



KERALA SOLID WASTE MANAGEMENT PROJECT
Executive Summary for Proposed Scientific Landfill at
Ambalamedu, Ernakulam District of Kerala



Category: B1 – 7(i)

Sector as per NABET Scheme: 37

Study Period: December 2023 to February 2024

ToR Identification No.: TO24B3401KL5888163N, dated: 08.08.2024

Prepared by



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Executive Summary

1 Introduction

Kerala State Solid Waste Management Project (KSWMP), under Local Self Government Department (LSGD), is planning to implement the solid waste management project in 93 ULBs (87 municipalities and 6 corporations) vide G.O (Rt) No. 1420/2020/LSGD dated 29-07-2020. Initially, it is planned to establish a Scientific Landfill (SLF) at Ambalamedu, Kochi to cover the inert generated nearby Urban Local Bodies (ULBs). Presently, in India it is practiced that the dry & wet wastes are segregated at source and the dry waste is disposed in the earmarked municipal solid waste area. The dry waste contains silt, textiles, leather, plastic, glass and metals which poses environmental problems related to air, water, and odour. If Scientific Landfill is implemented the environmental problems due to waste disposal can be solved to greater extent.

The proposed project SLF falls under Item 7 (i) (Common Municipal Solid Waste Management facilities) as per Environmental Impact Assessment MoEF&CC notification dated September 14th, 2006 and its amendments. The project is categorised under 'B1' and will require Environmental Clearance from State Environmental Impact Assessment Authority (SEIAA) – Kerala as per the above notification. M/s. ABC Techno Labs India Private Limited, Chennai which is a NABET accredited consultancy organization has been engaged by M/s. KSWMP to carry out an Environment Impact Assessment (EIA) study to obtain EC for the proposed scientific landfill at Ambalamedu, Ernakulam district.

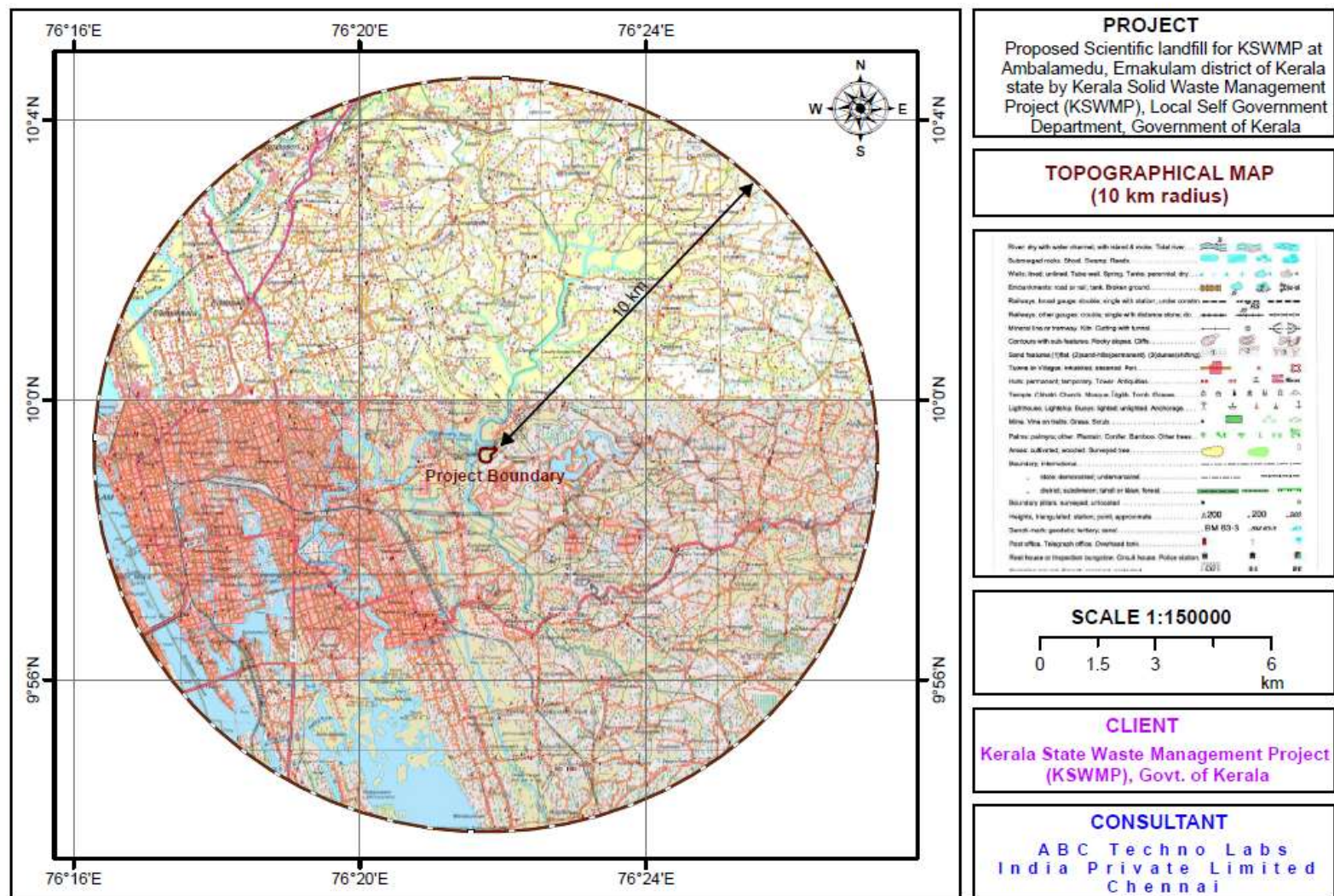
The proposed construction & development of SLF located within the Industrial area of Kochi near Irumbanam and land is owned by KINFRA which is a government agency under the Government of Kerala. The project site is well isolated from settlements and environmentally sensitive areas. The land is bounded by FACT gypsum dump site in the east and in the south Kerala Enviro Infrastructure Limited (KEIL) which is in operation to treat common hazardous waste. The other two sides of the site are shielded by Chithrapuzha river and sufficient offsets of SLF site requirement criteria is provided.

The project site spreads over in an area of 25 acres. It is planned to dispose about 4 lakh tons of inert at an average of 20000 TPA (ranges from 117 TPD in 2024 & 194 TPD in 2055) in an area of about 18.14 acres over a period 20 years. The land parcel proposed by KSWMP for development of regional scientific landfill located at Ambalamedu, Kunnathnadu taluk, Ernakulam district of Kerala with the survey no. 23/4, 23/3, 23/5, 7/5, 7/4, 6/4, 23/2pt, 22/4pt, 22/3pt, 7/3pt, 5/3pt, 6/2pt, 6/3pt, 6/1pt, 6/7pt. The topo map of the study area is shown in ES Figure 1.

The auto generated ToR was granted by SEIAA Kerala vide ToR Identification no. TO24B3401KL5888163N, dated 08-08-2024. The EIA report has been prepared on the basis of one season baseline environmental data monitored during December 2023 to February 2024. The report also covers environmental impact assessment and social impact assessment as per World Bank Policies. KSWMP is having well defined Environmental Social Management Framework prepared in the year 2020 which is also applicable for this project. The Bank's environmental, social, and legal safeguard policies are designed to prevent and mitigate undue harm to people and their environment in the implementation of specific development projects, and to ascertain that project benefits reach the target population.



Environmental Impact Assessment Report for the Proposed Scientific Landfill at Ambalamedu, Ernakulam District of Kerala.



Source: Survey of India Toposheet No.58B/8 & 58C/5

ES Figure 1 Topo Map of the Project site



A detailed coverage of project description, background environmental quality, pollution sources, anticipated environmental impacts and mitigation measures, environmental monitoring programme, additional studies, project benefits, environmental monitoring plan and all related aspects have been covered in this report as per MoEF&CC guidelines.

2 Project Description

Scientific landfilling is the method of disposing of inert solid waste in an engineering designed land area for spreading inert waste into thin layers, compacting to the smallest volume and covering with soil on daily basis. A brief note on proposed project site covering engineering facilities, life of SLF, various utilities with project cost is given below:

ES Table 1 Salient Features of the project

Description	Details
Project activity in brief	The implementation of SLF will have four major steps such as ➤ Ground improvement and Land development ➤ SLF Construction ➤ Leachate management ➤ Allied Infrastructure ➤ Shifting of HT line and development of approach road. ➤ Inert/rejects will be collected and transported to the SLF site by tipper/RCV. ➤ The expected annual disposal of inert is 20000 TPA
Project life span	20 years of operation and 15 years post closure maintenance.
Manpower requirement	Construction phase – about 200 persons Operation Phase – about 85 persons
Water requirement & source	During Construction Phase – 35 KLD through tankers During Operation & Maintenance Phase for drinking – 3 KLD by Kerala Water Authority (KWA)
Power requirement & source	Power requirement at SLF would be about 88.52 kW
Estimated cost of the project	~ INR 274.79 Crore.

The SLF is planned in an area of 18.14 acres of land to accommodate 4,00,000 MT of inert waste over a period of 20 years. The project will have associated leachate collection & treatment plant with designed capacity of 400 KLD against the generation of 300 KLD. The boundary co-ordinates of the proposed SLF site are 9°59'20.10"N 76°21'58.51"E to 9°59'18.76"N 76°21'56.41"E.

The project site is well connected with road, rail & airways. The site can be accessed by SH41 (3.5 km – N) & NH85 (3 km – SSW) which is connecting the Cochin port and Cochin International Airport. The nearest railway station is Tripunithura located in the SSW direction at a distance of about 4 km. The project is planned to be completed in 28 months on obtaining all statutory clearances. A detailed compliance of site selection criteria as per CPHEEO/SWM Guidelines is ensured. Waste generation per day from each ULB is estimated based on the population projection for the year 2021 to 2055.

