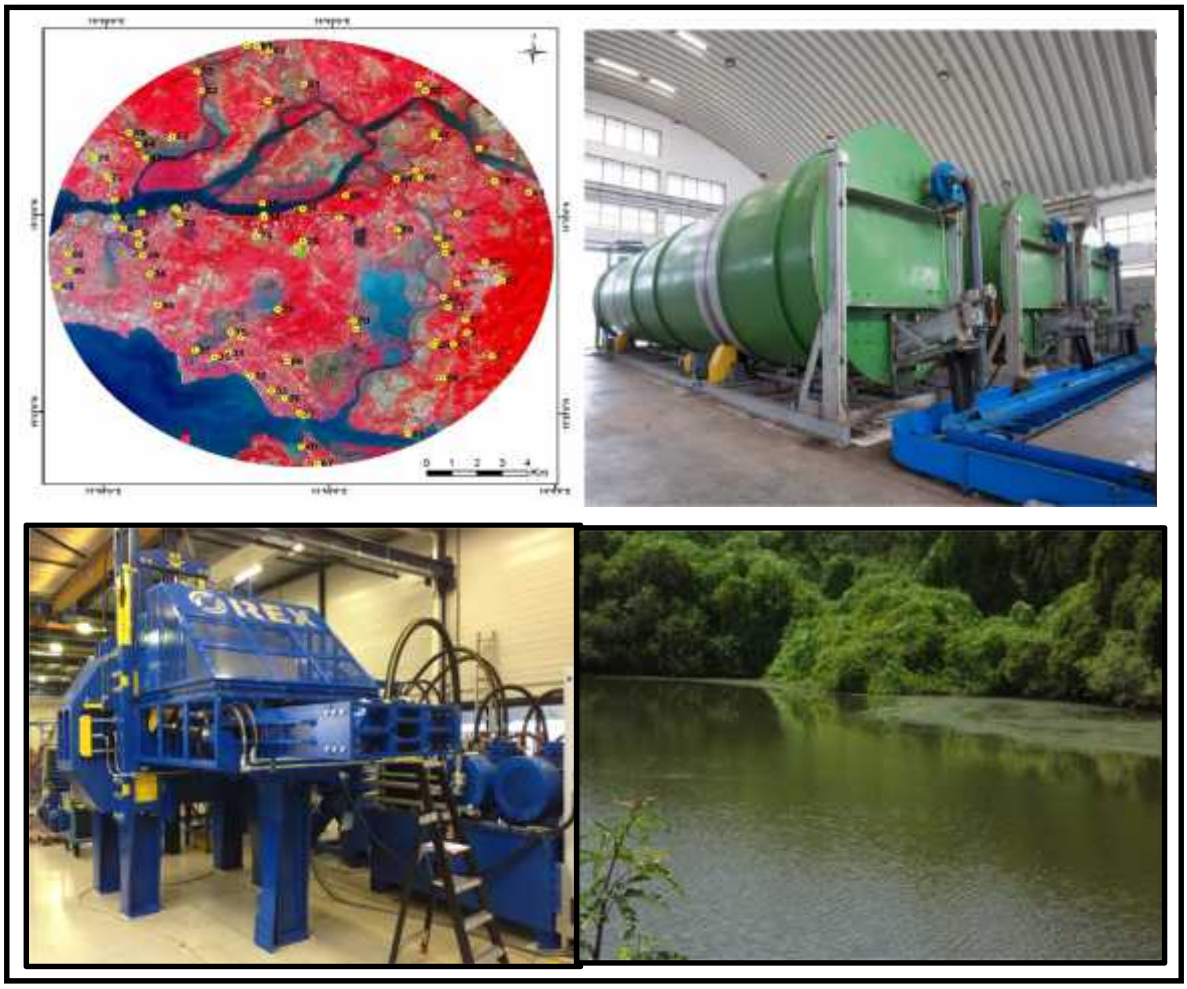
Draft Report

Environmental Impact Assessment (EIA) Study for Proposed Municipal Solid Waste Management Facility (MSWMF) at Bainguinim, Tiswadi Taluka, North Goa



Sponsor

Goa Waste Management Corporation (GWMC), Goa

CSIR- National Environmental Engineering Research Institute
Nagpur – 440 020

April 2019

Annexure – VII

Declaration by Experts Contributing to the *Environmental Impact Assessment (EIA) Study for Proposed Municipal Solid Waste Management Facility (MSWMF) at Bainguinim, Tiswadi Taluka, North Goa*

I, hereby, certify that I was a part of the EIA team in the following capacity that developed the above EIA.

EIA coordinator : **Dr. M. Suresh Kumar**
Signature & Date :

Period of involvement : **January 2017 – June 2019**
Contact information : **Chief Scientist & Head,**
EIS Division, CSIR-NEERI
Nagpur

Functional Area Experts :

Sr. No.	Functional Areas	Name of the Expert/s	Involvements (period and task**)	Signature and Date
1	Air Pollution Monitoring Prevention and Control (AP) / Air Quality Modeling and Prediction(AQ)	Dr. T. V.B.P.S. Rama Krishna	Air Quality Monitoring	
			Air Quality Modelling and Prediction	
2	Water Pollution Monitoring Prevention and Control (WP)	Dr. Sheikh Basha	Water Pollution Monitoring, Prevention and Control	
		Dr. M. Suresh Kumar (TM)		
		Dr. P.V. Nidheesh (TM)		
3	Ecology and Biodiversity (EB)	Dr. L.N. Sangolkar	Ecology and Biodiversity, Terrestrial Biology	
		Dr. M. Suresh Kumar (TM)		
		Dr. Kanchan Kumari		
4	Noise & Vibration (NV)	Mr. Satish Lokhande	Noise Monitoring, Prediction of Impacts and EMP	
5	Socio-economic Aspects (SE)	Dr. G.K. Khadse	Socio-economic Status	
		Mr. Sanjay Bodhale	Quality of Life	
6	Soil Conservation (SC)	Pravin Naoghare	Soil Conservation	
		Ms. R. Nikhade (TM)		

Sr. No.	Functional Areas	Name of the Expert/s	Involvements (period and task**)	Signature and Date
7	Hydrogeology (HG)	Dr. P.R. Pujari	Hydrogeology	
8	Solid and Hazardous Waste	Dr. M. Suresh Kumar	Solid and Hazardous Waste – Characterization and classification & management	
9	Land-use & Land-cover (LULC)	Dr. Ritesh Vijay	Remote Sensing & GIS for LULC	
10	Risk Assessment & Hazard Management (RH)	Mr. Ankit Gupta	Risk Assessment & Hazard Management	
		Dr. S.P. Ghuge (TM)		

Declaration by the Head of the accredited consultant organization

I, **Dr. Rakesh Kumar,** hereby, confirm that the above mentioned experts prepared the ***Environmental Impact Assessment (EIA) Study for Proposed Municipal Solid Waste Management Facility (MSWMF) at Bainguinim, Tiswadi Taluka, North Goa.*** I also confirm that the consultant organization shall be fully accountable for any mis-leading information mentioned in this statement.

