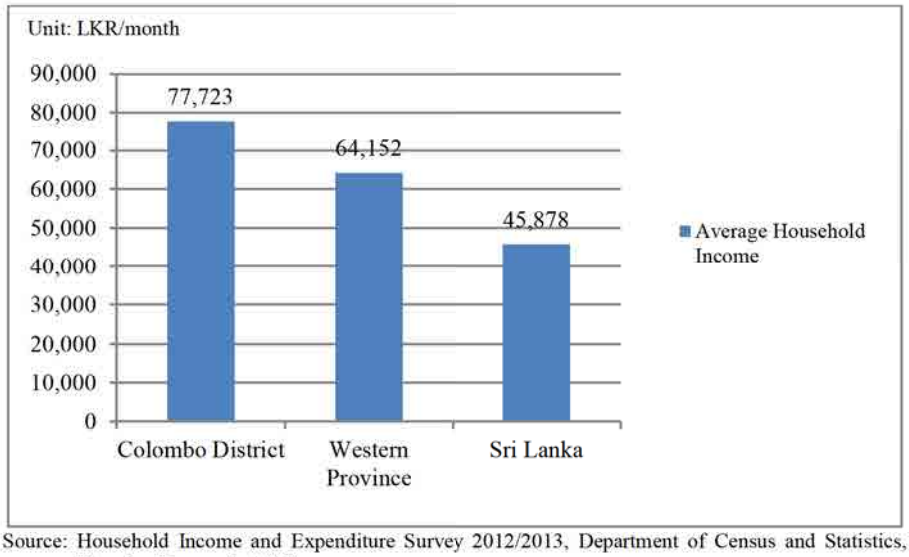
Average household income data is available from "Household Income and Expenditure Survey 2012/2013". Some of the data are presented in **Table 2.2-9** and **Figure 2.2-1** The average monthly household income in Colombo District is 77,723 LKR (2012/13). The biggest percentage (37.4%) of household income comes from wages and salaries. Household income of Colombo District is higher than the national average (41% higher) and provincial average (17.5% higher).

Table 2.2-9 Breakdown of Monthly Household Income - 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-Agric. Activities	19,807	24.8%
7	Other Cash Income	8,811	11.0%
8	Income by Adhoc Gain	6,271	7.9%
9	Non-Monetary Income	12,266	15.4%
10	Income in Kind	2,078	2.6%

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

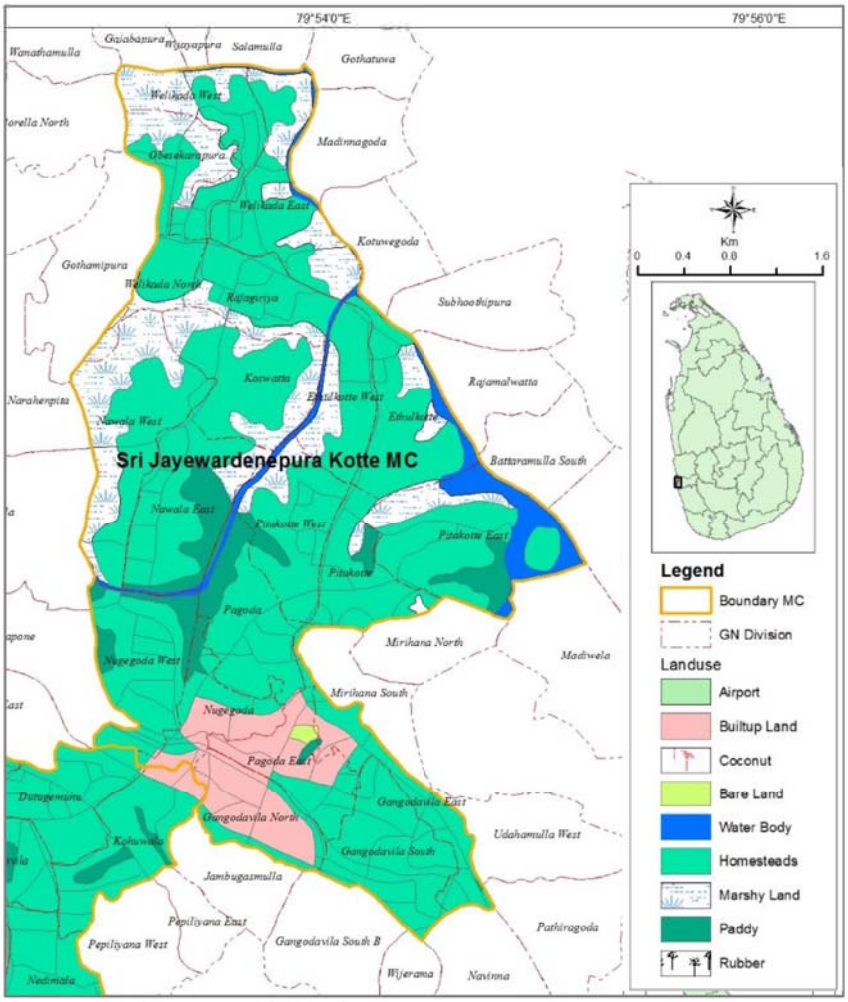


Source: Household Income and Expenditure Survey 2012/2013, Department of Census and Statistics, Ministry of Policy Planning Economic Affairs

Figure 2.2-1 Comparison of Monthly Household Income

2.2.8 Land Use

Land use status in Sri Jayawardenapura Kotte is shown in **Table 2.2-10** and **Figure 2.2-2** Roughly 70% of Sri Jayawardenapura Kotte MC has been developed, and the remaining areas are marshland, lakes, and farmland.



Source: Survey Department of Sri Lanka

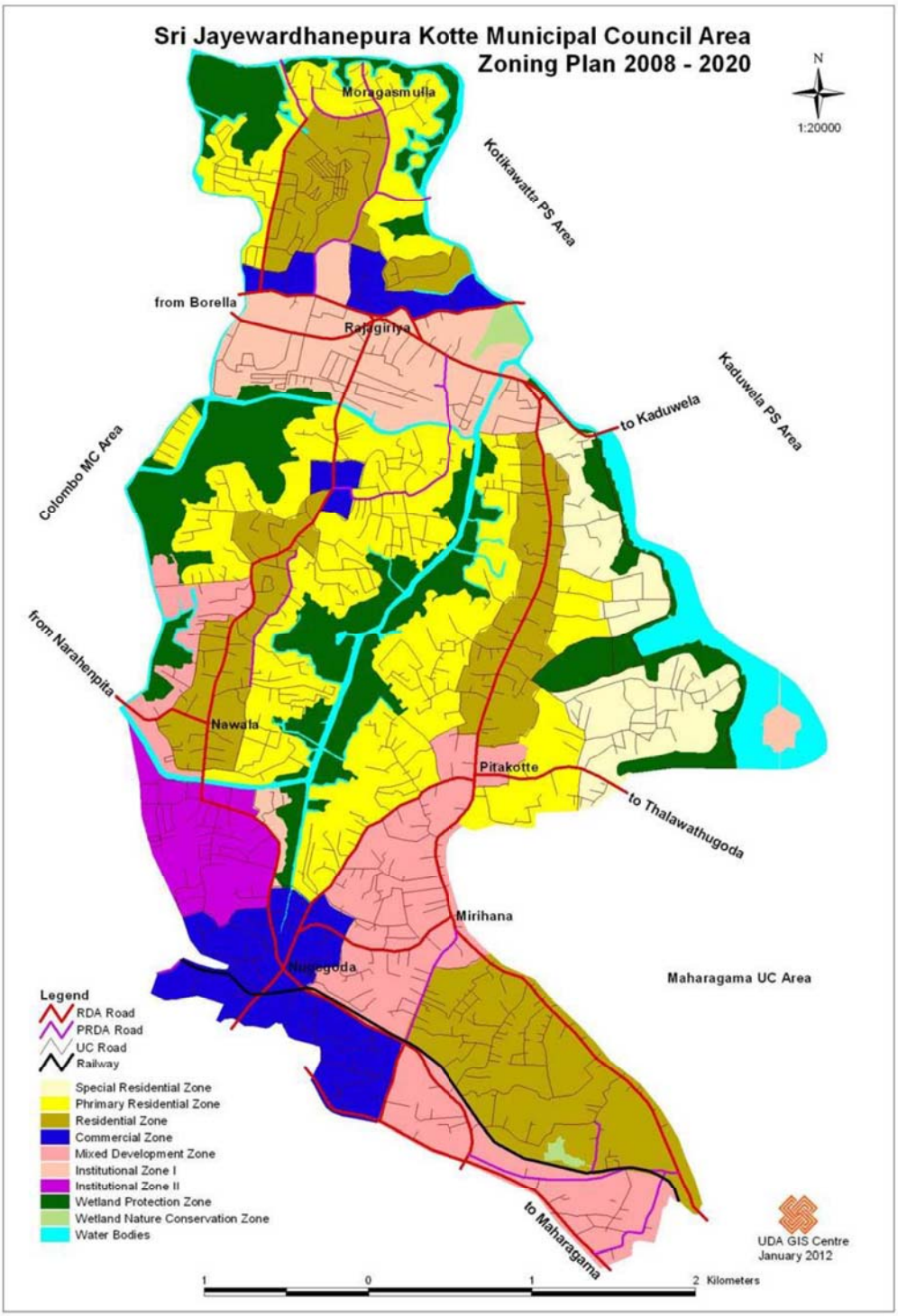
Figure 2.2-2 Land Use in Sri Jayawardenapura Kotte MC

Table 2.2-10 Land Use in Sri Jayawardenapura Kotte MC

Land use Type	Area (Ha)
Built up Area	117.83
Other Crops	2.74
Homesteads	1060.21
Marshy	304.53
Paddy	94.48
Rubber	1.45
Waterbody	69.36

Source: Survey Department of Sri Lanka

According to land planning, areas that are not designated as wetland nature protection zones are intended for housing and other developments (**Figure 2.2-3**).



Source: Urban Development Authority

Figure 2.2-3 Land Use Plan for Sri Jayawardenapura Kotte (2008- 2020)

Note: 2008-2020 Zoning Plan was prepared by the Urban Development Authority, demarcating various zones in accordance with the current land use. The Special Residential Zone exclusively for residential housing, whereas the Primary Residential Zone is for residents allowed to engage in small-scale business. The Mixed Development Zone is for all purposes within specific scopes which vary depending on municipalities.

2.2.9 Water Supply and Sanitation

(1) Water Supply

Table 2.2-11 shows the types of drinking water facilities in Sri Jayawardenapura Kotte MC. Nearly 100% of the households have access to piped water supply. The system can experience a drop in pressure during the peak demand periods because of the increasing number of service connections that have been added. Low-income households which typically cannot afford roof storage tanks, are unable to obtain water during peak periods.

Table 2.2-11 Access to Drinking Water Sources in Sri Jayawardenapura Kotte MC

No.	Name of GND	GND Code	Total	Protected Well Within Premises	Protected Well Out Side Premises	Un Protected Well	Tap Within Unit (Main Line)	Tap Within Premises (Out Side Main Line)	Tap Outside Premises (Main Line)	Rural Water Project	Tube Well	Bourses	River, Tank, Stream	Rain Water	Bottle Water	Other
1	Obsekarapura	514C	2,858	14	1	-	2,662	105	65	-	3	-	-	-	-	8
2	Welikada West	514A	1,505	28	1	1	1,391	71	10	-	2	-	-	-	1	-
3	Welikada East	514	1,743	36	10	4	1,520	76	92	-	3	-	-	-	1	1
4	Rajagiriya	514B	782	2	-	-	727	18	29	-	1	-	-	-	5	-
5	Welikada North	514D	1,216	7	-	-	1,104	34	63	-	-	-	-	-	-	8
6	Nawala West	520	1,096	33	5	-	981	53	4	-	12	-	-	-	8	-
7	Koswatta	520A	1,529	43	2	1	1,354	83	43	-	1	-	-	-	2	-
8	Ethulkotte West	521A	912	20	-	-	858	24	9	-	1	-	-	-	-	-
9	Ethulkotte	521	1,586	38	1	2	1,451	62	28	-	2	-	-	-	2	-
10	Pitakotte East	522A	1,070	44	2	24	945	35	13	-	1	-	-	-	6	-
11	Pitakotte	522B	961	32	1	-	901	11	5	-	5	-	-	-	2	4
12	Pitakotte West	522	1,430	74	2	-	1,324	17	8	-	1	-	-	-	3	1
13	Nawala East	520B	1,442	61	4	-	1,344	21	8	-	3	-	-	-	1	-
14	Nugegoda West	519B	1,478	37	-	-	1,248	113	56	-	9	-	-	-	9	6
15	Pagoda	519A	1,447	57	2	1	1,355	18	7	-	3	-	-	-	4	-
16	Nugegoda	519	928	24	3	-	889	6	3	-	-	-	-	-	3	-
17	Pagoda East	519C	1,498	48	4	2	1,351	28	59	-	5	-	-	-	1	-
18	Gangodavila North	526	1,324	96	2	2	1,190	18	6	-	6	-	-	-	2	2
19	Gangodavila South	526A	1,921	132	9	10	1,513	213	40	-	2	-	-	-	2	-
20	Gangodavila East	526C	857	40	1	-	753	17	46	-	-	-	-	-	-	-
	SJKMC Total		27,583	866	50	47	24,861	1,023	594	-	60	-	-	-	52	30

Source: Census of Population and Housing 2012, Department of Census and Statistics

(2) Sanitation

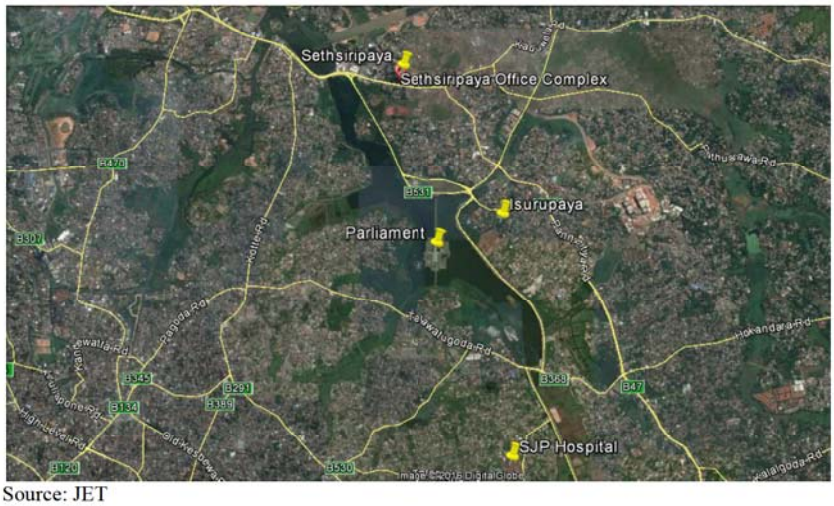
Table 2.2-12 shows the distribution of sanitary facilities in Sri Jayawardenapura Kotte MC. Approximately 96% of the households have water sealed toilets (traps to block odour), connected to septic tanks. Much of the domestic wastewater is treated in septic tanks and soakage pits.

Table 2.2-12 Access to Sanitation Facilities in Sri Jayawardenapura Kotte MC

No.	Name of GND	GND Code	Total	Water Seal and Connect to a Piped Sewer System	Water Seal and Connect to a Septic Tank	Pour Flush Toilet (Not Water Seal)	Direct Pit	Other	Not Using Toilet
1	Obsekarapura	538C	2,858	2,100	627	111	18	2	0
2	Welikada West	537	1,505	1,420	0	3	73	9	0
3	Welikada East	537A	1,743	1,579	94	17	52	1	0
4	Rajagiriya	537B	782	714	66	2	0	0	0
5	Welikada North	538	1,216	1,032	169	4	4	6	1
6	Nawala West	538B	1,096	1,061	24	9	1	1	0
7	Koswatta	538A	1,529	1,360	127	29	12	1	0
8	Ethulkotte West	540A	912	882	14	14	2	0	0
9	Ethulkotte	540	1,586	1,407	100	62	17	0	0
10	Pitakotte East	536A	1,070	910	83	60	16	1	0
11	Pitakotte	536	961	923	33	1	2	2	0
12	Pitakotte West	539/42A	1,430	1,239	154	36	1	0	0
13	Nawala East	540B	1,442	1,421	4	8	9	0	0
14	Nugegoda West	539/42	1,478	1,389	58	29	2	0	0
15	Pagoda	539/42B	1,447	1,361	24	25	35	2	0
16	Nugegoda	541	928	854	69	5	0	0	0
17	Pagoda East	539/42C	1,498	1,330	29	133	6	0	0
18	Gangodavila North	544	1,324	1,293	27	2	2	0	0
19	Gangodavila South	544A	1,921	1,779	59	28	54	1	0
20	Gangodavila East	545A	857	821	14	15	7	0	0
SJKMC Total			27,583	24,875	1,775	593	313	26	1

Source: Census of Population and Housing 2012, Department of Census and Statistics

Wastewater from the government district and other important institutions such as the National Parliament, Sethsiripaya, Isurupaya, and Sri Jayawardenapura Hospital Complex (SJP Hospital) are connected to the piped sewer system in Colombo MC via pumping stations (**Figure 2.2-4**).



Source: JET

Figure 2.2-4 Institutions Connected to the Sewer System in Colombo city

Sewage disposal using septic tanks is not effective because the groundwater table is high (elevations in most parts of Colombo MC are low) and there is little to no soil infiltration to provide treatment. In addition, small building lots make it difficult to install adequately sized septic tanks. During the rainy season, rising groundwater levels and low permeability of soil undermine proper absorption mechanisms of soakage pits and septic tanks. Consequently, the surrounding waterways and groundwater are contaminated.

In commercial buildings, on-site sanitation facilities are not properly maintained therefore the treatment capacity deteriorates year after year.

Water quality in Diyawanna Oya, the main water body in Sri Jayewardenepura, is worsening.

2.2.10 Solid Waste Collection and Disposal

Solid waste generation is becoming very high because of rapid urbanization and industrialization. Waste generation is 150 tons/day equivalent to 1.27 kg/person/day. Households, commercial establishments, public institutions, hospitals and medical centres, and markets produce a large quantity of solid waste. The problem is worsened by the large and medium scale industries located in the city. The Sri Jayawardenapura General Hospital and a few other medical centres also generate significant amounts of waste. The composition of solid waste generated within the municipal area is given in **Table 2.2-13**.

There are two main waste collection and disposal methods:

- door-to-door waste collection and disposal at dumpsite by the municipal solid waste management personnel
- same service offered by private company

About 100 tons/day of solid waste is collected by the MCs solid waste collection and disposal services.

At present, the MC collects about 50 ton/day of waste from 10 wards under the supervision of PHI. The waste collected is transported to the Karadiyana disposal site. The remainder is handled by a private company appointed by the council.

Table 2.2-13 Composition of Solid Waste - Sri Jayawardenapura Kotte MC

Category	%
Bio-degradable	63.63
Paper & cardboard	8.22
Glass	1.50
Metal	0.98
Wood	0.83
Rubber & Cloths	4.75
Polythene+ plastic	8.92
Soil & Ceramic	3.65
Electronic waste	0.02
Demolition waste	1.41
Other	6.54

Source: Sri Jayawardenapura Kotte MC

Sauce: JET

Figure 2.2-5 Karadiyana Final 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 by on-site sanitation facilities which are typically septic tanks. However, septic tanks do not function properly in densely populated urban areas such as Sri Jayawardenapura Kotte. The problem is worsen by high groundwater levels and inadequate soil percolation. Increasing levels of BOD, ammonia, and counts of coliform groups are being detected in local water bodies (See 2.1.5).

Sewage treatment is necessary to deal with the increasing volumes of wastewater and to preserve and protect the water environment.

CHAPTER 3 PLANNING BASIS FOR SEWERAGE SYSTEM

3.1 SANITATION PROVISION

In October 2010, NWSDB, with the country's financial support, prepared the "Project Proposal for Sri Jayawardenapura Kotte Wastewater Disposal System". The plan identifies approximately 47 km of gravity sewer and 15 km of force main to be developed by 2040. The estimated maximum daily flow is 21,500 m^3. Wastewater would receive primary treatment and be discharged to the sea via a 1.7 km, 1,500 mm diameter HDPE outfall pipe. The population projection is based on the 2009 population as taken from the census statistics in 2001 and the annual report of the Sri Jayawardenapura Kotte statistics bureau.

The M/P for the sewerage system will draw on the previous project proposal and use the 2012 census data and assumed that an advanced biological treatment process will be adopted.

3.1.1 Target Year

According to the "NWSDB Design Manual D7 Wastewater Collection, Treatment, Disposal & Re-Use 2012", the design period for the collection network, pumping stations, treatment plant, and effluent disposal and utilization is 30 years. Therefore, 2046 is selected as the target year for this M/P.

3.1.2 Planning and Design Criteria

(1) Sewage Flow Estimate

Table 3.1-1 Basis for Estimating Sewage Flow

Item	Value	Remarks
Per capita water consumption	120 lpcd	
Domestic flow	80%	of water consumption
Non-domestic flow	35%	of Domestic Flow
Average dry weather flow (ADWF)	Domestic + Non-domestic flow	
Daily maximum dry weather flow	1.15 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: Peak Dry Weather Flow (PDWF) + Infiltration
Planning of Pumping Station: Hourly Maximum Dry Weather Flow + Infiltration
Source: JET

(2) Trunk Sewers

a. Hydraulic Calculations 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 (pressure flow):

Manning Formula

$Q = A \times V$, $V = 1/n \times R2/3 \times S1/2$

where, Q: Flow (m^3/sec), V: Velocity of Flow (m/sec),
n: Roughness Coefficient, R: Hydraulic Radius (m),
S: Hydraulic Gradient, A: Cross Section Area (m^2)

Hazen William Formula

$Q = A \times V$, $V = 0.84935 \times C \times R0.63 \times S0.54$

where, Q: Flow (m^3/sec), V: Velocity of Flow (m/sec),

C: Flow Velocity Coefficient, R: Hydraulic Radius (m),
S: Hydraulic Gradient, A: Cross Section Area (m^2)

Table 3.1-2 Coefficients for Sewer Design

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

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

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

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

d. Minimum Earth 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 either 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 also noted that MTPS entails site acquisition, depending on the surrounding environment and location.

Table 3.1-4 Types of Pumping Stations

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

Source: JET

(4) Sewage Treatment Facilities

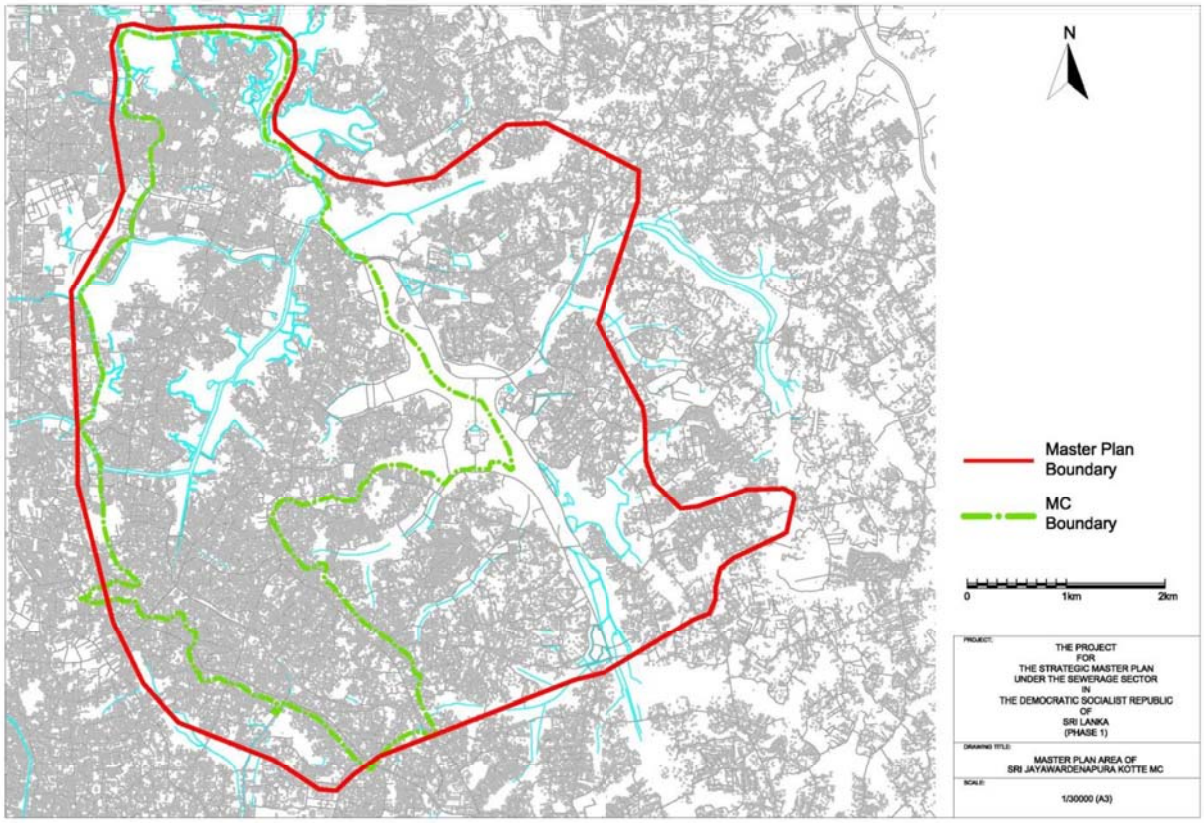
The sewage treatment process is selected by considering the following factors:

- raw water quality & discharge standard
- land availability
- construction and O&M cost
- easy to operate and maintain

3.1.3 Sewage Collection Area

The sewage collection area selected for the M/P is shown in **Figure 3.1-1** and includes:

- developed and populated areas that will be almost fully saturated by 2046
- city centre including large-scale commercial areas, large-scale facilities, such as schools, hotels, housing estate, religious and institutional buildings
- high population density residential areas
- areas suitable for applying centralized sewerage system
- areas next to the MC boundary that can be cost effectively included



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

Figure 3.1-1 Proposed Sewage Collection Area for Sri Jayawardenapura Kotte

Table 3.1-5 shows the 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	**Kaduwela DSD**		3	**Maharagama DSD**	
1.1	492	Subhoothipura	3.1	525A	Udahamulla East
1.2	492 A	Battaramulla South	3.2	524	Madiwella
1.3	492 B	Battaramulla North	3.3	493A	Thalawathugoda West
1.4	492 D	Rajamalwatta	3.4	493B	Thalawathugoda East
1.5	477	Thalangama North A	3.5	526B	Gangodavila South B
1.6	479B	Asiri Uyana	3.6	526D	Jambugasmulla
1.7	479A	Pahalawela	4	**Maharagama DSD**	
2	**Sri Jayawardanapura Kotte DSD**		4.1	523	Mirihana North
2.1	514C	Obsekarapura	4.2	523A	Mirihana South
2.2	514A	Welikada West	4.3	524A	Pragathipura
2.3	514	Welikada East	4.4	525	Thalapathpitiya
2.4	514B	Rajagiriya	4.5	525B	Udahamulla West
2.5	514D	Welikada North	5	**Kaduwela DSD**	
2.6	520	Nawala West	5.1	492C	Udumulla
2.7	520A	Koswatta	5.2	479F	Aruppitiya
2.8	521A	Ethulkotte West	5.3	479E	Batapotha
2.9	521	Ethulkotte	6	**Dehiwala DSD**	
2.10	522A	Pitakotte East	6.1	537A	Dutugemunu
2.11	522B	Pitakotte	6.2	537B	Kohuwala
2.12	522	Pitakotte West			
2.13	520B	Nawala East			
2.14	519B	Nugegoda West			
2.15	519A	Pagoda			
2.16	519	Nugegoda			
2.17	519C	Pagoda East			
2.18	526	Gangodavila North			
2.19	526A	Gangodavila South			
2.20	526C	Gangodavila East			

Note: S/No 1-3 are referring to "PROJECT PROPOSAL FOR SRI JAYEWARDENEPURA KOTTE WASTEWATER DISPOSAL SYSTEM"
Source: JET based on data of Department of Census and Statistics

3.1.4 Sewage Flow

Rate of population increase in the project area and planned population is calculated as shown in Section1 **APPENDIX 12**. Sewage flow to be treated is calculated as shown in Table 3.1-6. Detailed calculations can be found in **APPENDIX 1**.

Table 3.1-6 Estimated Sewage Flow

M/P Area (ha)	Item	2046	Remarks	
3392	a Population	198,000		
	b Water Consumption (l/d/cap)	120		
	c Return Factor (%)	80		
	d Domestic Flow (m^3/d)	19,008	d = a x b x c	
	e Non-Domestic Flow (m^3/d)	6,653	e = d x 30%	
	f Point Source (m^3/d)			
	g Infiltration (m^3/d)	5,132	g = (d + e + f) x 20%	
	h Daily Average Flow (m^3/d)	30,793	h= d + e + f + g	
	i Daily Maximum Flow (m^3/d)	34,642	i = (d + e + f) x 1.15 + g	For STP design
	j Hourly Maximum Flow (m^3/d)	46,190	j = (d + e + f) x 1. 6+ g	For PS design
	k Peak Flow (m^3/d)	82,115	k= (d + e + f) x 3.0+ g	For Sewer design

Source: JET

3.1.5 Influent Sewage Quality

The design influent sewage quality is shown in **Table 3.1-7** The assumed influent concentrations were decided through consultation with NWSDB taking into consideration of the data of Moratuwa/Ratmalana STP, Jaela/Ekala STP and the domestic wastewater quality measurement results of several STP near Colombo city. Details of the design influent wastewater quality are shown in **APPENDIX 2**.

Table 3.1-7 Design Influent Sewage Quality

Parameter	Influent Sewage
	Design Value
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 Sri Jayawardenapura Kotte 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 Sri Jayawardenapura Kotte

4.2 WASTEWATER COLLECTION FACILITIES

The design of the STP and location of major pumping stations depends on the layout of the trunk sewers. The length of branch sewers will be similar to those in other 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	508,800m	Including Force Main
	Sub-Total (Branch Sewer)		508,800m	
Trunk Sewer	315mm	HDPE Pipe	680m	
	355mm	HDPE Pipe	70m	
	400mm	GRP Pipe	4,330m	Pipe Jacking (90m)
	500mm	GRP Pipe	2,360m	Pipe Jacking (140m)
	600mm	GRP Pipe	2,590m	Pipe Jacking (300m)
	700mm	GRP Pipe	1,720m	Pipe Jacking (1,140m)
	800mm	GRP Pipe	4,110m	Pipe Jacking (2,560m)
	900mm	GRP Pipe	2,240m	Pipe Jacking (380m)
	1200mm	GRP Pipe	2,080m	Pipe Jacking (160m)
	1400mm	GRP Pipe	250m	Pipe Jacking (250m)
	1600mm	GRP Pipe	2800m	Pipe Jacking (880m)
	110mm	HDPE Pipe	410m	Force Main
	180mm	HDPE Pipe	790m	Force Main, Pipe Jacking (70m)
	225mm	HDPE Pipe	1,110m	Force Main
	250mm	HDPE Pipe	310m	Force Main, Pipe Jacking (130m)
	315mm	HDPE Pipe	1,110m	Force Main
	355mm	HDPE Pipe	50m	Force Main, Pipe Jacking (50m)
	400mm	HDPE Pipe	2,310m	Force Main, Pipe Jacking (150m)
	Sub-Total (Trunk Sewer)		29,340m	Sub-Total (Pipe Jacking) 6,280m
Total	Branch Sewer + Trunk Sewer		538,140m	
	Crossing: Railway Crossing (1 location), River Crossing (9 locations)			

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

4.2.2 Wastewater 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 2.5 m^3/min	40 m	2+(1)	land requirement is about 0.1 ha
MPS-02	Approximately 3.7 m^3/min	45 m	2+(1)	land requirement is about 0.1 ha
MPS-03	Approximately 16.7 m^3/min	15 m	2+(1)	land requirement is about 0.1 ha
MPS-04	Approximately 1.8 m^3/min	30 m	2+(1)	land requirement is about 0.08 ha
MPS-05	Approximately 17.3 m^3/min	15 m	3+(1)	land requirement is about 0.1 ha
MTPS-01	Approximately 2.6 m^3/min	30 m	1+(1)	
MTPS-02	Approximately 3.2 m^3/min	10 m	1+(1)	
MTPS-03	Approximately 0.3 m^3/min	35 m	1+(1)	
MTPS-04	Approximately 1.5 m^3/min	25 m	1+(1)	

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

4.2.3 Service /House Connections

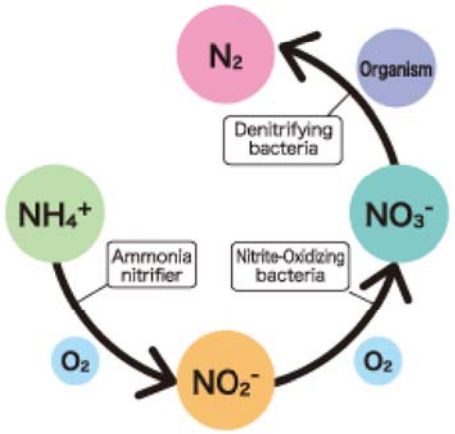
Based on the projected population of 198,000 people and an average family size of four people, in 2046, there will be approximately 49,500 households (Household Income and Expenditure Survey 2012/13 issued by the Department of Census and Statistics(DCS)).