Following assumptions are considered to project the waste generation:



- Per capita per day waste generation in Municipality area is 0.419 kg
- Per capita per day waste generation in Corporation area is 0.545 kg
- Per year increase in per capita waste generation is 1.3%
- Percentage of waste rejects is 12%

As per the secondary data received, projected population in 2024 year is 19,07,433 while total solid waste generation is estimated approximately 978.8 MT/ day. 12% rejects of total waste generation are considered as a landfillable waste, hence average quantity of reject is estimated about 20000 TPA. The annual and cumulative generation of the reject/ inert quantities are presented in the below ES Table 2.

ES Table 2 Volume Calculation

Sl. No	Year	Waste (TPD)	Waste/ year (cum)	Vol. of inert waste (cum)	Vol. of daily soil cover (cum)	Volume of liner (cum)	Tot. req. volume (cum)	Cumulative volume (cum)
				Volume: 1	10%	5%		
1	2024	116.7	42610	42610	4261	2130	49001	49001
2	2025	118.9	43405	43405	4340	2170	49915	98916
3	2026	121.1	44208	44208	4421	2210	50839	149756
4	2027	123.3	45020	45020	4502	2251	51773	201529
8	2028	125.6	45841	45841	4584	2292	53671	254246
6	2029	127.9	46671	46671	4667	2334	53671	307918
7	2030	130.2	47509	47509	4750	2375	54635	362553
8	2031	132.5	48356	48356	4835	2418	55609	418162
9	2032	134.8	49211	49211	4921	2461	56593	474754
10	2033	137.2	50075	50075	5008	2504	57587	532341
11	2034	139.6	50948	50948	5095	2547	58590	590932
12	2035	142.0	51830	51830	5183	2591	59604	650536
13	2036	144.4	52720	52720	5272	2636	60628	711164
14	2037	146.9	53619	53619	5362	2681	61662	772827
15	2038	149.4	54527	54527	5453	2726	62706	835533
16	2039	151.9	55444	55444	5544	2772	63761	899294
17	2040	154.4	56369	56369	5637	2818	64825	964118
18	2041	157.0	57304	57304	5730	2865	65899	1030018
19	2042	159.6	58246	58246	5825	2912	66983	1097001
20	2043	162.2	59198	59198	5920	2960	68078	1165079
21	2044	164.8	60158	60158	6016	3008	69182	1234261
22	2045	167.5	61127	61127	6113	3056	70297	1304558
23	2046	170.1	62070	62070	6207	3103	71380	1357938
24	2047	172.7	63020	63020	6302	3151	72473	1448411
25	2048	175.3	63978	63978	6398	3199	73575	1521985
26	2049	177.9	64944	64944	6494	3247	7486	1596671
27	2050	180.6	68918	65918	6592	3296	75806	1672477
28	2051	183.3	66900	66900	6690	3345	76935	1749413
29	2052	186.0	67890	67890	6789	3395	78074	1827486
30	2053	188.7	68888	68888	6889	3444	79221	1906707

Sl. No	Year	Waste (TPD)	Waste/ year (cum)	Vol. of inert waste (cum)	Vol. of daily soil cover (cum)	Volume of liner (cum)	Tot. req. volume (cum)	Cumulative volume (cum)
				Volume: 1	10%	5%		
31	2054	191.5	69893	69893	6989	3495	80377	1987084
32	2055	194.3	70906	70906	7091	3545	81542	2068626

***Multiple projects and state of art technologies are identified under KSWMP to minimize the reject and limit it to less than 3 % in keeping with the philosophy of “zero percent landfill”. Transport planning is done considering 12% rejects.

The land parcel proposed by KSWMP for development of regional Scientific landfill is located at Ambalamedu, Kunnathnadu Taluk, Ernakulam District of Kerala and has an area of approximately 25 acres. The general layout is shown in ES Figure 2 with existing HT line. The overall project will be carried out two phases, one is KSWMP Phase which covers 18.14 acres land after realignment of EHT line A (Under WB fund) and other GoK phase covers 6.86 acres will be developed after realignment of EHT B & C (under GoK fund). The layout of the overall area covering both the phases with EHT line is shown in ES Figure 2.



ES Figure 2 SLF general layout plan with EHT line

The land area break-up of total land parcel and the facilities planned for SLF is given in below ES Table 3.

ES Table 3 Detailed land area break-up with proposed facilities

S.No	Particular	Nos.	Length	Width	Total Area	Unit
1	Administrative Block-1	1	18	12	216	m ²
2	Administrative Block-2	1	6	3	18	m ²
3	Administrative Block-3	1	6	3	18	m ²



S.No	Particular	Nos.	Length	Width	Total Area	Unit
4	Parking	1			115	m ²
5	Weighbridge	2	12	3.5	84	m ²
6	Scale Room	2	4	4	32	M ²
7	Tyre Washing System	1	29	4	116	m ²
8	Vehicle workshop and washing area	1			420	m ²
9	Toilet Block	3	8	4	96	m ²
10	Security Room	1	3	3	9	m ²
11	Entry Gate	1	0	8	0	No
12	Road (7.0m Wide)	1	1190	7	8330	RM
13	Restroom and Canteen	1	15	5	75	m ²
14	Allied Infra SWM Drain	1	375	1.5	412.5	m ²
15	Fence	1	1303		0	RM
16	Fire Fighting Station	1	10	10	100	m ²
17	Power Room	1	10	10	100	m ²
18	Leachate Pond	1	40	17	680	m ²
19	Piezometer monitoring well	4			0	Nos.
20	Leachate Treatment Plant	1			345	m ²
21	Green Belt-01	1			10,194	m ²
22	Green Belt-02 (94+461)	1			534	m ²
23	SLF Footprint Area	1			49300	m ²
24	SWD Length	1	1065	1.5	1597.5	RM
25	Street Light	60				
Total Site Area		1			72792	m²
		1			18.14	Acre

Note: Total Greenbelt proposed is around 15% of the total land area

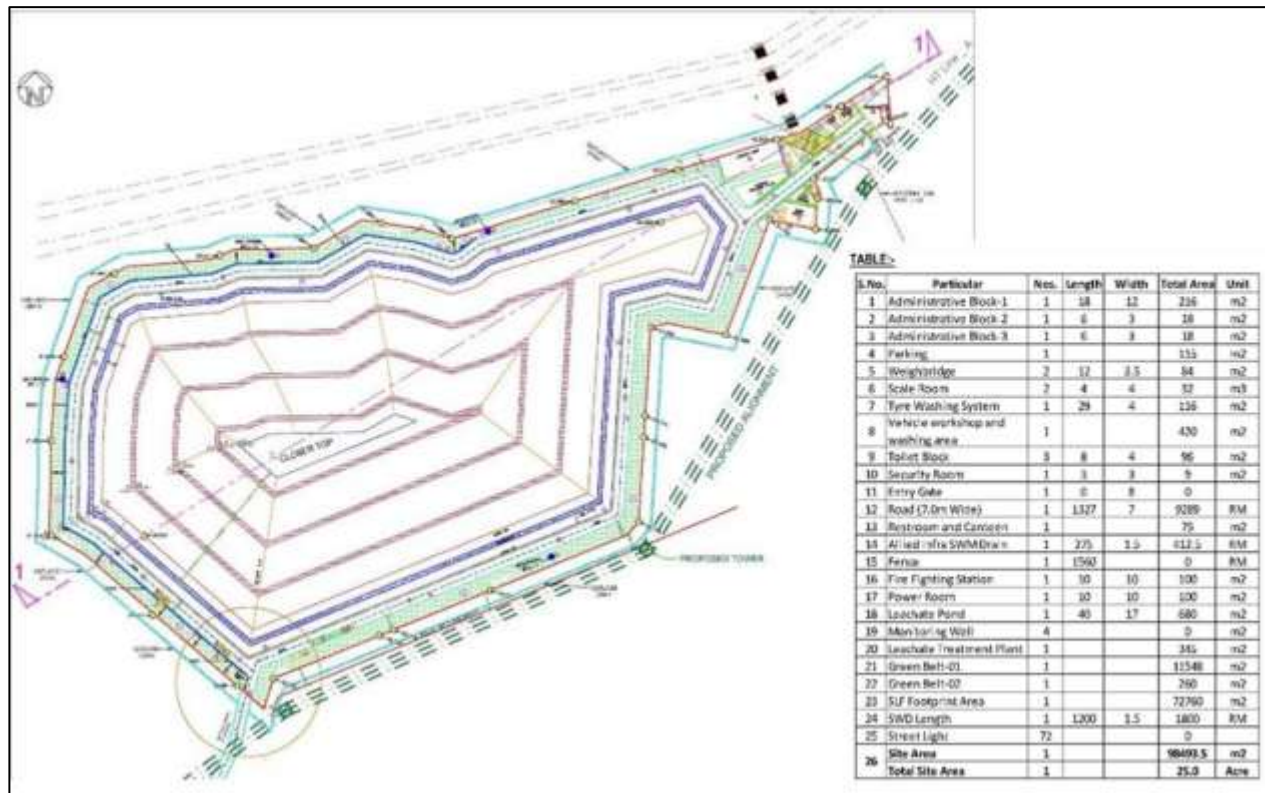
Based on the soil investigations it is understood that the subsoil is very weak and rock levels vary. Without any ground improvement the subsoil will not be capable of transferring the bearing pressures of the order of 250 to 300 kPa on account of its very high compressibility characteristics. Therefore, ground improvement is necessary to improve the weak/very weak sub-soil noticed at the project site. Considering the clayey soil, it will be necessary to adopt preloading with Prefabricated Vertical Drains (PVD).