Signature	:	
Name	:	**Dr. Rakesh Kumar**
Designation	:	**Director**
Name of the EIA Consultant Organisation	:	**CSIR-NEERI**
NABET Certificate No. & issue Date	:	**NABET/EIA/1720/RA 0088** **March 15, 2018**

Contents

Item				Page No.
		3.4.3.6	Coastal Geomorphology	3.47
	3.4.4	Hydrogeology		3.47
		3.4.4.1	Occurrence of Ground Water and Aquifer Characteristics of various	3.47
3.5	Biological Environment			3.57
	3.5.1	Introduction		3.57
	3.5.2	Reconnaissance		3.57
	3.5.3	Sampling Location and Methodology		3.58
	3.5.4	Biodiversity in Study Area		3.58
	3.5.5	Floristic Structure and Composition		3.58
	3.5.6	Mangroves		3.58
	3.5.7	Medicinal Plants in Study Area		3.59
	3.5.8	Fauna		3.59
3.6	Socio-economic Environment			3.66
	3.6.1	Introduction		3.66
	3.6.2	Demography and Socio-economic (secondary data description)		3.67
	3.6.3	Methodology Adopted for the Study		3.67
	3.6.4	Socio-economic Profile of the Study Area		3.69
		3.6.4.1	Demographic Aspects	3.69
		3.6.4.2	Average Household Size	3.69
		3.6.4.3	Population Density	3.69
		3.6.4.4	Sex Ratio	3.69
	3.6.5	Social Structure		3.69
	3.6.6	Literacy Levels		3.72
	3.6.7	Occupational Structure		3.74
		3.6.7.1	Workers Pattern	3.74
		3.6.7.2	Main Workers Employment Pattern	3.76
	3.6.8	Infrastructure Resource Base		3.78
	3.6.9	Town Details		3.79
	3.6.10	Land Use Pattern of the Study Area		3.82
		3.6.10.1	Land use as per Census Records	3.82
		3.6.10.2	Main Commodities	3.82
	3.6.11	Infrastructure and accessibility, Primary Observations in the Core Zone		3.86
		3.6.11.1	Health Care Facilities and Accessibility	3.86
		3.6.11.2	Accessibility to Educational Institutions	3.87

Item			Page No.
		3.6.11.3 Water Resources	3.87
		3.6.11.4 Housing Typology	3.87
		3.6.11.5 Communication facilities	3.87
		3.6.11.6 Transportation	3.87
		3.6.11.7 Road Connectivity	3.88
		3.6.11.8 Market Facility	3.88
		3.6.11.9 Electricity	3.88
	3.6.12	Awareness about Government schemes and programmers	3.88
	3.6.13	Other Observations	3.88
	3.6.14	CSR and Developmental Activities	3.88
	3.6.15	Suggestions for improvement of Socio-Economic Status	3.88
	3.6.16	Quality of Life Assessment	3.90
Chapter 4 : Anticipated Environmental Impacts & Mitigation Measures			**4.1-4.19**
4.1		Identification of Impacts	4.1
4.2		Prediction of Impacts	4.1
	4.2.1	Air Environment	4.4
	4.2.2	Impact due to Proposed CMSWMF	4.4
		4.2.2.1 Air Quality Model Description	4.5
		4.2.2.2 Air Quality Modeling and Predictions	4.6
	4.2.3	Impact due to Transportation	4.6
	4.2.4	Impact of Fugitive Emissions	4.6
4.3		Noise Environment	4.11
4.4		Water Environment	4.13
4.5		Land Environment	4.14
	4.5.1	Impacts on Land use & Aesthetics	4.14
	4.5.2	Impacts on Topography & Geology	4.14
	4.5.3	Impact on Soils	4.14
	4.5.4	Impacts due to waste disposal	4.14
4.6		Biological Environment	4.16
4.7		Socio-economic Environment	4.17
4.8		Mitigation Measures	4.18
Chapter 5 : Environmental Monitoring Program			**5.1-5.3**
5.1		Monitoring Schedule and Parameters	5.1
5.2		Air Quality Monitoring	5.2
5.3		Water Quality Monitoring	5.2
5.4		Noise Monitoring	5.2
5.5		Solid & Hazardous Wastes	5.2
5.6		House Keeping	5.2

List of Figures

List of Plates

List of Tables

List of Annexures

Compliance of ToR

Compliance of ToR

Sr. No.	ToR	Compliance
1.0	**Background** This should include, profile of the Corporation of City of Panaji (CCP) as a Project Proponent (PP), contact address, implementing organization (Concessioner), Project Consultants for design of the plant as well as Environmental Consultants appointed, if any. (Supporting documents may be annexed).	Information on PP is provided in section 1.1 of the report. Information of the project consultant, CSIR NEERI Nagpur is provided in Chapter 9.
1.	The PP must furnish information on any/all similar projects handled/being handled by it in the State of Goa detailing the project stage and clearly spelling out the feasibility thresholds, feeding centres, probable commissioning dates.	Goa Waste Management Corporation is implementing similar project at in North Goa at Saligao and Proposed Facility for South Goa at Cacora. This information is provided in Section 1.1 of the report.
2.	A special mention must be made of judicial interventions/'Stop work orders', if any, in the ongoing projects of similar scope handled by it. Submissions made by the PP in this regard to the Appellate Authority must be shared with the Goa-SEAC (hereinafter referred as 'Committee').	Details are provided in section 1.6-1.8, Chapter 1 of the report.
3.	A statement on available/earmarked funding for the proposal must be shared with the Committee. Escalation costs, if any, envisioned through the project period must be accounted for.	Details are provided in section 1.5, Chapter 1.
4.	A statement of justification and 'cost benefit analysis' of 'Saligao Solid Waste Management Facility (SSWMF)' vis-à-vis 'separate discrete facility proposed at Bainguinim' be prepared by the PP, defining the minimum threshold quantum and source of waste for operationalizing the facilities.	Cost benefit analysis of the proposed activity is provided in Chapter 6.
5.	Chronologically provide sequence of the project from its initiation till date with reference to administrative approvals taken up by the PP. Describe the geographical location	Details are provide in Section 1.6.

Sr. No.	ToR	Compliance
	of the proposed facility and its surroundings, capacity, need, goal and objectives for proposed MSWMF, significance of the project both at local and regional level may be mentioned clearly.	
6.	Detailed demography/land-use/existing, proposed & approved residential colonies/archaeological sites/World Heritage Monuments/Hospitals (existing and proposed)/perennial lentic and lotic water-bodies surrounding the project-site as well as buffer area of 5 and 10 km radius around the site should be superimposed on a Google imagery at a decipherable scale.	Mentioned in Chapter 3 under the section 3.4.2
7.	A separate plan be prepared delineating the existing/TCP-approved residential colonies/settlement around the boundaries of the proposed facility within a radius of 3 km (i.e. zone of likely impact).	NA
8.	Adequate and rational sensitization of the local stakeholders by the PP on the proposed and sentiments of the local stakeholders towards the proposal, if any, be furnished	NA
9.	PP must furnish primary database on biodiversity inventories based on ground-truthing, and not secondary data available. The biological data shall have to be collected for one cycle covering all seasons.	Biological environment of the proposed project site and buffer area is provided in Section 3.5 of the report.
10.	Considering the rich bird diversity of Kadamba plateau region, PP shall study the 'Habitat value' of the proposed site for biodiversity with special reference to the avifaunal diversity	
11.	Discuss project location with reference to distance from major landmarks, policy, legal and administrative framework within which the project is set, major stakeholder(s)/Department(s) of the State and Central Government with their specific roles, applicable laws, clearance requirements at various levels of project execution and their	Detailed in Chapter 2.