4.3 SEWAGE TREATMENT FACILITY

4.3.1 Treatment Method

(1) Compliance with the Allowable Discharge Limits

The allowable discharge limits (shown in **APPENDIX 4**) are being amended and a draft is available to the public, although it has not yet been gazetted. The effluent quality from the proposed treatment plant will comply with the amended discharge limits. The allowable limits for organic substances in the amended version are not expected to change much. Limits for heavy metals will be stricter. The amendment introduces an allowable discharge limit for nitrates, set at 10 mg/L as NO_3-N. This new requirement will have a significant impact on the selection of treatment methods.



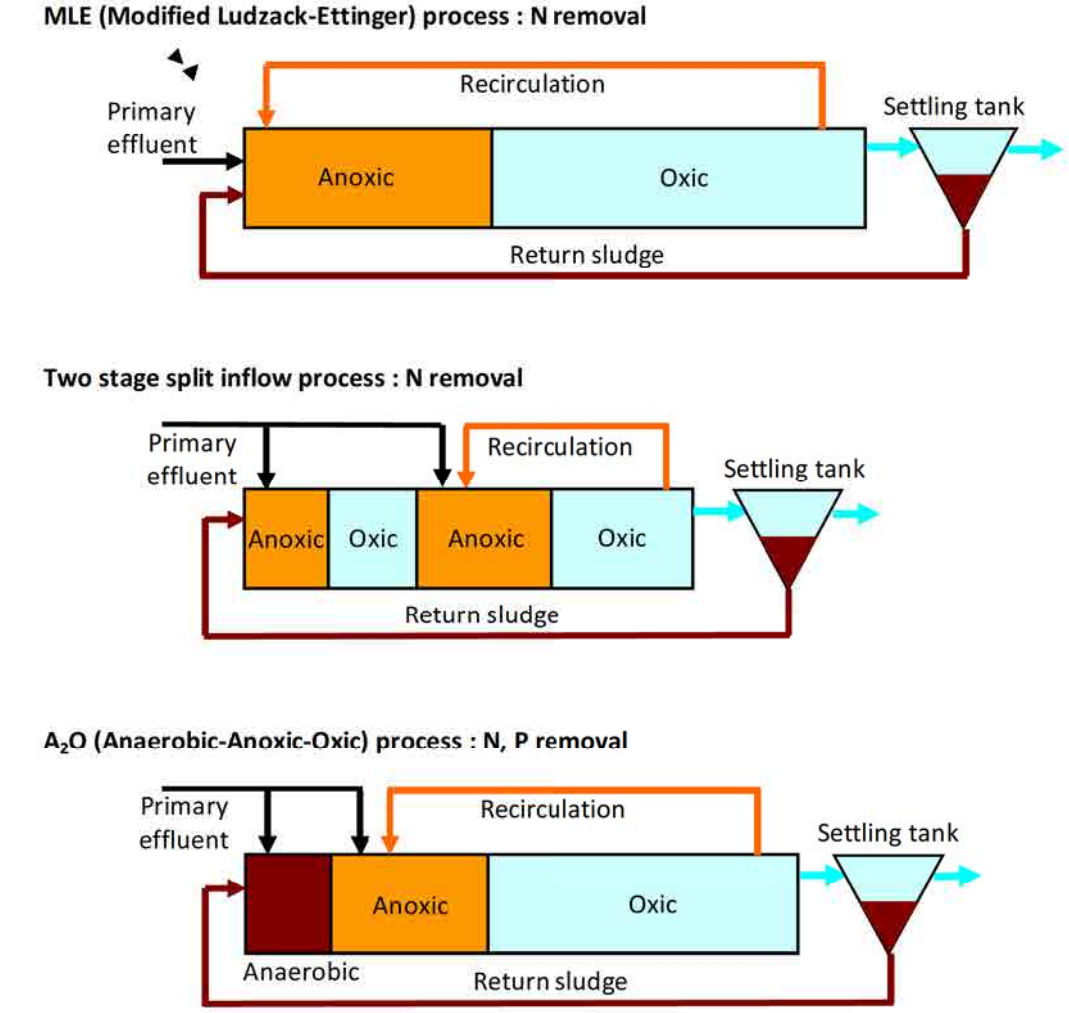
Source:http://www.zeolite-anammox.com/#!faq/c12z9

Figure 4.3-1 Nitrogen Cycle

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

(2) Preferred treatment process

The projected daily maximum sewage inflow is 35,000 m^3/d which is considered as a mid-sized operation. The commonly used oxidation ditch (OD) process is for smaller scale plants and is not suitable for the Sri Jayawardenapura Kotte STP. Considering that nitrates and nitrogen removal is required, the treatment process should use a form of biological nutrient removal (BNR). Activated-sludge BNR systems 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. A pumped recycle is typically included to return nitrified mixed liquor from the oxic zone to the anoxic zones for denitrification. **Figure 4.3-2** shows some of the commonly used BNR processes.



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 shortened hydraulic retention time (HRT) in the nitrification zone, potentially reducing the space required.

4.3.2 STP Site

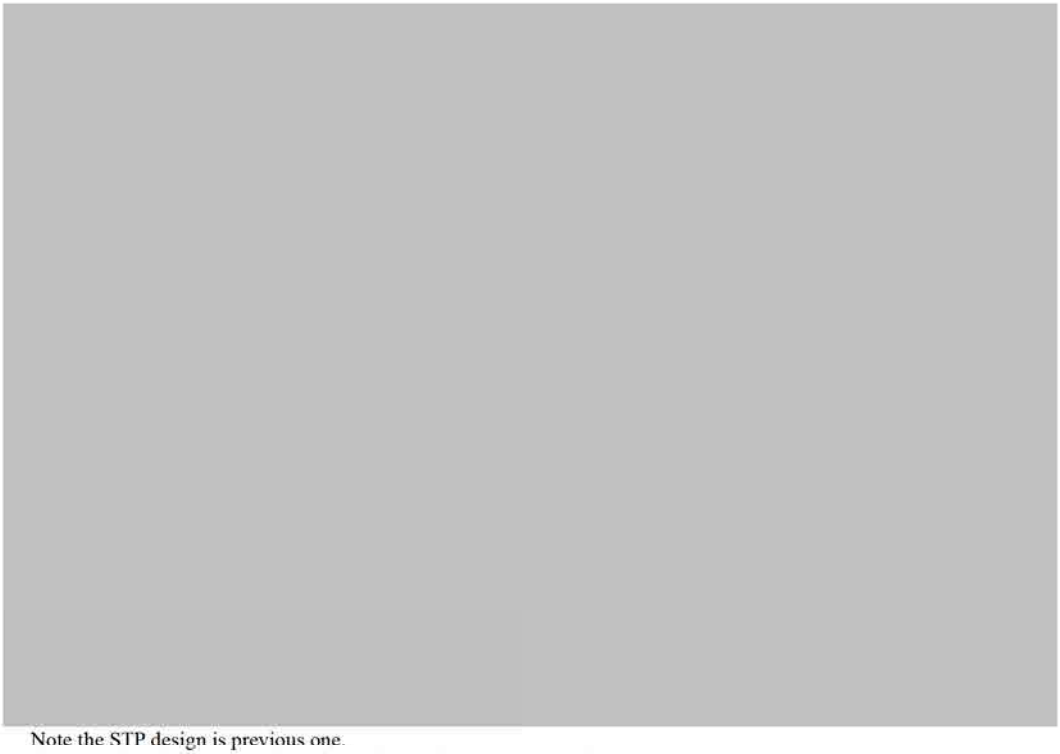
The STP site is located at Koswatte, Battaramulla in Sri Jayawardenapura Kotte city (Source: JET

Figure 4.3-3). The irregular shaped site is about 5 ha but the overhead power lines limit the area available for the STP to the southwestern are of only 2 ha. In addition, there is a small water channel that flows through the middle of the site. The site function as a flood retention area in case of heavy rainfall therefore the north part of STP site should not be used. A site layout plan is shown in **Figure 4.3-4** so staging structure should be adopted.

Photos of the STP site and the boat course downstream of the STP site are shown in **Figure 4.3-5** and **Figure 4.3-6**.

Source: JET

Figure 4.3-3 STP Site Location



Note the STP design is previous one.
Source: Sri Lanka Land Reclamation and Development Corporation (SLLRDC)

Figure 4.3-4 STP Site Layout Plan

Figure 4.3-5 STP site (Left: Western part Right: Eastern part)

Figure 4.3-6 STP site (Left: Southern part Right: Boat course downstream of the STP site)

4.3.3 Sewage Treatment Process

(1) Required treatment level

The design influent sewage quality and target effluent quality values are shown in **Table 4.3-1** Some of the target values are more stringent than the allowable discharge limits. This is to prevent the deterioration of water quality in the water channel and the boat course located downstream of the effluent discharge point. These target values may change depending on results of investigations by CEA.

Table 4.3-1 Assumed 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

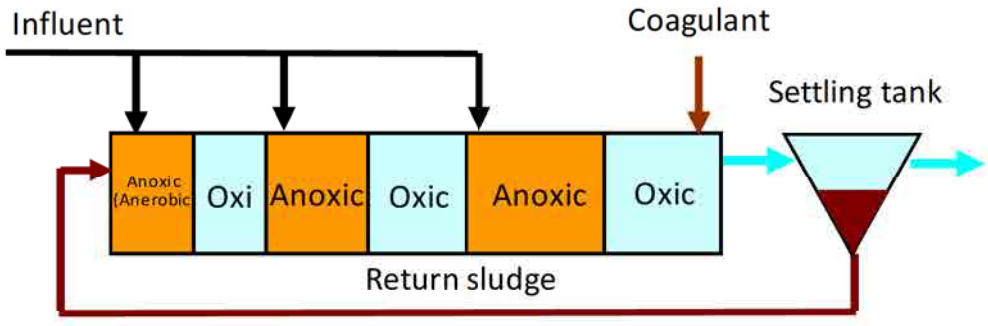
The selected BNR process must satisfy the following conditions;

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 have been made to incorporate step-aeration. Step-feed BNR configurations can remove high levels of nutrients in a reduced tank volume as compared to plug flow configurations.

A three-stage step-feed BNR process is determined to be the most appropriate treatment process. Source: JET

Figure 4.3-7 shows the proposed scheme.



Source: JET

Figure 4.3-7 Three-stage Step-feed BNR Process

Influent is introduced to each denitrification tank in equal amount. The capacity of each tank is determined so that each stage may have the same amount of biomass amount.

This process configuration, offers the following advantages:

1) high nitrogen removal efficiency (about 80%) 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 4.3-8 shows the preliminary site layout for the three-stage step-feed BNR treatment plant.

Figure 4.3-8 Preliminary Layout of the Treatment Plant

(4) Main Unit Processes

1) Screen and Grit Chamber

Screening is the first operation of the waste 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 unnecessary abrasion and wear of mechanical equipment, deposition in pipelines and channels, and accumulation in aeration basins. Grit removal is after screening and before 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 amount that can be accepted should not exceed 0.5% of the influent flow rate.

2) Primary Sedimentation

Typically, the next stage in treatment would be primary sedimentation where the 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 from the process because there is not enough land available. Sewage will flow directly to the BNR process.

3) BNR Reactors

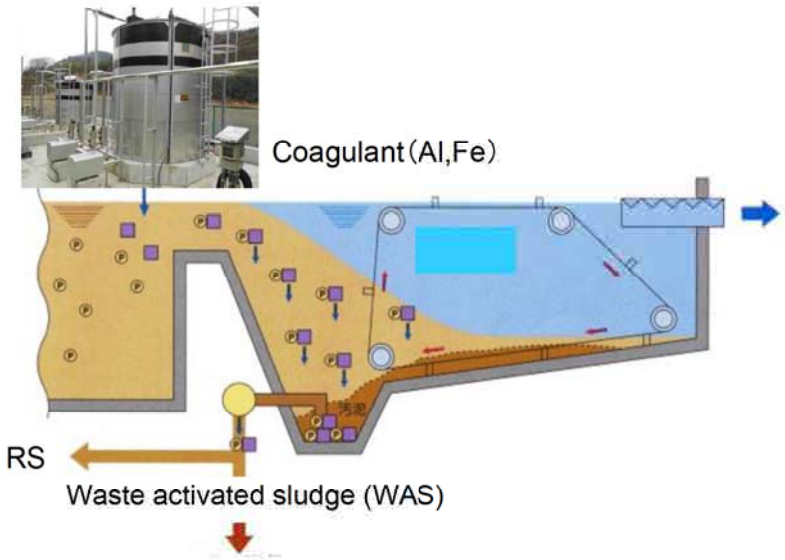
Wastewater flows into the BNR reactor tanks entering the main part of the process. The total HRT of the reactor is estimated to be 9.5 hours. Influent is divided equally into three portions and step-fed into each anoxic tank. Aerobic decomposition of organic substances and nitrification takes place in the oxic tanks. Return activated sludge which contains nitrate is sent to the first anoxic tank. In each anoxic tank, denitrification takes place and nitrate is converted to nitrogen (N_2). 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 volatile fatty acid (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 in 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). Source: JET

Figure 4.3-9 shows the principle of the simultaneous precipitation method.



Source: JET

Figure 4.3-9 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 $25m^3/m^2/d$. 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 is 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.

6) Others

The administration building will be constructed over the wastewater treatment facilities or combined with the sludge treatment building to save space.

(5) Odour Control

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 because it is an aerobic process.

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

Odour control options are:

- activated carbon adsorption
- biological deodorization in combination with 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 Sludge Produced by the Teatment Process

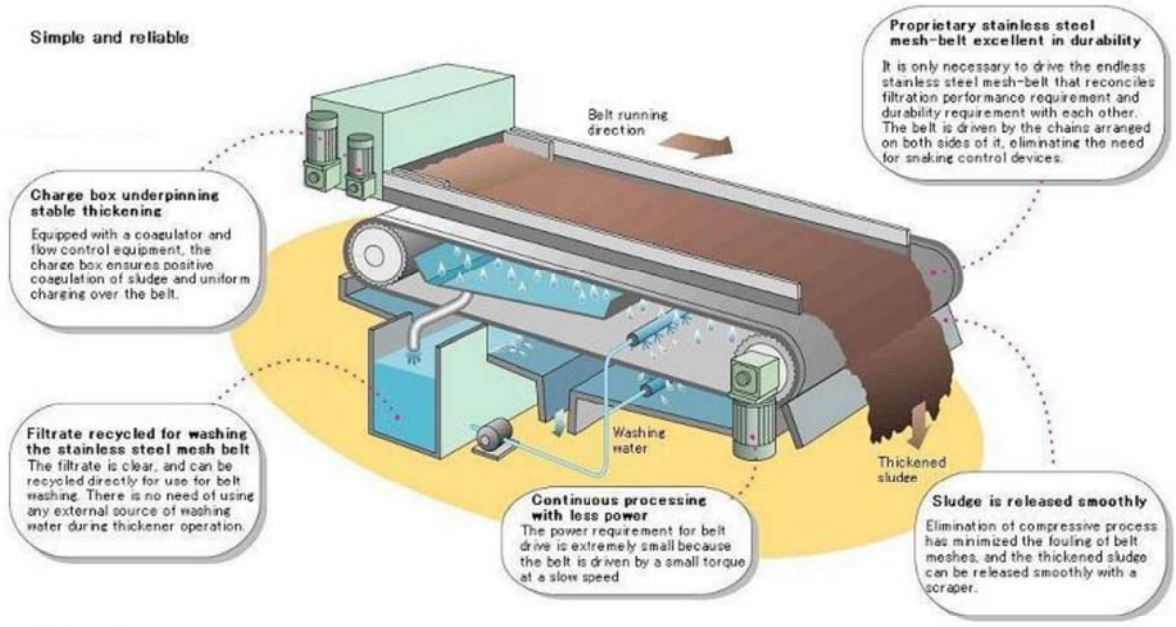
The three-stage step-feed BNR process will produce waste activated sludge (WAS). The amount of WAS at the design flow of 35,000 m^3/d is estimated to be 34 t/d of dewatered sludge with a moisture content 80%, (equivalent to 6.9 t/d of dry solids). WAS contains mostly protein which is the main constituent of biomass. Waste sludge from the BNR process is aerobically stabilized because of the long 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) Waste Sludge Treatment

1) Thickening

Sludge thickening normally refers to the process of reducing the free water content. Thickening is an important process because it reduces the volume of sludge 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 of sludge thickening are: dissolved air floatation (DAF), centrifugation, gravity belt thickener and screw press. **Figure 4.3-10** shows the gravity belt thickening machine which has gained popularity because of its simple structure and low energy consumption. This type of thickener can be enclosed to prevent odour emission.



Source: Kubota Corporation.

Figure 4.3-10 Gravity Belt Thickener

2) Anaerobic Digestion

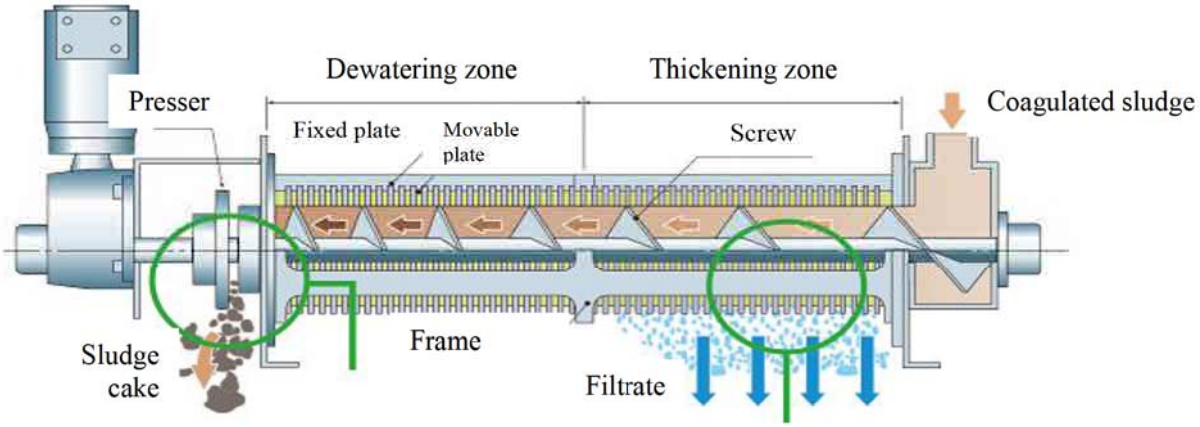
Anaerobic digestion is not considered in the sludge treatment process because it doesn't work well for waste activated sludge alone.

3) Dewatering

Dewatering refers to the reduction of floc-bound and capillary water content. Sludge dewatering is required at the STP prior to disposal. Since dewatering processes differ significantly in their ability to reduce the water content, the sludge disposal method will generally have a major influence on the dewatering method 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 type dewatering machines are becoming popular for the following reasons: 1) compact size supplied as a unit containing dewatering equipment, coagulation equipment, and control panel; 2) easy to operate, unmanned operation is possible; 3) direct dewatering of excess sludge without thickening is possible.

A diagram of the pressurized screw press is shown in **Figure 4.3-11**.

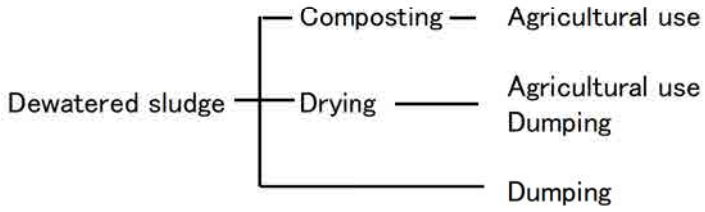


Source: Japan STP Construction Association

Figure 4.3-11 Pressurized Screw Press

(3) Sludge Disposal

There are several options for the final disposal of waste sludge as shown in **Figure 4.3-12**.



Source: JET

Figure 4.3-12 Sludge Disposal Options

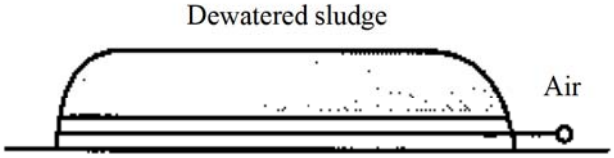
Nitrogen and phosphorus in sewage sludge are essential nutrients for plant growth. Therefore, use of dewatered sludge as compost or dried sludge for agricultural purpose is ideal.

In sludge composting, some pre-conditioning is usually required by adding organic materials to dewatered sludge to adjust moisture content and the C/N ratio. The composting process breaks down the organic substances and matured compost has no offensive odour. During composting, fermentation temperature will rise to over 65℃, destroying pathogenic bacteria in the process. Matured compost have no offensive odour. Composting is preferable to drying and dumping because it recycles the nutrients and is also hygienic. However, strict quality control and education of users are essential.

There are different sludge composting methods. The simplest method is the pile composting shown in **Figure 4.3-13** 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. Air is supplied by a blower system or through periodical turnover by shovel or tractor. It usually takes 10-14 days for the first stage fermentation. The second stage fermentation takes 1 to 3 months to produce matured composted sludge. Since the STP site is too small to accommodate a composting facility, dewatered sludge should be sent to a composting plant located elsewhere.

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

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



Source: JET

Figure 4.3-13 Pile Composting

4.4 ON-SITE FACILITIES AND SEPTAGE MANAGEMENT

4.4.1 On-site Facilities

To connect the entire area in Sri Jayawardenapura Kotte to the sewerage system will take a long time. In some areas, septic tanks will continue to be used for wastewater treatment. The design, construction, and maintenance of septic tanks should comply with Sri Lank Standards 745 Part II: 2009 so 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 functional sustainability. Therefore, users and owners should be aware of the following precautions:

(i) Sludge removal

A septic tank requires sludge removal at regular intervals. 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 at the STP to be constructed.

(ii) Access Cover

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

(iii) Mosquitoes

To prevent mosquito breeding, make sure that the septic tank is kept tightly closed. Vents must be 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. Solid matter should be cleared from the access cover, using a long and flexible stick.

CHAPTER 5 INSTITUTIONAL ARRANGEMENTS FOR IMPLEMENTATION

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

5.1 PROJECT IMPLEMENTATION AND MANAGEMENT

5.1.1 Examples of Project Implementation Structures in Sri Lanka

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

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

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

(N: NWSDB)
Source: JET

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

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

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

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

5.1.2 Public Works in Sri Jayawardenapura Kotte 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 Sri Jayawardenapura Kotte MC

Water works	Responsible organization		NWSDB, Western Central
	Water supply schemes		9
	Blanch offices		21
	Planning & Designing		Engineer 3, Technical 2, Others 7
	WTP	Full scale	1
		Partial scale	1
		Out-sourcing	no
	Laboratory		0
		Out-sourcing	-
	Transmission and Distribution		Engineer 47, Technical 175, Others 1,219
	Meter reading		198
	Charge Collection		Area engineer 9, Senior commercial 10, Others 38
		Out-sourcing	no
Solid waste management	Responsible organization		MC (Public health department)
	Works		Collection, transportation and disposal
	Type of tasks	Planning & Designing	Implementing (Public Health department)
		Construction	Implementing (Engineering department)
		O&M	Implementing (Public Health department)
	Financing sources		MC budget, Service charge
	Service charge		
	Dumping site	Location	Karadivana (by soild waste management authority of province)
		Capacity	
	Collection	Method	by vehicles
		Vehicles	Compactor 8, Tractor 2, Cart 14,
	Staff	PHI	1
		Supervisor	-
		Labors	-
	Out-sourcing		no
On-site sanitation	Responsible organization		No responsibility on MC, All the responsibility on house-owners
	Type of tasks	Planning & Designing	-
		Construction	-
		O&M	-
	No. of septic tanks	At present	-
		Future	-
	Financing sources		-
	Services	Installation	-
		Approval	-
		Supervisor	-
	Sludge removal	Frequency	-
		Procedure	-
		Sludge disposal site	-
	Service charge	Installation	-
		Sludge disposal	-
	Staff	Supervisor	-
		PHI	-
		Upper level labor	-
		Labors	-
	Out-sourcing		-
Road construction and maintenance works	Responsible organization		MC (Engineering department)
	Works		MC road networks
	Type of tasks	Planning & Designing	Implementing
		Construction	Implementing
		O&M	Implementing
	Financing sources		MC budget, Government subsidy
	Staff	Engineer	2
		Technical officer	8
		Others	8 (work supervisor)
	Out-sourcing	Details	Laying of as con concrete
		Type of contract	Tender called contracts
Storm water management	Responsible organization		No responsibility on MC nor NWSDB
	Works		-
	Type of tasks	Planning & Designing	-
		Construction	-
		O&M	-
	Existing drainage system		-
	Financing sources		-
	Staff	Engineer	-
		Technical officer	-
		Others	-
	Out-sourcing		-

Source: MC

The water supply system in Sri Jayawardenapura Kotte is one of 9 systems operated by NWSDB, Western Central 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 and the MC is not involved.

5.1.3 Organizational Options for Implementing Sewerage Works

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

Table 5.1-3 Organizational Options for Implementing Sewerage Works

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

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

Source: JET

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

In Options 3 and 4, the 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, human resources, customer service, and billing. The savings in administrative overhead can help reduce the sewerage service charge.

B) Experience and knowledge

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

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

5.2 ORGANIZATION FOR IMPLEMENTATION

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

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

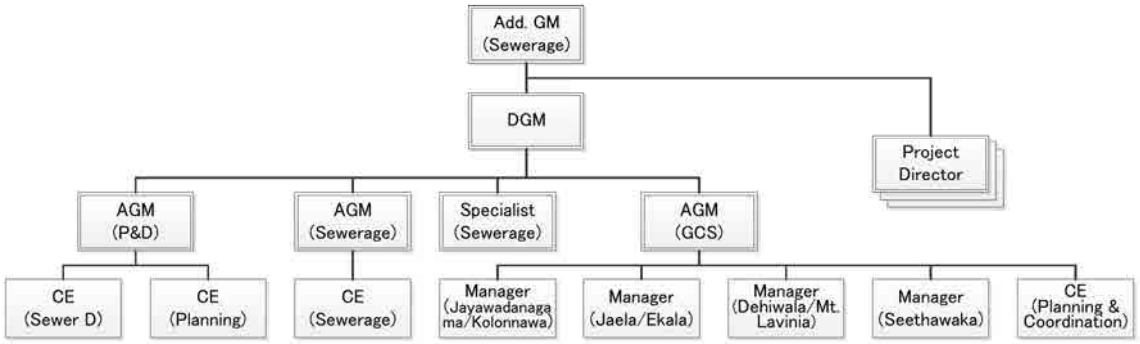
Option-1		Implementation Stage			
		Planning	Designing	Construction	O&M
NWSDB	Tasks	Supervision Decision of STP site and others	Supervision	Supervision	O&M of sewerage works Consideration of out-sourcing
	Staff	* Technical Team	* PD under DGM * Staff in Project Management Units (PMU)	⇒	* Staff in STP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

Option-2		Implementation Stage			
		Planning	Designing	Construction	O&M
NWSDB	Tasks	Supervision Decision of STP site and others	Supervision	Supervision	Supervision
	Staff	* Technical Team	* PD under DGM * Staff in PMU	⇒	* Supervisor of O&M of sewerage system
RSC	Tasks		Supporting project activities	⇒	Supporting O&M of sewerage system Public awareness Promotion of house connection
	Staff		* Manager in sewerage works	⇒	⇒
MC	Tasks	Cooperation for planning works	Cooperation for land acquisition	Cooperation for STP and sewer networks construction	Monitoring of effluent Public awareness Promotion of house connection
	Staff	*Staff for tasks above	⇒	⇒	⇒

Source: JET

5.2.1 Organization of the NWSDB Sewerage Department

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

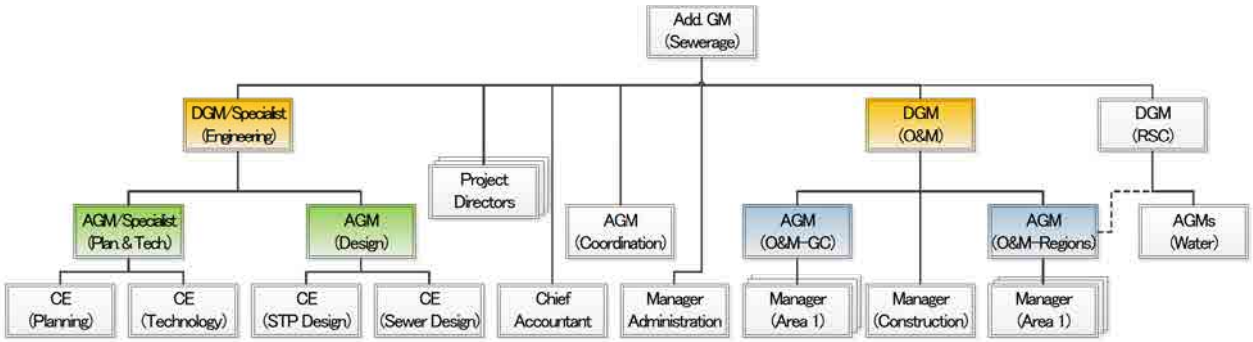


Source: JET

Figure 5.2-1 Organization of the NWSDB Sewerage Department

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

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

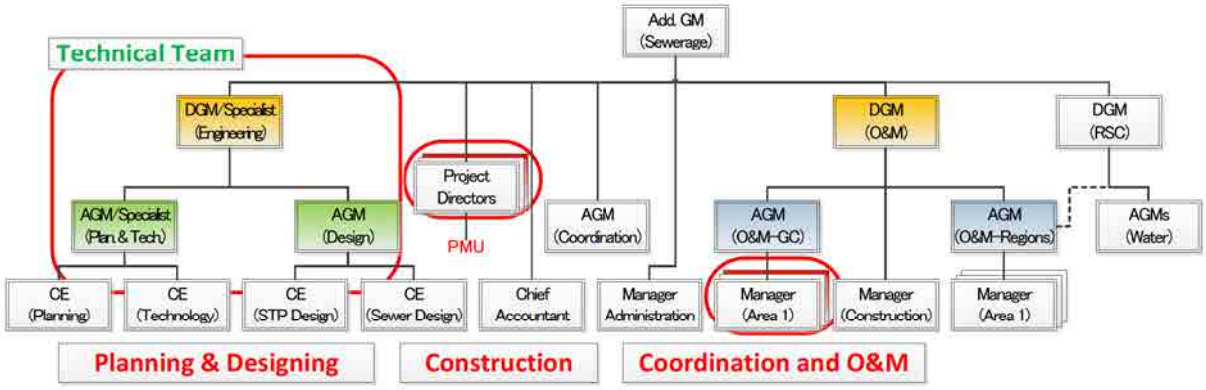


Source: JET

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

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

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



Source: JET

Figure 5.2-3 NWSDB Sewerage Department Responsibilities for Project Implementation

5.2.2 Organization of RSC Western Central

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

5.2.3 Organization of Sri Jayawardenapura Kotte MC

Sri Jayawardenapura Kotte 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.

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

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

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

Source: JET

Satisfactory working conditions and compensation are important to keep staff motivated. 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 the Private Sector

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

Source: JET

(2) MC

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

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

5.3.2 Development of Human Resources

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

(1) NWSDB Training Centre

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

Table 5.3-3 Required Training Programs for Sewerage Systems

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

Source: JET

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

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

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

5.3.3 Sewer Maintenance Equipment and Vehicles

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

Table 5.3-4 Sewer Maintenance Equipment & Vehicles 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 Central is already managing customer service for water supply. When sewerage is added to their responsibilities, they will have to deal with and track customer complaints such as foul odour and clogged pipes. They can learn from other locations where sewerage systems are already in operation.

5.4 CONSTRUCTION MANAGEMENT FOR THE PROJECT

The project management unit (PMU) established under the PD will oversee the activities during construction.

5.4.1 PMU

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

5.4.2 Project Office

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

CHAPTER 6 COST ESTIMATE AND PROCUREMENT

6.1 PROJECT COST

6.1.1 Construction and Project Costs

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

Project cost is estimated based on the following conditions.