With the shifting of EHT line A, B & C the dimensions and volumetric capacity with capping slope of 1:4 ratio in the SLF area is presented in the below:

2.1 Closure profile & section of SLF

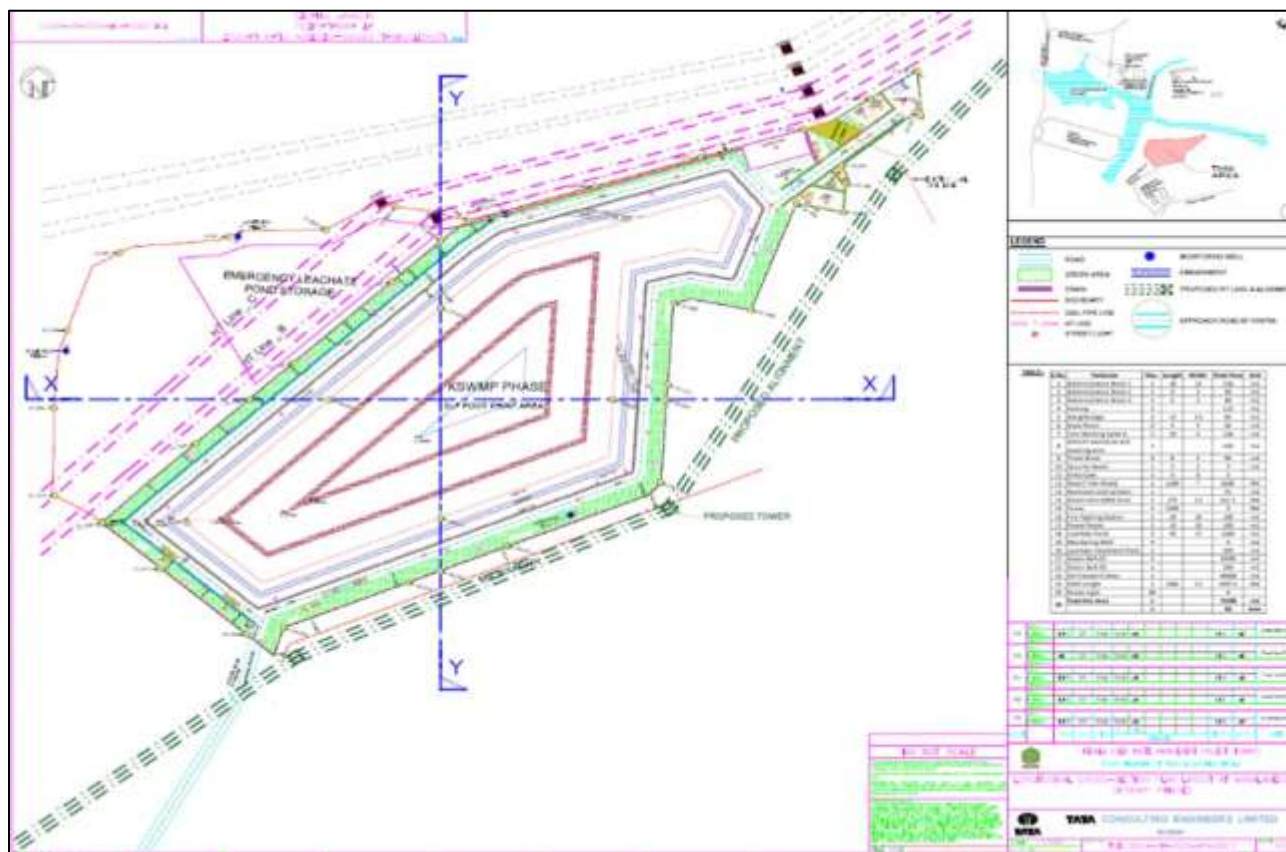
The closure profile of SLF KSWMP phase plus GoK Phase (Combined) is planned and proposed based on the available footprint area and required capacity with capping slope of 1:4 and required berm of 3m width at required intervals of height to ensure slope stability, smooth movement of landfill vehicles and post closure maintenance. The ES Figure 3 shows the closure profile of combining two phases and the cross section of SLF is ES Figure 4. After closure, no construction activities of any sort will be permitted without scientific

evidence for utilizing the site for any other purposes. The remaining plant area of 27,559 sq.m will be used for next 15 years as a maintenance period.



ES Figure 3 Interim Arrangement – SLF Plant

The construction of landfill planned to be taken up into phase wise manner. After filling of each phase, it will be covered with top cover progressively and subsequently the landfill space will be utilized as per SWM Rules. The inert is disposed in thin layers, well compacted to maximise the density. The waste is covered with soil on daily basis. Any Landfill gas such as methane from the anaerobic degradation of organic material will be collected through horizontal and vertical vent pipes. The facilities at the scientific landfill include leachate collection & treatment system, and storm water management system to avoid ground and surface water pollution & erosion respectively. The SLF facilities covers groundwater monitoring well, firefighting system, tyre washing system, greenbelt and other associated facilities. The maximum height envisaged for SLF is 23m from the AGL. The slope will be maintained at 1:4 horizontal - vertical ratio. The SLF will also have greenbelt width of 2m along the periphery.



ES Figure 4 SLF Closure profile (SLF KSWMP phase)

2.2 Mechanism or Collection & Transportation

Waste gets unloaded either directly into tertiary transport vehicles (direct unloading) or into a storage area. Following technologies are studied for the project:

1. **Direct Unloading (Elevated Ramp and Storage)** – not proposed due to non-suitability
2. **Unloading to Storage (Static Compactor)** – proposed only at Kochi due to higher quantity of waste
3. **Unloading to Storage (Portable Compactor)** - proposed at location, vehicle movement is limited
4. **Refuse Compact Vehicle (RCV)** – specialised trucks designed to collect & compact waste materials

The combination of static compactor and RCV is planned for the project.

2.3 Steps for Landfill Development

Ground Clearing

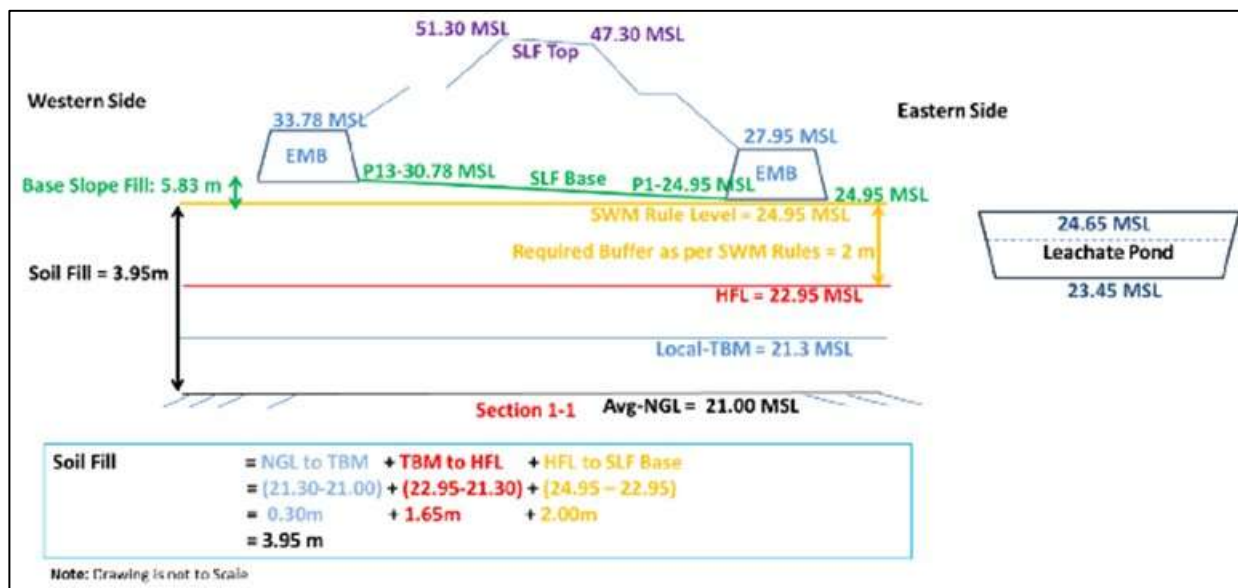
The site is presently occupied with patchy spontaneous vegetation, which need to be removed in order to develop the proposed landfill. The site is unapproachable due to growth of wild bushes and spontaneous trees. However, a attempt has been made to count the number of trees which are likely to be affected due to the proposed SLF. In this attempt,

Coconut, Areca, Acacia, Eucalyptus trees are not accounted for transplantation. Species like Mango, Neem, Charu, Anjili have been planned for transplantation. The girth which are greater than 40 cm are expected to be about 10 – 15 in numbers which is also not planned for transplantation. Whereas, the girth less than 30 cm is expected to be about 100 in numbers are planned to be used in the greenbelt. It is also planned to remove about 30 numbers of trees having girth of 40 cm a suitable greenbelt will be developed as mitigation measures.

Ground Level Raising

The local temporary benchmark at the proposed site as given in the topographic contour map is considered, and the lowest natural ground level (NGL) is 20.60m MSL, the highest natural ground level (NGL) is 21.332m MSL. The average ground level at the site is 21 meters AMSL. The given High Flood Level (HFL) is 22.95m MSL.

The maximum water level expected at site is HFL 22.95m (MSL) with respect to the local TBM as per topographic survey map provided. Further, due to Climate change maximum 3.3 mm per year water level rise is envisaged based on Government of India document. Accordingly, maximum 132 mm (i.e., 13.2 cm) rise is expected in next 40 years from HFL 22.95m MSL to level 23.082m MSL.