Sr. No.	ToR	Compliance
	current status	
12.	Describe in detail if any litigation(s) are pending against the proposed project and/or any directives or 'orders' passed by any court of law/statutory authority. In addition, the PP should inform its area of jurisdiction vis-à-vis Appellate Authority to resolve legal disputes, if any.	No
2.0	**Project Description** Background information for implementation of the project and baseline studies taken up, if any, and overall scenario of the proposed facility in the context of Panaji's solid waste management issues and challenges, procedures adopted for selection of technology, criteria for site-selection should be discussed. Following information should be included :	Detailed in Chapter 2.
	õ Primary waste characteristics, physical, chemical in Municipalities and Panchayats catchment areas and comparison with waste characteristic at the existing facility at Calangute. This characterization shall be done for one season and the sheets with the dates, area of sampling, time, duly signed by the GWMC officials shall be submitted as part of the report. The sample size shall be arrived at based on the calculations shall be placed as part of the report	Provided in Chapter 2, Table 2.1.
	õ Population/area covered under MSWMF	Data is provided in Section 2.1 of the report.
	õ Expected quality/quantity of solid waste (MSW) generated (based on the resident plus floating population)	Data is provided in Table 2.1
	õ Quantity of MSW actually collected (average figure) – details of seasonal variation for actual collection (from secondary sources)	Presented in Chapter 2.
	õ Methodology for collection of MSW –	Details are given in Section 2.2

Sr. No.	ToR	Compliance
	doorstep collection, segregation at source, community bins, collection from commercial, hotels and office premises, etc.	
	õ Transportation of MSW – type of vehicles (fast or slow moving), frequency of transportation and distance of transportation, Access to the solid waste mgt site (preferably alternate/multiple).	Presented in Chapter 2. Figure 2.4.
	Details of the Proposed MSWMF The information will be sourced from engineering and design studies conducted for the project. This section should contain the following details :	
	õ Land requirement for the facility, including its optimization, break up for various purposes and its availability, if any	Presented in Chapter 2.
	õ Details of the following may be furnished – J Each unit in the facility, with a brief description of its operations	Details are provided in Sections 2.4.2, 2.42. and 2.4.4.
	J Proposed protocol for waste acceptance (system for sampling, parameters, analysis methods, time lags, number of people, qualifications, manifest system, etc.)	Presented in Chapter 2.
	J Ultimate disposal of the waste – details of the methodology of disposal including life span and design of the existing/proposed site	Details are provided in Sections 2.4.2, 2.42. and 2.4.4
	J Existing solid waste dumping scenario on the proposed site	NA
	J Details of chosen waste treatment process/technology and whether it is in compliance with the applicable law (at present "Municipal Solid Wastes (Management and Handling)	Details are provided in Sections 2.4.2, 2.42. and 2.4.4

Sr. No.	ToR	Compliance
	Rules, 2000")	
	J Details of safety measures for occupational health	Data provided under the section 7.2.
	õ Mass and Energy Balance flow diagram (step-by-step) for the process technology proposed	Presented in Chapter 2, Figure 2.5.
	õ Energy conversion technology should be clearly detailed out with specifications of the biogas engines and alternators used for this conversion process	Presented in Chapter 2, under the section 2.6.9 and 2.6.10.
	õ List of plant(s) and equipment(s) to be set up and vehicles to be used	Details are provided in Sections 2.4.2, 2.42. and 2.4.4
	õ Details on expansion/up gradation of the existing processing facility, if any.	NA
	õ Source of water and electrical power/ details about captive utility of in-plant power generation	Given in Chapter 2. Under the section 2.4.
	õ The quality of compost being generated from the existing facility	Presented in Chapter 2, in Table 2.3.
	õ Details of the laboratory facilities available for testing, analysis etc.	NA
	õ Specific details on leachate collection system around the plant and around the facility, generation rates, treatment and disposal	Presented in Chapter 2, under the section 2.6.13.
	õ Details of the landfill operation – filling, layers, equipment, compaction levels, cross-checking mechanism, stability considerations, landfill gas monitoring,troubleshooting mechanism, etc. and analysis and report of the landfill at a similar existing plant in Goa	Presented in Chapter 2, under the section 2.6.14.
	õ Details pertaining to monitoring of test wells within and around the landfill site as per standard procedure, its locations,	Presented in Chapter 7, under the section 7.4.

Sr. No.	ToR	Compliance
	frequency of monitoring, parameters as prescribed by the CPCB norms, etc.	
	õ Fire detection, suppression and safety & health protection measures during project design and operations	Detailed in Chapter 2 and Chapter 7, under the sections 2.6.14 and 7.4.3 respectively.
	õ Feasibility study for utilization of segregated combustible fuel (SCF) or Preparation of Refuse Derived Fuel (RDF) to produce electricity and/or replace traditional sources of fuel in local industries. Its production and quality (Calorific value and C/H ratio) as well as list of promising buyers	Detailed in Chapter 2 under the section 2.6.7.
	õ Assessment of generation of horticulture waste, transportation plan and feasibility study for utilization of the same for manufacture of briquettes or other alternative treatment methodologies	This is mixed with the biodegradable waste and processed the details are mentioned in the Chapter 2.
	õ Assessment of generation of slaughter house waste, transportation plan and treatment methodologies	NA
	Provide a contour map on 1:1000 scale for the study area showing proposed breakup of the land. Detailed layout plan of proposed project development, communication facilities, access/approach roads, internal roads, landscape, sewage disposal facilities, and waste disposal etc. to be given. Layout plan of proposed development of built up areas with covered construction such as DG-Set rooms, Administrative buildings, Utilities such as Main and Stand- by Power, Water supply installations, location of STP, RWH structures & Green Belt area etc.	Detailed in Chapter 1, as layout map.
3.0	Description of the Environment in the Delineated Study Area As a primary requirement of EIA process, the proponent should collect baseline data in the project area as well as in the area within 10 km	Details are provided in Chapter 3.