Construction cost	:	Estimated with price level at January, 2017
Consulting cost	:	Estimated with price level at January, 2017
Consulting period	:	2019～2026
Construction period	:	2021～2026
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 57.2 billion LKR or 44.1 billion Japanese Yen (JPY), excluding tax and duty, as shown in **Table 6.1-1** Details of the 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 Sri Jayawardenapura Kotte STP (Q=35,000m3/day)	4,887,272,727	5,644,800,000	12,218,181,818	9,408,000,000
	B Trunk Sewer & Pump Station	3,884,573,000	4,878,220,000	10,219,925,000	7,869,338,000
	C Branch Sewer & Pump Station	7,079,587,000	3,522,960,000	11,654,860,000	8,974,242,000
	D House Connection	4,950,000,000	0	4,950,000,000	3,811,500,000
	Sub-total of 1(A-D)	20,801,432,727	14,045,980,000	39,042,966,818	30,063,080,000
2	Administration cost	2,700,000,000	0	2,700,000,000	2,079,000,000
3	Consulting cost	1,354,000,000	3,129,000,000	5,417,636,000	4,171,580,000
4	Physical contingency for construction cost	1,309,000,000	773,000,000	2,312,896,000	1,780,930,000
5	Price escalation for construction cost	5,381,000,000	1,419,000,000	7,223,857,000	5,562,370,000
6	Land acquisition and compensation	-	-	-	-
7	Interest during construction	0	323,000,000	419,481,000	323,000,000
8	Front-end Fee	0	84,000,000	109,091,000	84,000,000
9	Tax and duty	9,861,000,000	0	9,861,000,000	7,592,970,000
	Sub-total of (2-9)	20,605,000,000	5,728,000,000	28,043,961,000	21,593,850,000
	Total including Tax and Duty	41,406,432,727	19,773,980,000	67,086,926,000	51,656,933,000
	Total excluding Tax and Duty	31,545,432,727	19,773,980,000	57,225,926,000	44,063,963,000
	Eligible Portion (1, 3, 4, 5 and 7)	28,845,432,727	19,689,980,000	54,416,835,000	41,900,963,000
	Non-Eligible Portion (2, 6, 8 and 9)	12,561,000,000	84,000,000	12,670,091,000	9,755,970,000

Source: JET

6.1.2 Operation and Maintenance (O&M) Cost

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

Table 6.1-2 Estimated O&M Cost

	Total Amount (LKR/year)	Total Amount (JPY/year)
Sri Jayawardenapura Kotte	499,877,000	386,112,000

Source: JET

6.2 MULTI-PHASED CONSTRUCTION

Construction should be conducted in phases because of the size of the project - service area of 3,392 ha and cost of 57.2 billion LKR (44.1 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 SRI JAYAWARDENAPURA KOTTE MUNICIPAL COUNCIL

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

In this MC, the amount shown under the "Revenue, Grant & Reimbursement" account is also posted to the "Other Revenue" account. The MC also receives grants to cover part of the project cost, which is posted to the "Capital Receipts and Grants" account.

Table 7.1-1 Summary of Income & Expenditure for Sri Jayawardenapura Kotte MC

Unit: million LKR

	Year	2012	2013	2014	2015
Actual Revenue					
	Assessment Rates	166.99	177.34	198.37	226.26
	Rent	24.47	27.64	23.20	25.28
	License Fees	2.70	8.08	5.48	5.86
	Charges for Service	42.27	41.15	59.08	56.29
	Warrant Cost / Fine	12.17	11.51	12.67	3.51
	Stamp duty	86.83	242.95	214.35	425.35
	Court Fines	14.42	1.47	1.14	1.38
	Other Revenue*1	209.62	219.52	258.35	384.99
	Total	**559.46**	**729.65**	**772.64**	**1,128.91**
Recurrent Expenditure					
	Personal Emoluments	261.92	292.21	335.25	441.25
	Travelling Expenses	4.82	6.06	5.72	3.25
	Supplies & Equipment	68.39	78.40	107.01	87.76
	Repairs to Capital Assets	7.13	6.30	7.55	9.18
	Transport	129.82	170.00	180.75	157.36
	Interest & Dividends	4.15	6.42	4.39	19.11
	Grants	13.72	16.00	19.01	16.94
	Pension Gratuity	2.91	3.01	2.74	2.90
	Total	**492.85**	**578.41**	**662.42**	**737.75**
Actual revenue minus Recurrent Expenditure		**66.61**	**151.24**	**110.22**	**391.16**
	Revenue, Grant & Reimbursement	200.34	207.36	247.96	376.19
	Capital Receipts & Grants	11.63	68.15	343.04	272.87
	Capital Expenditure	149.56	254.18	667.51	730.18
	Total Surplus (deficits)	**-71.32**	**-34.79**	**-214.24**	**-66.15**

Note: *1; Other revenue includes "Revenue, Grant & Reimbursement".
Source: Sri Jayawardenapura Kotte MC

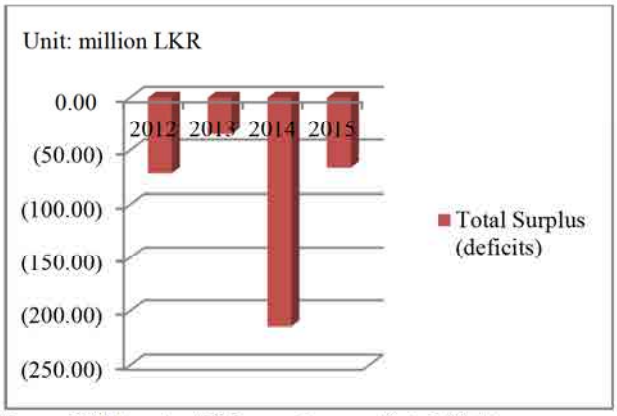
Sri Jayawardenapura Kotte MC has recorded an annual budget deficit since 2012, even after including salary reimbursement and capital receipts and grants. The annual deficit was largest in 2014. The deficit occurs because "Capital Expenditure" exceeds "Capital Receipts & Grants" as shown in **Figure 7.1-3**.

The difference between actual revenues and recurrent expenditures is positive which indicates that revenues are adequate for covering operating and maintenance costs (**Figure 7.1-2**). However, this result is somewhat misleading because actual revenues include salary reimbursement from the central government.

The capital account balance (capital receipts minus capital expenditures) has had large deficits (138 million to 457 million LKR) and the deficits have been increasing rapidly. These large deficits were enough to nullify the positive balance in recurrent accounts.

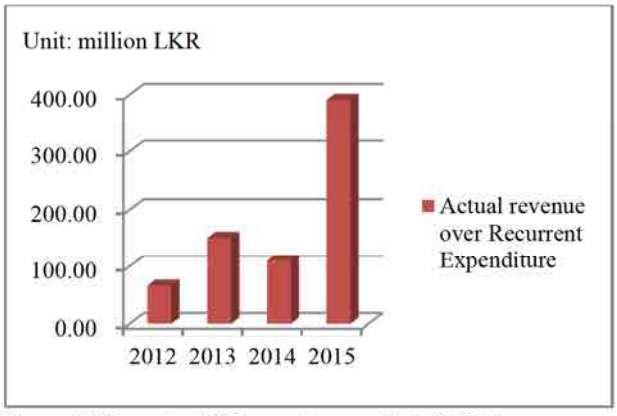
The deficit as a percentage of total revenue was 13%, 5%, 28%, 6% in 2012, 2013, 2014, and 2015. According to the MC, capital expenditure in 2015 included several housing construction projects' for low income settlement. These houses will be sold and the MC expects to recover most of the expenditure. Sri Jayawardenapura Kotte MC's financial condition is slightly weak. Nevertheless, the deficit amount is manageable.

Considering the weak financial condition of the MC, it is recommended that sewerage services be implemented and operated by NWSDB with the cost burden for construction shifted to the central government (in the event of an ODA loan, repayment should be borne by the central government). The sewerage tariff should be set to fully recover the O&M costs.



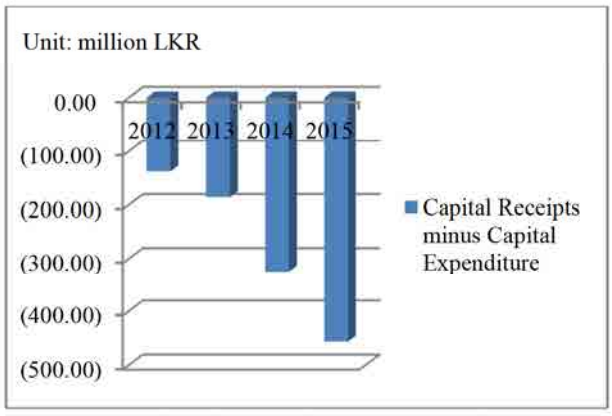
Source: JET, based on Sri Jayawardenapura Kotte MC data

Figure 7.1-1 Trend of Total Surplus (deficits) - Sri Jayawardenapura Kotte MC



Source: JET, based on Sri Jayawardenapura Kotte MC data

Figure 7.1-2 Trend of Actual Revenue minus Recurrent Expenditure - Sri Jayawardenapura Kotte MC



Source: JET, based on Sri Jayawardenapura Kotte MC data

Figure 7.1-3 Trend of Capital Receipts minus Capital Expenditure - Sri Jayawardenapura Kotte MC

7.2 FINANCING SEWERAGE FACILITY CONSTRUCTION AND O&M

7.2.1 Construction, O&M and Replacement Costs

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

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

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

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

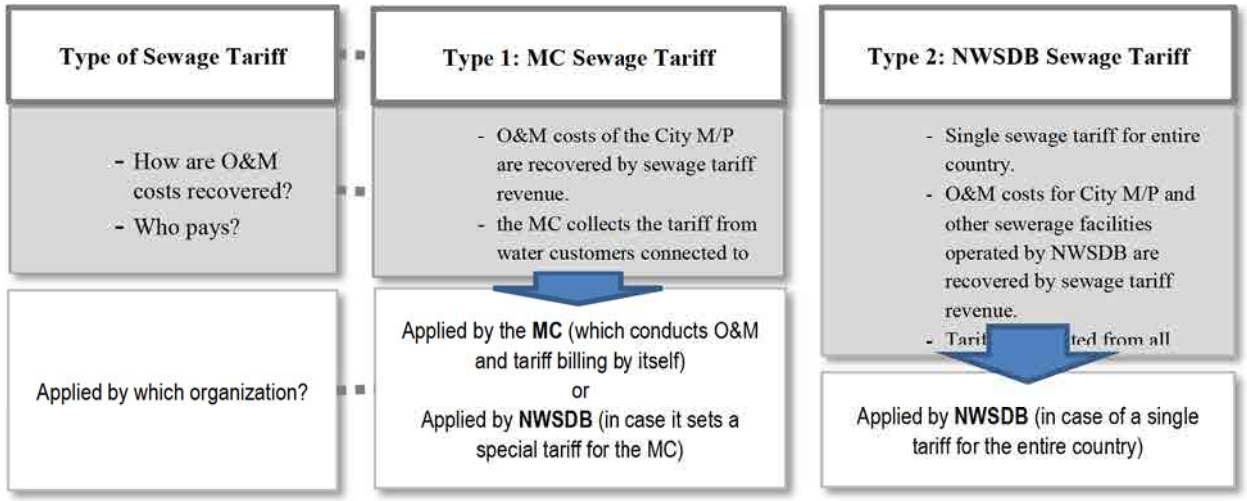
Therefore, the sewage tariff is structured to cover the only the O&M costs of the sewerage facilities.

7.2.2 Sewage Tariffs

(1) Two Types of Tariffs

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

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

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 incrementally implemented in 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.

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

Source: JET

Figure 7.2-2 Implementation Schedule for Tariffs

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

7.2.3 Assumptions for Calculating Proposed Tariffs

The following assumptions are used to calculate the proposed sewage tariff:

- 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: 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 -Sri Jayawardenapura Kotte MC

No.	Items	Unit	Description	Amount
1	Annual O&M costs	LKR/year	Total	499,876,455
2	Expected profit (10%) (=1x10%)	LKR/year	Total	49,987,646
3	**O&M costs with profit** (=1+2)	LKR/year	**Total**	**549,864,101**
4	Sewage Flow	m^3/day	Domestic Flow	19,008
		m^3/day	Non-Domestic Flow	6,653
		m^3/year	Total	9,366,265
5	Sewage Return Factor	%		80.0
6	**Water Consumption Volume** *1	m^3/year	**Total**	11,707,831
7	**Sewage Tariff** (=3/6)	LKR/m^3		**46.97**

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) - Sri Jayawardenapura Kotte MC

Items	Unit	Description	Amount
Operating Expense	LKR	Existing (2015)*1	410,282,866
		New facilities (City M/P)*2	499,876,455
		Total	**910,159,321**
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	723,772,801
Expected Profit (5%)	LKR	Total	36,188,640
O/M costs after subtraction plus profit	LKR	**Total**	**759,961,441**
Water Consumption Volume of Sewerage Customers	m^3/year	Existing (2015)	6,240,008
		New facilities (City M/P)	11,707,831
		Total	**17,947,839**
Sewage Tariff	LKR/m^3	-	**42.34**

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

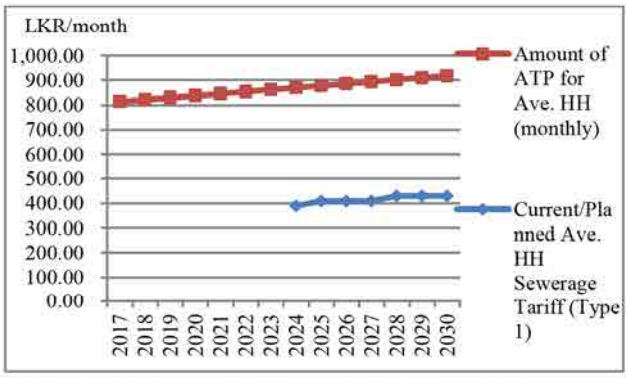
If the City M/P is implemented, the NWSDB sewage tariff would reach 42.34/m^3. LKR (third increase), when the STP operation reaches full capacity.

7.2.5 Affordability and Ability to Pay

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

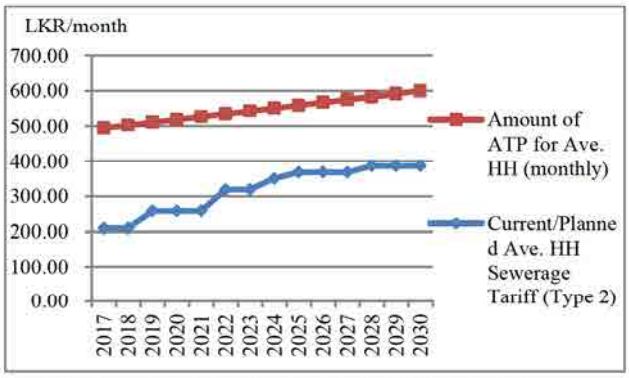
- third tariff increment for City M/P is set for 2024
- trend of household income increase shall continue
- the increase in sewage tariff for domestic, commercial, and industrial customers should be the same. If the increase for commercial and industrial customers is higher than that of domestic customers, 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 set at 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 based on the District HH income data
Source: JET

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

As shown in the **Figure 7.2-3**, the monthly household sewage charge (Type 1) is 45% to 48% of the ATP and is affordable. 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) is 42% to 66% of the ATP and is affordable.

It is recommended to check the average household income data again when the actual tariff is prepared.

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 to avoid charging a customer

more for sewage than for water consumption. In this example, the domestic sewage tariff would be 50% of the water tariff and would be added to the water bill.

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

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

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

Source: JET

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

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

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

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

Note: *; Small and Medium Enterprises
Source: JET

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

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

7.3 FINANCIAL PLAN CONCLUSIONS

A) The financial condition of Sri Jayawardenapura Kotte MC is weak. Therefore, the sewerage services should be implemented and operated by NWSDB with the cost burden for construction shifted to the central government (in the event of an ODA loan, repayment should be borne by the central government)

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 implmeneted incrementally
- small-scale replacements should be covered by NWSDB's or the MC's own budget, but large-scale ones should be funded as projects by the central government.

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 MC is estimated at 46.97/m^3 LKR

E) Type 2 sewage tariff for NWSDB is estimated at 42.34/m^3 LKR

F) Both sewage charges (Type 1 and Type 2) are under 66% of the household ATP (1% of average household income). This indicates that an average household can afford the sewage charge.

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 presented 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 M/P (Section I of this report). No regulations specific to or published by Sri Jayawardenapura Kotte MC relevant to the Project were identified. National regulations described in the Strategic Sewerage M/P 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 Sri Jayawardenapura Kotte MC could not be found. (see **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 Environmental Impact Assessment (EIA) procedure. Scoping of the project components and reasons for evaluation are shown in **Table 8.5-1**.

Table 8.5-1 Environmental Scoping

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

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

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

8.6 TOR FOR ENVIRONMENTAL AND SOCIAL CONSIDERATIONS STUDY

8.6.1 Purpose

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

8.6.2 Items to be Targeted and Evaluated in the Study

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

8.6.3 Target Areas

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

8.6.4 Target Periods

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

8.6.5 Contents and Methodology for ESC Study

The information to be collected and the typical counter-measures to be reviewed 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.	M/P F/S
		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.	M/P F/S
		O	B+	Study: Water pollution standards, treatment methods, water quality, flow rates, pollution loads.	M/P
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.	M/P F/S
		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
		O	B-	Study: Sludge generation. Method: Treatment method.	F/S
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
		O	B-	Study: Treatment method and possible noise generation.	F/S
06	Ground Subsidence	P/C	C-	Study: Geographic conditions. Method: Geographic survey.	F/S
		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.	M/P F/S
08	Geographical Features	P/C	C-	Study: Geographic conditions. Method: Geographical survey.	F/S

		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
10	Biota and Ecosystems	P/C	C-	Study: Inventory of flora and fauna in the construction area.	F/S EIA
		O	C+/C-	Method: Site survey, hearing survey of concerned parties	
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.	M/P F/S
		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.	M/P F/S
		O	B-	Study: Industrial safety regulations. Method: Literature surveys.	M/P F/S
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.	M/P F/S
		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.	M/P F/S
		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.	M/P F/S
		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.	M/P F/S (EIA)
		O	C-		
19a	Indigenous and ethnic populations	P/C	C-	Study: Census/demographic data, economic status, and land use patterns of affected peoples. Method: Interview survey of concerned parties, relevant laws, and regulations.	M/P F/S (EIA)
		O	C-		
20	Misdistribution of benefits and damages	P/C	C-	Study: Social and economic conditions. Method: Hearing surveys of concerned parties, public consultation.	M/P F/S
		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.	M/P F/S
		O	C-		
22	Gender	P/C	C-	Study: Working conditions/statistics of women, gender equality policies. Method: Interview survey of concerned parties, relevant laws, and regulations.	M/P F/S
		O	C+	Study: Health and working conditions of women. Method: Hearing survey of concerned parties, data collection.	M/P F/S
23	Children's Rights	P/C	C-	Study: Child labour laws. Method: Interview survey of concerned parties, relevant laws and regulations.	M/P F/S (EIA)
		O	C+	Study: Water borne diseases and children Method: Interview survey of concerned parties, data collection.	M/P F/S
24	Cultural Heritage	P/C	C-	Study: Location of cultural heritage sites. Method: Site survey, location of registered heritage/historical sites, Interview survey of concerned parties.	M/P F/S (EIA)

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

Source: JET

8.6.6 Prediction and Evaluation of Potential Impacts

Prediction and evaluation of potential impacts should be conducted for items ranked A, B, or C in Section 8.5: Environmental 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 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 plans, 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 a Faculty of Science Professor of Colombo University and a local NGO were conducted at the start of the Project to understand the needs of 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 of the 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 as 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 Initial Environmental Examination (IEE)/EIA	Literature search Site survey
		Jun						
		Jul						
		Aug						
		Sep						
Feasibility Study (F/S)	2017	May			Sri Jayawardenapura Kotte MC (If selected for F/S)		EIA Study	EMP(draft) Monitoring Plan(draft) EIA Report Resettlement Action Plan Stakeholder Meeting
		Jun						
		Jul						
		Aug						
		Sep						
		Oct						
		Nov						
		Dec						

Source: JET

Figure 8.8-1 Schedule for ESC Surveys

CHAPTER 9 CONCLUSION AND RECOMMENDATION

9.1 F/S IMPLEMENTATION

The most important aspect in implementing a sewerage project is the acquisition of land for the STP and sludge disposal site.

In Sri Jayawardenapura Kotte MC, NWSDB and the Joint Coordination Committee have confirmed that a site for a STP has been identified, and a sludge disposal site is available. NWSDB is also considering the construction of a composting plant at separate a site presently used for pipe storage.

Therefore, the sewerage project in Sri Jayawardenapura Kotte can start immediately after conducting an F/S.

9.2 RISK AND MITIGATION MEASURES

Risks and mitigation measures associated with the implementation of the Project are listed in **Table 9.2-1** Major risks include delays in land acquisition as well as increase in the construction cost.

Table 9.2-1 Risks and Mitigation Measures

Risks	Mitigation Measures
Delay: due to the start of Pumping Stations and STP, if the identified lands are not acquired before the commencement of the project	Joint Coordinating Committee (JCC), UDA, NWSDB and other relevant agencies must take appropriate actions in a timely manner for clearing project sites before the construction.
Delay: due to the start of pumping stations and STP, if necessary approvals for the EIA and the drainage plan of SLLRDC are not granted before the commencement of project	JCC, UDA, NWSDB and other relevant agencies must take appropriate actions in a timely manner to obtain necessary approvals before the construction.
Cost Increase: if there are variances in cost for building foundations and pipe trenching and bedding.	Soil test must be carried out to identify the soil conditions.
Low Inflow: of sewage at the treatment plant, if the development of the city is delayed.	JCC must make the appropriate stage wise sewerage development plan based on the city development carried-out by Mega polis.

Source: JET

9.3 CONCLUSION AND RECOMMENDATIONS

The sewerage project in Sri Jayawardenapura Kotte is of very high priority, because the city is the administrative capital of Sri Lanka. The population to be served is significant. The proposed sewage treatment process is an advanced biological system that can remove nitrogen and phosphorus. It is expected to have a significant positive impact on water quality.

The locations for pumping stations are not yet identified. These locations and land requirements need to be determined at the F/S stage, so that sites can be acquired together with the STP site. The F/S should include geotechnical and other basic site investigations so that construction cost can be estimated accurately and that problems during construction can be avoided

APPENDICES

APPENDICES

APPENDIX 1: Waste Water Flow Calculation

SRI JAYAWARDANAPURA KOTTE WASTE WATER FLOW CALCULATION

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

1	Kaduwela DSD		Population 2001	Population 2012	Population 2046	% covered	Population 2046 in covered area	Domestic Water consumption (cum/d)	Domestic Waste Water Flow (cum)	Non-Domestic Flow(cum/d)	Domestic + Non-Domestic Waste Water Flow (cum/d)	Infiltration (cum/d)	Total Waste Water Flow (cum/d)
1.1	492	Subhoothipura	2628	2568	2568	100%	2568	308	247	86	333	67	399
1.2	492 A	Battaramulla South	2257	1580	1580	100%	1580	190	152	53	205	41	246
1.3	492 B	Battaramulla North	3,331	2001	2001	100%	2001	240	192	67	259	52	311
1.4	492 D	Rajamalwatta	2,449	2014	2014	100%	2014	242	193	68	261	52	313
1.5	477	Thalangama North A	8,383	9250	10718	50%	5359	643	514	180	695	139	833
1.6	479B	Asiri Uyana	3,599	3057	3057	50%	1529	183	147	51	198	40	238
1.7	479A	Pahalawela	5,283	4442	4442	50%	2221	267	213	75	288	58	345
		Sub Total 1	27,930	24912	26380		17272	2073	1658	580	2238	448	2686
2	Sri Jayawardanapura Kotte DSD												
2.1	514C	Obsekarapura	11,517	11963	12662	100%	12662	1519	1216	425	1641	328	1969
2.2	514A	Welikada West	5,532	7004	9981	100%	9981	1198	958	335	1294	259	1552
2.3	514	Welikada East	7,343	6749	6749	100%	6749	810	648	227	875	175	1050
2.4	514B	Rajagiriya	4,291	3591	3591	100%	3591	431	345	121	465	93	558
2.5	514D	Welikada North	5,151	4834	4834	100%	4834	580	464	162	626	125	752
2.6	520	Nawala West	4,517	4059	4059	100%	4059	487	390	136	526	105	631
2.7	520A	Koswatta	6,424	5707	5707	100%	5707	685	548	192	740	148	888
2.8	521A	Ethulkotte West	3,516	3371	3371	100%	3371	405	324	113	437	87	524
2.9	521	Ethulkotte	6,229	5929	5929	100%	5929	711	569	199	768	154	922
2.10	522A	Pitakotte East	4,121	3984	3984	100%	3984	478	382	134	516	103	620
2.11	522B	Pitakotte	3,771	3634	3634	100%	3634	436	349	122	471	94	565
2.12	522	Pitakotte West	5,400	5301	5301	100%	5301	636	509	178	687	137	824
2.13	520B	Nawala East	5,811	5473	5473	100%	5473	657	525	184	709	142	851
2.14	519B	Nugegoda West	6,238	5627	5627	100%	5627	675	540	189	729	146	875
2.15	519A	Pagoda	6,363	5446	5446	100%	5446	654	523	183	706	141	847
2.16	519	Nugegoda	5,517	3365	3365	100%	3365	404	323	113	436	87	523
2.17	519C	Pagoda East	6,014	5944	5944	100%	5944	713	571	200	770	154	924
2.18	526	Gangodavila North	6,418	5352	5352	100%	5352	642	514	180	694	139	832
2.19	526A	Gangodavila South	8,198	7305	7305	100%	7305	877	701	245	947	189	1136
2.20	526C	Gangodavila East	3,995	3287	3287	100%	3287	394	316	110	426	85	511
		Sub Total 2	116,366	107925	111601		111601	13392	10714	3750	14463	2893	17356
3	Maharagama DSD												
3.1	525A	Udahamulla East	6,042	6309	6730	100%	6730	808	646	226	872	174	1047
3.2	524	Madiwella	6,472	6244	6244	75%	4683	562	450	157	607	121	728
3.3	493A	Thalawathugoda West	4,876	5492	6563	60%	3938	473	378	132	510	102	612
3.4	493B	Thalawathugoda East	5,351	6217	7784	60%	4670	560	448	157	605	121	726
3.5	526B	Gangodavila South B	6,541	7391	8875	60%	5325	639	511	179	690	138	828
3.6	526D	Jambugasmulla	4,910	3828	3828	75%	2871	345	276	96	372	74	446
		Sub Total 3	34,192	35481	40024		28217	3386	2709	948	3657	731	4388
4	Maharagama DSD												
4.1	523	Mirihana North	6,339	6222	6222	100%	6222	747	597	209	806	161	968
4.2	523A	Mirihana South	5,745	6043	6518	100%	6518	782	626	219	845	169	1014
4.3	524A	Pragathipura	5,420	5838	6524	100%	6524	783	626	219	846	169	1015
4.4	525	Thalapathpitiya	7,373	7086	7086	100%	7086	850	680	238	918	184	1102
4.5	525B	Udahamulla West	4,261	4780	5678	90%	5110	613	491	172	662	132	795
		Sub Total 4	29,138	29969	32028		31460	3775	3020	1057	4077	815	4893
5	Kaduwela DSD												0
5.1	492C	Udumulla	2,447	2465	2492	100%	2492	299	239	84	323	65	388
5.2	479F	*Aruppitiya*	1,893	2354	3265	10%	327	39	31	11	42	8	51
5.3	479E	*Batapotha*	6,546	7582	9449	15%	1417	170	136	48	184	37	220
		Sub Total 5	10,886	12401	15206		4236	508	407	142	549	110	659
6	Dehiwala DSD												
6.1	537A	*Dutugemunu*	5,941	4806	4806	50%	2403	288	231	81	311	62	374
6.2	537B	*Kohuwala*	7,508	5475	5475	50%	2738	329	263	92	355	71	426
		Sub Total 6	13,449	10281	10281		5141	617	493	173	666	133	799
		Grand Total	231,961	220,969	235,520		197,926	23,751	19,001	6,650	25,651	5,130	30,781

GND 's where population increased from 2001 to 2012 (shaded rows)

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°C		6.7	6.4	7.0	6.6-8.5	-	6.7			pH at 26°C
Total Suspended Solids at 104°C	mg/l	163	90	139	232	-	156	160	458	Total Suspended Solids at 104°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

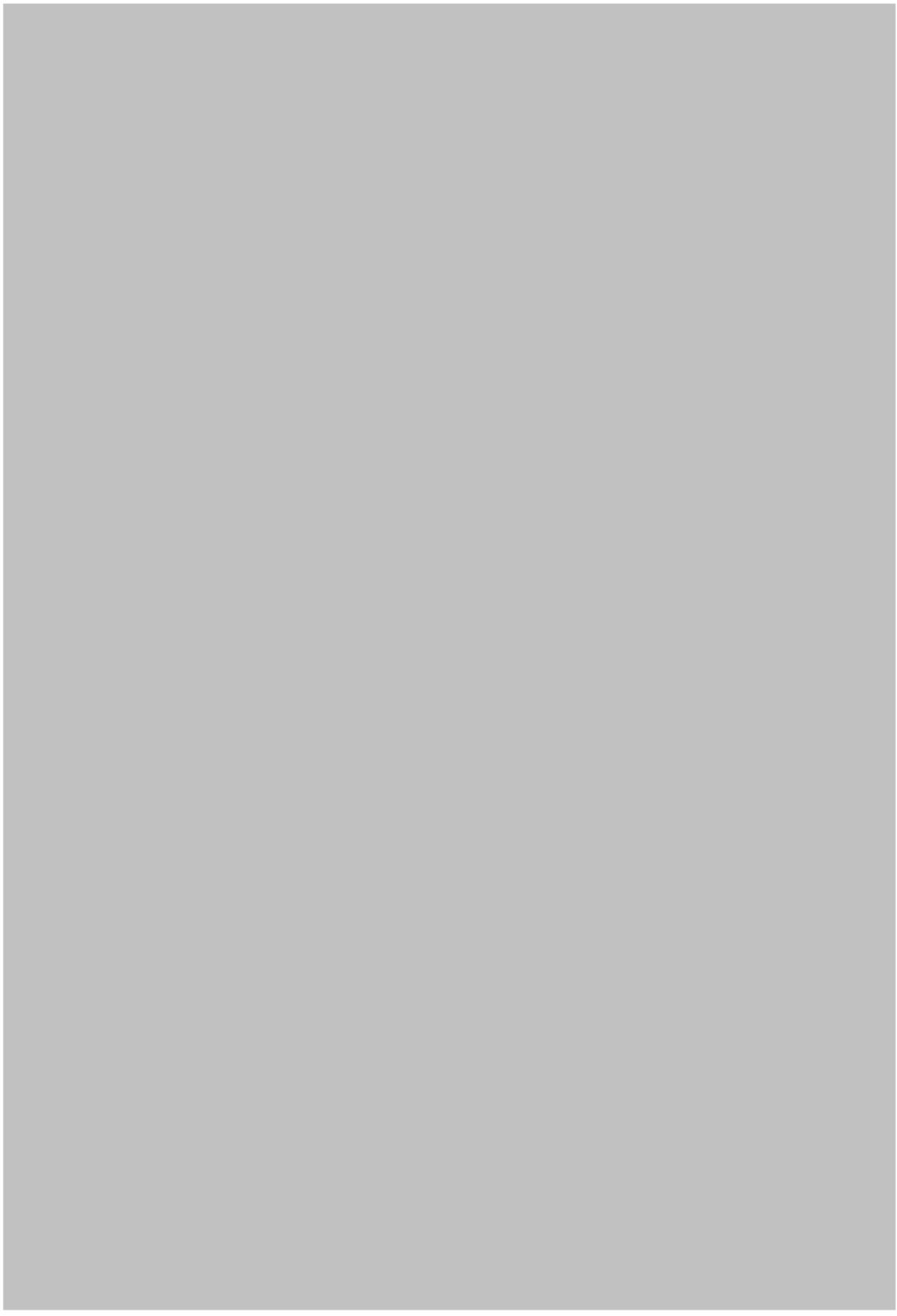
***Average of 1-year measurement

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

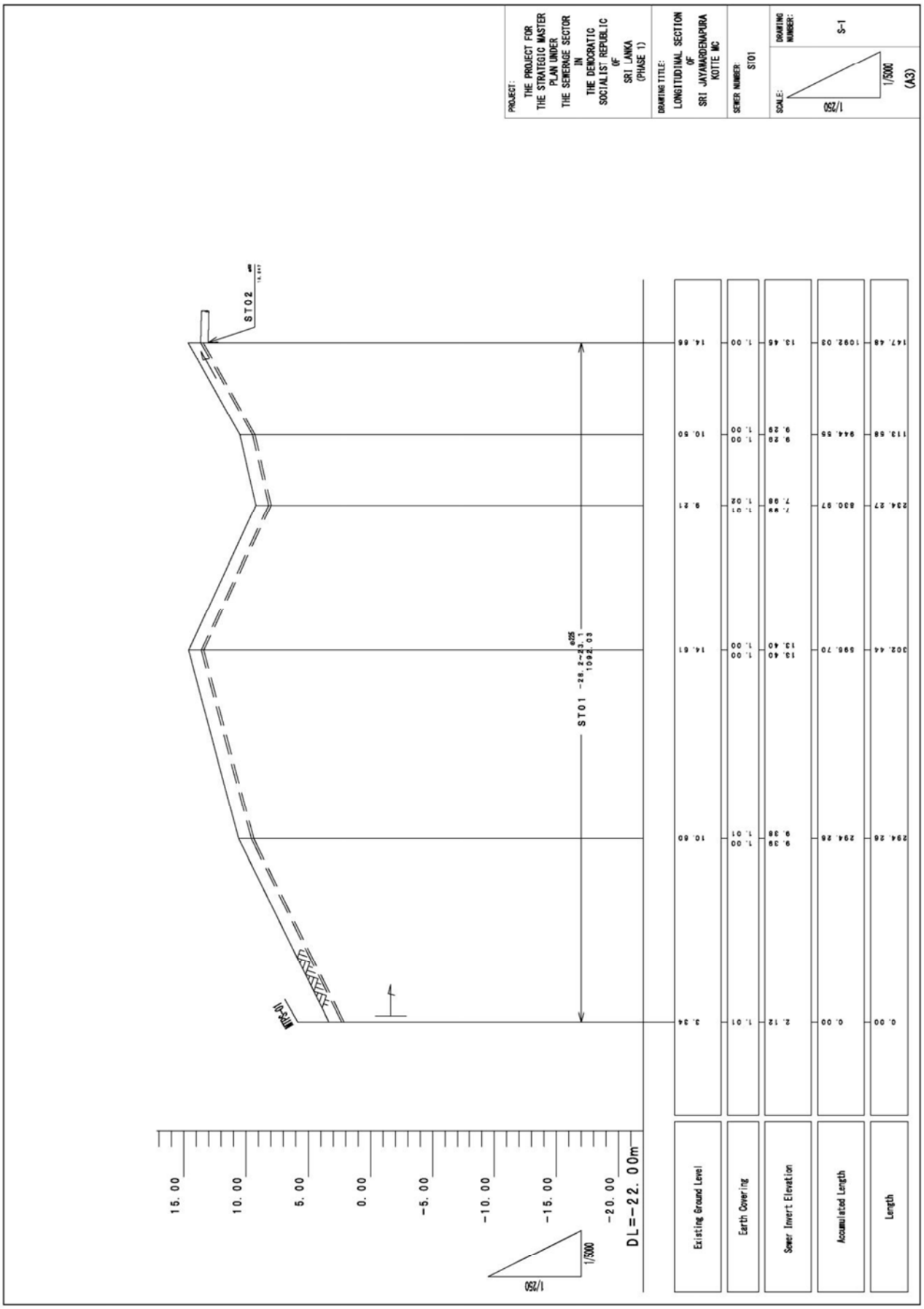
Master Plan Area	Unit Sewer Water ($m^3/s/ha$)	Legend	P
Sri Jayawardenapura Kotte MC	0.000280	◎: Main Sewer	P. 1