Source: FSR, TCE

ES Figure 5 Schematic Diagram for SLF Base Levels at SLF Closure Stage

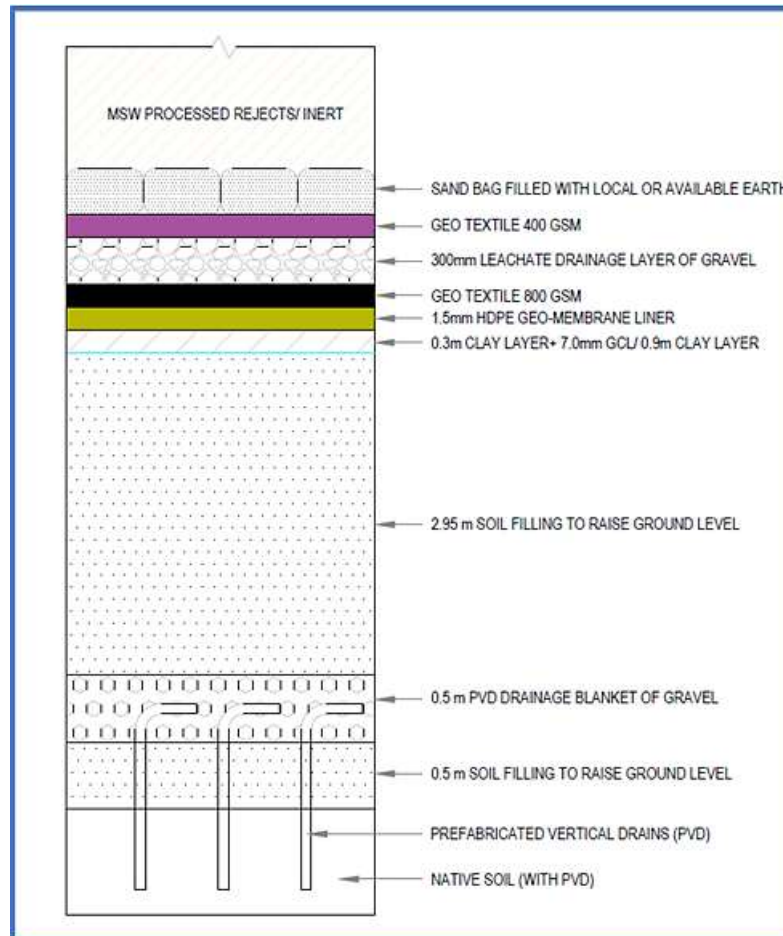
The existing ground level is planned to raise the ground by minimum 2m above HFL 22.95m MSL to level 24.95m MSL. Hence, there would be minimum buffer of 1.868m (24.95m MSL - 23.082m MSL = 1.868) even after 40 years from now based on above assumptions. The total rise envisaged in existing ground level is around 3.95 m (i.e. 1.95 + 2.00) to account for the water barrier between high flood level and SLF base, plus filling of 1.3 m for settlement allowance on eastern side and 1.64 m on the western side.

Ground Improvement

Ground improvement depths can vary between 3.8m to as high as 11.8m. It is envisaged to adopt PVDs (to accelerate the consolidation of weak clay layer).

SLF Subgrade Preparation

After installation of PVDs and raising the existing ground by 3.65 meter by filling with suitable material, the subgrade of well compacted 0.3 m thick soil of good earth/ murrum will be provided.



ES Figure 6 SLF Base Liners along with Base Subgrade soil 300mm thick

SLF Embankment and Base

The embankment as designed of height 3m, side slope 2H:1V with top width of 3m and bottom width of 15m will be constructed at site.

As per SWM Manual 2016 base clay layer of 0.9m thickness of permeability of $\leq 1 \times 10^{-7}$ cm per second (cm/s) is provided for the SLF base. However, it is proposed to replace the base clay layer of 0.9m thickness with clay layer of 0.3m thickness and Geo Clay Liner in order to reduce the dependence on good soil from borrow pit and reduce environment impact also. After construction of the SLF base subgrade of 300mm are made of compacted clay layer, the base liners such as Geo Clay Liner (GCL 7 mm Thickness with $k_f \leq 5 \times 10^{-9}$ cm per second (cm/s)) will be installed for bottom lining above 300mm clay layer. Above GCL then



HDPE Geomembrane on 1.5 mm thick will be installed, the geomembrane layer is employed to avoid leachate seepage. Only HDPE geomembranes that meet the standards of the GRI GM 13 or ASTM (American Society for Testing and Materials) specifications will be utilized.

Then above HDPE layer, the Geotextile of 800 GSM (GT-800 GSM) will be installed as per SWM Manual 2016 as the landfill height is more than 20 meters. It will act as protective layer for the HDPE Geomembrane. The GT-800 GSM act as a cushion will prevent piercing of the HDPE Geomembrane liner by drainage gravels. Above GT 800 GSM, then a 300mm thick layer of gravel or aggregates (size 20–25mm) will be provided as leachate drainage media/layer so that any leachate produced from waste/rejects/inert will be collected in a leachate collecting system. To collect the leachate and drain it to a leachate pond, the header and lateral HDPE pipes will be placed in the leachate drainage media/layer. The geotextile of 400 GSM (GT-400 GSM) is provided as filtration and separation layer above the leachate drainage media/layer. It prevents clogging of leachate drainage media/layer and perforated leachate pipe line. As a protective layer 200 mm of soil or soil bags is proposed to protect GT-400 GSM from solid waste Rejects/ Inert and landfill vehicular movement. Leachate pond of sufficient capacity shall be provided to store leachate, from which it will be removed for treatment in the Leachate Treatment Plant (LTP).

2.4 Leachate Drainage Layer

Above GT 800 GSM, a 300mm thick layer of gravel or aggregates (size 25–50mm) of hydraulic conductivity of $>1 \times 10^{-2}$ cm/s as per SWM Manual 2016, will be provided as leachate drainage media/layer so that any leachate produced from inert wastes will be collected in a leachate collecting system.

Estimation of Leachate

In order to fulfil the discharge standards, the leachate generation is estimated at rate of 26.23mm/sq.m/day. The leachate quantity estimated to the tune of 300 KLD and will be treated in 400 KLD capacity of LTP.

Leachate storage system

The leachate collection and solar evaporation pond is proposed for collection, storage and evaporation. The leachate pond is proposed for capacity of 1.8 days (~2 days) retention time. The leachate pond of 40m x 17m with height is considered as 1.2m. An emergency leachate storage pond of 22 days storage capacity is also proposed in GoK phase area to accommodate additional quantity of leachate in case of excess rainfall. It is proposed to collect the leachate first in the leachate Storage Pond as presented below and irrigate the same on the sloping sidewall of the pond and evaporate the maximum possible leachate. When there is heavy rainfall, the volume of leachate can significantly increase, making it more important to have an effective leachate management system in place. The capacity of LTP is planned accordingly (LTP Capacity is expected at 400 KLD higher than the daily generation) to meet the highest infiltration due to heavy rainfall.

The remaining leachate shall be supplied to the Leachate Treatment Plant (LTP) for treatment and disposal. The treated leachate shall be utilised for sprinkling, dust suppressing, and watering on the landscaping provided at the site and used as per PCB



norms. The sludge and sediments settled at the bottom of leachate storage pond shall be disposed as per PCB norms, rules, guidelines and conditions of consent to establish and operate on regular interval.

Leachate Treatment Disposal System

The leachate treatment plant of capacity 400 KLD is planned for full leachate generation volume that will cater in both KSWMP & GoK Phase.

The Leachate Treatment Plant consist of following components,

1. Primary Treatment

The Primary Treatment System comprises of Screening, Equalization, Neutralisation, Primary flocculation.

2. Secondary Treatment

The Secondary Treatment System comprises of Anaerobic Digester, Moving Bed Bio Reactor, Secondary Flocculator, and Sludge Handling.

3. Tertiary Treatment

The Tertiary Treatment System comprises of Chlorination, Multigrade Sand Filter, Activated Carbon Filter (ACF), Ultra Filtration (UF), Reverse Osmosis (RO), Multiple Effect Evaporator (MEE), and Agitated Thin Film Dryer (ATFD).

The anaerobic digester's where BOD/COD reduction will be achieved by virtue of anaerobic microbial activities. Two anaerobic reactors of 2750 KL capacity are proposed for the project. The overflow from anaerobic reactors goes to two stage Moving Bed Bio Reactors (MBBR) tanks of 900 KL capacity are proposed for the project. The bio-solids formed in the biological process in MBBR will be separated in the downstream secondary clarifier and reactive clarifier of proposed capacity of 70 KL tank. The flow of screw press for feed pump (2 nos.) and dewatering sludge (1 no.) of capacity 6 cum/hr is proposed. The expected quantity of sludge is about 6 kg/hr will be disposed in the drying bed provided along with LTP. The size of drying bed is 4m x 5m. The sludge will be tested for hazardous material by conducting (Toxicity Characteristic Leaching Procedure) TCLP test accordingly it will be disposed.

Primary treatment

Screening

The screening chamber is provided to arrest the floating materials from the leachate. The screen compartment is made of MS perforated material. The arrested material needs to be disposed off as per regulatory requirements. The bar screen chamber of 2.5 KL capacity is proposed for the project. The equalization tanks of 400 KL capacity (2 tanks of 200 KL capacity) are proposed for the project. The 10 KL neutralization tank is proposed for the project. The 3.5 KL capacity of flash mixer and flocculator is proposed for the project. The 70 KL of primary clarifier and 70 KL of intermittent collection tank is proposed for the project.

The chlorination contact tank of 70 KL capacity is proposed. The multigrade sand filter capacity flow of 20 cum/hr is proposed for the project. To eliminating adherent particles on



the filter media, filter backwashing is planned once in a day. The ACF flow capacity of 20 cum/hr is proposed.