Sr. No.	ToR	Compliance
	of the proposed project boundary (buffer zone). Map of the study area clearly delineating the location of various monitoring stations (air/water/soil and noise) superimposed with location of habitats are to be shown. Primary data (baseline data), wherever feasible, should be collected for one season except rainy season. Secondary data should be collected for area within 10 km aerial distance from the project site-boundary, as specifically mentioned at column 9(iii) of Form-I of EIA Notification 2006. The following components of the environment shall be studied :	
3.1	**Land Environment** a) **Land use / Land cover :** Data on the land use (conformity with existing development regulation), habitation, and forest cover around the proposed CMSWMF Ascertained from local authorities, revenue records etc.	Details are given in section 3.4.
	b) **Topography :** Baseline data needs to be given on existing situation of the land at the proposed project area, including description of plateau features, terrain analysis, slope and elevation, microclimatic factors	Detailed in Chapter 3, under the section 3.4.3.2
	c) **Geology :** Baseline data should be provided on rock types, regional tectonic setting and history of any seismicity and associated hazards. Information on distance of quarries/excavation, if any, from habitat, restrictions for cutting/filling, environmental controls, etc. should be provided	Detailed in Chapter 3, under the section 3.3.4.3.4
	d) **Soil :** Data including type, stratification (soil profile), characteristics, soil properties, porosity and permeability, inherent fertility etc. are important from engineering considerations for designs of structures like landfills, green belt	Details are provided in section 3.4.1.

Sr. No.	ToR	Compliance
	development, etc. should be submitted. The current level of soil and water contamination, if any, due to existing dumps need to be ascertained.	
3.2	**Water Environment** a) **Groundwater :** Baseline data on groundwater sources (springs, open-dug wells, bore wells), including data on depth (groundwater table), physico-chemical parameters is to be collected at least for one season	Details are provided in section 3.3. A total of 12 groundwater samples were collected and analyzed.
	b) **Surface water:** Baseline data on location of surface lentic and lotic water sources details such as their present quality and utility, if any. Details of water bodies present within the project area and 5 kms. Surrounding the site-boundary should be provided	Details are provided in section 3.3. A total of 2 surface water samples were collected and analyzed.
	c) Prepare an existing **drainage map** on a toposheet of the site with 1.5 km surrounding with natural surface drainage flow points	
	d) Estimate **water intake requirements** for the project and identify the source of water to be used (provide water balance table). Ground water budgeting, if being used, has to be provided. Rainwater harvesting (if proposed) to be detailed out.	Presented in Chapter 2.
	e) Quantity of **wastewater generated** during construction and operational phase and details of its treatment and disposal is to be provided.	Presented in Chapter 2.
3.3	Biological Environment	
	a) **Terrestrial Ecology:** Inventory of Flora and Fauna based on primary data in the study area as well as that within 10 km of its boundary, shall be included in the list of flora and fauna along with classification as per the schedule given in the Wildlife Protection Act, 1972 (for fauna) and in the Red Book Data (flora). Also, a statement clearly specifying whether the study area	Data is provided in section 3.5.

Sr. No.	ToR	Compliance
	forms a part of an ecologically sensitive area should be provided. In the event of occurrence of any scheduled –I species, as per IWPA, 1972, a conservation plan be prepared in consultation with and authenticated by the Chief Wildlife Warden (CWW), Govt. of Goa	
	b) A particular emphasis be laid down on avifaunal diversity highlighting the raptors and scavenging birds at the existing site, besides the forest bird species of the general plateau around the area within a radius of 10 km.	Data is provided in section 3.5.
	c) In the water bodies within 5 kms. of crow-fly distance surrounding the site-boundary, excluding the marine realm; an inventory of fresh-water biodiversity to be compiled with emphasis on icthyofauna and waders, if any.	Presented in Chapter 3 under biological component.
	d) Inventory of Agro-biodiversity within 5 kms buffer zone highlighting local cultivars, if any.	Data is provided in section 3.5.
	e) Designated Wildlife protected areas/Natural habitat of any IWPA scheduled species, if any, within 10 km radius of project boundary be brought on record	Presented in Chapter 3 under biological component.
3.4	**Air Environment** Climatological data is to be obtained from nearest Indian Meteorological Department (IMD) station for one full year. Micro meteorological data consisting of wind speed, wind direction, temperature, cloud cover (amount and height), humidity, inversions, rainfall (peak and average daily rainfall) and wind rose patterns, from primary and secondary sources in the study area. Baseline data of air pollutants parameters extending an area of 10 km from the project should be monitored at a number of locations. Description of base line data of ambient air parameters namely PM_{10} and $PM_{2.5}$, oxides of	Data is provided in section 3.1. Samples were collected at 5 locations and analyzed.

Sr. No.	ToR	Compliance
	Nitrogen (NOx), Sulphur dioxide, and carbon monoxide are to be collected. One season data is to be monitored other than monsoon as per the CPCB Norms. Sampling locations are to be located as per CPCB norms.	
3.5	**Noise** Baseline data on noise pollution at the project area and the neighbourhood residential areas is to be monitored as per the CPCB norms.	Details are provided in Section 3.2. Noise levels were monitored at 5 locations.
3.6	**Socio-Economic and Occupational Health Environments:** Baseline data at the project area shall include the demography of the village panchayat at the project site, existing residential projects around the proposed site, existing infrastructure facilities in the proposed area and anticipated area of impact due to the proposed activity. This should be clearly demarcated on a map denoting the existing and proposed project within 1.5 km around the project site.	Presented in Chapter 3 under Socio-economic component.
4.0	**Anticipated Environmental Impacts and Mitigation Measures** This section should describe the likely impact of the project on each of the environmental parameters of Land Environment (Topography, Geology and Soil), Water Environment (Groundwater and surface water), Biological Environment, and Air Environment. The methods adopted/proposed to be adopted for assessing the impact such as model studies, empirical methods, reference to existing similar situations, and reference to previous studies should be discussed in detail. Details of specific mitigation methods to reduce adverse effects of the project, best environmental practices and conservation of natural resources should be detailed out of each of the parameters. A separate dedicated technical section on 'Odor emanation, mitigation & management' shall be written by an accredited domain-expert, defining the budgetary outlay for the purpose.	Anticipated environmental impacts and mitigation measured was prepared and is given in Chapter 4.

Sr. No.	ToR	Compliance
	This should include proposed measures for fire detection, suppression and occupational safety and health protection measures during project design and operations, scheme for storm water management within and around the proposed facility, details on impacts of landfill gases and its preventive measures, as per CPCB norms and action plan for green belt development, including the details of species, width of plantation, height & density and planning schedule as per CPCB norms. PP shall give special attention to the menace of insect and rodent vector breeding at the site and around it. In view of this apprehension; an inventory of arthropod and rodent species of pest/vector value shall be prepared by PP based on ground-truthing. Control measures shall be spelt out. A detailed discussion should also be included for socio-economic and health environment for resident population anticipated living around the project site with detailing of specific details on odour, noise and transportation. Impact of the project on socio-cultural and tourism aspects should be assessed.	
	Environmental Monitoring Program õ Frequency, location, parameters of monitoring air, water, noise and soil during operation of SWMF õ Compilation and analysis of data and reporting system in a discrete EMP document	Detailed environmental monitoring programme is provided in Chapter 5.
	Institutional arrangement by PP to implement mitigation measures shall be identified and steps to strengthen or expand existing arrangements, if required, shall be proposed. A detailed responsibility chart to be included for mitigation measures for construction and operational phase of the project and for any disaster mitigation.	Details are provided in Chapter 5.