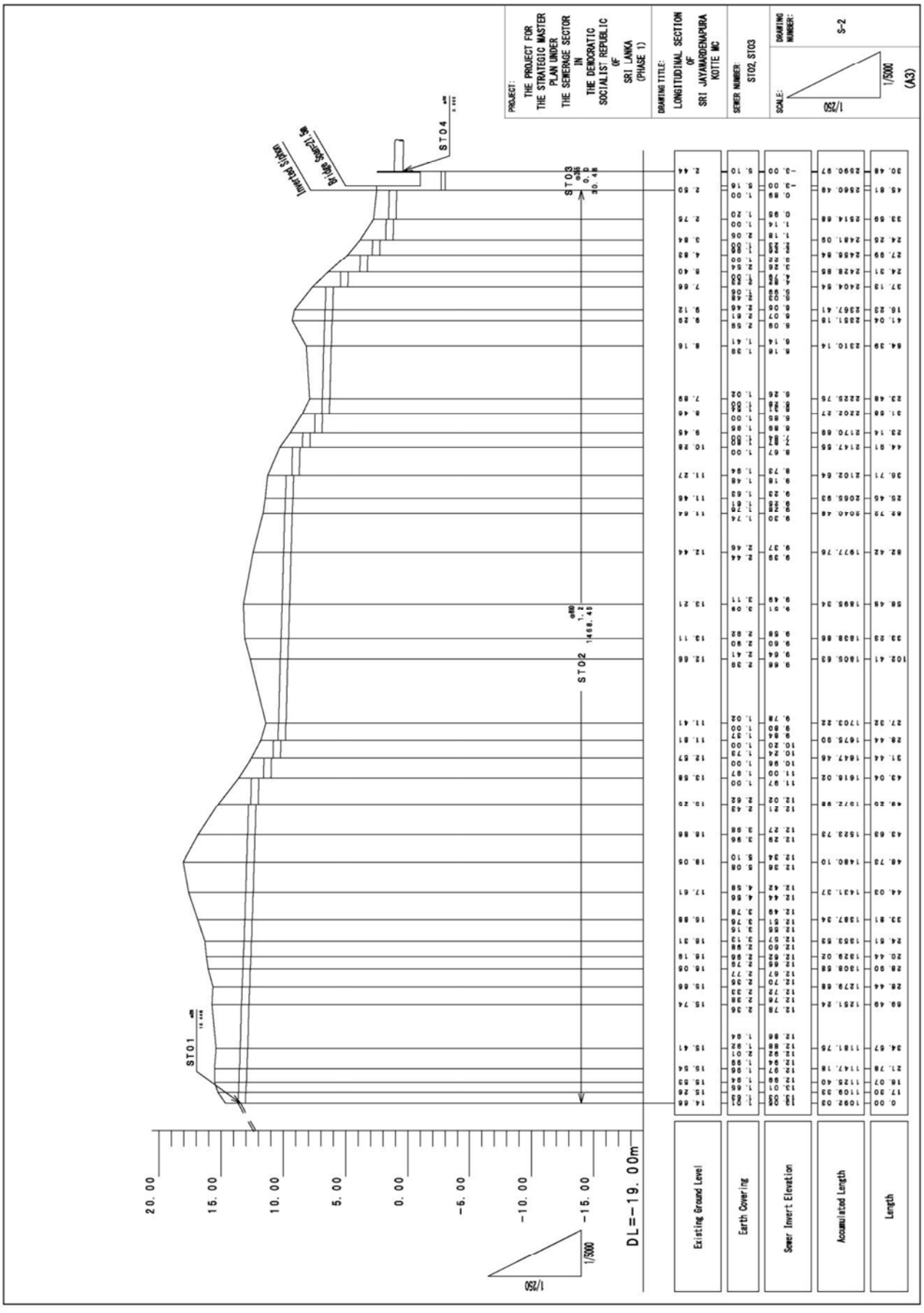
Line No.	Catchment Area		Length	Design Outflow			Design Sewer Line							Note
				Sewer Water Outflow		Total Outflow	Dia (Internal Diameter)	Slope	V	Cap	Existing Ground Level	Sewer Invert Elevation	Earth Covering	
	Area	Accumulated Area	Accumulated Length	Area Input	Point Input						Upper / Lower	Upper / Lower	Upper / Lower	
	(ha)	(ha)	(m)	(m^3/s)	(m^3/s)	(m^3/s)	(mm)	(‰)	(m/s)	(m^3/s)	(m)	(m)	(m)	
			1092				HDPE				3.34	2.119	1.01	From MTPS-01
ST01 ◎	155.23	155.23	1092	0.043		0.043	⊙ 225 (201)	Force Main			14.66	13.446	1.00	
			1469				GRP				14.66	13.047	1.01	
ST02 ◎	224.34	379.57	2561	0.106		0.106	⊙ 600 (600)	1.20	0.75	0.213	2.50	0.892	1.00	
			31				HDPE				2.50	-3.000	5.16	
ST03 ◎		379.57	2591	0.106		0.106	⊙ 355 (324.8)	Inverted Siphon			2.44	-3.000	5.10	
			537				GRP				2.44	0.390	1.34	
ST04 ◎	133.17	512.74	3128	0.144		0.144	⊙ 700 (700)	1.00	0.76	0.293	3.55	-0.365	3.21	To ST09
			62				HDPE				2.82	1.157	1.33	
ST05 ◎	97.78	97.78	62	0.027		0.027	⊙ 355 (324.8)	2.40	0.70	0.055	1.87	0.533	1.00	
			15				HDPE				1.87	-4.190	5.87	
ST06 ◎		97.78	77	0.027		0.027	⊙ 200 (178.6)	Inverted Siphon			1.77	-4.190	5.77	
			1054				GRP				1.77	0.130	1.13	
ST07 ◎	93.16	190.94	1131	0.053		0.053	⊙ 500 (500)	1.50	0.74	0.146	3.51	-1.769	4.77	To MTPS-02
			721				GRP				3.51	2.003	1.00	From MTPS-02
ST08 ◎	54.97	245.91	1852	0.069		0.069	⊙ 500 (500)	1.50	0.74	0.146	3.55	0.615	2.43	
			867				GRP				3.55	-0.465	3.21	
ST09 ◎	49.70	808.35	3994	0.226		0.226	⊙ 800 (800)	0.90	0.79	0.397	4.32	-1.583	5.09	
			41				GRP				4.32	-4.700	8.51	
ST10 ◎		808.35	4034	0.226		0.226	⊙ 500 (500)	Inverted Siphon			4.30	-4.700	8.49	
			709				GRP				4.30	-1.910	5.40	
ST11 ◎	93.03	901.38	4743	0.252		0.252	⊙ 800 (800)	0.90	0.79	0.397	5.71	-2.886	7.79	To MPS-03
			1105				HDPE				2.21	0.903	1.01	From MPS-01
ST12 ◎	296.47	296.47	1105	0.083		0.083	⊙ 315 (281.8)	Force Main			26.94	25.641	1.00	To ST14
			2310				HDPE				4.66	-0.130	4.41	From MPS-02
ST13 ◎	440.11	440.11	2310	0.123		0.123	⊙ 400 (366)	Force Main			26.94	25.556	1.01	
			1408				GRP				26.94	24.342	1.79	
ST14 ◎	159.19	895.77	3718	0.251		0.251	⊙ 800 (800)	0.90	0.79	0.397	2.65	0.840	1.00	To ST18
			618				HDPE				20.56	19.243	1.02	
ST15 ◎	69.95	69.95	618	0.020		0.020	⊙ 315 (281.8)	2.70	0.68	0.043	2.54	0.454	1.79	
			11				HDPE				2.54	-1.100	3.47	
ST16 ◎		69.95	629	0.020		0.020	⊙ 180 (164.6)	Inverted Siphon			2.30	-1.100	3.23	
			59				HDPE				2.30	0.284	1.72	
ST17 ◎	2.09	72.04	687	0.020		0.020	⊙ 315 (281.8)	2.70	0.68	0.043	2.65	0.106	2.25	
			2235				GRP				2.65	-0.512	2.25	
ST18 ◎	109.58	1077.39	5952	0.302		0.302	⊙ 900 (900)	0.80	0.80	0.512	5.71	-3.669	8.47	
			107				GRP				5.71	-3.969	8.46	
ST19 ◎		1978.77	6059	0.554		0.554	⊙ 1200 (1200)	0.60	0.84	0.955	4.43	-5.971	9.19	To MPS-03
			278				GRP				4.43	1.452	1.76	From MPS-03
ST20 ◎	66.95	2045.72	6336	0.573		0.573	⊙ 1200 (1200)	0.60	0.84	0.955	3.21	0.090	1.91	
			33				GRP				3.21	-1.700	4.40	
ST21 ◎		2045.72	6369	0.573		0.573	⊙ 500 (500)×2	Inverted Siphon			3.15	-1.700	4.34	To ST22

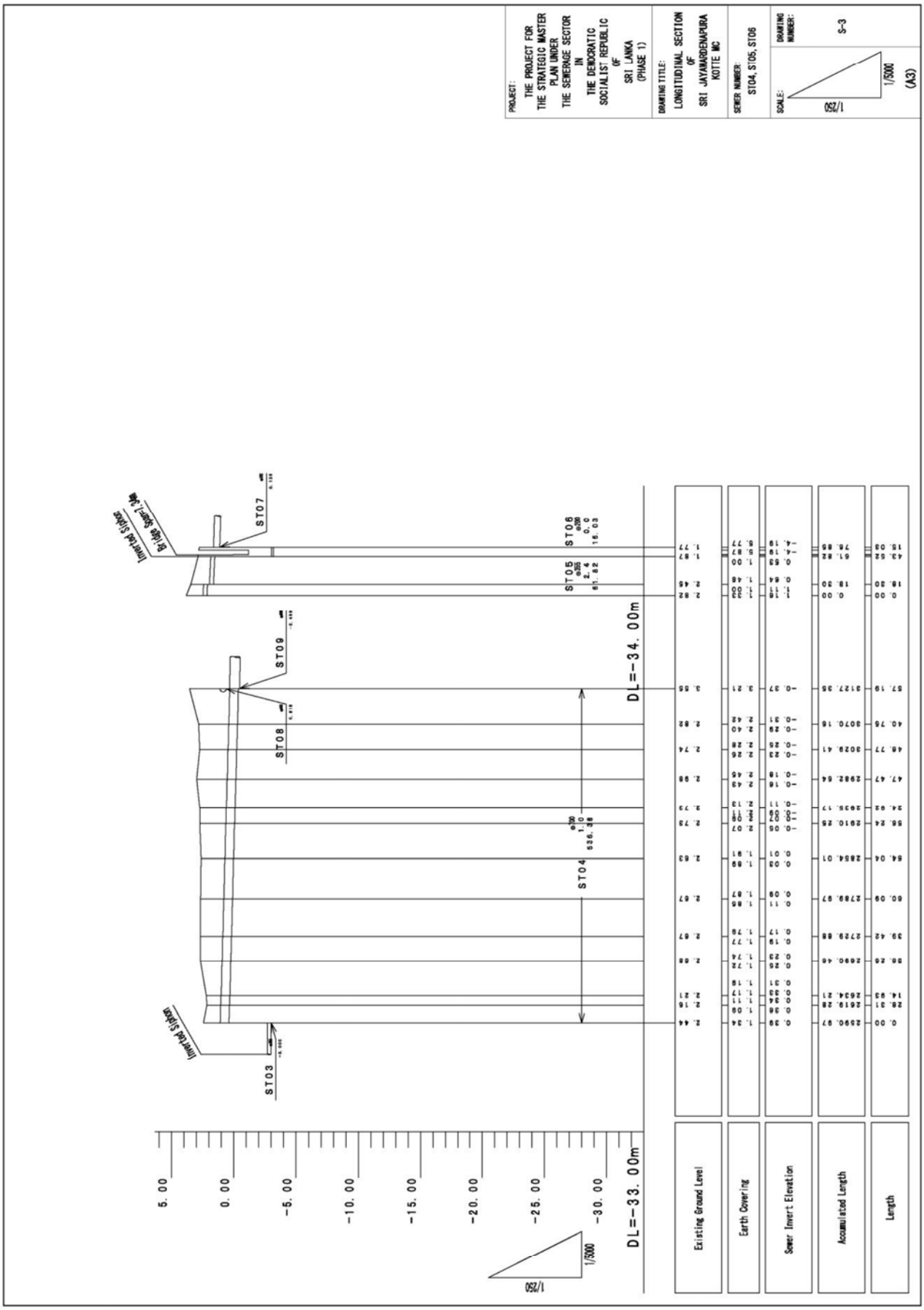
SEWER DESIGN CALCULATIONS

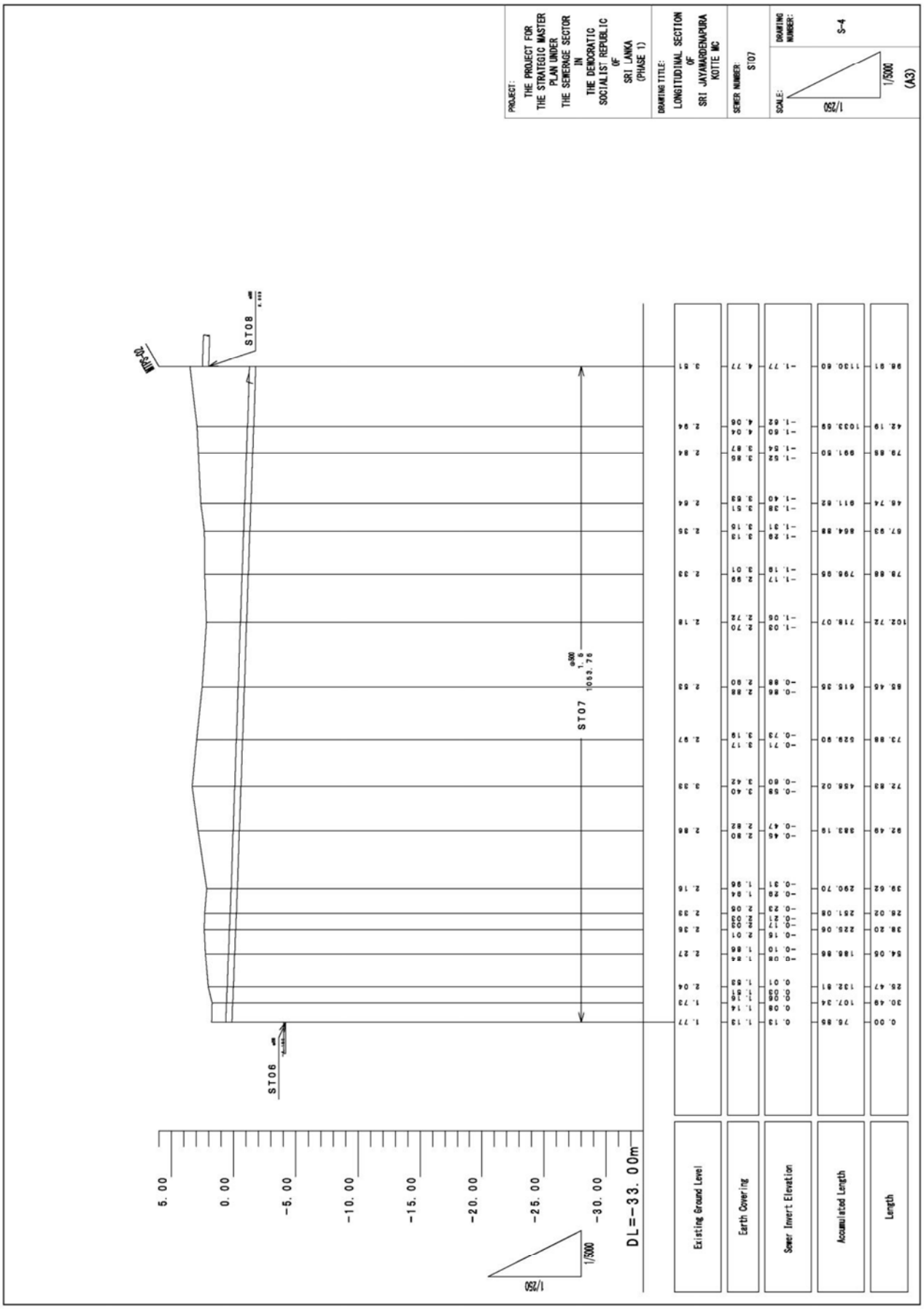
Master Plan Area: Sri Jayawardenapura Kotte MC
Unit Sewer Water ($m^3/s/ha$): 0.000280
Legend: ◎: Main Sewer
P. 2

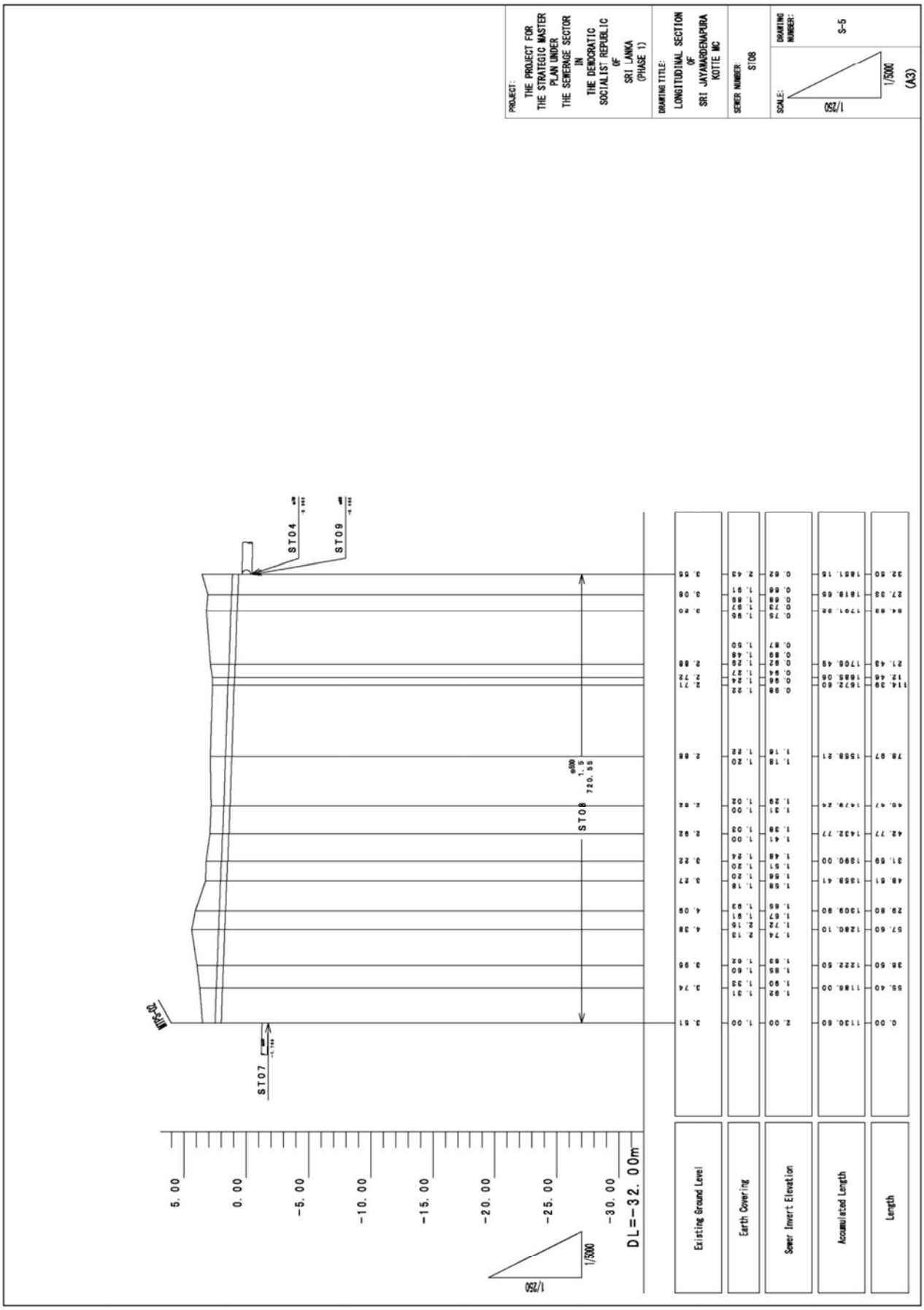
Line No.	Catchment Area		Length	Design Outflow			Design Sewer Line							Note
				Sewer Water Outflow		Total Outflow	Dia (Internal Diameter)	Slope	V	Cap	Existing Ground Level	Sewer invert Elevation	Earth Covering	
	Area	Accumulated Area	Accumulated Length	Area Input	Point Input						Upper / Lower	Upper / Lower	Upper / Lower	
	(ha)	(ha)	(m)	(m^3/s)	(m^3/s)	(m^3/s)	(mm)	(‰)	(m/s)	(m^3/s)	(m)	(m)	(m)	
			646				GRP				3.15	-0.350	2.29	
ST22 ◎	99.47	2145.19	7014	0.601		0.601	⊙ 1200 (1200)	0.60	0.84	0.955	2.18	-0.957	1.92	
			19				GRP	Inverted Siphon			2.18	-2.000	3.57	
ST23 ◎		2145.19	7033	0.601		0.601	⊙ 600 (600)×2				2.18	-2.000	3.57	
			1051				GRP				2.18	-1.200	2.17	
ST24 ◎	51.18	2196.37	8083	0.615		0.615	⊙ 1200 (1200)	0.60	0.84	0.955	4.18	-2.425	5.39	To ST42
			304				HDPE	Force Main			2.40	-3.600	5.76	From MPS-04
ST25 ◎	208.25	208.25	304	0.058		0.058	⊙ 250 (228.6)				14.57	13.333	1.00	
			684				GRP				14.57	12.767	1.20	
ST26 ◎	85.89	294.14	988	0.082		0.082	⊙ 600 (600)	1.20	0.75	0.213	3.31	0.992	1.71	
			16				HDPE	Inverted Siphon			3.31	-4.700	7.67	
ST27 ◎		294.14	1004	0.082		0.082	⊙ 355 (324.8)				3.20	-4.700	7.56	
			418				GRP				3.20	0.760	1.83	
ST28 ◎	82.24	376.38	1421	0.105		0.105	⊙ 600 (600)	1.20	0.75	0.213	2.89	0.100	2.18	To ST30
			1476				GRP				7.63	5.578	1.65	
ST29 ◎	135.79	135.79	1476	0.038		0.038	⊙ 400 (400)	1.80	0.70	0.088	2.89	-1.655	4.14	
			42				GRP				2.89	-1.955	4.14	
ST30 ◎		512.17	1518	0.143		0.143	⊙ 700 (700)	1.00	0.76	0.293	3.51	-1.997	4.80	
			43				GRP	Inverted Siphon			3.51	-9.000	12.10	
ST31 ◎		512.17	1561	0.143		0.143	⊙ 400 (400)				3.18	-9.000	11.77	
			93				GRP				3.18	-2.450	4.92	
ST32 ◎		512.17	1653	0.143		0.143	⊙ 700 (700)	1.00	0.76	0.293	2.56	-2.563	4.41	To ST38
			404				HDPE	Force Main			9.48	8.368	1.01	From MTPS-03
ST33 ◎	19.16	19.16	404	0.005		0.005	⊙ 110 (98)				32.73	31.624	1.00	
			1203				GRP				32.73	30.084	2.24	
ST34 ◎	80.63	99.79	1607	0.028		0.028	⊙ 400 (400)	1.80	0.70	0.088	2.20	0.543	1.25	
			12				HDPE	Inverted Siphon			2.20	-2.000	3.99	
ST35 ◎		99.79	1619	0.028		0.028	⊙ 225 (201)				2.21	-2.000	4.00	
			289				GRP				2.21	0.300	1.50	
ST36 ◎	51.91	151.70	1907	0.042		0.042	⊙ 400 (400)	1.80	0.70	0.088	2.63	-0.380	2.60	
			506				GRP				2.63	-0.480	2.60	
ST37 ◎	11.97	163.67	2413	0.046		0.046	⊙ 500 (500)	1.50	0.74	0.146	2.56	-1.519	3.57	
			1044				GRP				2.56	-2.593	4.44	
ST38 ◎	18.81	694.65	3456	0.195		0.195	⊙ 700 (700)	1.00	0.76	0.293	3.12	-4.035	6.45	To ST41
			779				HDPE	Force Main			2.81	1.634	1.00	From MTPS-04
ST39 ◎	91.00	91.00	779	0.025		0.025	⊙ 180 (164.6)				8.70	7.526	1.00	
			1313				GRP				8.70	6.888	1.41	
ST40 ◎	43.91	134.91	2091	0.038		0.038	⊙ 400 (400)	1.80	0.70	0.088	3.12	-0.520	3.23	
			1122				GRP				3.12	-4.135	6.45	
ST41 ◎	53.41	882.97	4578	0.247		0.247	⊙ 800 (800)	0.90	0.79	0.397	4.18	-5.586	8.96	
			245				GRP				4.18	-6.136	8.95	
ST42 ◎	4.47	3083.81	8328	0.863		0.863	⊙ 1400 (1400)	0.50	0.83	1.193	3.07	-6.338	8.04	To MPS-05
			2516				GRP				3.07	0.551	1.00	From MPS-05
ST43 ◎	308.19	3392.00	10843	0.950		0.950	⊙ 1600 (1600)	0.50	0.89	1.581	6.24	-2.168	6.89	
			279				GRP				6.24	-2.188	6.91	
ST44 ◎		3392.00	11122	0.950		0.950	⊙ 1600 (1600)	0.50	0.89	1.581	0.00	-2.594	1.08	To STP

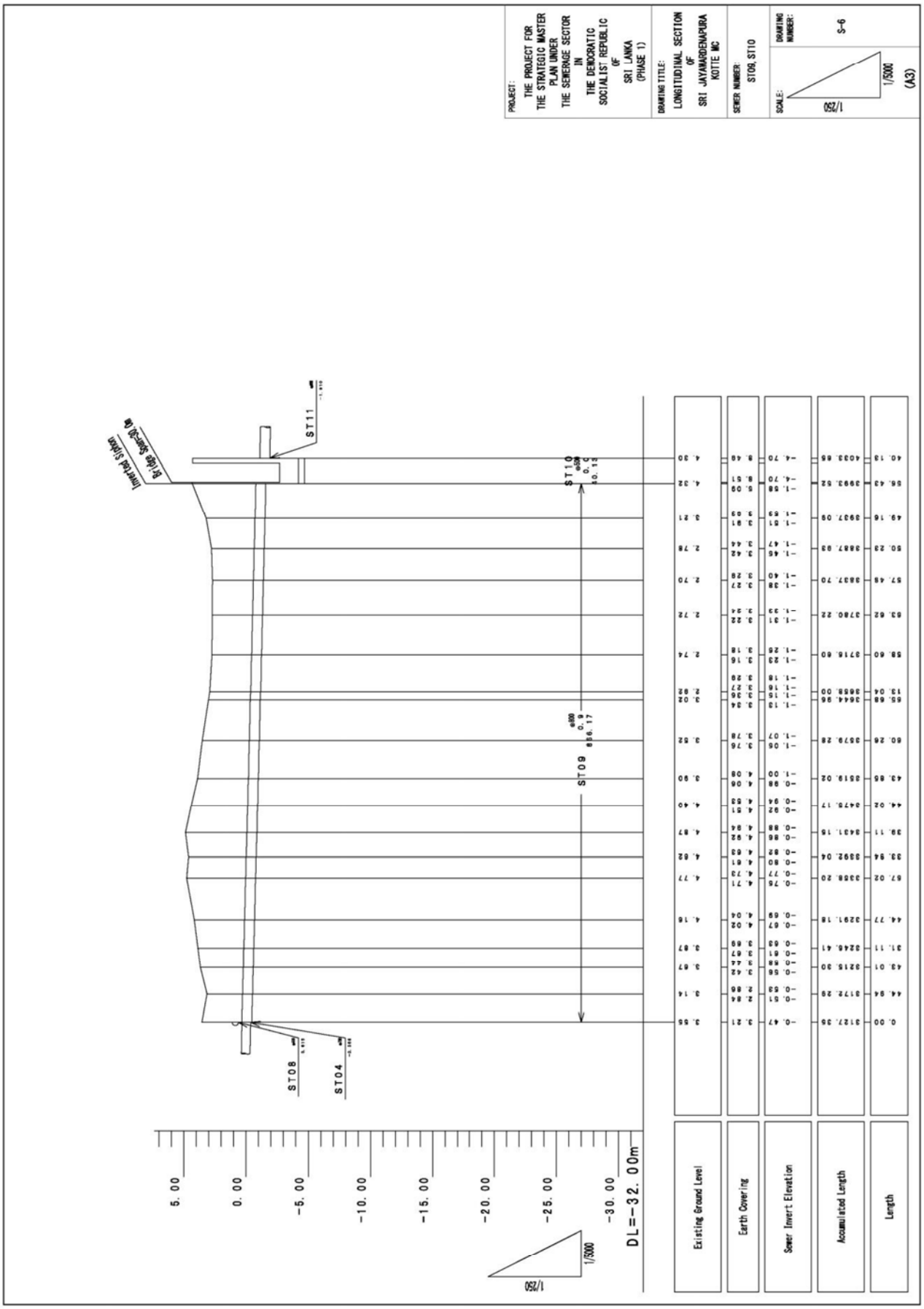

PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF SRI JAYAWARDENAPURA KOTTE MC
SEWER NUMBER:
ST01
DRAWING NUMBER:
S-1
SCALE:
1/250
1/5000
(A3)
ST02
ST01 -26.2~23.1 ø225 1092.03
MH-01
15.00
10.00
5.00
0.00
-5.00
-10.00
-15.00
-20.00
DL=-22.00m
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length
14.66 1.00 13.45 1092.03 147.48
10.50 1.00 9.28 944.55 113.58
9.21 1.01 7.98 830.97 234.27
14.61 1.00 13.40 696.70 302.44
10.60 1.01 9.38 294.26 294.26
3.34 1.01 2.12 0.00 0.00