The RO membrane which do not allow ions to higher sizes to pass through. The feed stream is split into two streams one is the permeate (product) which is low TDS and other is the reject containing all the rejected salts. Two stage RO process is proposed for the project. First stage RO (RO1) feed tank of capacity 120 KL is proposed whereas second stage RO (RO 2) feed tank will be reject tank of RO1 of capacity 60 KL. The product of RO1 & RO2 will be collected in combined tank of capacity 150 KL which can be reused other industrial needs. The 80 KLD RO reject will be further treated using Multiple Effect Evaporator (MEE) system using coal-based boiler as steam and distillate to be treated in Agitated Thin Film Dryer (ATFD) process. The salt remaining from the ATFD process will be sent to TSDF for disposal. The MEE is proposed having 4 effect forced circulation system, ATFD will be of 10 m², boiler of 2 tonnes capacity and cooling tower of 500 TR.

2.5 SLF Equipment

The landfill equipment two numbers of each, compactors, dozer, water tanker (5 KL capacity), tippers (10.5 cum capacity) front end loader with back – hoe are envisaged.

The stone pitching will be provided on the outer slope side to the SLF embankment in order to avoid soil erosion. Garland drains length of about 700m is considered (one on each South and North side) for proposed SWD planning. Two storm water drains from North-East to South-West flow direction are proposed on Northern and Southern side of SLF acting as garland drains. The interception and diversion hume pipes of 1.2m diameter is proposed at every 100m distance all around the perimeter towards north and north-west side of the SLF footprint area. It is estimated that the surface run-off will be to the tune of about 4694 cum/hr during normal rainfall and about 9306 cum/hr during torrential rainy days. A flood protection dyke/earthen embankment of about 900 meter is provided below the green belt along northern and western periphery of the site to avoid influx of flood water and to confine the filled up soil material for the footprint of SLF.

2.6 Final Closure layers of Scientific Landfill

Once the waste has been filled to the designated capacity in the Scientific landfill, it will be capped/closed to prevent rainwater ingress. To minimize storm water infiltration in the landfill body a surface sealing system will be built following the final completion of each landfill portion. The closure cap liner system, Scientific landfill closure, will consist of the capping liner layers in line with the SWM 2016 Rules.

The top layer will be of vegetative soil of 45 cm thickness with the slope of top cover will be 1:4. This layer will aid in the growth of the grass. Grass will help to avoid erosion during the wet season. Coir mesh is proposed on the surface of the scientific closure to reduce the erosion of top cover soil.

2.7 Landfill Gas Management

Since, Ambalamedu landfill is going to receive rejects which are inert in nature. There is very little organic content in rejects going into the SLF, the chances of landfill gas generation is



also very low. As such it has been suggested to have a passive gas venting wells placed at every 2500 sqm intervals to remove the landfill gas.

2.8 Raw material requirement

About 7.0 Lakh cubic meter plus 3 lakh m³ for preloading is estimated to borrow material which will be sourced from nearest filling earth mines which is having valid Environmental Clearance. The sand, cement, steel and aggregate requirements are approximately 283 tonnes, 65 tonnes, 1440 tonnes (course & fine aggregates) respectively.

2.9 Green belt

The Plantation of native species plant and trees are proposed with width of 10m wherever possible or else at the minimum of 2m along the periphery of the site as green buffer to control ambient air quaintly and for better aesthetics and the total area covered by green belt is 68,283 sq.m after completion of both KSWMP & GoK phase.

2.10 SLF Allied Infrastructure

A temporary access to the site is existing at present. A permanent concrete approach road is planned to be developed. In addition compound wall, entry & exit gate, site office, weighbridge & security Surveillance, water connection, supply and storage, parking, vehicle cleaning & washing area and workshop, odor, dust & fire control (water tanker) ground water monitoring well/Piezometer are part of the project will also be provided.

3 Description of the environment

An area, covering a 10 km radius around the project site for the purpose of the baseline studies. Primary data on micrometeorology, ambient air, noise, traffic, soil, water, flora-fauna & socio-economic data were collected during the monitoring period of December 2023 to February 2024. Secondary data was collected from various departments of State/Central Government Organizations, Semi-Government and Public Sector organizations. The scope of the study has been carried out as per Standard/approved ToR by SEIAA Kerala vide ToR Identification no TO24B3401KL5888163N dated 08-08-2024.

3.1 Site specific meteorology

The continuous weather monitoring station was installed at project site to collect the micro meteorological parameters. The wind rose pattern for the period from December 2023 to February 2024 was collected. From the wind rose, it can be observed that the wind is predominantly from ESE and WNW.

The project site and its surrounding area s witnessed with dendritic pattern. From the drainage pattern, it is evident that the project area is bestowed with good drainage facilities and the area is not inundated by flood. From the drainage map, it was concluded that ephemeral drains which are located around the site not affected. It is also evident from the drainage map that, Chitrapuzha river facilitate the drainage system.

3.2 Hydrogeology

The ground water regions are witnessed with surface water break in the North West and south as the site is surrounded by Chithrapuzha River. Hence, the groundwater table



measurements are confined to eastern side. A total number of 34 wells have been inventoried during the study period the water level ranges from 0.75m to 10.28m during the pre-monsoon season. Whereas in post-monsoon the levels are recorded from 0.35m to 9.68m. 34 groundwater samples have been collected during hydrogeological studies from the inventoried well and the analytical results are in conformity with drinking water standards. The deep fractured rock has transmissivity ranging from 15.64 to 319 m²/day. As per CGWB, the groundwater exploitation the area falls in SAFE category. The groundwater slopes generally follows the topographical features and towards East direction. The groundwater movement is observed to be 4 to 5 m/d.

3.3 Land Use pattern

The land use pattern within 10 km radius based on IRS-P6. From the LU/LC studies, it could be corroborated that, the project area falls under grass land and covers about 1.12 sq.km and the built-up area is predominant to the extent of 221.42 sq.km (about 70.34%). River and canal system occupies about 15.23 sq.km. The second predominant land is agricultural land which is about 23.06 sq.km.

3.4 Air environment

Eight locations were identified for establishing ambient air quality monitoring covering industrial, residential and commercial areas. This also includes up, down and cross wind directions for the parameters such as PM₁₀, PM_{2.5}, SO_x, NO_x, and CO as per ToR requirements. In addition, the other parameters in line with NAAQ have been recorded and included in the baseline. All the recorded values with respect to AAQ are well within the AAQ norms. The recorded pollutants concentration ranges are as follows:

PM₁₀ = 37 – 64 µg/m³

PM_{2.5} = 17 – 28 µg/m³

SO_x = 5.1 – 11.6 µg/m³

NO_x = 12.7 – 22.9 µg/m³

CO = BDL (<0.1) – 0.31 µg/m³

3.5 Surface and groundwater quality

In case of surface water quality, three samples were collected from the various sources like river and ponds. The tested parameters are within the prescribed norms of Designated Best of Use of CPCB, Class 'B' norms. Total Coliform is exceeding the limit of 500, and biological oxygen demand is exceeding in SW1 by 7mg/l. the reason could be attributable to untreated discharge of sewage in Chithrapuzha river

Akin to surface water, ten groundwater samples were also drawn considering up and down gradient with respect to proposed SLF from existing bore wells and open dug wells in the study area and the tested results are compared with the standards (IS 10500: Indian Standards/Specific for Drinking water) reference values. It was observed that most parameters are well within the permissible limits of drinking water norms of IS: 10500 except Odor in GW1 & GW2 were agreeable and odorless at rest of the locations. The reason could be the sample location is surrounded by various oil storage plant and other fertilizer



industries. On the whole, the groundwater quality in the study area is observed to be good and suitable for domestic consumption.

Aluminium, Selenium, Phenolic Compounds, Copper, Cadmium, Mercury, Nickel, Total Arsenic, Total Chromium and Cyanide in all groundwater samples were found below detection limit.

3.6 Noise Environment

The noise level have been identified industrial, residential, commercial and silent zones. The maximum Leq. values at study area for day and night time was observed to be 58.3 dB(A) (N6) & 48.4 dB(A) (N6) respectively, and minimum Leq. values at study area for day and night time was observed to be 47.9 dB(A) at N1 & 41.6 dB(A) at N1 respectively. However, the recorded noise levels were found within the CPCB limits.

3.7 Soil Environment

For studying soil quality of the study area, eight (8) sampling locations were selected to assess the soil conditions in and vicinity of the project area based on various land use conditions. The samples have been analysed as per the established scientific methods for physio-chemical parameters and standards of Indian Council of Agricultural Research soil classification

The pH of the soil samples ranged from 6.49 to 7.45 indicating the neutral in nature. The electrical conductance of the soil samples varied from 0.084 $\mu\text{S}/\text{cm}$ to 0.318 $\mu\text{S}/\text{cm}$ based on the Conductivity results it can be concluded that the ionic content of the soil samples is within the limits that does not harm the crops. Bulk densities of the soil samples varied from 1.22 to 1.38 gm/cc.

Available nitrogen in the soil samples varied from 81 kg/ha to 248 kg/ha which is indicating in good quantities in the soil samples. Available phosphorus in the region varied from 19.7 kg/ha to 71.8 kg/ha revealing the distribution from medium to average sufficient quantities. Available potassium levels in the samples ranged from 244 Kg/ha to 382 Kg/ha, which is indicating average quantities in the soil samples. From the above observations, it was found that the soil in the study area shows moderate fertility and ideal for plant growth. Soil amendment is not required for any plantation purposes.