Sr. No.	ToR	Compliance
	Project Benefits – This section should detail out the positive impacts of the CMSWMF including improvements in physical infrastructure, if any	Data is provided in Chapter 6.
5.0	**Public Hearing and Stakeholder Consultations** Public hearing and stakeholder consultations shall be conducted, if applicable, including community consultations at the affected community levels. The objective of the consultation sessions shall be to improve project components with regard to proper environmental management. Issues identified by the public and other stakeholders during public hearing along with the issues raised by the public and the appropriate responses of the project proponent should be included in the final EIA report.	NA
6.0	**Environmental Management Plans (EMPs)** Based on the impacts predicted, EMPs shall be prepared to fulfil all requirements of GoI, MoEF and GoG. The scope of EMPs shall include: õ Recommendation of feasible and cost-effective measures to prevent or reduce significant negative impacts to acceptable levels.	EMP during construction phase as well as operational phase is given in Chapter 7.
	õ Description of implementation arrangement needed for the project	Details are provided in Chapter 7.
	õ Specification of environmental supervision, monitoring and auditing requirements, including the technical aspects of monitoring the effectiveness of mitigation measures (including measurement methodologies, data analysis, reporting schedules, emergency procedures, detailed budget & procurement schedules).	Details are given in Section 7.3

Sr. No.	ToR	Compliance
	õ Summary matrix of environmental monitoring, during construction and operation stages, along with the requirement of monitoring facilities, frequency, location, parameters of monitoring, compilation and analysis of data, comparison with base line data, compliance to accepted norms and reporting system, and plantation monitoring program	Details are provided in section 7.3 of Chapter 7. Detailed environmental monitoring programme is given in Chapter 5.
	õ Post-closure plan for landfill site, if any	Presented in Chapter 7.
	õ Listing of all the mandatory government clearance conditions, and the status of procuring clearances	Presented in Chapter 7.
7.0	**Executive Summary (Summary EIA)** This should be a summary of the EIA report condensed to 10 A-4 size pages. It should necessarily cover in brief the following chapters of the EIA report. Introduction, Project Description and Description of the Environment, Anticipated Environmental Impacts and Mitigation Measures, Additional Studies, Environmental Monitoring Program/ Project benefits, and Environmental Management Plan (EMP). Such an Executive Summary may be required during public hearing process, as applicable, for distribution to public on demand. If required, it has to be translated into a local language(s).	Executive Summary of the project is provided in Chapter 8.
8.0	**Disclosure of Consultant Engaged** This shall include the names of the consultants engaged with their brief resume and nature of consultancy rendered. The following general points should be noted	Details are provided in Chapter 9.
	õ All documents should be properly indexed, page numbered	Yes, provided.
	õ Period/data of data collection should be clearly indicated	Yes, provided

Sr. No.	ToR	Compliance
	õ While preparing the EIA report, the instructions for the proponents and instruction for the consultants issued by MoEF vide O.M. No. J-11013/41/2006-IA.II(I) dated 4th August, 2009 and 5th October 2011, which are available on the website of the Ministry, should also be followed	Yes, considered.
	õ The consultants involved in the preparation of EIA/EMP report after accreditation with Quality Council of India (QCI)/National Accreditation Board of Education and Training (NABET) would need to include a certificate in this regard in the EIA/EMP reports prepared by them and data provided by other organization/laboratories including their status of approvals etc. In this regard circular no. F.No.J-I1013/77/2004-IA-II(I) dated 2nd December, 2009, 18th March 2010, 28th May 2010, 28th June 2010 and 30th September 2011 posted on the Ministry's website http://www.moef.nic.in may be referred	Yes, details are provided in Chapter 9.
	õ After the preparation of the draft (as per the generic structure prescribed in Appendix-III of the EIA Notification, 2006) covering the above mentioned ToRs', the project proponent shall get the Public Hearing conducted, if applicable, and take further necessary action for obtaining prior environmental clearance (EC) in accordance with the procedure prescribed under the EIA Notification, 2006.	Complied with
	õ The copy of the letter received from Goa-SEAC on the TORs' prescribed for the project should be attached as an annexure to the final EIA-EMP report. The compliance statement of ToRs' prescribed should also be incorporated.	Annexure 10

Chapter 1

Introduction

Chapter 1
Introduction

Management of solid waste is of growing concern to the general public at large, local authorities and business communities in cities and towns across India. The problem is exacerbating in urban areas due to rapid strides in population growth, coupled with an economic boom that encourages the consumption of goods and hence, wastes generation. As per Census 2011, the urban population accounts for 31 % of the total population. Due to several technical, financial, institutional and social constraints, the MSW generated in most of the Indian cities and towns is being disposed off on open land. As per the Municipal Solid Waste (Management & Handling) Rules, 2000 enacted by Govt. of India, all the States and Municipal Authorities were required to improve/remediate existing dump sites and establish proper waste processing and disposal facilities. However, this target could not be achieved by most of the Municipal Authorities due to some constraints. The haphazard and unscientific disposal of MSW in the past several years have led to the contamination of air, soil and water resources in and around such dumpsites thereby posing serious risk to human and animal health. Environmentally sound management of MSW has therefore emerged as a growing challenge for various States and Municipal authorities in the Country.

1.1 Information about Project Proponent

Goa Waste Management Corporation (GWMC), a nodal agency for executing Solid Waste Management infrastructure projects in the state of Goa. GWMC has proposed a Solid Waste Management Facility at Bainginium Village on the acquired land for the purpose, on similar lines as set up in North Goa at Saligao and Proposed Facility for South Goa at Cacora. The Proposed Facility at Bainguinim is considered to be a Central Facility for the state of Goa as there is a need to enhance the existing SWM system for Regional Area and thus improve the health and having standards of its residents. The main objective of the establishment of Centralized Solid Waste Management Facility (CSWMF) is for the scientific processing and disposal of the solid waste by the local bodies in compliance with the MSW Rules, 2016.

The Government of Goa, is implementing this project through Goa Waste Management Corporation (GWMC), Saligao. Accordingly, GWMC has undertaken the work for establishment of the 250 tons/day (TPD) capacity Centralized Municipal Solid Waste (MSW) Processing Facility based on Recycle & Sorting Line, Segregation, Bio-methanation and In-vessel Composting at Baingunim in North Goa District. For this proposed facility, GWMC retained CSIR-NEERI, Nagpur to carry out Environmental Impact Assessment (EIA) studies as per the ToR issued by State Expert Appraisal Committee (SEAC), Goa.

1.2 Details of EIA Consultant and NABET Accreditation

The EIA consultant for the proposed project is National Environmental Engineering Research Institute (NEERI), which is a Constituent Laboratory of Council of Scientific & Industrial Research (CSIR), India (Website: www.neeri.res.in) was established in 1958. The details about the CSIR-NEERI and NABET Accreditation are given in **Chapter 9**.