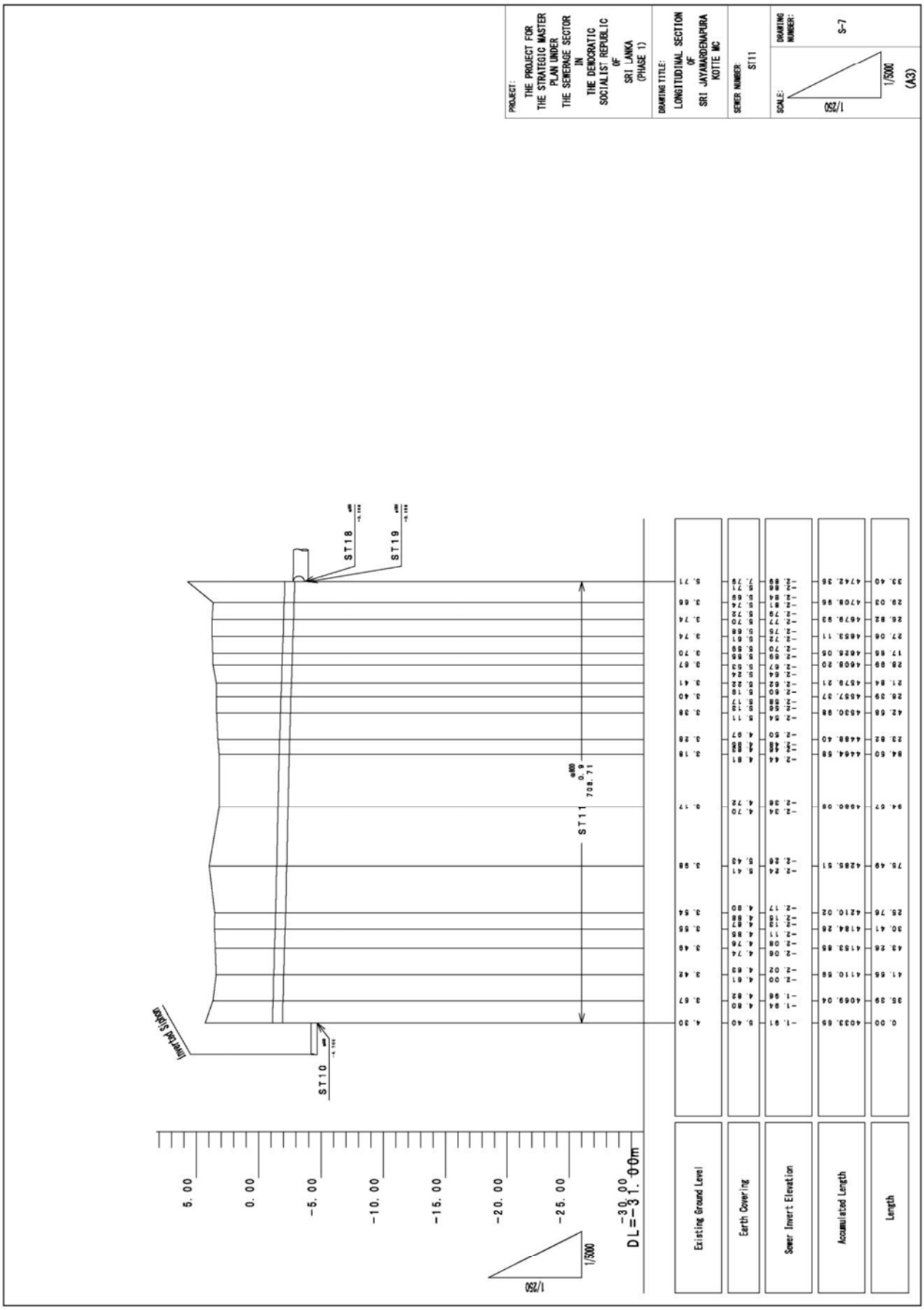

PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF SRI JAYAWARDENAPURA KOTTE MC
SEWER NUMBER:
ST02, ST03
DRAWING NUMBER:
S-2
SCALE:
1/5000
1/250
(A3)
ST01
ST02
ST03
ST04
DL=-19.00m
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

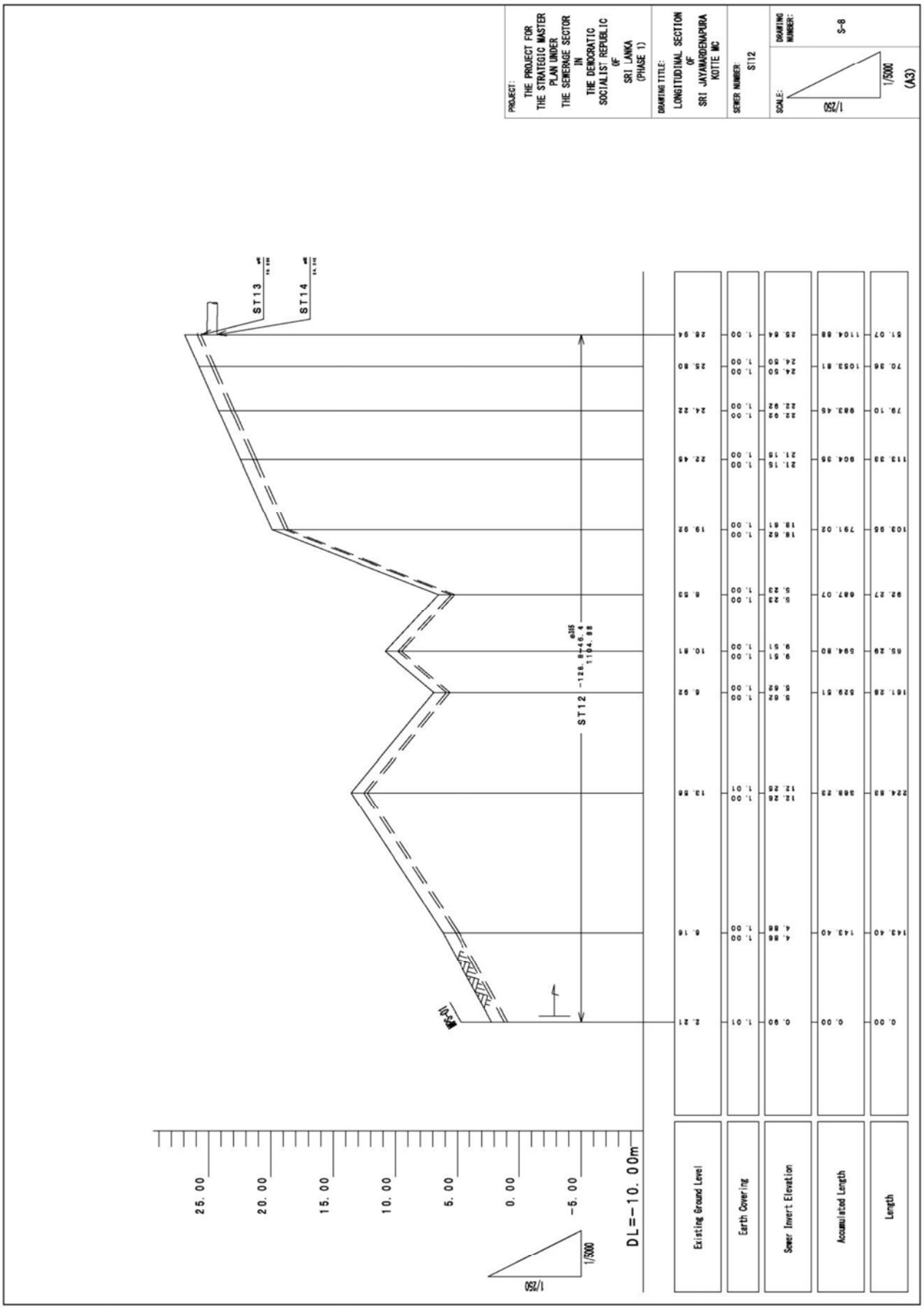

PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF SRI JAYAWARDENAPURA KOTTE MC
SEWER NUMBER:
ST04, ST05, ST06
DRAWING NUMBER:
S-3
SCALE:
1/250
1/5000
(A3)
Inverted Siphon
Box Culv. 1.2m
ST07
ST06
ST05
ST09
ST08
ST04
ST03
DL=-34.00m
DL=-33.00m
5.00
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
-30.00
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length

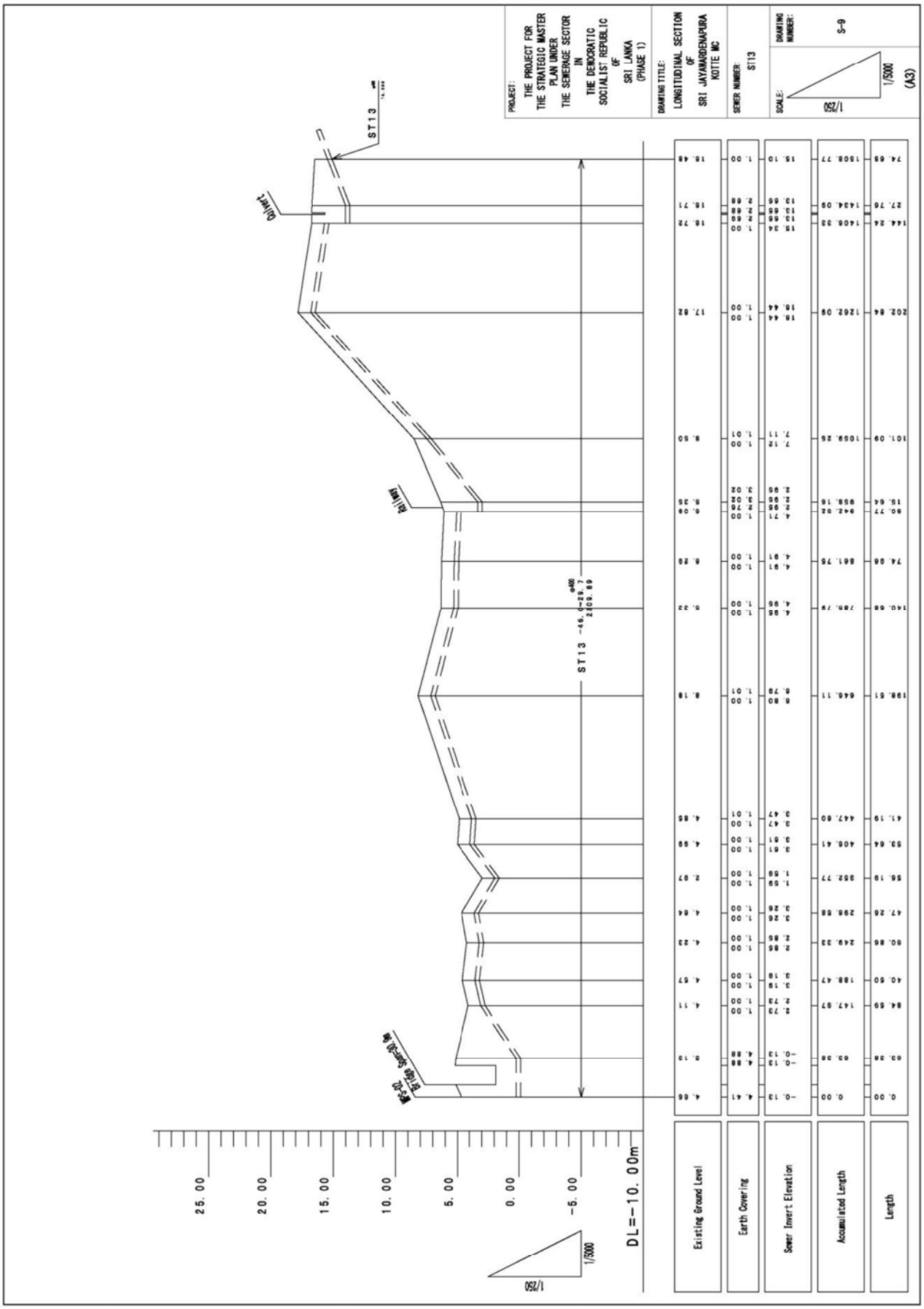

PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF SRI JAYAWARDENAPURA KOTTE MC
SEWER NUMBER:
ST07
DRAWING NUMBER:
S-4
SCALE:
1/250
1/5000
(A3)
MH-20
ST08
ST07
ST06
1053.78
DL=-33.00m
5.00
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
-30.00
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length

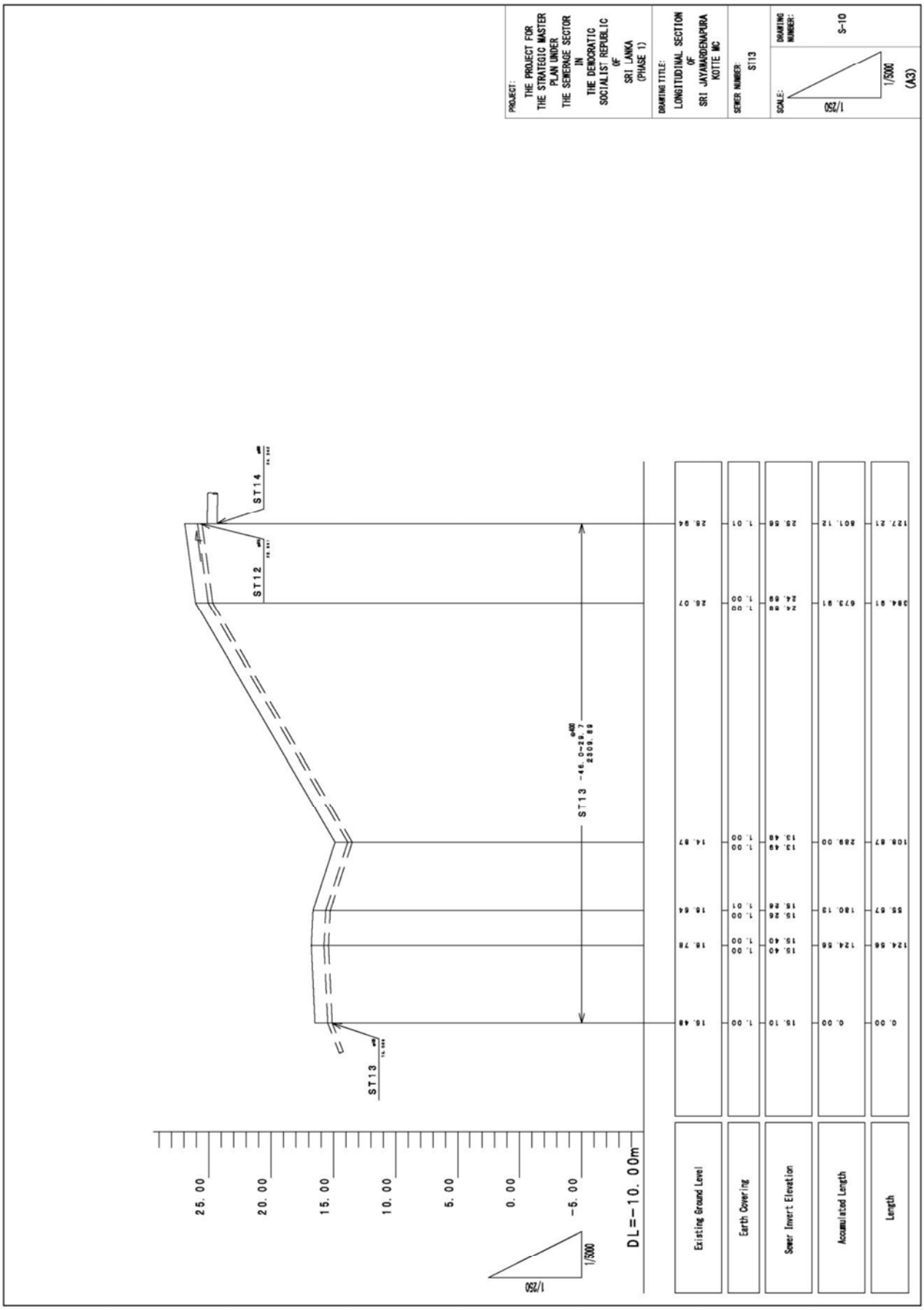

PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF SRI JAYAWARDENAPURA KOTTE MC
SEWER NUMBER:
ST08
DRAWING NUMBER:
S-5
SCALE:
1/250
1/5000
(A3)
ST04
ST09
ST08
ST07
MH-20
720.55
DL=-32.00m
5.00
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
-30.00
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length

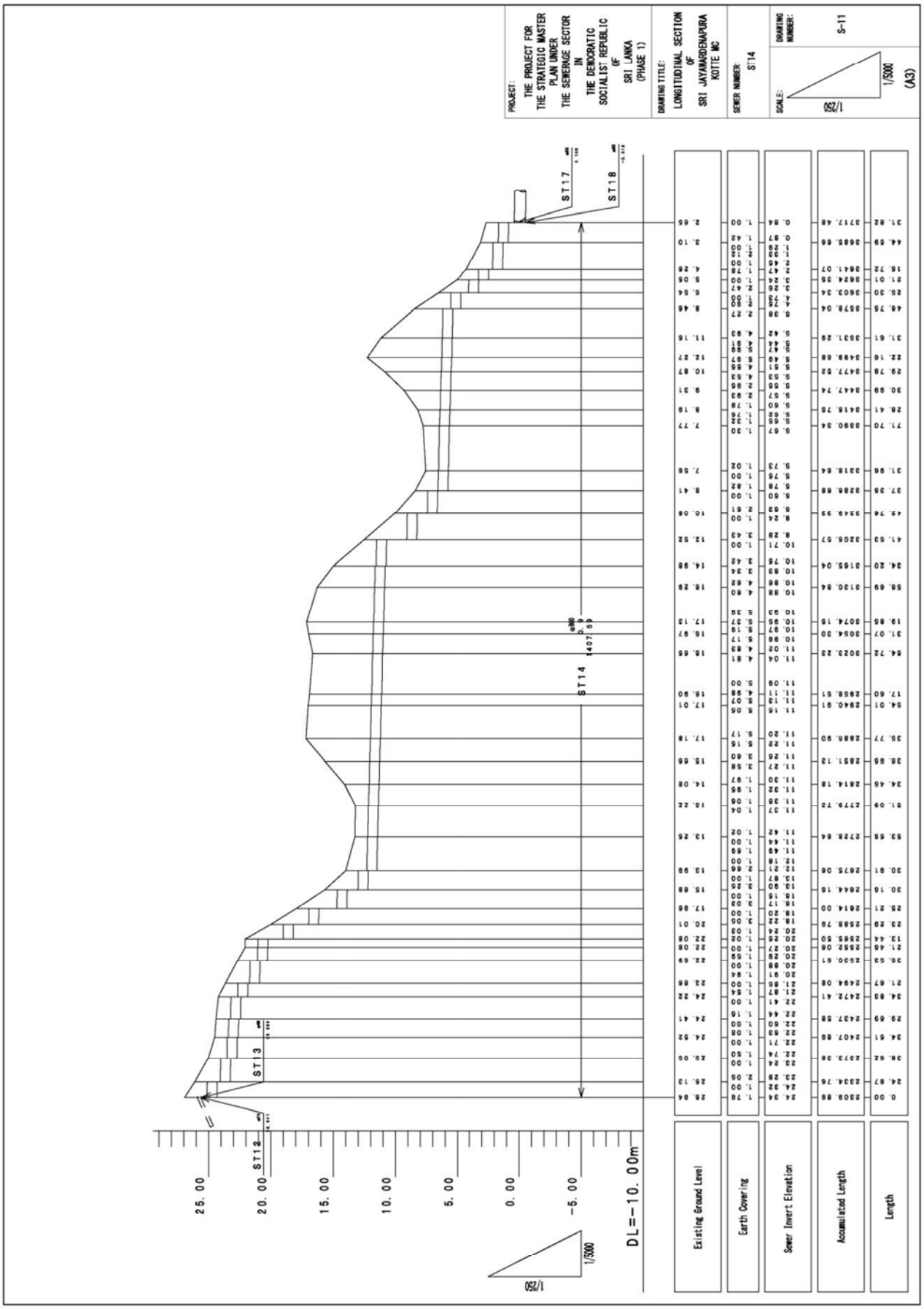

PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF SRI JAYAWARDENAPURA KOTTE MC
SEWER NUMBER:
ST09, ST10
DRAWING NUMBER:
S-6
SCALE:
1/250
1/5000
(A3)
Lower Kaduwela Pumping Station
ST11
ST10
ST09
ST08
ST04
DL=-32.00m
5.00
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
-30.00
1/250
1/5000
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length

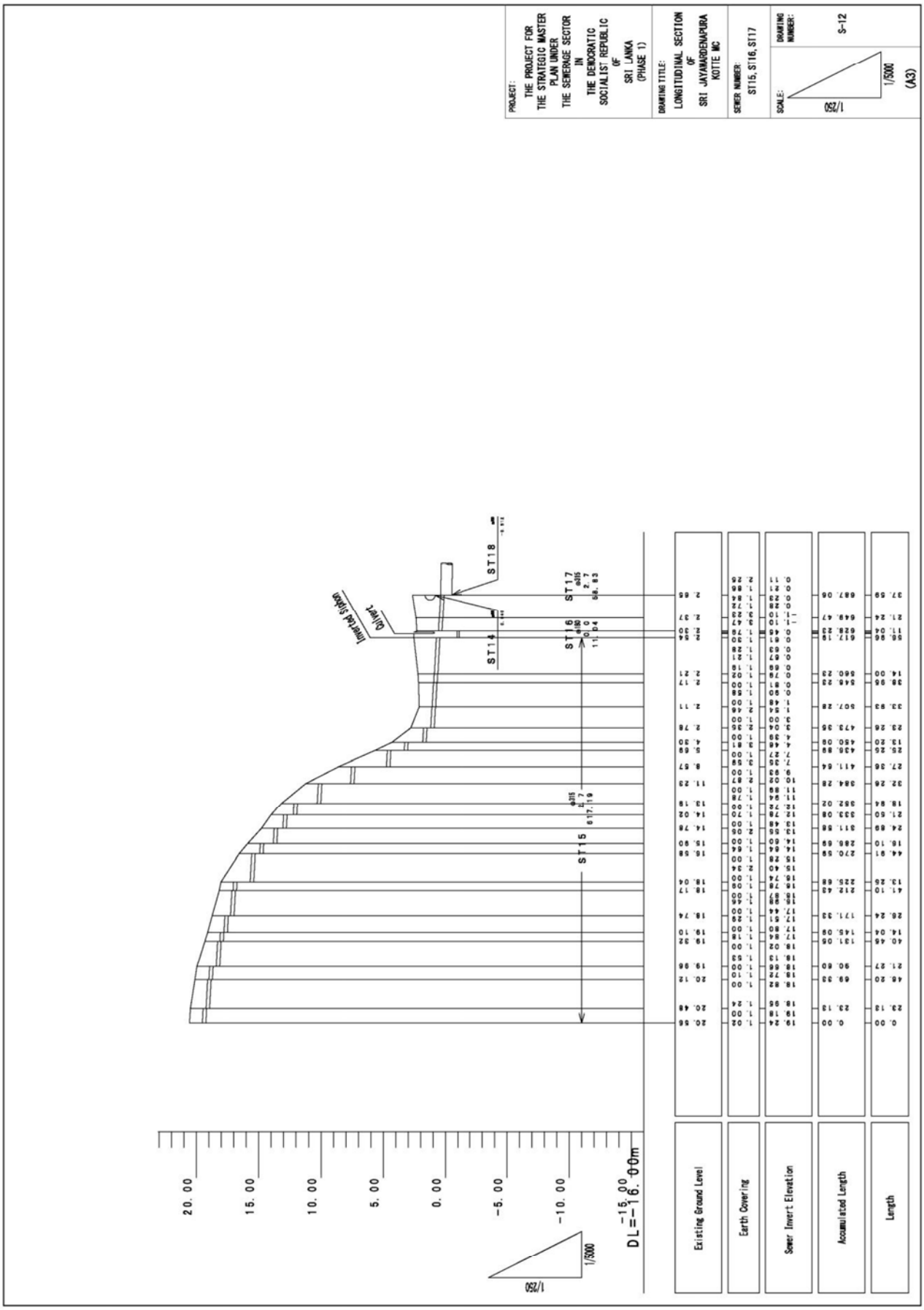

PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF SRI JAYAWARDENAPURA KOTTE MC
SEWER NUMBER:
ST11
DRAWING NUMBER:
S-7
SCALE:
1/250
1/5000
(A3)
ST18
ST19
ST11
ST10
Inverted Siphon
5.00
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
-30.00
DL=-31.00m
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length

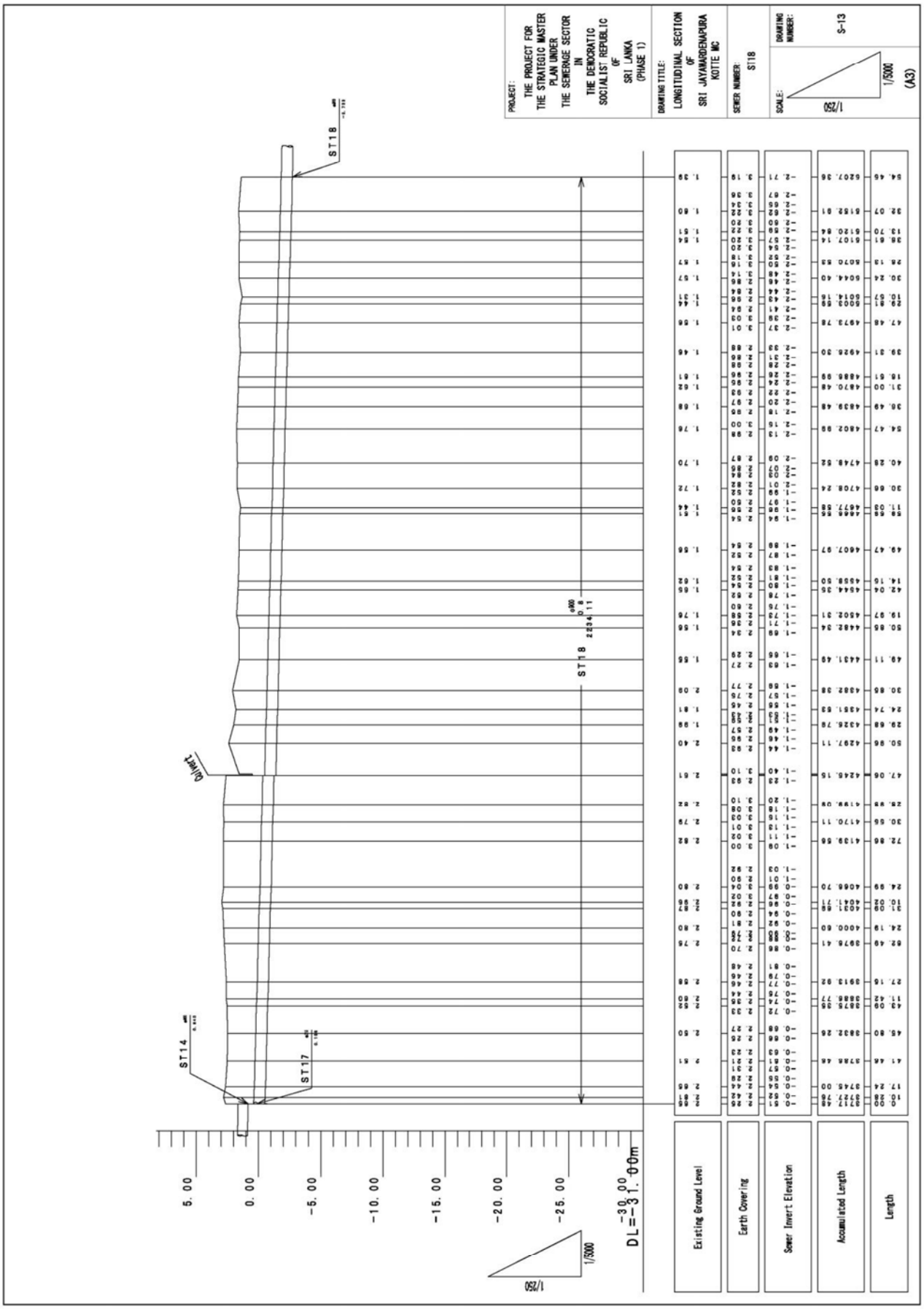

PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF SRI JAYAWARDENAPURA KOTTE MC
SEWER NUMBER:
ST12
DRAWING NUMBER:
S-8
SCALE:
1/5000
1/250
(A3)
ST13
ST14
ST12
DL=-10.00m
25.00
20.00
15.00
10.00
5.00
0.00
-5.00
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length

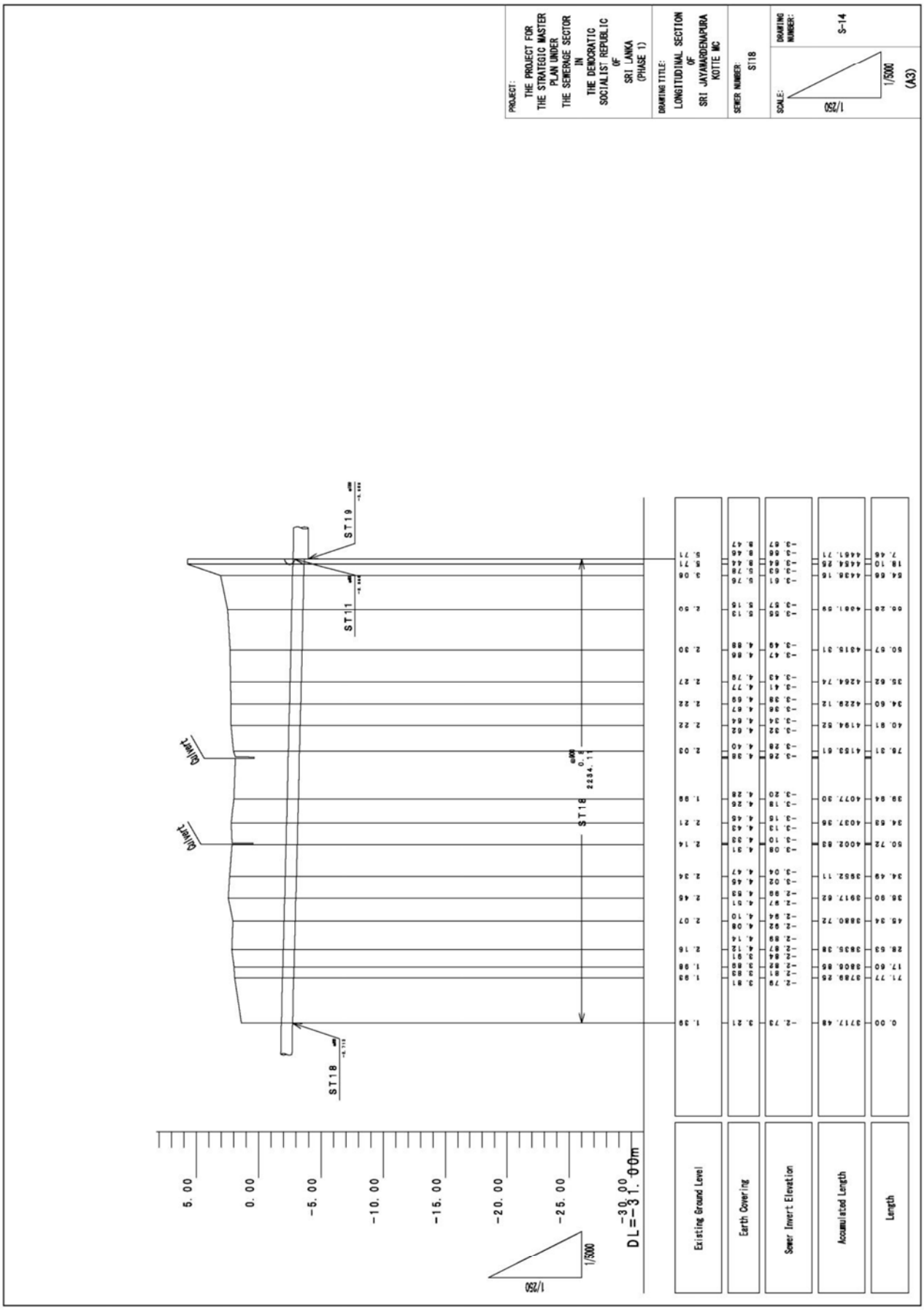

PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF SRI JAYAWARDENAPURA KOTTE MC
SEWER NUMBER:
ST13
DRAWING NUMBER:
S-9
SCALE:
1/250
1/5000
(A3)
ST13
Culvert
Rail Way
ST13 -46.0~-28.7 φ400 2109.89
BC-01 Conc=20.0m
DL=-10.00m
25.00
20.00
15.00
10.00
5.00
0.00
-5.00
1/5000
1/250
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length