3.8 Biological Environment

The assessment of the flora of the study area is carried out by an extensive field survey of the area of 10 km radius. The project area covering 10 km radial distance reveals the presence of FACT Forest located at 2 km towards East, Mangalavanam Bird Sanctuary located at 9.3 km towards West and Protected Area located at 0.95 km towards West of the study area. The results of survey exhibited dense vegetation with the existence of 179 terrestrial flora. However, coconut, Neem and Acacia trees are abundant widely distributed away from the study area. A total of 67 species of trees found in the study area along with 23 shrubs and 54 herbs 33 Climbers and 2 epiphytes.

As per IUCN red list *Borassus flabellifer* categorized as endangered species. During the vegetation survey in the study area no other species found to be endangered or threatened under IUCN (International Union for Conservation of Nature and Natural resources)



guidelines. The study area is marked with moderate population of fauna. With reference to the Wildlife Protection Act 1972 (Last Updated 1-4-2023) a total number of wildlife tabulated in this study is about 79 species belongs to schedule II, 3 species belongs to Appendix II and 2 species belongs to Appendix III of Wildlife protection Act, 1972 (Last Updated 1-4-2023).

3.9 Marine Environment

Seabed sediment and sea water samples were collected from 3 locations within 10 km radius of the project site. The collected marine sediment samples were analyzed and results of sediment analysis are pH 7.68 to 7.97, TOC content in marine sediment samples ranges from 3.11 to 3.99 %. Phosphorus 216 to 309, Iron ranges from 687 to 915: Zinc 80 to 119 mg/kg, Manganese 102 to 148, Lead 7.14 to 10.7 Chromium 6.6 to 23.7, Copper 29.6 to 32.8 mg/kg. Cadmium, Nickel, Mercury, Selenium, Total Arsenic, Total Petroleum Hydrocarbon in all intertidal sediment samples were found Below Detection Limit (BDL). The Seawater Salinity 18.6 ppt to 26.9 ppt, turbidity 2.1 to 2.7 NTU. The DO level of the marine samples found to be in the range between 6.4 to 6.8 mg/l. The BOD level of the marine samples found to be <2 mg/l.

Manganese, Lead, Cadmium, Nickel, Chromium, Copper, Mercury, Selenium, Total Arsenic, Cyanide, Total Petroleum Hydrocarbon in all Marine water samples were found below detection limit.

3.10 Anticipated Environmental Impacts and Mitigation Measures

Proposed landfill site is discussed under two categories viz. Impacts and mitigation measures during construction and impacts and mitigation measures during operation. Site works for SLF consists of preconstruction activities like site clearing, construction of access road, levelling and raising the ground level to above the flood level. Construction of the bottom liner system, leachate collection and treatment plant, SW drainage system and land fill gas collection and venting system are actual SLF activities.

3.11 Impacts & mitigation measures during construction phase

As the project site admeasuring about 25 acres and the proposed land requires shifting of HT lines, levelling and laying of approach road. Site clearing activities like removal of bushes, transplantation and levelling are expected. Hence, the impacts on air, water, noise and soil within close proximity of the project site is expected during construction phase. It is planned to approach KSEB for shifting the lines away from the proposed SLF site. Initially, KSEB will carry out the preliminary survey followed by detailed profile survey, tentative tower locations, geotechnical Investigation etc. as per their SOP. The design consists of sag analysis, foundation of towers etc. and detailed cost estimate. On remitting the cost by KSWMP, the work will be started by KSEB.

Ambient air quality monitoring and noise monitoring shall be conducted during dismantling and excavation works to conform the standards applicable to industrial area. All good construction practice and compliance with OSHA norms shall be ensured. C & D waste generated shall be utilized for reused for construction purpose of SLF.



Site clearing and levelling

It is plan to transplant the existing tree to the proposed green belt around the site. Species like Mango, Neem, Charu, Anjili have been planned for transplantation. The girth which are greater than 40 cm are expected to be about 10 – 15 in numbers which is also not planned for transplantation. Whereas, the girth less than 30 cm is expected to be about 100 in numbers are planned to be used in the greenbelt. It is also planned to remove about 30 numbers of trees having girth of 40 cm a suitable greenbelt will be developed as mitigation measures.

The construction period (for both KSWMP & GoK phases) is expected to be prolonged for 28 months. Hence, it can be stated that the impacts if any, will be short term impact and the remedial measures likely to be taken at the time of construction. The estimated quantity of filling material required for the project is about 7,00,000 m³. The filling is planned to be carried out during the non-peak hours to avoid traffic congestion and different approach routes to reach the site.

The borrow material will be excavated from the area identified for earth mining and should have proper EC to meet the quantity of 7,00,000 m³. The scientific landfill site will be prepared in such a way so as to avoid surface discharge of soil or silt (run off). Suitable surface drains along with settling traps are planned to be provided to avoid siltation of the surface water. Moreover, it is planned to start the filling operation after monsoon which will help in reducing fugitive dust generation as well as siltation/run-off.

The internal access roads (7m wide) for the landfill site of about 1306m in length is also planned. In order to avoid fugitive dust generation and spillages from the trucks, the trucks will be covered by tarpaulins and by controlling the speed of vehicles along with wetting of roads. The construction site will be cordoned by wind curtains to control fugitive dust dispersion. During construction of LFG lines and leaching protection liners, the quality of materials such as HDPE geomembranes and pipes are to ensure the LFG collection system is durable, leak-proof, and resistant to degradation over time. Construction of vertical and horizontal gas collection pipes to collect and remove gas from the landfill are ensured.

The drainage density of project site is 0.6 km/sq.km and the top soil layer is unsaturated with low infiltration capacity of clay soil and it is concluded that ephemeral drains which are located around the site not affected. The annual average run-off volume increases from 1,16,493.76 m³ to 1,76,347.58 m³, showing an increase of 59,853.89 m³ of run-off about 33.9% in post construction. A suitable surface water drain is planned to control the surface run- off flood. The SLF project involves in land disturbance as the land is mildly undulated and disturbance is restricted to 25 acres. Hence, soil erosion if any is limited to 25 acres of land. A minor amount of erosion may occur due to filling activities of twelve months period which can be controlled by providing suitable SWD with silt trapping facilities.

To ensure that there is no health risk or damage to amenity due to dust emission, implementing a dust prevention strategy like wind curtains all around the site, implementing dust suppression measures, such as wetting of exposed areas twice a day are planned. During construction phase, strict administrative measures will be enforced to store all



materials such as aggregate, sand, bricks in earmarked places. Material like cement will be stored under covered sheds.

Minimize the quantity of uncontaminated storm-water entering cleared areas. cut-off or intercept drains to redirect storm-water away from cleared areas and slopes to stable (vegetated) areas are planned. Water velocities by providing mild slopes in the drains are planned. All the internal roads will have surface drain with the width of 1200mm and depth of 1100mm about 1306m length will be provided which will collect the surface water according to terrain height. The SLF area of drainage is considered into two parts i.e northern half and southern half. The interception and diversion hume pipes of 1.2m diameter is proposed at every 100m distance all around the perimeter towards north and north-west side of the SLF footprint area.

The contractor's labourer will be accommodated by the contractor in the surrounding villages. During construction of SLF, labour camps are not envisaged inside the SLF site. It has been estimated that during construction phase maximum of 200 persons may be temporarily deployed from the nearby villages.

A green belt to tune of about 13,155 sq.m. In addition to this, foot prints of proper SLF of about 70,000 sq. m will be covered by grass land at the final stage of closing of SLF.

Air Quality

During the construction phase, the major pollutant of concern will be particulate matter (PM_{10} and $PM_{2.5}$). Water sprinkling will be done for dust suppression to all inactive disturbed surface areas on regular basis especially during dry and windy days. Wheel washing will be for vehicles from the construction site to reduce the mud and dirt. The vehicle speeds on unpaved roads will be restricted to 15 – 20 kmph. Pollution Under Control (PUC) certificates and Bharat IV compliance certified vehicles will be used. All material laden trucks will be covered with tarpaulin sheets to prevent fugitive dust emissions during transportation of filling materials.

The gaseous pollutants namely CO, and NO_x released due to construction vehicular exhausts are noxious in nature. As said earlier, the construction phase is temporary and ceases after a few months. As such the load of gaseous pollutants generated will be for a short duration of time. In order to estimate emissions associated with the construction mainly due to filling factors like daily number of vehicles which are plying at site increases the ground level concentration are taken into account.

In the present case, AERMOD view dispersion model has been used. The emission factors applied in the analysis were calculated based on the Upward Flux Method for estimation of fugitive emissions and based on the Bharat Stage-IV standards of vehicle at optimum operating conditions in haul roads of length 1km. For the modelling purposes, the Sulphur dioxide has not been considered since the vehicle's SO_x emission is almost nil due to introduction of BS-IV norms for the oil companies.

From the air quality modelling isopleths, it is evident that the GLC increases during the construction phase. In this case, the transportation of material in haul road (unpaved approached road) was considered for a distance of 1 km from the SLF site on the FACT



road. The maximum GLC observed during the construction phase is $23.3 \mu\text{g}/\text{m}^3$, $2.04 \mu\text{g}/\text{m}^3$, & $1.07 \mu\text{g}/\text{m}^3$ for parameters PM, NO_x & CO respectively.

Wet suppression and wind speed reduction barriers will be used to control open dust sources at construction sites. Stringent construction material handling/overhauling procedures will be followed. Truck carrying soil, sand, stone dust, and stone will be duly covered to avoid spilling and fugitive emissions. Safety equipment for the workers like dust mask will be provided. Monitoring of air quality at regular intervals will be conducted during construction phase in line with the requirements of SPCB.