1.3 Purpose of the Project

The existing number of decentralized units are insufficient. Also finding areas in ULBs for setting up of new de-centralized compost units is a difficult proposition due to the fact that land is scarce commodity and not available for setting up the required CMSWM facilities. The Present decentralized facilities are completely manual in operation. Crude disposal of Solid waste is adopted without any facility for disposal and resource recovery. Crude dumping of waste is happening at various locations in the outskirts of the city due to the absence of a centralized Engineered MSW treatment facility. Therefore, in order to safeguard the population from health hazards, maintain a clean and hygienic environment it is extremely essential to implement the proposed CMSWM facility. Development and implementation of this integrated SW management plan is based on the 4R Environmental Protection Rules (Reduce, recycle, Reuse, and Recover).

1.4 Project Setting

Based on the available data, discussions with the local residents, City Development Plan (CDP), City Sanitation Plan, Regional Plan Goa - 2021 (RPG-2021) and other site investigations performed by CCP and other government officials, the design of the components of MSW management system is proposed.

The site is located at village Bainginium village Tiswadi taluka, and bearing survey nos. 20 Sub Division no-1-1, 3-A-1, 2-A, of village Bainginium. (Old Survey no 20/1 (P), 20/2 (P) and 20/3-A (P) (**Figure 1.1**). The land has been acquired by the Government for setting up the Integrated Solid Waste Management Facility and is admeasuring 171312 sq.mts. While the overall layout area of the plant is 17 hectares, major part of the area is covered with deep quarry pits (approx. 5 hectares). Also, a water pipeline and HT line passes through the plot, for which minimum buffer space has been provided. On the lower south side of the plot there is a fort wall of archeological significance, from which 50 m clear buffer space has been provided. Further a 30-m wide green belt has been planned around the periphery of the ISWM facility. Keeping in view the above features in the plot, useable area for providing the ISWM is approx. 7 hectares, in which the complete facility, for the design year 2041 and secured land fill for up to year 2026 has been proposed.

1.5 Financial Framework

The total cost of the proposed SWM project is 169.17 crores which is proposed to be funded by Government of India, State Government and ULB and the Concessionaire under DBFOT basis.

Such a model distributes the ownership of the project and makes the involved parties responsible for the long-term success of the project.

Swachh Bharat Mission (SBM): SBM launched in October 2014 under Ministry of Urban Development (MoUD) is an important step taken in response to the challenge of rapid urbanization. The mission objectives include the following

- Elimination of open defecation
- Eradication of Manual Scavenging
- Modern and Scientific Municipal Solid Waste Management
- To effect behavioral change regarding healthy sanitation practices
- Generate awareness about sanitation and its linkage with public health
- Capacity Augmentation of ULB's
- To create an enabling environment for private sector participation in Capex (capital expenditure) and Opex (operation and maintenance).

Under the scheme, the central assistance for solid waste management is 35%. It is proposed to approach the centre for special assistance for setting up the modern integrated solid waste management facility.

Private Investment: The private investment has been involved in collection, transport of SWM, running and maintenance of ISWM through PPP mode of Design Built Own Operate Transfer (DBOOT) or Built Own Operate (BOO) in the past by many corporations. The private party (PP) contributes through equity for part of capital expenditure and is remunerated by way of tipping fee.

This is a typical model, which has been followed by various corporations in the country.

However our observation has been that for any project to be developed on PPP basis, the project should be is financially and economically viable for both the parties involved. It is only then that the project can be sustained for the years to come. For the private party to invest in, the project should generate attractive returns over the period of time, such that the private party is able to not only recover the capital cost or investment but also make a reasonable profit from the operation of the plant.

In the business of Solid Waste Management, the revenue generated from the collection and the selling of waste is an important aspect of making the whole cycle of SWM financially viable.

It is evident from the operations and maintenance cost and the resource recovery that the operator will have a deficit in terms of meeting the collection as well as the operation cost only from the sale of products. Further more there is no possibility to recover the capital investment required for the proper functioning of the ISWM facility. This problem is more compounded as the plants are built (hence capital investment requirement) for a future projection of 25 years population and waste generation, while the waste quantum as received is as per present population. The resource recovery is based on present waste as received at the ISWM site.

1.6 Judicial Interventions

In the Order of the Hon'ble High Court dated 13.08.2013 w.r.t Suo Motu Writ Petition 2/2007, specific directions had been given to certain Village Panchayats, Municipal Councils, Corporation and the State Government w.r.t Solid Waste Management; which are as follows:

a. Directions to the Corporation/ Municipal Councils included time-bound targets to identify sites and to set-up sanitary landfills (as applicable) for burial of inert/residual waste collected by the Municipal Councils/ Corporations. In addition, there were specific directions about collection, baling and disposal of the plastic waste.

b. Directions to the Village Panchayats include the following Clauses among others:

   i. The Village Panchayats shall ensure that the plastic waste that is collected every week from all wards of the Village Panchayats is baled properly and stored at an appropriate site, until it is collected by the agency appointed for the purpose. If the Government selects a site for storage of plastic waste, the Village Panchayats shall transport the plastic waste to this site in secure condition for baling.

   ii. The VPs of Calangute, Candolim, Taleigao, Benaulim, Colva and Chicalim have to make adequate composting facilities for disposal of organic/biodegradable waste.

   iii. The Village Panchayats of Mandrem, Morjim, Taleigao, Benaulim, Varca, Colva, Majorda, Chicalim, Sancoale and Fatorpa were directed not to issue construction licence/s to multi-dwelling projects of 5 residential units and above, until the Goa State Pollution Control Board was satisfied that the plastic waste is collected weekly from all wards of the Village and baled properly for onwards disposal through the plastic waste collector.

c. Directions to the State Government include setting up of two or more sanitary landfills within a period of one year for accepting the residual/inert waste of VPs of North & South Goa, setting up of a plastic waste disposal unit and appointment of an Agency for collection of plastic waste among others.

Past the Order of the Hon'ble High Court, the State has undertaken proactive measures towards Solid Waste Management including setting up of a collection mechanism for dry/non-biodegradable waste, undertaking procedures for setting up two solid waste management facilities in the State, etc.

1.7 Petition Filed before the Hon'ble National Green Tribunal, New Delhi:

The Saligao Civic & Consumer Cell (SCCC) & Anr. had filed a petition against the State Government for the Solid Waste Management Facility at Calangute / Saligao in the **Hon'ble National Green Tribunal, New Delhi**. The Joint Statement on behalf of both the parties is as follows:

Joint Statement dated 27.01.2017:

BEFORE THE NATIONAL GREEN TRIBUNAL,
PRINCIPAL BENCH, NEW DELHI

Appeal No. 15 of 2015
(M.A. No. 658 of 2015)

Saligao Civic and Consumer Cell (SCCC) & Anr.
Vs.
Goa State Infrastructure Dev. Corp. Ltd. & Ors.