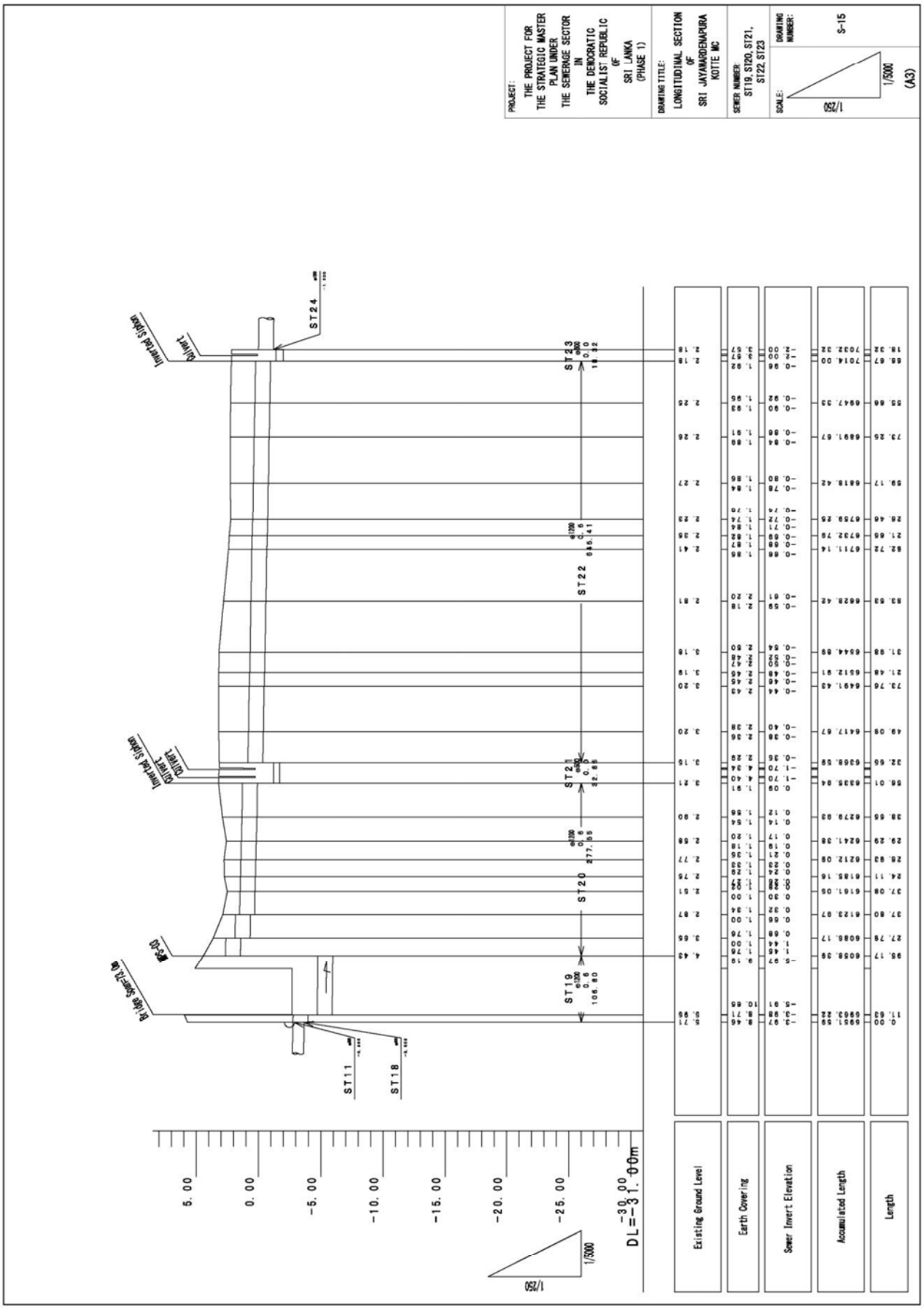

PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF SRI JAYAWARDENAPURA KOTTE MC
SEWER NUMBER:
ST13
DRAWING NUMBER:
S-10
SCALE:
1/250
1/5000
(A3)
ST14
ST12
ST13
ST13 -46.0~29.7 ø400 2909.88
DL=-10.00m
25.00
20.00
15.00
10.00
5.00
0.00
-5.00
1/250
1/5000
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length
28.94 1.01 25.56 801.12 127.21
28.07 1.00 24.68 673.91 384.91
14.87 1.00 13.48 289.00 108.87
18.64 1.00 15.28 180.13 55.87
18.78 1.00 15.40 124.56 124.56
15.48 1.00 15.10 0.00 0.00

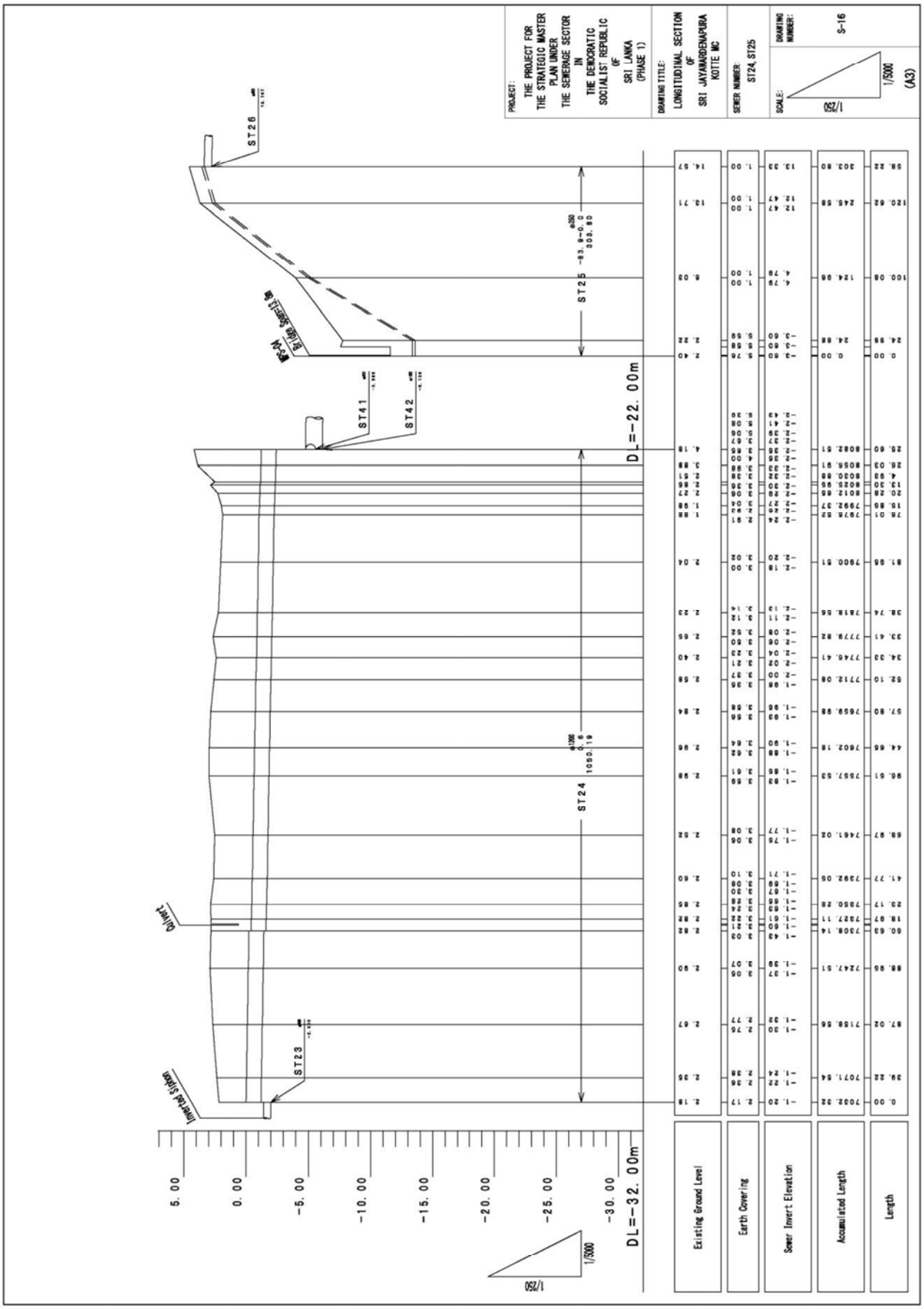

PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF SRI JAYAWARDENAPURA KOTTE MC
SEWER NUMBER:
ST14
DRAWING NUMBER:
S-11
SCALE:
1/250
1/5000
(A3)
ST17
ST18
ST13
ST12
ST14
DL=-10.00m
25.00
20.00
15.00
10.00
5.00
0.00
-5.00
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length

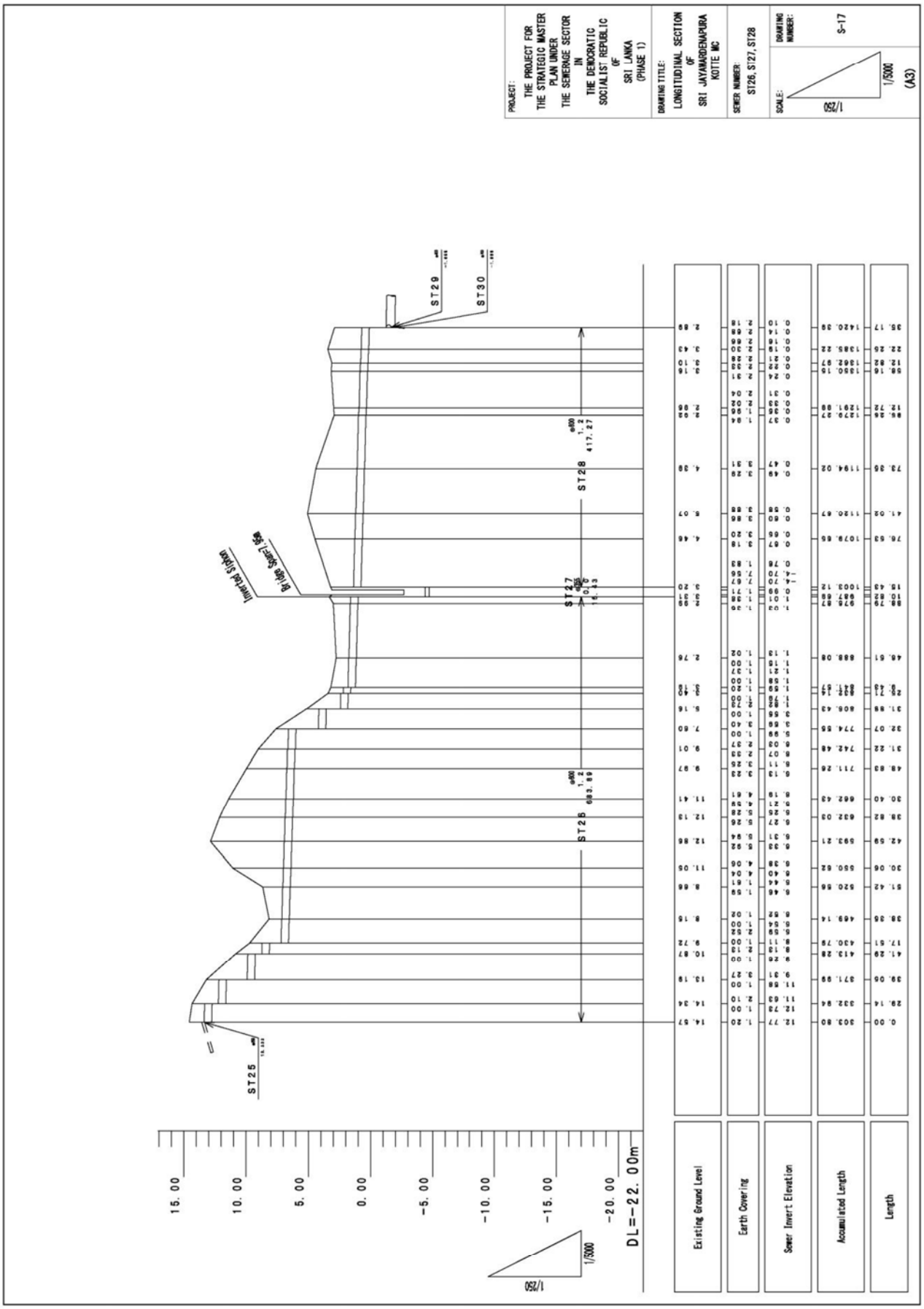

PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF SRI JAYAWARDENAPURA KOTTE MC
SEWER NUMBER:
ST15, ST16, ST17
DRAWING NUMBER:
S-12
SCALE:
1/250
1/5000
(A3)
ST18
ST17
ST16
ST15
ST14
Outlet
Inlet to Siphon
20.00
15.00
10.00
5.00
0.00
-5.00
-10.00
-15.00
DL=-16.00m
1/5000
1/250
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length

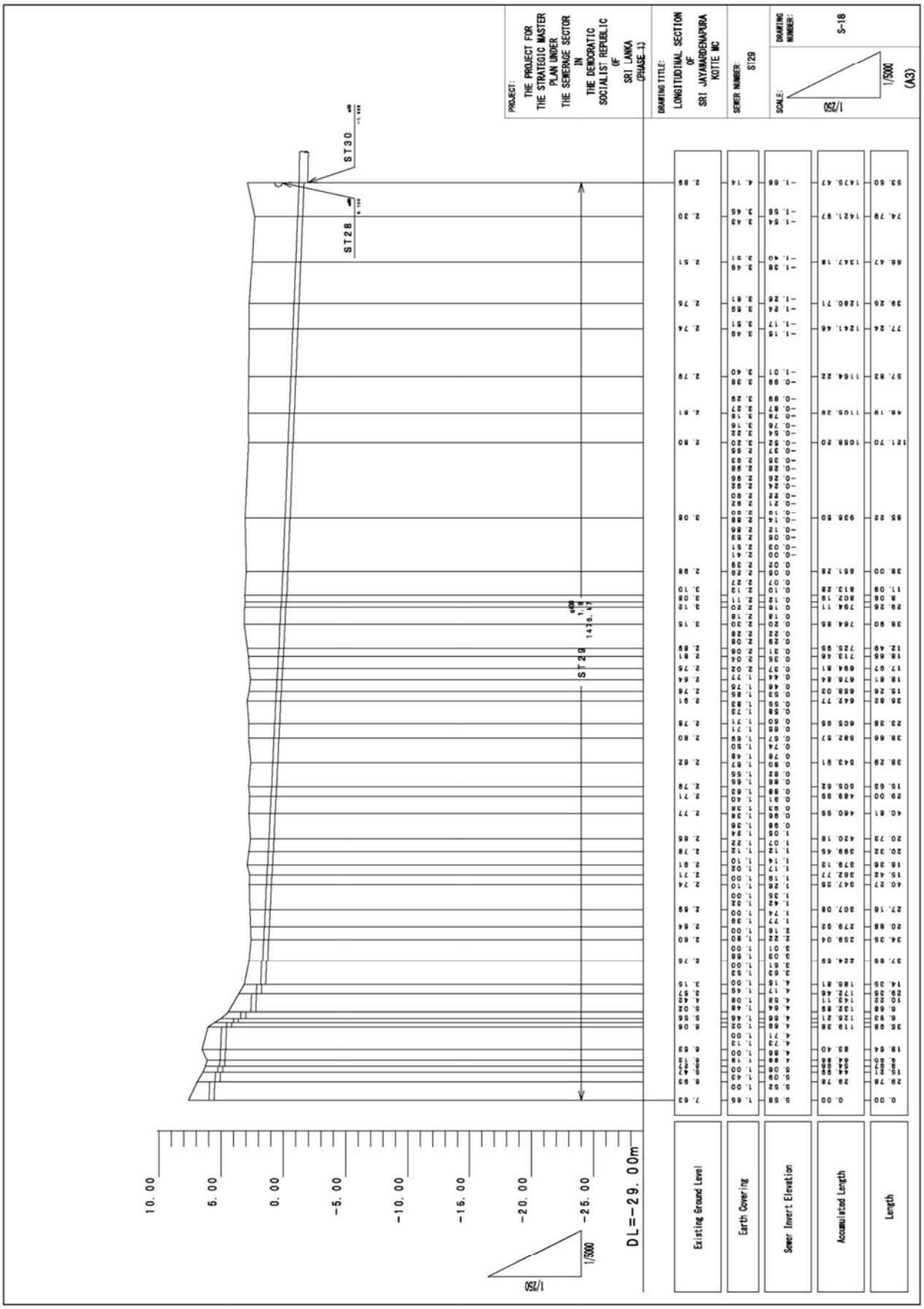

PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF SRI JAYAWARDENAPURA KOTTE MC
SEWER NUMBER:
ST18
DRAWING NUMBER:
S-13
SCALE:
1/5000
1/250
(A3)
ST18
ST14
ST17
Outlet
ST18
Φ900
D.B
2294.11
5.00
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
-30.00
DL=-31.00m
1/5000
1/250
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length

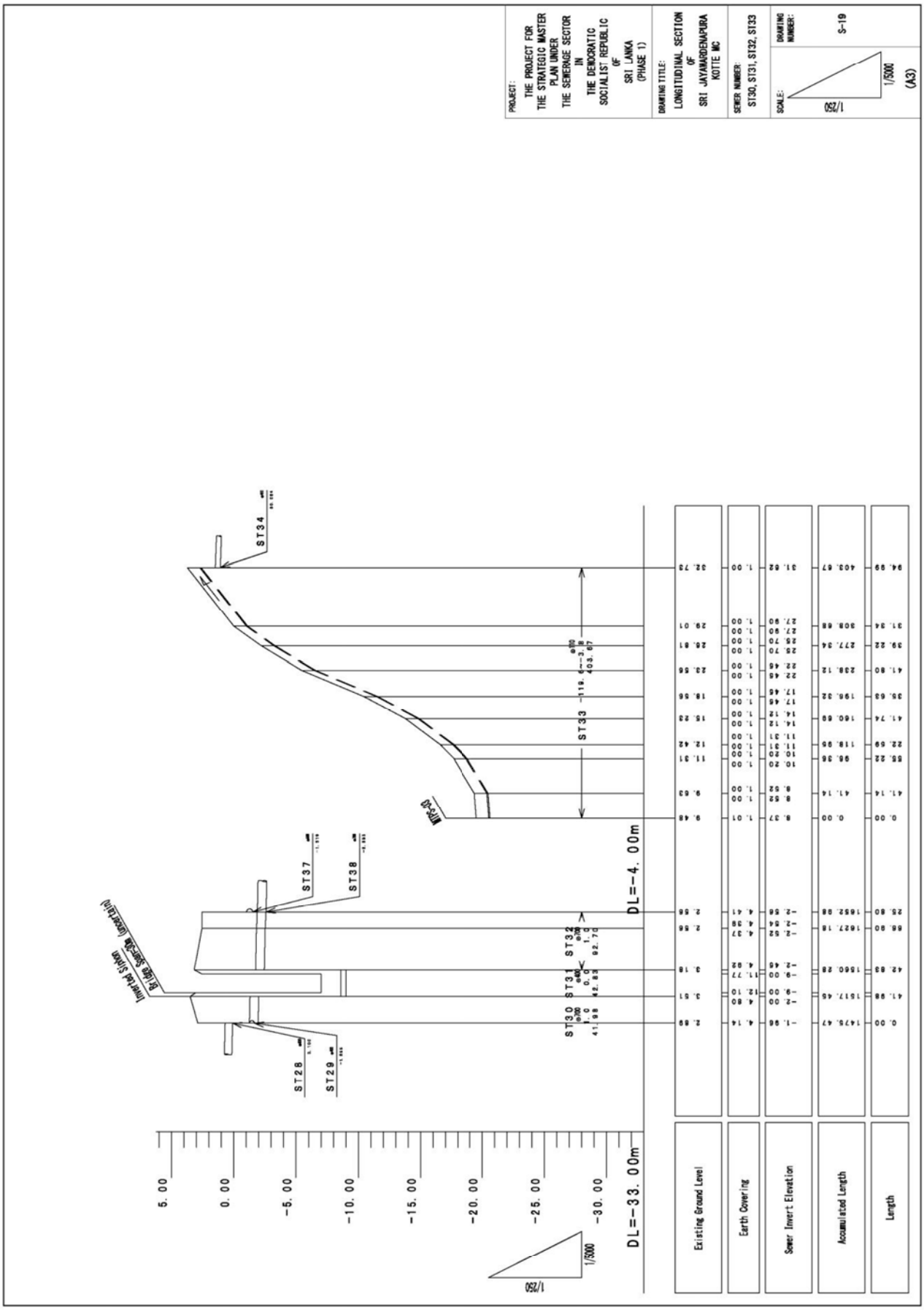

PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF SRI JAYAWARDENAPURA KOTTE MC
SEWER NUMBER:
ST18
DRAWING NUMBER:
S-14
SCALE:
1/250
1/5000
(A3)
ST19
ST11
ST18
Dd1/Pert
Dd1/Pert
5.00
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
-30.00
DL=-31.00m
1/250
1/5000
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length

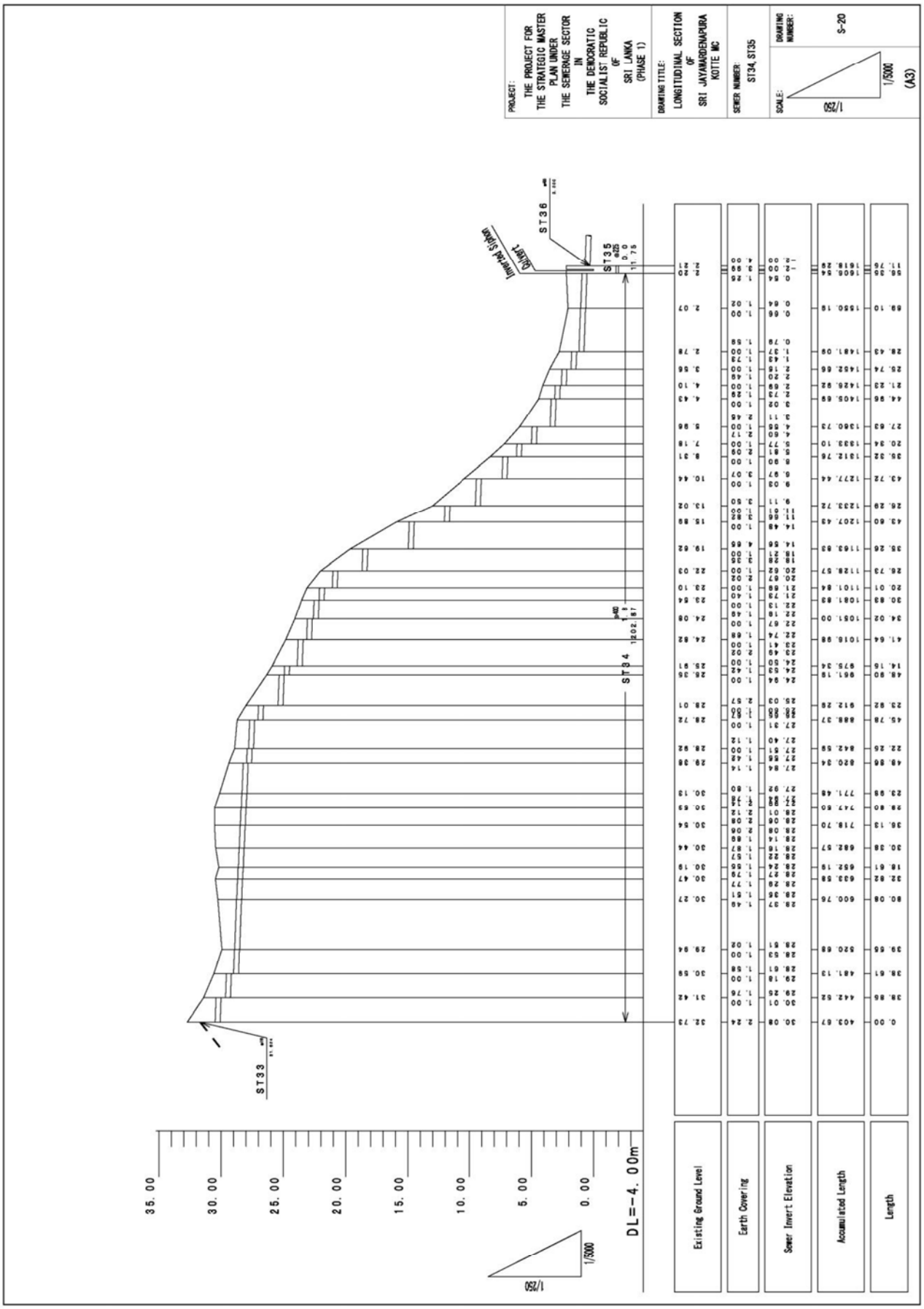

PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF SRI JAYAWARDENAPURA KOTTE MC
SEWER NUMBER:
ST19, ST20, ST21, ST22, ST23
DRAWING NUMBER:
S-15
SCALE:
1/250
1/5000
(A3)
ST24
ST23
ST22
ST21
ST20
ST19
ST11
ST18
Inverted Siphon
Bridge Span=21.0m
DL=-31.00m
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length

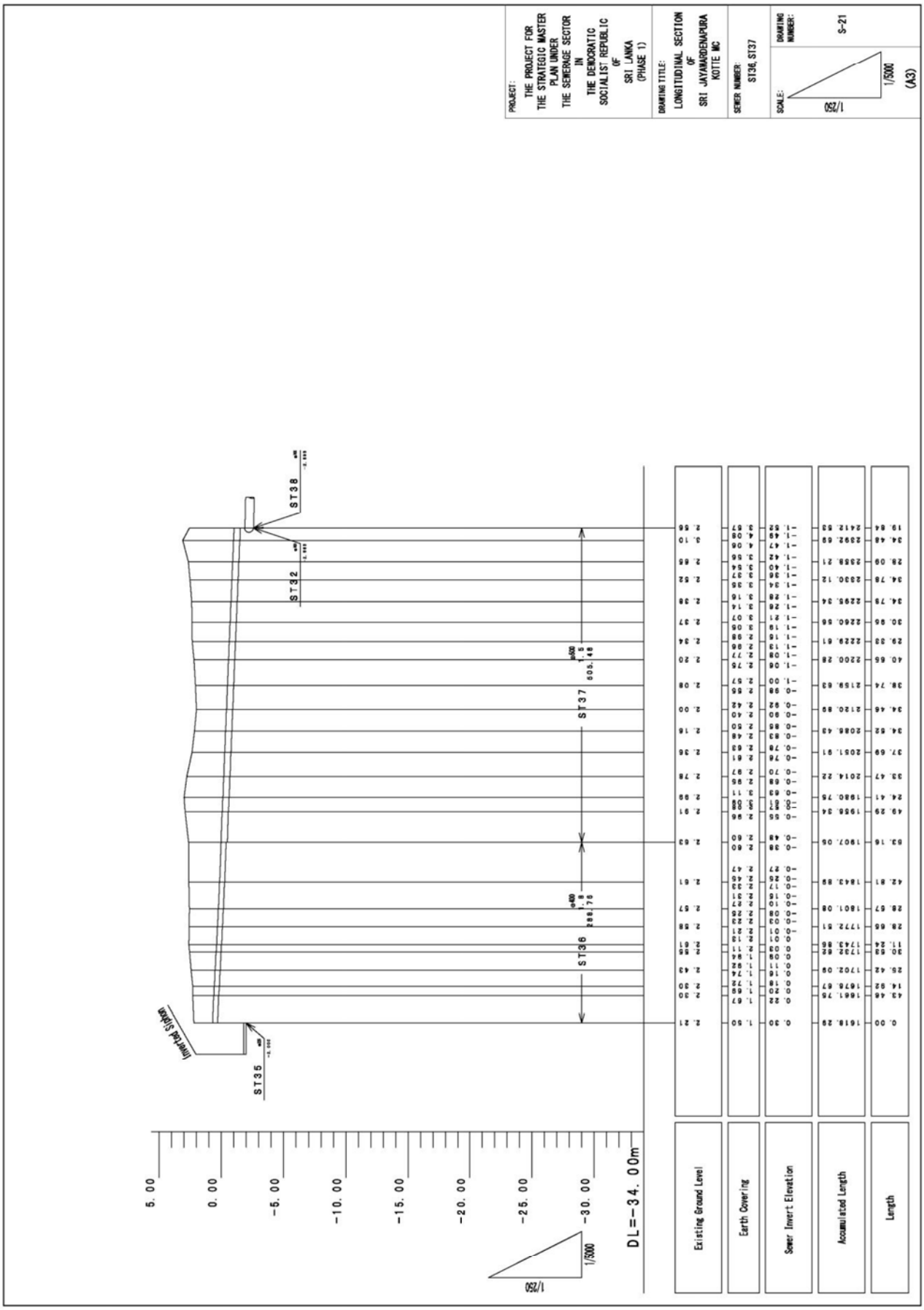

PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF SRI JAYAWARDENAPURA KOTTE MC
SEWER NUMBER:
ST24, ST25
DRAWING NUMBER:
S-16
SCALE:
1/250
1/5000
(A3)
ST26
ST25
ST24
ST23
ST41
ST42
DL=-22.00m
DL=-32.00m
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length

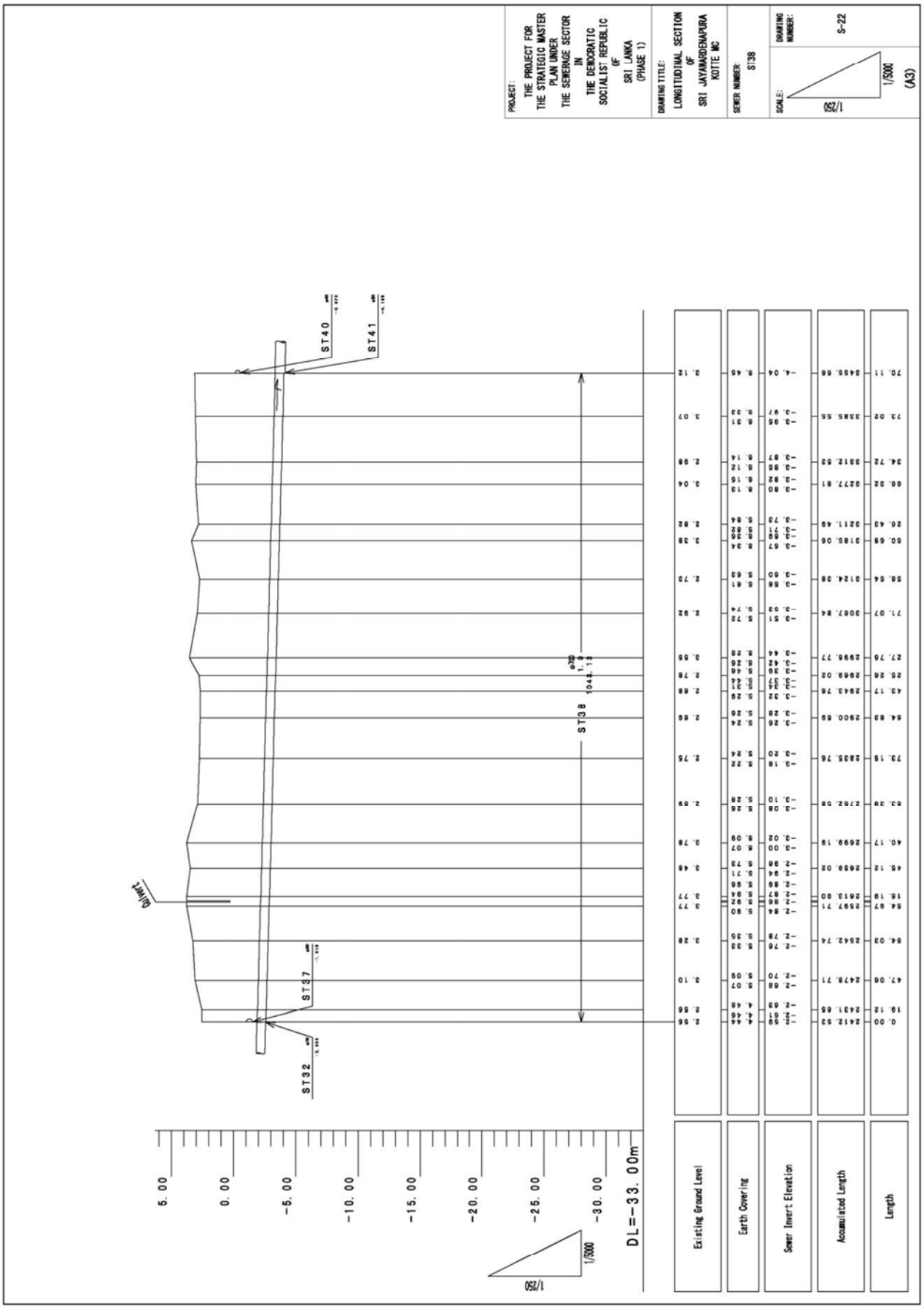

PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF SRI JAYAWARDENAPURA KOTTE MC
SEWER NUMBER:
ST26, ST27, ST28
DRAWING NUMBER:
S-17
SCALE:
1/250
1/5000
(A3)
ST29
ST30
ST28
ST27
ST26
ST25
Lower-tail Siphon
By-Pass Sewer(-)Pipe
15.00
10.00
5.00
0.00
-5.00
-10.00
-15.00
-20.00
DL=-22.00m
1/250
1/5000
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length