Surface water

The impacts on surface water quality during construction phase mainly arise due to site clearing and ground level raising etc. A levelling and filling activities normally increase the level of suspended solids in the surface water run-off. The mitigation measures are construction wastewater generated from site will be controlled through the drainage system with sediment traps (silting basin/water intercepting ditch) for arresting the silt/sediment load before its disposal. All the washable construction material will be stored under sheds or enclosed space by fencing it with brick or earth in order to prevent spillage into the drainage network, so that the same does not find its way into the surface water run-off.

Groundwater

The groundwater will not be extracted for construction work. The construction water is estimated about 35,000 litre which is sourced from private water tankers. Any significant modification in the ground water regime of the area is not anticipated. Therefore, the construction phase of the proposed SLF site will have insignificant impact on the ground water.

Noise levels

Noise on construction site results from machinery used for excavation, levelling and from fixed machineries such as compressors, concrete mixers and dumpers. It is predicted that the noise levels in the surrounding environment due to above said noise sources at a distance of 100m will be 78.4 dB(A) and at 500m will be 69.7 dB(A). It is also predicted that the noise levels from these sources at 1500m distance will be 64.0 dB(A). Therefore, background noise levels in the nearest settlements which is located at a distance of about 500m beyond will not be receiving any impact. Further, the above prediction is without any attenuation factors like green belt, wind curtains etc. It is expected that with mitigation measures it will be limited to ambient level.

Traffic management

The existing traffic and LoS in SH-41 LoS is excellent. The additional load due to plying of vehicles laden with filling material will reduce the Level of Services to some extent but it is for a filling period of twelve months. The number of additional trips of the trucks will be about 100/day in addition to existing traffic flow. This can controlled by multi sources of filling material and reaching the site via all possible directions.



4 Impacts and Mitigation Measures During Operation

The operational activities of the project are likely to have some stress on the environment. The land use pattern of 25 acres will be converted into built-up area which is the predominant land use within 10 km radius. A meagre amount of landfill gas is expected and will have gas vents. Domestic effluent generation is very less as the operation phase manpower is only 85 nos. Leachate generation may cause groundwater pollution. The environmental parameters likely to be affected are quality of air, groundwater, and soil/land due to release of LFG from SLF.

Air quality

From the present environmental scenario, the existing air quality status has been reviewed. It was observed that the maximum of all C98 pollutant concentrations in the study area for PM₁₀, PM_{2.5}, SO_x and NO_x are 58, 27, 5.4 and 19.4 µg/m³ respectively. These concentrations are due to the emissions emitted into the atmosphere from the existing industrial activities in the area, road transport as well as due to urban activity in the study area.

Based on the above, the emissions have been predicted for the proposed SLF project for operation phase. Air quality modelling isopleths have been shown in Figure 4-2, 4-3 & 4-4 for PM, CO & NO_x respectively. From the result, it is evident that the GLC increases during the operation phase due to reduced vehicle operations when compared to construction phase. In this case, the transportation in haul road was considered for 1 km distance from the SLF site to the Fact road. The maximum GLC observed during the operation phase for parameters PM, NO_x & CO 2.66 µg/m³, 0.322 µg/m³, & 1.07 µg/m³ respectively. The incremental concentrations at the baseline monitoring locations(receptors) are given in ES Table 4 which is well within the air pollutant limit prescribed by CPCB.

ES Table 4 Resultant concentration due to proposed activity during construction stage

Pollutant	Monitoring Station	Concentration (µg/m ³)			Permissible Limit (µg/m ³)
		Max. Baseline	Incremental	Resultant	
Particulate Matter	AAQ 1	48	13	61	100
	AAQ 2	51	8.03	59.03	
	AAQ 3	62	7.87	69.87	
	AAQ 4	51	2.92	53.92	
	AAQ 5	57	2.09	59.09	
	AAQ 6	64	1.41	65.41	
	AAQ 7	56	0.16	56.16	
	AAQ 8	58	0.26	58.26	
Oxides of Nitrogen	AAQ 1	14.7	1.37	16.07	80
	AAQ 2	17.2	0.85	18.05	
	AAQ 3	19.4	0.95	20.35	
	AAQ 4	16.7	0.28	16.98	
	AAQ 5	18.1	0.26	18.36	
	AAQ 6	22.9	0.21	23.11	



Pollutant	Monitoring Station	Concentration ($\mu\text{g}/\text{m}^3$)			Permissible Limit ($\mu\text{g}/\text{m}^3$)
		Max. Baseline	Incremental	Resultant	
	AAQ 7	17.2	0.02	17.22	
	AAQ 8	19.4	0.03	19.43	
Carbon monoxide	AAQ 1	0.1	0.72	0.82	2
	AAQ 2	0.17	0.45	0.62	
	AAQ 3	0.28	0.5	0.78	
	AAQ 4	0.1	0.15	0.25	
	AAQ 5	0.26	0.14	0.4	
	AAQ 6	0.31	0.11	0.42	
	AAQ 7	0.27	0.01	0.28	
	AAQ 8	0.29	0.01	0.3	

Methane Calculation

The IPCC guidelines enumerates, to estimate the annual emission based on the Mass Balance Calculation which is considered for SLF which reflect the worst-case scenario of SLF. The estimated methane emission from the SLF are shown below:

Average methane generation tonnes per year = 10,364.5 t/yr

Average methane generation tonnes per sec = 0.000328 t/s

Average Methane generation gram per sec = 3.28×10^{-11} g/s

Average methane generation in terms m^3/s = $3.28 \times 10^{-9} \times 0.657 = 2.15 \times 10^{-9}$

Average H_2S generation is 30% of total methane = $2.15 \times 10^{-9} \times 0.30 = 0.645 \times 10^{-9} \text{ m}^3/\text{s}$.

As the generation is very meagre the SLF is safe and does not warrant for further analysis. In order to mitigate the meagre emission LFG vent is provided at a distance of every 2500 sq.m of SLF disposal footprints.

Noise Environment

The proposed project related activities will lead to minimum generation of noise due to vehicular movement that may have minor impact on the surrounding communities in terms of minor increase in background noise levels.

Initially, it is expected 4 trucks per day with 40 ton capacity each will be deployed to SLF site to dispose the inert waste collected from various places by RCV/static compactor. Similarly, one dozer will be operating at SLF to compact the inert material. The operation of dozer at SLF site will be maximum of 2 hours in a day. Most of the machines will be working intermittently during operation of the proposed facilities. However, these machines would be housed in acoustic enclosures in such a way that they would not be contributing any additional noise levels in the surrounding environment.

In view of this, the propagation modelling considered for operation and the predicted noise level at source during operation is 100 dB(A). The results of the noise modelling reveal that the maximum noise level will be 100 dB(A) at project site due to the SLF activity. The noise level at 100m, 500m and 1500m is predicted using Dwani Pro software and the predicted levels are 75, 40 and 25 dB(A) respectively. The results are predicted without any attenuation factors. It is expected with attenuation factors as given in mitigation measures will reduce



the noise level to the extent possible/within the permissible norms. The mitigation in order to avoid any permanent noise source to the people working inside the SLF site are acoustic enclosures on dozer and DG set at the site is provided for noise attenuation. Workers will be provided with suitable personal protective equipment (PPE) such as earmuffs, earplugs etc., moreover suitable green belt will be developed to reduce noise level.

Traffic management

The existing traffic and LoS in SH-41 LoS is excellent. Hence, the additional load on the carrying capacity of the concern roads is not likely to have any change in the LoS value. The traffic flow during operation will be to the tune of four to five vehicles per day.

Water Environment

The total water requirement during operation phase is estimated to be about 3 KLD which will be sourced from Kerala Water Authority (KWA). On Operation, the SLF wastewater generation from leachate is estimated to be about 300 KLD which will be treated in Leachate Treatment Plant (LTP) having capacity of 400 KLD. The entire treated water of 300 KLD planned to be used for industry which requires the water in the nearby areas as per the designated use of the treated water.

Biological Environment

The impact on terrestrial ecology will be due to emission of gaseous pollutants like methane. The gaseous pollutants generation is at a very low dose. The methane emissions during the operation phase will be restricted within the norms. Development of adequate green belt at and around the site will help in reducing the impacts on the flora and fauna as the plant species will act as air and noise pollution sink.

The closure profile of SLF KSWMP phase plus GoK Phase (Combined) is planned and proposed based on the available footprint area and required capacity with capping slope of 1:4 with berm of 3m width at required intervals of height to ensure slope stability, smooth movement of landfill vehicles and post closure maintenance. After closure, no construction activities of any sort will be permitted without scientific evidence for utilizing the site for any other purposes. The remaining plant area of 27,559 sq.m will be used for next 15 years as a maintenance period. Once the waste has been filled to the designated capacity in the Scientific landfill, it must be capped/closed to prevent rainwater ingress. The primary goals of the final cover system are closure cap liner system for scientific landfill will consist of the layers which is in line with the SWM 2016 rules

4.1 Compacted Clay Liner (CCL)

The mineral material (60 cm) will be of clay or amended soil and should satisfy permeability requirements of $k = 10^{-7}$ cm/s. However, due to dearth of good soil for clay barrier, it can be replaced by 300 mm thick compacted and further supplemented with Geosynthetic Clay Liner (GCL). The first layer on top of the waste material will be 300 mm thick compacted soil. To function as an effective barrier, the CCL will have a low permeability. To attain this permeability, good quality soil must be utilized and it must be compacted to 90% proctor density. Adequate testing must be performed to guarantee that the desired density is obtained. It also recommended to use 10% lime to improve soil qualities.



GCL is planned in addition to CCL, since, it is difficult to obtain desired permeability using locally available soil. GCLs are hydraulic barriers that are factory manufactured and comprise of a layer of Bentonite or other very low permeability material and/or Geomembranes that are mechanically bonded together by needling, stitching, or chemical adhesives. GCL's single and clear primary function is that of a liquid barrier. To ensure proper GCL installation, all standards for laying will be rigorously followed. The top layer of vegetative soil of 45 cm thickness with the slope of top cover 1:4 is planned to aid the growth of the grass which will help to avoid erosion during the wet season.