CORAM: **HON'BLE MR. JUSTICE SWATANTER KUMAR, CHAIRPERSON**
HON'BLE MR. JUSTICE SONAM PHINTSO WANGDI, JUDICIAL MEMBER
HON'BLE DR. D. K. AGRAWAL, EXPERT MEMBER
HON'BLE PROF. A. R. YOUSUF, EXPERT MEMBER

Present:	**Appellant:**	**Mr. Rahul Choudhary and Mr. Ritwick Dutta, Advs.**
	Respondent No. 1, 2, & 6:	**Mr. Atmaram N.S. Nandkarni, AG of Goa, Mr. Dattaprasad Lawande, Mr. S.S. Rebello, Mr. Purna M. Bhandari, Mr. Anshuman Srivastava and Mr. Anuj Sharma, Advs. for State of Goa , GSIDC, GSPCB**
	Respondent No. 3 :	**Mr. Vijay Panjwani, Adv. wtih Mr. Bhupendra Kumar, LA, CPCB**
	Respondent No. 4 :	**Mr. Siddhesh Kotwal and Mr. Shreya Bhatnagar, Advs.**
	Respondent No. 7 :	**Mr. Vikram Grover, Mr. Rishi Raj Sharma and Mr. Rahul Sharma, Advs.**

Date and Remarks	**Orders of the Tribunal**
Item No. 09 **January 27, 2016**	This Appeal had been filed challenging the Environmental Clearance granted to the Project Proponent vide orders dated 01th November, 2014 and 03rd March, 2015 on different grounds. In view of the course of action that we propose to adopt, it is not necessary to refer to the facts giving rise to the present appeal in any greater detail. Suffice it to be noted that the application has been filed in public interest in which there are certain grievances that have been raised in relation to establishment of Waste to Energy plant at Saligao in the State of Goa. Matter was argued on different on dates during the course of which the parties came to resolve their issues. We had directed Appellant to sit down with the experts of the respondents, Government as well as the Project Proponent for the purpose. Keeping in view the fact that

the entire State of Goa does not have a single Municipal Solid Waste Disposal plant as of today, it is generating about 400 MT Municipal Solid Waste every day of which 100 MT Municipal Solid Waste is from Saligao alone. In fact there was already approximately 55000 MT Municipal Solid Waste collected at the site in question. This needed solutions both in the interest of Ecology and Environment and Public Health.

After deliberations, the parties have agreed that the project could be permitted to go on subject to the compliance of the conditions that they have agreed and signed and filed before the Tribunal. Within the ambit and scope of Order XXIII Rule (1) CPC read with Section 19 of the NGT, Act, 2010, we are also of the considered opinion that resolution of these disputes would not only be in public interest but would also protect the environment. It would prevent further degradation of ecology and environment as well as public health.

Thus this Appeal No. 15 of 2015 stands disposed of while declining to set aside Environmental Clearance order dated 04th November, 2014 and 03rd March, 2015.

We direct that the Project Proponent shall be bound by the agreed terms which are as follows:

"

A. *The commitments on behalf of the Respondent No.1, Project Proponent and Respondent No.7, Concessionaire.*

1. *The Plant in question at Saligao of the State Government shall be utilised to process and treat a fresh waste of 100 metric tonnes only in terms of the Environmental Clearance granted as well as the consent of the Goa State Pollution Control Board.*

2. *In addition to the aforesaid fresh waste*

of 100 metric tonnes per day, the superficial layer of fresh waste at the existing dump shall be remedied separately at the Plant under a separate temporary consent order issued by the Board.

3. Once the fresh waste presently existing on the old waste dump is processed, the Plant shall revert to its capacity of 100 metric tonnes only, in terms of the Environmental Clearance and existing consent to establish.

4. The process of processing and handling of the existing waste including mobile and other requirements including covering the existing waste during the monsoon prior to 15 May every year shall be adequately provided for and covered by the Goa State Pollution Control Board separately in their order for consent to operate issued under the Water and Air Acts.

5. Excavation and processing of old waste from the quarry shall be completed within a period of 30 months excluding the monsoon.

6. The fresh waste which is brought in everyday upto an extent of 100 metric tonnes shall be off loaded only on the tipping floor of the Plant. There shall be no off loading of any fresh waste or dumping of any waste inside the Plant in the open area (except the tipping floor).

7. In the event of there being a breakdown of the Plant or any other apparatus thereof, then waste to the extent of 500 metric tonnes could be accumulated on the tipping floor and stored thereon and beyond this 500 metric tonnes, no fresh waste shall be received at the Plant until the Plant becomes operational upon rectification of the cause of breakdown.

8. In such circumstances, no sooner the Plant becomes re-operational, it may work in a higher capacity so as to process the existing accumulated wastes on tipping floor and new waste simultaneously till the arrears is

declared.

9. Respondent No. 7 shall make the first portion/cell of the landfill site ready for use, and only upon its certification by the Goa State Pollution Control Board, the consent to operate the plant shall be issued by the GPSCB.

10. The plot where the Plant is situated presently has 33% green area. In addition to this green area within its precincts, in and around the Plant bordering on the periphery of the boundary of the plot where the Plant is situated has already been declared as a natural cover/no development zone. Such protection shall continue to be in operation and the area shall not be altered for any other land use except of course for natural cover/vegetation/social forestry.

11. The Plant shall be monitored continuously through CCTV footage. CCTV shall be installed by Respondent No. 7 at the Entry gate and the tipping floor and the pit head (old waste). The footage will be stored for upto 30 days and will be made available to the Respondent No. 1, or the Goa State Pollution Control Board or any other Authority which in law is entitled to conduct any inspection.

B.

1. One or two Authorised Representatives duly nominated with the Managing Director of Goa State Information Development Corporation by the present Appellants or two alternative nominees (in case earlier nominated whenever unable to attend) in their place shall be entitled to visit the Plant every month for the purpose of ensuring and satisfying on behalf of the local community that the Plant is being run and operated by the Respondent No. 7 as per the guidelines and commitments made herein. For this purpose, the same persons during visits shall be entitled to view the CCTV footage and other records available with Respondent No. 1 herein under prior

intimation to Respondent No. 1. They will also be permitted to take pictures.

2. *The Appellants shall be at liberty in the event of having noticed any violations after the commencement of the Plant to be brought to the attention of the Goa State Pollution Control Board and the Director, Science and Technology."*

Thus the Appeal No. 15 of 2015 stands disposed of without any order as to cost.

We grant liberty to Appellant to approach the Tribunal if the terms are defaulted.

M.A. No. 658 of 2015

The M.A. No. 658 of 2015 does not survive for consideration as the main Appeal itself stands disposed of.

Thus the M.A. No. 658 of 2015 also stands disposed of.

.....,CP
(Swatanter Kumar)

.....,JM
(Sonam Phintso Wangdi)

.....,EM
(Dr. D.K. Agrawal)

.....,EM
(Prof. A.R. Yousuf)

Joint Statement dated 16.03.2017:

BEFORE THE NATIONAL GREEN TRIBUNAL

PRINCIPAL BENCH, NEW DELHI

APPEAL NO. 15 of 2015

SALIGAO CIVIC and CONSUMER
CELL (SCCC) & ANR .....APPELLANTS

VERSES

GCA STATE INFRASTRUCTURE
DEVELOPMENT CORPORATION & Ors. .....RESPONDENTS

MAY IT PLEASE YOUR LORDSHIPS:

The Appellants, the Respondent No. 1, Goa State Infrastructure Development Corporation. Respondent No. 2, Department of Science and Technology and Respondent No. 7, Concessionaire of the Plant have all had a meeting convened by the Learned Advocate General, State of Goa, and are accordingly filing this joint statement before the Hon'ble Tribunal in terms of the Order dated 26th February 2016.