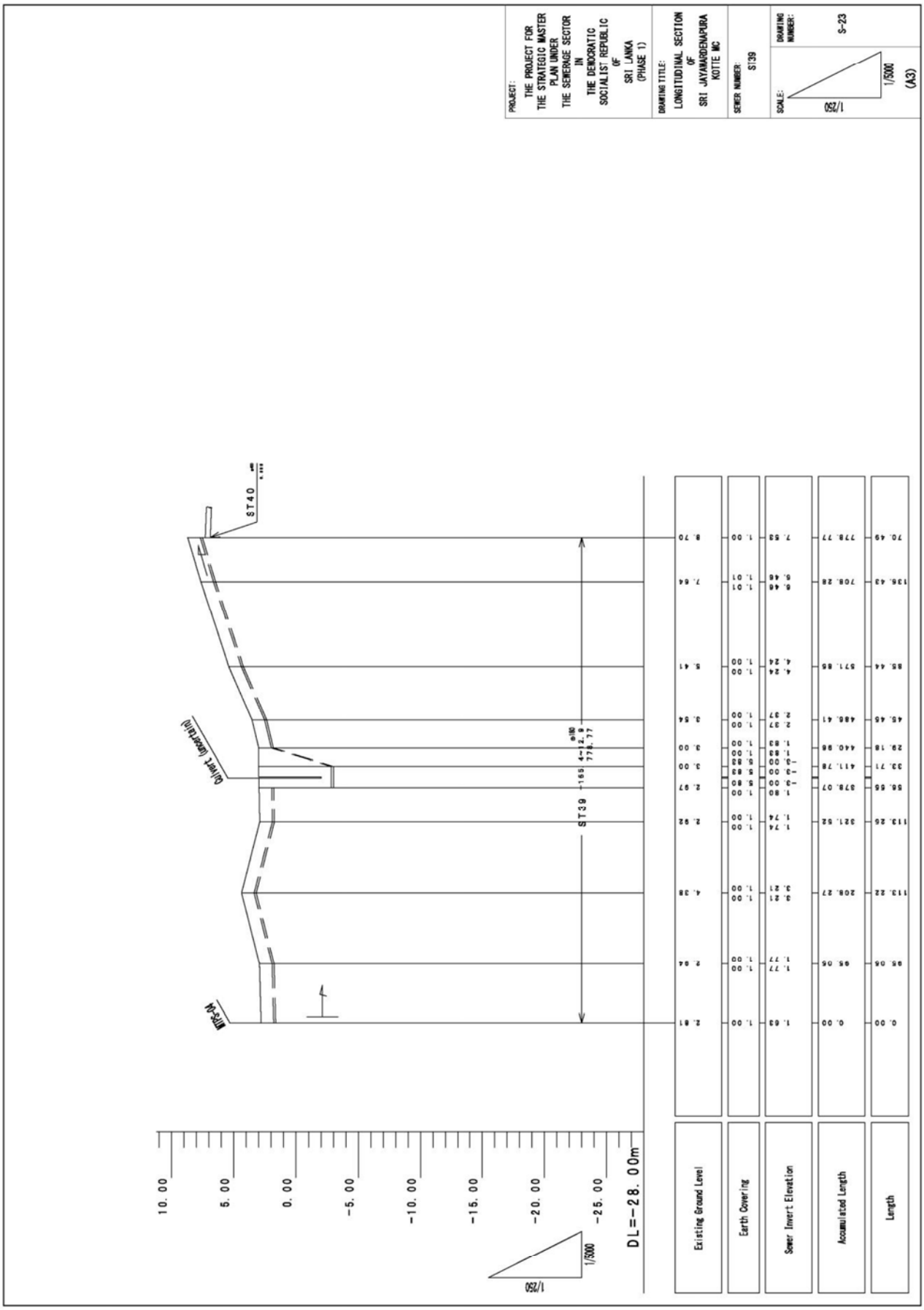

PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF SRI JAYAWARDENAPURA KOTTE MC
SEWER NUMBER:
ST29
DRAWING NUMBER:
S-18
SCALE:
1/250
1/5000
(A3)
ST30
ST28
ST29
1416.47
DL=-29.00m
10.00
5.00
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length

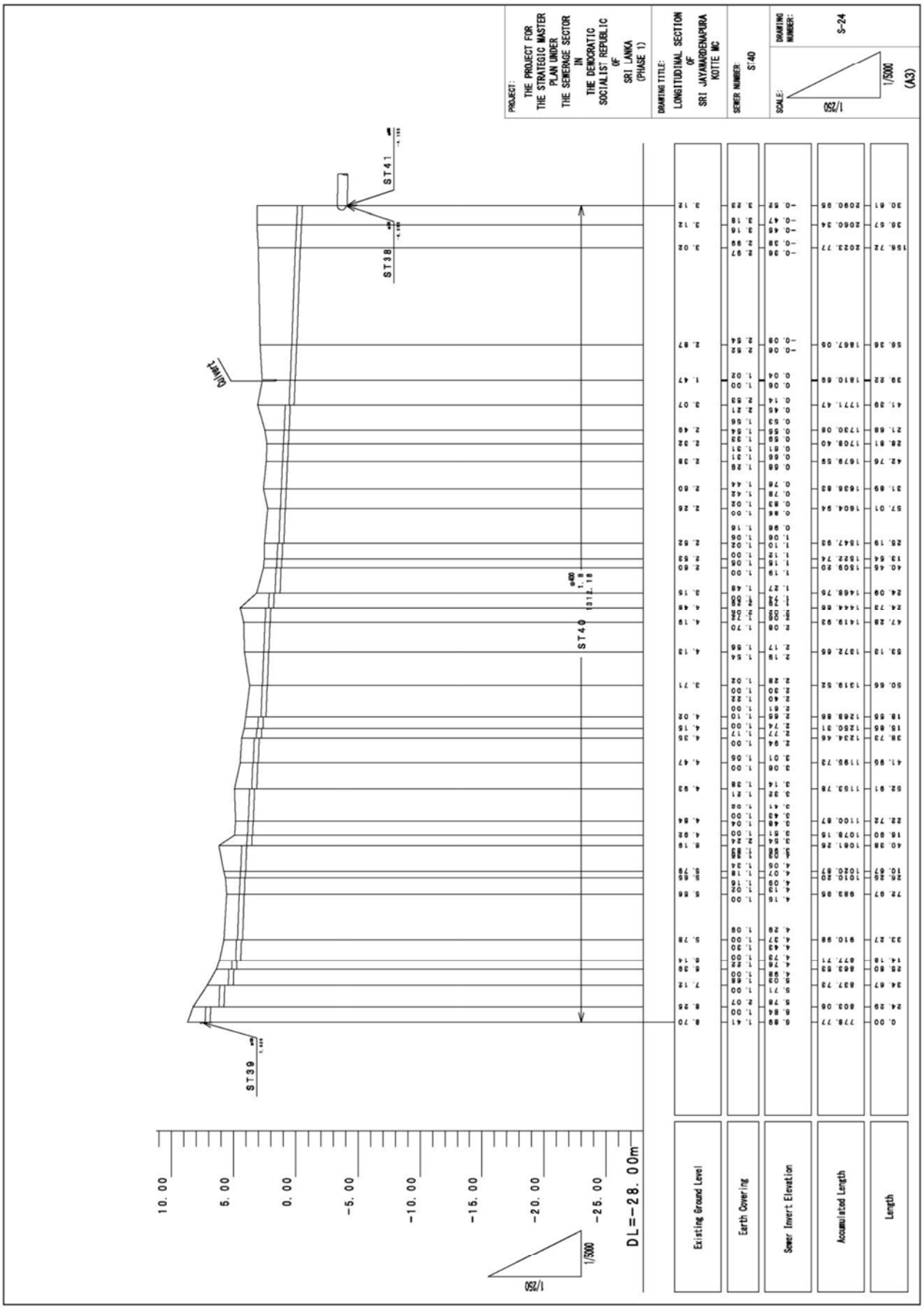

PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF SRI JAYAWARDENAPURA KOTTE MC
SEWER NUMBER:
ST30, ST31, ST32, ST33
DRAWING NUMBER:
S-19
SCALE:
1/250
1/5000
(A3)
ST34
ST33
ST32
ST31
ST30
ST37
ST38
ST28
ST29
MTP-43
Inner-Red Stream
Bellipe Supercha (Covered-In)
DL=-4.00m
DL=-33.00m
5.00
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
-30.00
1/5000
1/250
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length

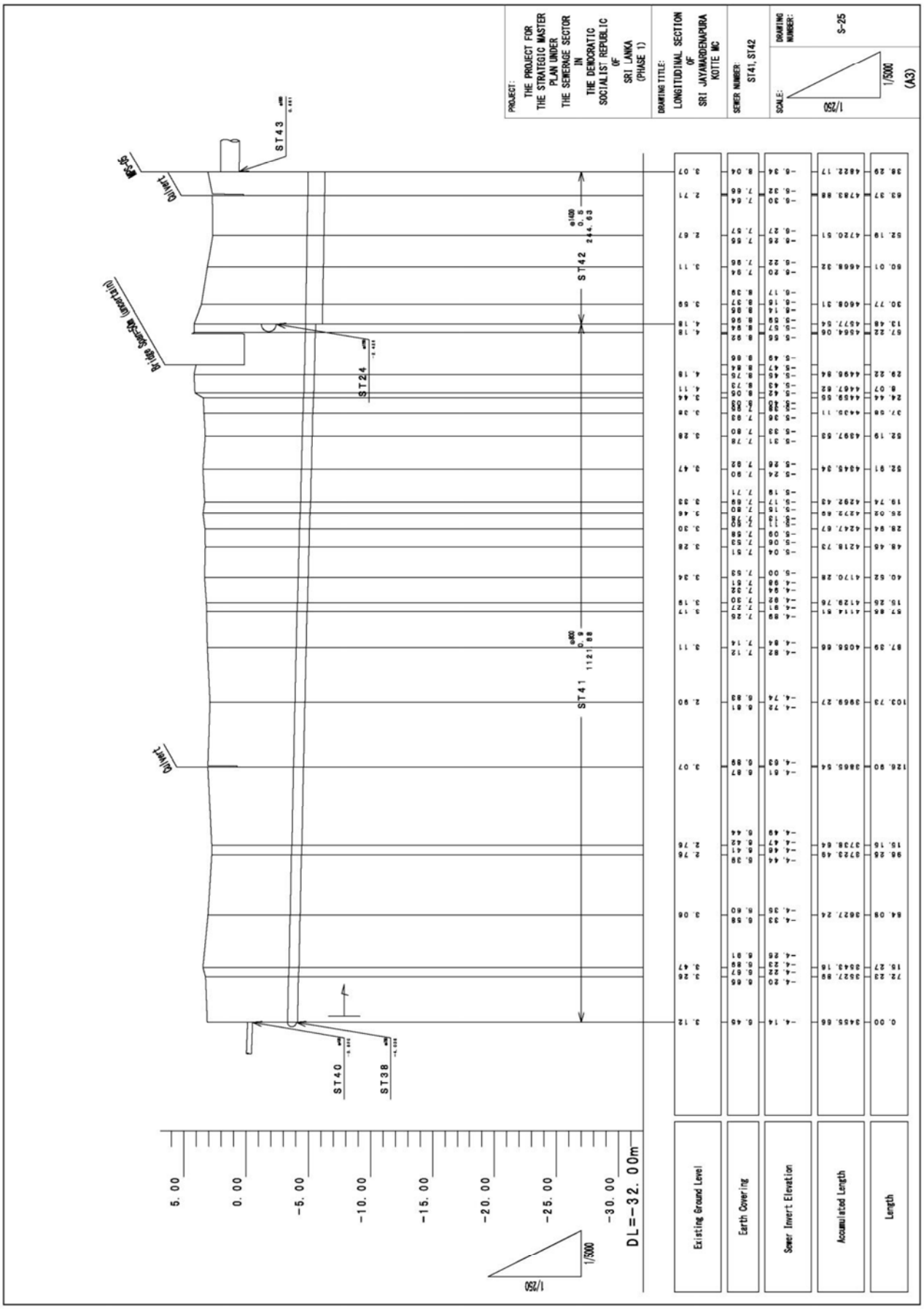

PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF SRI JAYAWARDENAPURA KOTTE MC
SEWER NUMBER:
ST34, ST35
DRAWING NUMBER:
S-20
SCALE:
1/5000
1/250
(A3)
ST36
ST35
ST34
ST33
Internal Climb Manhole
DL=-4.00m
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length

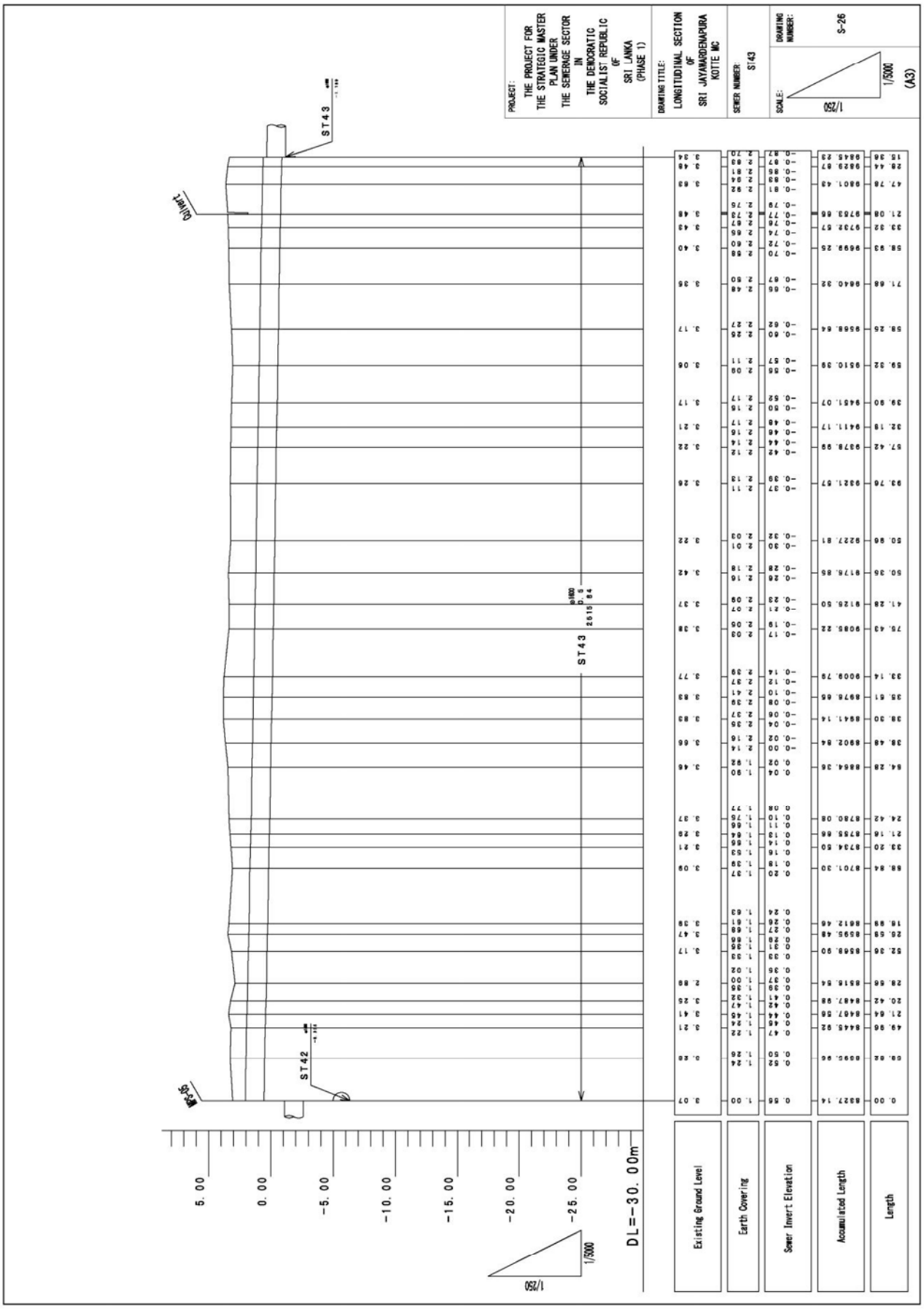

PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF SRI JAYAWARDENAPURA KOTTE MC
SEWER NUMBER:
ST36, ST37
DRAWING NUMBER:
S-21
SCALE:
1/250
1/5000
(A3)
ST38
ST32
ST37
ST36
ST35
INVERTED SIPHON
DL=-34.00m
5.00
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
-30.00
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length

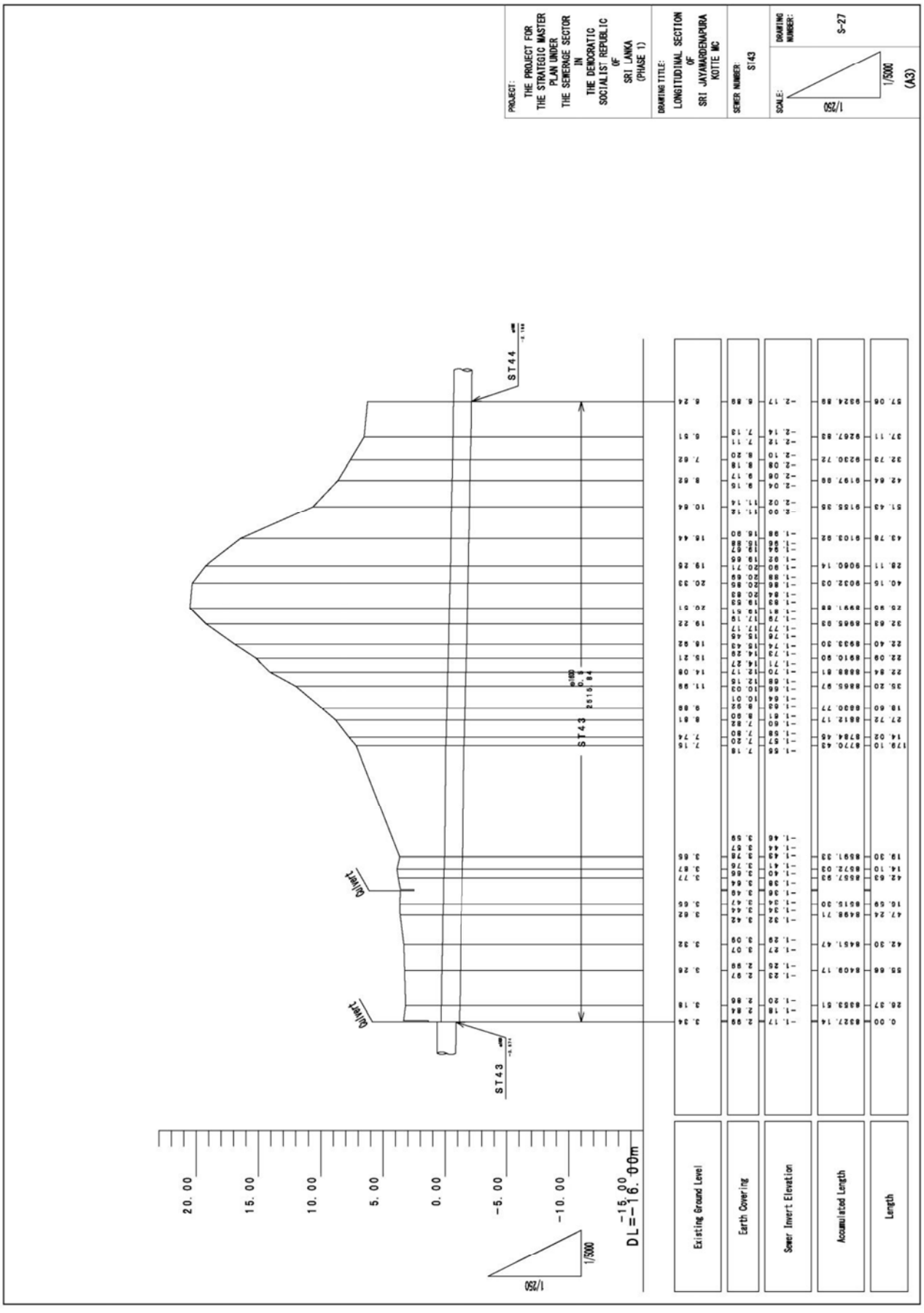

PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF SRI JAYAWARDENAPURA KOTTE MC
SEWER NUMBER:
ST38
DRAWING NUMBER:
S-22
SCALE:
1/250
1/5000
(A3)
ST40
ST41
ST38
ST37
ST32
CULVERT
DL=-33.00m
5.00
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
-30.00
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length

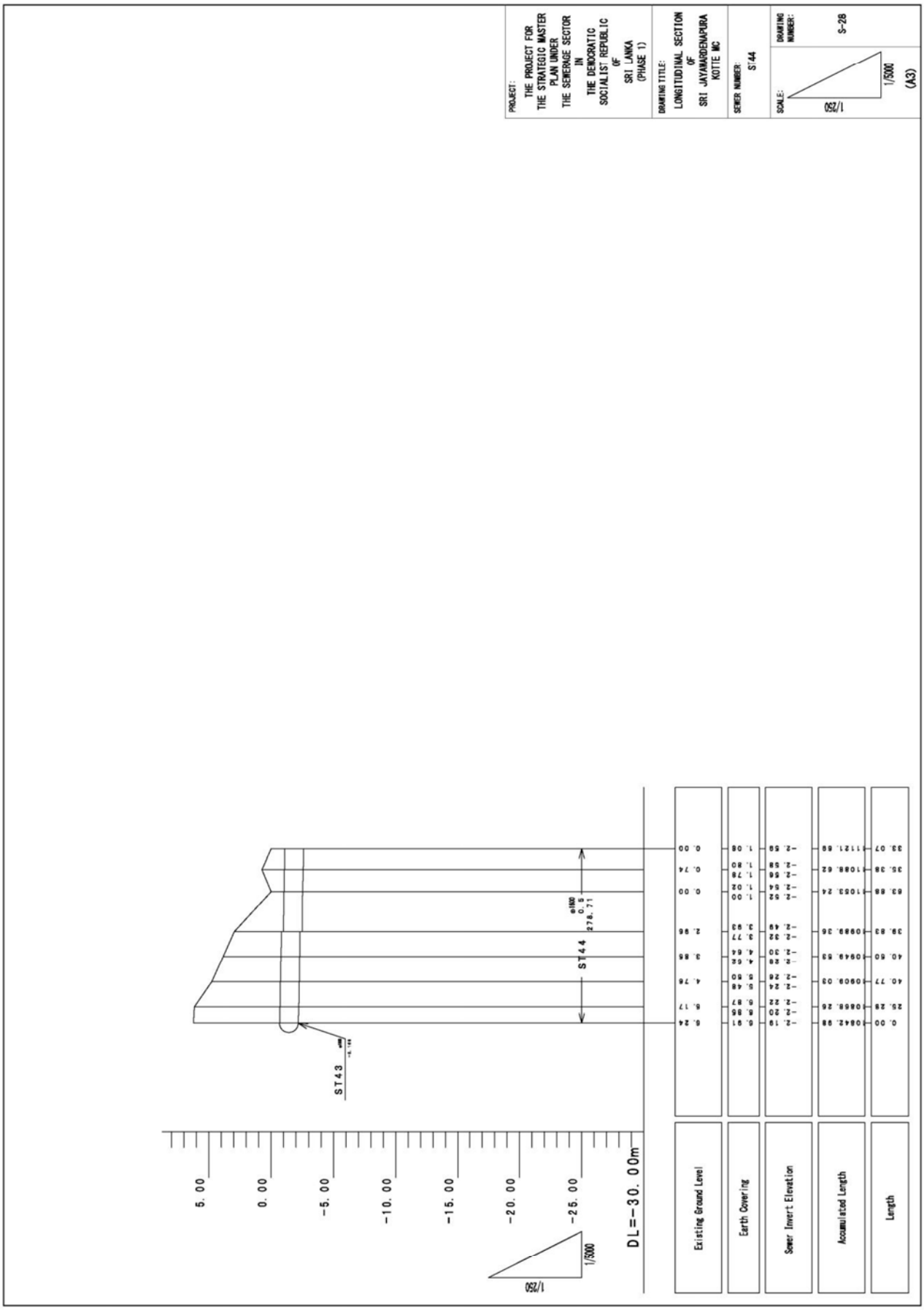

PROJECT:
THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF SRI JAYAWARDENAPURA KOTTE MC
SEWER NUMBER:
S139
DRAWING NUMBER:
S-23
SCALE:
1/5000
1/250
(A3)
ST40
ST39
MH'S-04
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length
10.00
5.00
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
DL=-28.00m
1/5000
1/250


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 SRI JAYAWARDENAPURA KOTTE MC
SEWER NUMBER:
ST40
DRAWING NUMBER:
S-24
SCALE:
1/5000
1/250
(A3)
ST41
ST38
ST40
ST39
DL=-28.00m
10.00
5.00
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
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 SRI JAYAWARDENAPURA KOTTE MC
SEWER NUMBER:
ST41, ST42
DRAWING NUMBER:
S-25
SCALE:
1/5000
1/250
(A3)
ST43
ST42
ST24
ST41
ST40
ST38
MH
Box type Spillway (Under Study)
Outlet
DL=-32.00m
5.00
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
-30.00
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 SRI JAYAWARDENAPURA KOTTE MC
SEWER NUMBER:
ST43
DRAWING NUMBER:
S-26
SCALE:
1/5000
1/250
(A3)
ST43
ST42
DL=-30.00m
5.00
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
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 SRI JAYAWARDENAPURA KOTTE MC
SEWER NUMBER:
ST43
DRAWING NUMBER:
S-27
SCALE:
1/250
1/5000
(A3)
ST44
ST43
DLINE
DLINE
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 SRI JAYAWARDENAPURA KOTTE MC
SEWER NUMBER:
ST44
DRAWING NUMBER:
S-28
SCALE:
1/250
1/5000
(A3)
ST43
ST44
DL=-30.00m
5.00
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
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

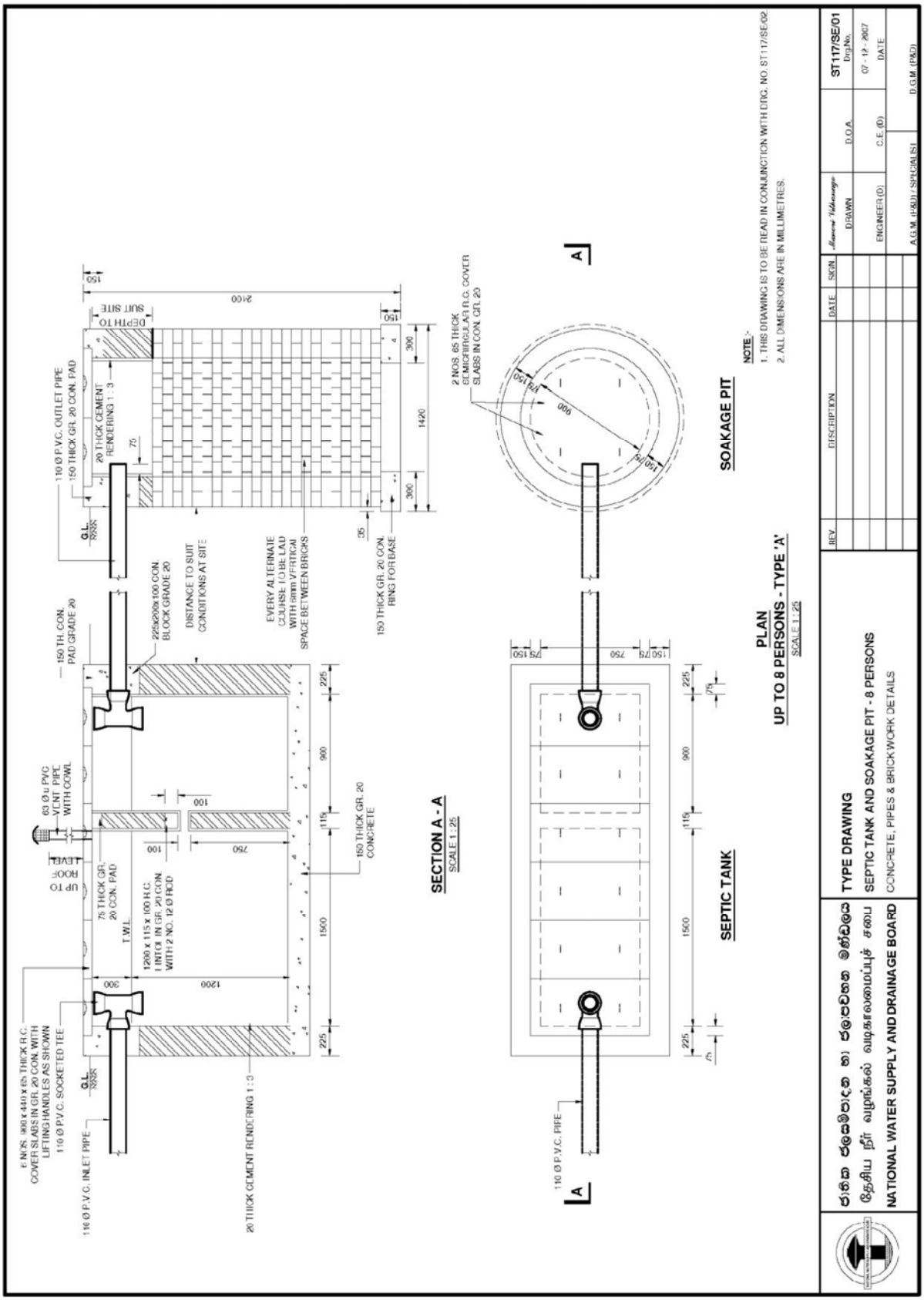
34.	Sulphates (as S)	mg/l, max.	250
35.	Radio Active Material: (a) Alpha emitters (b) Beta emitters	 micro curie/ml, max micro curie/ml, max	 10^{-8} 10^{-7}

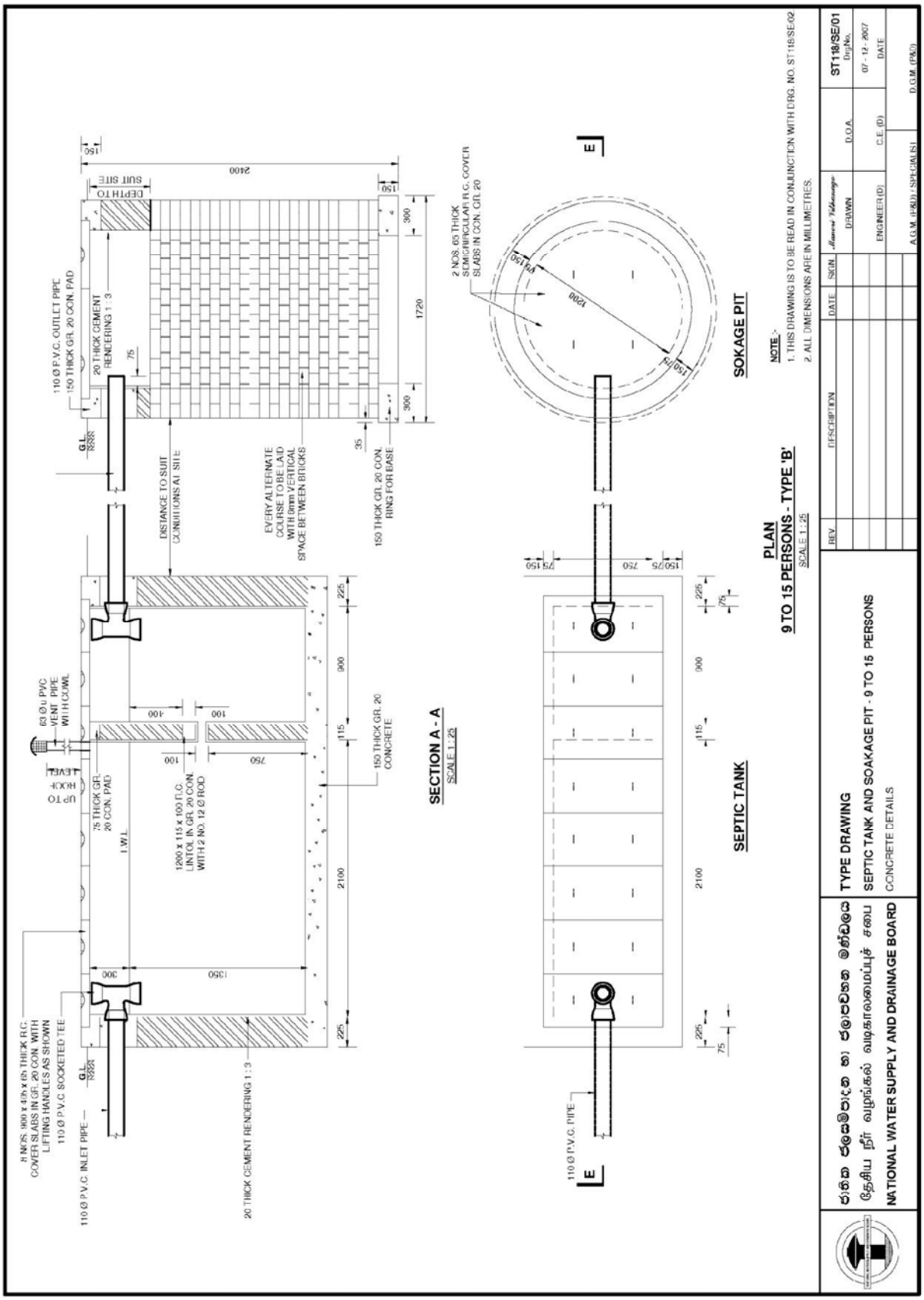
Note 1: All efforts should be made to remove unpleasant odour as practicable as possible.