This landfill is proposed only for disposal of Inert and solid waste process rejects, however small amount of organic matter reaching SLF is inevitable. Due to the anaerobic decomposition of the organic material in the landfill, landfill gas likely to be generated. Basically, this gas consists of methane and carbon dioxide. Both passive venting and gas collecting under suction pressure are prevailing methods for handling the gas. As such it has been suggested to have a passive gas venting wells placed at every 2500 sq.m intervals to remove the landfill gas.

5 Analysis of alternative site and technology

Before identifying the location of Amballamedu, two alternative sites have been considered for the project activity. The availability of land and other regulatory criteria as required to meet the site selection considerations and after analysing the permutation and combination of all the sites, this present site at Ambalamedu SLF has been finalized. Based on the land availability and compliance to CPHEEO/SWM guidelines the Ambalamedu site is chosen. The technology envisaged for the project is customized civil work and suitable for identified site.

6 Environmental monitoring program

Regular environmental monitoring for air quality, water quality, noise levels and soil quality program is also detailed in this chapter. The equipment for monitoring will be procured or the work of monitoring will be out sourced by SLF operating authority.

Ambient air, noise, surface water, groundwater quality around landfill site, inert waste characterization, soil and leachate water, flora and fauna are to be monitored on regular basis of once in six months. Monitoring of all environmental samples will be done as per the guidelines and protocols of MoEF&CC/SPCB.

The estimated environmental cost for the project is INR 3,25,00,000 which includes CER cost of INR 2,74,00,000. The monitoring cost for year is earmarked to the tune of INR 36,00,000/- excluding equipment cost. In addition, for occupational health & safety issues, development of green belt of about Rs. 15,00,000/- will be allocated for every year.

6.1 Documentation and reporting

Methodology of monitoring (sampling and analysis) will be prepared as separate documents as SOP (Standard Operating Procedure) wherever required. The records of the monitoring will be documented. Immediately upon the completion of monitoring as per the planned schedule, report will be forwarded to the concerned regulatory agencies.



7 Additional studies

The additional studies are pertaining to three multidisciplinary areas pertaining to this project. The first is concerned with the public consultation which will be held by pollution control board on receipt of draft report EIA/EMP report. The second is risk assessment study prevailing at present in the study area and the likely impact as a result of implementation of the proposed project. The third one is social Impact assessment that may arise due to the proposed project.

7.1 Risk Assessment

Risk assessment is primarily carried out to identify and quantify the major hazards and the risk associated with disposal at project site, which may lead to emergency consequences (disasters) affecting the public safety and health. The emergency preparedness plan is prepared to mitigate the consequences. For this, the approach involves hazards identification, hazard assessment and evaluation. The major hazards anticipated are w.r.t project is fire in SLF area, Natural disaster (earthquakes, flooding etc.), rainfall induced erosion and slope instability etc. and land sinking/unequal settlement. The natural disasters will be coordinated with District Disaster Management Authority. The project specific disasters like fire, slope instability and subsidence are taken care while designing the SLF.

The occupational safety, health and working conditions code, 2020 will be followed. All employees will be trained read the safety statement, with managers and supervisors being fully aware of the statement's implications. High visibility clothing will be provided and worn by all site staff and visitors. Safety boots, goggles and facemask will be issued to all site workers. They will have steel toecaps and have a steel insert in the sole to resist injury from projections of glass, metal or other items in the deposited wastes.

The type of glove will be puncture resistant and will be suitable for the relevant task, e.g. litter collection, vehicle fueling, cold weather conditions. Safety helmets and eye protection will be provided. Ear defenders will be available for those driving site machinery or working in high noise areas. Operatives at landfill sites working all weather conditions and will need to be provided with suitable windproof wet weather clothing.

7.2 Socio – Economic

Baseline data according to the 2011 census, the study area of Vadavucode Puthencruz panchayath is rural area in which the number of households are 5,638. The total number of population is 22,378 in which the male and female population is 11,014 and 11,364. The male and female scheduled caste population is 2,348 and 2,385. The male and female schedule tribe population is 331 and 360. The male and female literate population is 70,061 and 68,749. Thripunithura municipality is an urban area in which the number of households are 28,971. The total number of population is 92,550 in which the male population is 45,298 and the female population is 47,252. The male and female scheduled caste population is 5,175 and 5,375. The male and female scheduled tribe population is 131 and 127. The male and female literate population is 41,045 and 42,204. Thrikkakara municipality is urban area in which the number of households are 19,348. The total number of population is 77,319 in which the male and female population is 38,035 and 39,284. The male and female schedule caste population is 3,487 and 3,636. The male and female scheduled tribe population is 188



and 192. The male and female literate population is 33,348 and 33,353. The Kochi corporation is the urban area in which the number of households are 1,58,535. The total number of population is 6,33,533 in which the male and female population is 3,12,358 and 3,21,195. The male and female scheduled caste population is 10,893 and 11,393. The male and female scheduled tribe population is 1,214 and 1,130. The male and female literate population of Kochi corporation is 2,77,690 and 2,82,463. Kizhakkambalam panchayath is the rural area in which the total number of households are 5,551. The total number of population is 23,186 in which the male and female population is 11,375 and 11,811. The male and female scheduled caste population is 1,072 and 1,095. The male and female scheduled tribe population is 27 and 44. The male and female literate population is 9,918 and 9,912. Thiruvaniyoor panchayath is the rural area in which the total number of households are 6,413. The total number of population is 25,327 in which the male and female population is 12,438 and 12,889. The male and female scheduled caste population is 2,348 and 2,385. The male and female scheduled tribe population is 74 and 99. The male and female literate population is 9,733 and 9,677. During Focus Group Discussion people were apprehensive about fire accident due to disposal waste as the knowledge about the inert was not understood thoroughly.

8 Project benefits

The benefits arising from the project is improved environmental, living conditions and public health in the vicinity of project site. Benefits are achieved through more effective removal of waste from in and around inhabitant areas and prevention of pollution arising due to accumulation of solid waste and the waste leachate entering into the drains, waterways and groundwater. Improved disposal of waste will also result in more pleasant surroundings by a reduction in odor and an improvement in the aesthetic quality of drains, waterways, low-lying areas and other areas where waste is dumped.

From the proposed project the major benefit is improving the degraded environment by establishing a Scientific Solid Waste Landfill facility. As a result of the proposed project there will be horizontal and vertical benefits to society and environment respectively by providing employment and expenditure of CER at the project site which improves the living standard.

9 Environment Cost Benefit Analysis

Environmental Cost Benefit analysis is not recommended at the scoping stage. Hence, it is not required as per the standard/Specific ToR given by SEIAA – Kerala vide ToR Identification no. TO24B3401KL5888163N, dated 08-08-2024. However, this chapter provides the information regarding the capital cost of the project and expenditure for the implementation of environmental mitigation measures which is about INR 274.79 crore and INR 3.25 Crore respectively. The safety measures like fire hydrant, slope stability, surface run-off drains are included in the capital cost of the project. Other features like Leachate Treatment Plant and capping of SLF forms integral part of the project are included in the capital cost.

10 Environmental Management Plan

The Environmental Policy of KSWMP emphasizes "adopting environmental management system and continual improvement in environmental quality by applying best available



practices". In line with KSWMP/SLF management's commitment for environmental protection, the project strives to conduct processing operation in compliance with relevant environmental legislations and regulations. Employ best management practices and environment control for sustainable development of the region. Consider regional carrying capacity in resource and pollution discharge related decisions and give emphasis to conserve energy, other natural resources and minimize waste generation. The Cost of the EMP is about 7.87 Crore.

10.1 Environmental Monitoring Cell

It is imperative to establish an effective organization to implement, maintain, monitor and control the environmental management system. A separate section Environmental Monitoring Cell (EMC) has been established to carry out day to day environmental Monitoring and inspection of SLF site. The environmental monitoring cell comprises of environmental engineer, chemist, lab assistant and other supporting staffs. The various Standard Operating Procedures (SOPs) planned to be followed are dust control procedure, noise control procedure, leachate treatment plant procedure, inert waste disposal procedure, fire-fighting procedure

Dedicated safety committee will be constituted are functions and operation of SLF. The safety committee looks after and reviews the safety aspect of the operations involved in disposal. The safety committee comprises of engineers, medical officer, environmental engineer, workmen, occupational health in- charge etc. The committee reviews the safety aspect of the operations periodically and the minutes of the meeting is communicated to higher management. The recommendations of the committee as well as corrective actions are planned to be implemented.

A surveillance for environmental parameters is carried out under EMC in SLF. Guidelines of KSPCB, MOEF&CC will be followed. EMC will carry out monitoring of all relevant parameters with respect to hygienic significance for SLF and surrounding natural environment. The monitoring data generated on routine basis serve as tools for assessment and control of operations impact; and to ensure environmental protection and to demonstrate the regulatory compliance as and when required. The basis of control measures to be adopted is in line with recommendation of SEAC.

The EHS head is assisted by chemists, laboratory assistants and other staffs. Services of forest officials are also taken for effective implementation of plantation and capping schemes. For development and maintenance of jobs like drainage, clearing settling pits etc. assistance from the SLF's civil engineering department will be taken. The officers of the department meet frequently to assess the progress and analyses the data collected during the preceding fortnight/month.

10.2 Project Cost

The estimated project cost is INR 274.79 crore. A good fraction of about Rs. 3.25 crore of the project cost is earmarked towards pollution control measures and CER. The project is scheduled to be completed in a period of 28 months