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

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

APPENDIX 5: General Layout of Septic Tank




SECTION A - A
SCALE 1:25
PLAN
9 TO 15 PERSONS - TYPE 'B'
SCALE 1:25
SOKAGE PIT
SEPTIC TANK
NOTE :-
1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH DRG. NO. ST118/SE/02
2. ALL DIMENSIONS ARE IN MILLIMETRES.
110 Ø P.V.C. OUTLET PIPE
150 THICK GR. 20 CON. PAD
20 THICK CEMENT RENDERING 1 : 3
DISTANCE TO SUIT CONDITIONS AT SITE
EVERY ALTERNATE COURSE TO BE LAID WITH 6mm VERTICAL SPACE BETWEEN BRICKS
150 THICK GR. 20 CON. RING FOR BASE
63 Ø u PVC VENT PIPE WITH COWL
75 THICK GR. 20 CON. PAD
1200 x 115 x 100 T.O. LINTOL IN GR. 20 CON. WITH 2 NO. 12 Ø ROD
150 THICK GR. 20 CONCRETE
110 Ø P.V.C. INLET PIPE
8 NOS. 900 x 450 x 65 THICK R.C. COVER SLABS IN GR. 20 CON. WITH LIFTING HANDLES AS SHOWN
110 Ø P.V.C. SOCKETED TEE
20 THICK CEMENT RENDERING 1 : 3
2 NOS. 65 THICK SEMICIRCULAR R.C. COVER SLABS IN CON. GR. 20
110 Ø P.V.C. PIPE
REV
DESCRIPTION
DATE
SIGN
DRAWN
ENGINEER (D)
A.G.M. (P&D) / SPECIALIST
D.G.M. (P&D)
D.O.A.
C.E. (D)
ST118/SE/01
Drg No.
07 - 12 - 2007
DATE
TYPE DRAWING
SEPTIC TANK AND SOAKAGE PIT - 9 TO 15 PERSONS
CONCRETE DETAILS
NATIONAL WATER SUPPLY AND DRAINAGE BOARD

APPENDIX 6: Detail of Project Costs

Sri Jayawardenapura Kotte Master Plan Area = 3393 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**									
	Sri Jayawardenapura Kotte STP (Q=35,000m3/day)	About 2400 USD/m3	Ls	1			4,887,272,727	5,644,800,000	12,218,181,818	9,406,000,000
	Sub-total of A						**4,887,272,727**	**5,644,800,000**	**12,218,181,818**	**9,406,000,000**
B										
B1	**Trunk Sewer**									
	Supply and install of HDPE OD315	Depth : not exceeding 1.5m	m	238	2,900	6,900	691,000	1,643,000	2,825,000	2,175,000
	Supply and install of HDPE OD315	Depth : not exceeding 2.0m	m	209	4,100	7,200	857,000	1,506,000	2,813,000	2,166,000
	Supply and install of HDPE OD315	Depth : not exceeding 2.5m	m	144	4,400	7,200	633,000	1,036,000	1,978,000	1,523,000
	Supply and install of HDPE OD315	Depth : not exceeding 3.0m	m	32	5,400	7,600	174,000	245,000	492,000	379,000
	Supply and install of HDPE OD315	Depth : not exceeding 4.0m	m	53	6,400	7,900	337,000	416,000	877,000	675,000
	Supply and install of HDPE OD355	Depth : not exceeding 1.5m	m	62	3,100	8,700	192,000	538,000	891,000	686,000
	Supply and install of GRP/FRP ND400	Depth : not exceeding 1.5m	m	1,266	3,800	22,700	4,810,000	28,734,000	42,127,000	32,438,000
	Supply and install of GRP/FRP ND400	Depth : not exceeding 2.0m	m	894	4,900	23,000	4,378,000	20,551,000	31,068,000	23,922,000
	Supply and install of GRP/FRP ND400	Depth : not exceeding 2.5m	m	742	7,300	23,000	5,418,000	17,070,000	27,587,000	21,242,000
	Supply and install of GRP/FRP ND400	Depth : not exceeding 3.0m	m	502	8,500	23,400	4,269,000	11,751,000	19,530,000	15,038,000
	Supply and install of GRP/FRP ND400	Depth : not exceeding 3.5m	m	528	8,700	23,400	4,593,000	12,354,000	20,637,000	15,891,000
	Supply and install of GRP/FRP ND400	Depth : not exceeding 4.0m	m	251	9,800	23,700	2,455,000	5,937,000	10,165,000	7,827,000
	Supply and install of GRP/FRP ND400	Depth : not exceeding 4.5m	m	54	10,100	23,700	540,000	1,268,000	2,187,000	1,684,000
	Supply and install of GRP/FRP ND500	Depth : not exceeding 1.5m	m	434	5,800	28,300	2,517,000	12,281,000	18,466,000	14,219,000
	Supply and install of GRP/FRP ND500	Depth : not exceeding 2.0m	m	277	7,400	28,800	2,048,000	7,969,000	12,397,000	9,546,000
	Supply and install of GRP/FRP ND500	Depth : not exceeding 2.5m	m	224	8,000	28,800	1,790,000	6,444,000	10,159,000	7,822,000
	Supply and install of GRP/FRP ND500	Depth : not exceeding 3.0m	m	539	12,800	29,200	6,896,000	15,732,000	27,327,000	21,042,000
	Supply and install of GRP/FRP ND500	Depth : not exceeding 3.5m	m	458	13,100	29,200	6,000,000	13,388,000	23,393,000	18,013,000
	Supply and install of GRP/FRP ND500	Depth : not exceeding 4.0m	m	155	14,700	29,600	2,274,000	4,579,000	8,221,000	6,330,000
	Supply and install of GRP/FRP ND500	Depth : not exceeding 4.5m	m	129	15,100	29,600	1,950,000	3,823,000	6,915,000	5,325,000
	Supply and install of GRP/FRP ND600	Depth : not exceeding 1.5m	m	331	6,400	34,000	2,121,000	11,267,000	16,753,000	12,900,000
	Supply and install of GRP/FRP ND600	Depth : not exceeding 2.0m	m	387	7,800	34,500	3,017,000	13,344,000	20,347,000	15,667,000
	Supply and install of GRP/FRP ND600	Depth : not exceeding 2.5m	m	303	12,000	34,300	6,780,000	19,492,000	32,094,000	24,715,000
	Supply and install of GRP/FRP ND600	Depth : not exceeding 3.0m	m	332	13,700	34,900	4,553,000	11,599,000	19,617,000	15,105,000
	Supply and install of GRP/FRP ND600	Depth : not exceeding 3.5m	m	430	14,000	34,900	6,014,000	14,992,000	25,484,000	19,623,000
	Supply and install of GRP/FRP ND600	Depth : not exceeding 4.0m	m	216	15,700	35,300	3,387,000	7,616,000	13,278,000	10,224,000
	Supply and install of GRP/FRP ND600	Depth : not exceeding 4.5m	m	30	16,200	35,300	487,000	1,061,000	1,865,000	1,436,000
	Supply and install of GRP/FRP ND700	Depth : not exceeding 1.5m	m	43	8,200	42,400	355,000	1,833,000	2,736,000	2,106,000
	Supply and install of GRP/FRP ND700	Depth : not exceeding 2.0m	m	220	10,100	43,000	2,220,000	9,451,000	14,494,000	11,160,000
	Supply and install of GRP/FRP ND700	Depth : not exceeding 2.5m	m	216	16,800	43,600	3,631,000	9,424,000	15,870,000	12,220,000
	Supply and install of GRP/FRP ND700	Depth : not exceeding 3.5m	m	57	21,300	44,800	1,218,000	2,562,000	4,345,000	3,500,000
	Supply and install of GRP/FRP ND700	Depth : not exceeding 4.5m	m	45	20,200	44,200	907,000	1,985,000	3,485,000	2,683,000
	Supply and install of GRP/FRP ND800	Depth : not exceeding 1.5m	m	287	8,900	51,400	2,377,000	13,728,000	20,296,000	15,558,000
	Supply and install of GRP/FRP ND800	Depth : not exceeding 2.0m	m	268	10,900	52,000	2,917,000	13,917,000	20,991,000	16,163,000
	Supply and install of GRP/FRP ND800	Depth : not exceeding 2.5m	m	104	16,300	52,000	1,699,000	5,419,000	8,737,000	6,727,000
	Supply and install of GRP/FRP ND800	Depth : not exceeding 3.0m	m	125	18,800	52,600	2,342,000	6,551,000	10,850,000	8,354,000
	Supply and install of GRP/FRP ND800	Depth : not exceeding 3.5m	m	494	19,100	52,600	9,433,000	25,977,000	43,169,000	33,240,000
	Supply and install of GRP/FRP ND800	Depth : not exceeding 4.0m	m	183	21,400	53,200	3,914,000	9,730,000	16,550,000	12,744,000
	Supply and install of GRP/FRP ND800	Depth : not exceeding 4.5m	m	105	22,000	53,200	2,311,000	5,588,000	9,568,000	7,367,000
	Supply and install of GRP/FRP ND900	Depth : not exceeding 2.5m	m	247	17,300	62,000	4,278,000	15,332,000	24,190,000	18,626,000
	Supply and install of GRP/FRP ND900	Depth : not exceeding 3.0m	m	780	19,800	62,600	15,435,000	48,799,000	78,810,000	60,684,000
	Supply and install of GRP/FRP ND900	Depth : not exceeding 3.5m	m	463	20,300	62,600	9,400,000	28,987,000	47,045,000	36,225,000
	Supply and install of GRP/FRP ND900	Depth : not exceeding 4.0m	m	89	22,600	63,200	2,020,000	5,648,000	9,355,000	7,203,000
	Supply and install of GRP/FRP ND900	Depth : not exceeding 4.5m	m	273	23,200	63,200	6,349,000	17,403,000	28,990,000	22,323,000
	Supply and install of GRP/FRP ND1200	Depth : not exceeding 1.5m	m	117	13,200	100,600	1,550,000	11,811,000	16,889,000	13,005,000
	Supply and install of GRP/FRP ND1200	Depth : not exceeding 2.0m	m	463	15,200	101,200	7,038,000	46,856,000	67,890,000	52,275,000
	Supply and install of GRP/FRP ND1200	Depth : not exceeding 2.5m	m	298	24,400	101,200	7,277,000	30,182,000	46,474,000	35,785,000
	Supply and install of GRP/FRP ND1200	Depth : not exceeding 3.0m	m	171	27,100	101,800	4,622,000	17,562,000	27,170,000	20,921,000
	Supply and install of GRP/FRP ND1200	Depth : not exceeding 3.5m	m	564	27,700	101,800	15,631,000	57,845,000	90,235,000	69,481,000
	Supply and install of GRP/FRP ND1200	Depth : not exceeding 4.0m	m	308	30,300	102,400	9,333,000	31,542,000	50,297,000	38,728,000
	Supply and install of GRP/FRP ND1600	Depth : not exceeding 1.5m	m	242	15,200	190,200	3,675,000	45,983,000	63,393,000	48,813,000
	Supply and install of GRP/FRP ND1600	Depth : not exceeding 2.0m	m	364	17,200	190,800	6,259,000	69,434,000	96,433,000	74,253,000
	Supply and install of GRP/FRP ND1600	Depth : not exceeding 2.5m	m	776	28,300	190,800	21,960,000	148,053,000	214,237,000	164,962,000
	Supply and install of GRP/FRP ND1600	Depth : not exceeding 3.0m	m	287	30,200	191,400	8,666,000	54,920,000	79,991,000	61,593,000
	Supply and install of GRP/FRP ND1600	Depth : not exceeding 3.5m	m	100	33,100	191,400	3,301,000	20,313,000	29,682,000	22,855,000
	Supply and install of GRP/FRP ND1600	Depth : not exceeding 4.0m	m	140	33,700	192,000	4,715,000	26,863,000	39,602,000	30,494,000
	Supply and install of HDPE OD110	Depth : not exceeding 1.5m	m	404	600	1,000	242,000	404,000	767,000	590,000
	Supply and install of HDPE OD180	Depth : not exceeding 1.5m	m	716	800	2,500	573,000	1,790,000	2,898,000	2,231,000
	Supply and install of HDPE OD180	Depth : not exceeding 3.5m	m	11	1,700	2,500	19,000	28,000	55,000	43,000
	Supply and install of HDPE OD225	Depth : not exceeding 1.5m	m	1,092	900	3,700	983,000	4,041,000	6,231,000	4,798,000
	Supply and install of HDPE OD225	Depth : not exceeding 4.0m	m	12	1,800	3,700	21,000	43,000	77,000	59,000
	Supply and install of HDPE OD250	Depth : not exceeding 1.5m	m	179	900	4,800	161,000	858,000	1,275,000	982,000
	Supply and install of HDPE OD315	Depth : not exceeding 1.5m	m	1,105	1,000	7,700	1,105,000	8,508,000	12,154,000	9,359,000
	Supply and install of HDPE OD400	Depth : not exceeding 1.2m	m	1,943	1,200	12,800	2,331,000	24,867,000	34,676,000	26,696,000
	Supply and install of HDPE OD400	Depth : not exceeding 3.0m	m	102	1,600	12,800	164,000	1,311,000	1,867,000	1,437,000
	Supply and install of HDPE OD400	Depth : not exceeding 3.5m	m	117	1,700	12,800	198,000	1,494,000	2,138,000	1,646,000
	Supply and install of GRP/FRP ND400(PJ)	Depth : not exceeding 10m	m	86	35,600	275,814	3,077,000	23,839,000	34,037,000	26,708,000
	Supply and install of GRP/FRP ND500(PJ)	Depth : not exceeding 10m	m	137	37,000	327,404	5,070,000	44,867,000	63,339,000	48,771,000
	Supply and install of GRP/FRP ND600(PJ)	Depth : not exceeding 10m	m	297	38,500	379,302	11,436,000	112,664,000	157,753,000	121,470,000
	Supply and install of GRP/FRP ND700(PJ)	Depth : not exceeding 10m	m	1,133	40,600	479,710	45,995,000	543,459,000	751,786,000	578,875,000
	Supply and install of GRP/FRP ND800(PJ)	Depth : not exceeding 10m	m	2,559	72,900	550,319	186,556,000	1,408,305,000	2,015,524,000	1,551,953,000
	Supply and install of GRP/FRP ND900(PJ)	Depth : not exceeding 10m	m	379	75,500	637,329	28,651,000	241,860,000	342,755,000	263,921,000
	Supply and install of GRP/FRP ND1200(PJ)	Depth : not exceeding 10m	m	158	85,700	855,622	13,577,000	135,239,000	189,212,000	145,693,000
	Supply and install of GRP/FRP ND1400(PJ)	Depth : not exceeding 10m	m	245	109,000	1,020,404	26,685,000	249,621,000	350,848,000	270,153,000
	Supply and install of GRP/FRP ND1600(PJ)	Depth : not exceeding 10m	m	880	109,000	1,074,304	95,913,000	945,323,000	1,323,605,000	1,019,176,000
	Supply and install of HDPE OD180(PJ)	Depth : not exceeding 10m	m	83	30,500	232,925	1,918,000	14,649,000	20,943,000	16,126,000
	Supply and install of HDPE OD200(PJ)	Depth : not exceeding 10m	m	15	30,700	233,541	461,000	3,510,000	5,019,000	3,865,000
	Supply and install of HDPE OD250(PJ)	Depth : not exceeding 10m	m	125	31,000	234,696	3,874,000	29,328,000	41,962,000	32,311,000
	Supply and install of HDPE OD355(PJ)	Depth : not exceeding 10m	m	46	32,000	254,100	1,469,000	11,686,000	16,620,000	12,797,000
	Supply and install of HDPE OD400(PJ)	Depth : not exceeding 10m	m	148	35,800	275,814	5,268,000	40,812,000	58,271,000	44,868,000
	Temporary road reinstatementAsphalt concrete	Add 10% of pipeline(W=1.2)	m2	38,609	2,000	0	77,217,000	0	77,217,000	59,457,000
	Permanent road reinstatementAsphalt concrete	Add 10% of pipeline(W=1.2)	m2	38,609	4,910	0	189,569,000	0	189,569,000	145,968,000
B2	**Pump Station**									
	Manhole Type Pumping Station		pc	4	22,000,000	0	88,000,000	0	88,000,000	67,760,000
	Major Pumping Station		pc	5	570,000,000	0	2,850,000,000	0	2,850,000,000	2,194,500,000
	Sub-total of B						**3,884,573,000**	**4,878,210,000**	**10,219,925,000**	**7,869,335,000**
C	**Branch Sewer**									
C1										
	Supply and install of HDPE OD225	Depth : not exceeding 2.5m	m	508,800	4,400	4,200	2,238,720,000	2,136,960,000	5,013,993,000	3,860,774,000
	Temporary road reinstatementAsphalt concrete	Add 10% of pipeline(W=1.2)	m2	671,616	2,000	0	1,343,232,000	0	1,343,232,000	1,034,289,000
	Permanent road reinstatementAsphalt concrete	Add 10% of pipeline(W=1.2)	m2	671,616	4,910	0	3,297,635,000	0	3,297,635,000	2,539,179,000
	Manhole Type Pump		pc	200	1,000,000	6,930,000	200,000,000	1,386,000,000	2,000,000,000	1,540,000,000
	Sub-total of C						**7,079,587,000**	**3,522,960,000**	**11,654,860,000**	**8,974,242,000**
D	**House Connection**									
D1										
	House Connection		HH	49,500	100,000	0	4,950,000,000	0	4,950,000,000	3,811,500,000
	Sub-total of D						**4,950,000,000**	**0**	**4,950,000,000**	**3,811,500,000**
	Sub-total of 1						**20,801,432,727**	**14,045,970,000**	**39,042,966,818**	**30,065,850,000**
2	Administration cost						2,500,000,000	0	2,500,000,000	2,075,000,000
3	Consulting cost						1,354,000,000	3,129,000,000	5,437,696,000	4,171,580,000
4	Physical contingency for construction cost						1,309,000,000	773,000,000	2,312,896,000	1,780,930,000
5	Price escalation for construction cost						5,381,000,000	1,419,000,000	7,223,857,000	5,562,370,000
6	Land acquisition and compensation									
7	Interest during construction						0	323,000,000	419,481,000	323,000,000
8	Front-end Fee						0	84,000,000	109,091,000	84,000,000
9	Tax and duty						9,861,000,000	0	9,861,000,000	7,592,970,000
	Sub-total of (2-9)						**20,605,000,000**	**5,728,000,000**	**28,043,961,000**	**21,593,850,000**
	Total including Tax and Duty						**41,406,432,727**	**19,773,970,000**	**67,086,926,000**	**51,656,933,000**
	Total excluding Tax and Duty						**31,545,432,727**	**19,773,970,000**	**57,225,926,000**	**44,065,963,000**
	Eligible Portion (1, 3, 4, 5 and 7)						**28,545,432,727**	**19,689,970,000**	**54,416,835,000**	**41,900,963,000**
	Non-Eligible Portion (2, 6, 8 and 9)						**12,561,000,000**	**84,000,000**	**12,670,091,000**	**9,755,970,000**

APPENDIX 7: Detail of Annual Fund Requirement

Annual Fund Requirement of Sri Jayawardenapura Kotte

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

FC & Total: million JPY
LC : million LKR

Annual Fund Requirement of Sri Jayawardenapura Kotte

Item	Total FC	Total LC	Total Total	2017 FC	2017 LC	2017 Total	2018 FC	2018 LC	2018 Total	2019 FC	2019 LC	2019 Total
A. ELIGIBLE PORTION												
I) Procurement / Construction	16,238	27,492	37,406	0	0	0	0	0	0	0	0	0
STP	5,645	4,887	9,408	0	0	0	0	0	0	0	0	0
Trunk Sewer	4,878	3,885	7,869	0	0	0	0	0	0	0	0	0
Branch Sewer	3,523	7,080	8,974	0	0	0	0	0	0	0	0	0
House Connection	0	4,959	3,812	0	0	0	0	0	0	0	0	0
Base cost for JICA financing	14,046	20,811	30,063	0	0	0	0	0	0	0	0	0
Price escalation	1,419	5,381	5,562	0	0	0	0	0	0	0	0	0
Physical contingency	773	1,300	1,781	0	0	0	0	0	0	0	0	0
II) Consulting services	3,129	1,356	4,171	0	0	0	0	0	0	601	232	780
Base cost	2,754	1,062	3,572	0	0	0	0	0	0	555	205	713
Price escalation	226	227	400	0	0	0	0	0	0	18	16	30
Physical contingency	149	64	199	0	0	0	0	0	0	29	11	37
Total (I + II)	19,367	28,845	41,578	0	0	0	0	0	0	601	232	780
B. NON ELIGIBLE PORTION												
a Procurement / Construction	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
Price escalation	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
b Land Acquisition	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
Price escalation	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
c Administration cost	0	2,705	2,079	0	0	0	0	0	0	0	51	39
d VAT	0	8,100	6,237	0	0	0	0	0	0	0	152	117
e Import Tax	0	1,704	1,356	0	0	0	0	0	0	0	55	42
Total (a+b+c+d+e)	0	12,560	9,671	0	0	0	0	0	0	0	257	198
TOTAL (A+B)	19,367	41,405	51,249	0	0	0	0	0	0	601	490	978
C. Interest during Construction	323	0	323	0	0	0	0	0	0	0	0	0
Interest during Construction(Const.)	321	0	321	0	0	0	0	0	0	0	0	0
Interest during Construction (Consul.)	2	0	2	0	0	0	0	0	0	0	0	0
D. Front End Fee	84	0	84	0	0	0	0	0	0	84	0	84
GRAND TOTAL (A+B+C+D)	19,774	41,405	51,656	0	0	0	0	0	0	685	490	1,062
E. JICA finance portion incl. IDC (A + C)	19,690	28,845	41,901	0	0	0	0	0	0	601	232	780

Item	2020 FC	2020 LC	2020 Total	2021 FC	2021 LC	2021 Total	2022 FC	2022 LC	2022 Total	2023 FC	2023 LC	2023 Total
A. ELIGIBLE PORTION												
I) Procurement / Construction	0	0	0	2,538	3,974	5,597	3,590	5,617	7,885	3,617	5,831	8,106
STP	0	0	0	1,008	873	1,680	1,452	1,257	2,419	1,452	1,257	2,419
Trunk Sewer	0	0	0	732	580	1,180	976	777	1,574	976	777	1,574
Branch Sewer	0	0	0	528	1,062	1,346	705	1,416	1,795	705	1,416	1,795
House Connection	0	0	0	0	743	572	0	990	762	0	990	762
Base cost for JICA financing	0	0	0	2,268	3,260	4,778	3,132	4,440	6,550	3,132	4,440	6,550
Price escalation	0	0	0	149	524	553	259	910	959	313	1,113	1,170
Physical contingency	0	0	0	121	189	267	170	267	375	172	278	386
II) Consulting services	437	145	549	356	119	448	419	191	566	344	191	492
Base cost	396	124	492	318	97	393	369	151	485	298	146	410
Price escalation	19	15	31	21	16	33	30	31	54	30	37	58
Physical contingency	21	7	26	17	6	21	20	9	27	16	9	23
Total (I + II)	437	145	549	2,894	4,092	6,045	3,979	5,808	8,451	3,961	6,022	8,598
B. NON ELIGIBLE PORTION												
a Procurement / Construction	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
Price escalation	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
b Land Acquisition	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
Price escalation	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
c Administration cost	0	36	27	0	393	302	0	549	423	0	558	430
d VAT	0	107	82	0	1,178	907	0	1,646	1,268	0	1,675	1,290
e Import Tax	0	40	31	0	263	203	0	362	279	0	360	277
Total (a+b+c+d+e)	0	182	140	0	1,833	1,412	0	2,557	1,969	0	2,593	1,997
TOTAL (A+B)	437	328	689	2,894	5,925	7,456	3,979	8,365	10,420	3,961	8,615	10,595
C. Interest during Construction	0	0	0	17	0	17	41	0	41	65	0	65
Interest during Construction(Const.)	0	0	0	17	0	17	40	0	40	65	0	65
Interest during Construction (Consul.)	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
GRAND TOTAL (A+B+C+D)	437	328	689	2,911	5,925	7,473	4,020	8,365	10,461	4,026	8,615	10,660
E. JICA finance portion incl. IDC (A + C)	437	145	549	2,911	4,092	6,062	4,020	5,808	8,492	4,026	6,022	8,663

Item	2024 FC	2024 LC	2024 Total	2025 FC	2025 LC	2025 Total	2026 FC	2026 LC	2026 Total	2027 FC	2027 LC	2027 Total
A. ELIGIBLE PORTION												
I) Procurement / Construction	3,675	6,052	8,335	2,340	4,850	6,074	509	1,169	1,409	0	0	0
STP	1,452	1,257	2,419	282	244	470	0	0	0	0	0	0
Trunk Sewer	976	777	1,574	976	777	1,574	244	194	393	0	0	0
Branch Sewer	705	1,416	1,795	705	1,416	1,795	176	354	449	0	0	0
House Connection	0	990	762	0	990	762	0	248	191	0	0	0
Base cost for JICA financing	3,132	4,440	6,550	1,962	3,427	4,601	420	796	1,033	0	0	0
Price escalation	368	1,324	1,388	266	1,191	1,183	65	317	309	0	0	0
Physical contingency	175	288	397	111	231	289	24	56	67	0	0	0
II) Consulting services	401	203	557	396	194	546	174	79	234	0	0	0
Base cost	342	149	456	332	137	438	144	53	185	0	0	0
Price escalation	40	44	74	45	48	82	22	21	38	0	0	0
Physical contingency	19	10	27	19	9	26	8	4	11	0	0	0
Total (I + II)	4,076	6,255	8,892	2,736	5,044	6,619	683	1,247	1,643	0	0	0
B. NON ELIGIBLE PORTION												
a Procurement / Construction	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
Price escalation	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
b Land Acquisition	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
Price escalation	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
c Administration cost	0	577	443	0	430	331	0	107	82	0	0	0
d VAT	0	1,732	1,334	0	1,289	993	0	320	246	0	0	0
e Import Tax	0	371	285	0	249	191	0	62	48	0	0	0
Total (a+b+c+d+e)	0	2,680	2,064	0	1,968	1,515	0	489	376	0	0	0
TOTAL (A+B)	4,076	8,935	10,956	2,736	7,012	8,135	683	1,736	2,020	0	0	0
C. Interest during Construction	90	0	90	109	0	109	0	0	0	0	0	0
Interest during Construction(Const.)	90	0	90	109	0	109	0	0	0	0	0	0
Interest during Construction (Consul.)	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
GRAND TOTAL (A+B+C+D)	4,166	8,935	11,046	2,845	7,012	8,244	683	1,736	2,020	0	0	0
E. JICA finance portion incl. IDC (A + C)	4,166	6,255	8,983	2,845	5,044	6,728	683	1,247	1,644	0	0	0

APPENDIX 8: Breakdown of Operating Expenditure

Moratuwa Ratmalana - 8119

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

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

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

APPENDIX 9: Regulations and Organizations Related to ESC

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

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

1.1 Approvals Required for a Sewerage Project

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

Central Environmental Authority (CEA)

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

Coast Conservation and Coastal Resources Management Department (CC&CRMD - Commonly known as CCD)

Approval of the Director General of CC&CRMD is required for any development activity to be carried out within the Coastal Zone as defined under Coast Conservation Act.

Local Authority (LA) (Municipal Councils, Urban Councils or Pradeshiya Sabha)

To carryout construction activities of the project, the approval of relevant Local Authority must be obtained.

Mahaweli Authority of Sri Lanka (MASL)

As the responsible agency for Mahaweli River, the Mahaweli Authority in Sri Lanka 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.

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

Item	JICA Guidelines	Sri Lankan Policies and Regulations
		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.

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

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

APPENDIX 12: Record of Consultation with Public and Authorities

Record of Meeting/Discussion

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

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

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

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

Actions to be taken	by Whom	until When

Record of Meeting/Discussion

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

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

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

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

Actions to be taken	by Whom	until When

Record of Meeting/Discussion

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

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

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

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

Actions to be taken	by Whom	until When

APPENDIX 13: Draft EMP and EMoP

Mitigation Measures

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

Table 1: Environmental Impact – Mitigation Matrix

Environmental Impact / Issue	Mitigation Measure	Implementing Organization	Responsible Organization
	Planning and Design Phase		
Site Selection	Site selection process shall avoid land acquisition and involuntary resettlement where possible, including impacts on vulnerable persons. Locate sewage pipelines within the right of ways of roads to eliminate acquisition of new land. Avoid locating sewage pumping stations and wet wells within close proximity of any inhabited areas, sensitive sites such as hospitals, schools, temples, etc. to minimize nuisance impacts from odor, rodents, etc. as much as possible	Consultant/ NWSDB	NWSDB
Overall Environmental Management	An Environmental Management Plan shall be prepared and implemented.	Consultant/ NWSDB	NWSDB
Discharge standards	The design will specify the guidelines for the proper handling and disposal of waste to predetermined authorized disposal sites;	Consultant/ NWSDB	NWSDB
Archaeological resources	Consult the relevant records of national and/or local archaeological agencies regarding the archaeological potential of proposed sites of STP, pumping stations, and main sewers, to ensure that these are located in areas where there is a low risk of chance finds.	Consultant/ NWSDB	NWSDB
Public utilities	Telephone lines, electric poles and wires, and water pipes (old) existing within right-of-way (ROW) require shifting without disruption to services.	Consultant/ NWSDB	NWSDB
Traffic	In order to limit the disruption to the neighborhood and traffic flow, coordinate with NWSDB to provide guidance to the organization of construction works. The design will specify the handling and transportation of construction materials and equipment.	Consultant/ NWSDB	NWSDB
Safety	The design will include guidelines for site safety which will include specific requirements for physical division (fence), where necessary, of the construction site from passing pedestrians, children at play, vehicles, and any other people at risk. The design will include guidelines for workers' safety on site and the safety of visitors. Bills of quantities and technical description of works will include needed safety equipment.	Consultant/ NWSDB	NWSDB
	Construction Phase		
Soil erosion and sedimentation	Careful planning of construction activities that lead to heavy erosion, to avoid heavy rainy seasons Remove waste soil as soon as it is excavated, by loading directly onto trucks; The work, permanent or temporary shall consist of measures to control soil erosion, sedimentation and water pollution. Typical measures include the use of berms, dikes, sediment basins, fiber mats, mulches, grasses, slope drains and other devices. Adequate compaction of filled surfaces on completion and progressive re-vegetation of all disturbed areas as quickly as possible Protection of drainage channels with berms (i.e. ridge or embankment bordering channel) to prevent overspill Sedimentation traps will be constructed to reduce suspended solids before water is discharged to	Contractor	Consultant/ NWSDB

Environmental Impact / Issue	Mitigation Measure	Implementing Organization	Responsible Organization
	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.		
Transport of earth material	Vehicles will be properly maintained to ensure the good running conditions and those which are not in suitable condition will be replaced. Provide covers during transportation	Contractor	Consultant/ NWSDB
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

Environmental Impact / Issue	Mitigation Measure	Implementing Organization	Responsible Organization
Noise and vibration	Temporary noise barriers / screens will be placed. All construction work will be carried out during day time as much as possible and work will be stopped after 6 pm. Workers involved in high noise generating activities (such as compacting, concrete/cement mixing operations using the mixers) and handling high noise generating machinery and equipment will be provided with ear plugs or mufflers. To the extent possible, attempts will be made to use equipment and machinery that produce low noise levels Proper and regular maintenance and/or servicing of equipment and machinery will be carried out.	Contractor	Consultant/ NWS&DB
	Operational phase		
Impacts on Water Resources	Prevent seepage of polluted water to the ground by applying suitable lining for the ponds, raise the levels of the site and the tanks etc as applicable. Establish the STP on a sufficient high ground to avoid the flood impact. Avoid spillages of septage during operation – specially during unloading - and take precautionary measures to prevent mixing septage with storm water drainage system. As a precautionary step, it is proposed to monitor the ground water quality in the area. Ensure the disposal of treated effluent to a reed bed (artificial wet-land) with species which suit the climatic and coastal conditions of the area. Ensure the necessary effluent quality for disposal to inland waters	NWS&DB / MC	NWS&DB / MC / Consultant
Odor from STP	Shielding of the unloading bay to an extend to prevent odorous gases being blown away by the wind Hydraulic arrangements that would minimize agitation of sewage during the release to the treatment system Keeping much of the screen channel close to prevent release of gases to air Establish and properly maintain a thick green belt along the STP site and pumping station where applicable.	NWS&DB / MMC	MMC / NWSDB
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	Contractor	MC / NWSDB	Field reports	Project site	Once every six months

		tree should be compensated by planting of more trees around the area					
O&M 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, PM10, 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	