The commitments on behalf of Respondent No. 1, Respondent No. 2, and Respondent No. 7, Concessionaire.

1. The High Court has directed the Village Panchayats in the said Suo Moto Writ Petition 2 of 2007 to segregate the collected waste and deal with it as follows:

i. Compost the organic Bio-Degradable fraction in situ,

ii. Bale the Non- Biodegradable fractions for collection by the Contractor appointed by the State and ,

iii. Store the inert waste on temporary basis, till arrangements are made by the State for its disposal.

The Village Panchayats within their jurisdiction, are required at their garbage collection sites, to segregate solic waste that is collected from all wards of the village into Bio Degradable and Non Biodegrable fractions, in accordance with the Municipal Solid Waste Management Rules 2000 and the Judgment of the Hon'ble High Court dated 13/08/2013 in Suo Moto Writ Petition No. 2/2007.

2. Since the Government is relieving some of the Village Panchayats of the composting task, hence organic/ biodegradable waste shall be sent separately to the Plant for processing. This arrangement will ensure that Village Panchayats are compelled to take some responsibilities for the garbage generated in their areas and more importantly; this direction will be in compliance with the High Court Judgment dated 13/08/2013 and the MSW Rules, 2000.

3. The entire non-biodegradable waste after segregation by the Village Panchayats at their level, shall be handed over at the plant to the Concessionaire who shall be responsible for further segregation into recyclable, RDF and inert fractions. It shall be the responsibility of the plant operator/ concessionaire to dispose of the recyclable, RDF waste at its own cost and to dispose the inert waste in the landfill, in accordance with the Concession Agreement.

4. The present Environmental Clearance is for 100 tones capacity so also the consent of Goa State Pollution Control Board. As per the Concession Agreement, the plant is required to work upto 125 metric tones per day. The State Government shall be at liberty to have the Environmental Clearance amended and obtain fresh Consent from Goa State Pollution Control Board so as to utilise the plant capacity upto 125 metric tonnes.

5. Subject to Clause No. 4, for the purpose of computation of 100 tonnes or 125 tonnes as the case may be, entire waste which goes on the tipping floor only shall be taken into consideration. The already segregated plastic waste which goes directly to the storage area shall not be considered as the waste treated for the purpose of computing the quantified waste.

Date: Place:

Appellants **Respondent No. 1** **Respondent No. 2**

Respondent No. 7

1.8 Approvals/Permissions/Clearances for setting up of the Solid Waste Management Facility at Calangute

a. Consent to Establish:

The Goa State Pollution Control Board (GSPCB) vide letter no. 5/6099/13/12656 dated 20/11/2013 granted Consent to Establish under Air & Water Act for setting up of Solid Waste Management Facility at Calangute/Saligao.

b. Authorisation:

The Goa State Pollution Control Board vide letter no. 8/28/07-PCB/5814 dated 20/11/2013 had authorised Department of Science & Technology for setting up of Solid Waste Management Facility at Calangute/Saligao.

c. No Objection Certificate from Town & Country Planning Department:

The Town & Country Planning Department vide letter no. 33/2/TCP/CAL-SAL/TCP/13/3713 dated 27/09/2013 granted No Objection from planning point of view for acquisition of land for setting up of the Solid Waste Management Facility at Calangute/Saligao.

d. Notification of the area as Industrial Area:

The land acquired for setting up of the SWMF at Calangute/Saligao was notified as Industrial Area vide Government Notification No. 4/6/2014-IND/2014 dated 22/05/2014, as Industrial Estate by the Department of Industries.

e. Environmental Clearance:

The Goa State Environmental Impact Assessment Authority vide letter 3-181-2010/STE-DIR/91 dated 03/03/2015 granted Environmental Clearance for setting up of the Solid Waste Management Facility at Calangute/Saligao in accordance with the provisions of Environmental Impact Assessment (EIA) notification 2006.

f. Consent to Operate:

The Consent to Operate was also granted by the GSPCB to the Concessioner of the SWMF at Calangute/Saligao i.e. M/s Hindustan Waste Treatment Pvt. Ltd. who is the operator of the facility; vide letter no. 5/6098/13-PCB/Tech/9644 dated 26/08/2016.

Summary of Waste Treated at the Solid Waste Management Facility at Calangute/Saligao:

Sr. No.	Description	Unit	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Jan-17
1	Input Waste	MT	784.46	2,060.61	2,754.37	3,063.78	3,507.02	3,827.86
2	Recyclables	MT	64.85	199.90	319.59	369.20	440.78	505.83
3	Refused Derived Fuel (RDF)	MT	221.90	622.26	773.17	857.54	1,058.24	1,199.79
4	Compost Generated	MT	48.95	115.19	182.06	198.84	217.79	193.31
5	Inert Generated	MT	60.69	154.19	199.99	209.98	265.54	264.60
6	Biogas Generated	Nm^3	21,315	80,417	99,047	1,13,281	1,30,850	1,19,373
7	Biogas Generated	kW.hr	31,630	85,410	1,10,230	1,08,326	1,27,670	1,28,305

Sr. No.	Description	Unit	Feb-17	Mar-17	Apr-17	May-17	Jun-17	Total
1	Input Waste	MT	2,983.04	3,044.61	2,903.08	3,308.56	3,581.99	**31,819.38**
2	Recyclables	MT	401.14	393.17	371.72	422.35	473.27	**3,961.80**
3	Refused Derived Fuel (RDF)	MT	1,003.62	1,018.15	868.55	1,040.44	1,186.37	**9,850.04**
4	Compost Generated	MT	196.28	201.55	194.51	202.81	227.81	**1,979.11**
5	Inert Generated	MT	211.13	197.36	187.39	155.84	201.96	**2,108.67**
6	Biogas Generated	Nm^3	1,02,746	1,16,796	1,30,086	1,52,933	1,69,005	**12,35,849**
7	Biogas Generated	kW.hr	99,631	1,33,610	1,68,750	2,06,018	1,99,177	**13,98,757**

1.9 Brief Description of Nature of the Project and Regulatory Requirements

The Integrated Solid Waste Management Facility (ISWMF) is designed to process and treat 250 TPD of solid waste. The per capita waste generation for the Regional area is considered as 410 gm / capita / day. The ISWMF system has been proposed for the design year 2041, for a total capacity of 250 TPD which consist of **50** TPD of Non- Biodegradable waste, **150** TPD of wet biodegradable waste, and **50** TPD of Mixed waste. Centralized Integrated Solid Waste Management Facility (ISWMF) provisions for MRF Facility, Biomethantion system along with gas engines, In-Vessel Composting system, Sanitary Landfill, Mobile vehicles, workshop, Facility center for operators, having canteen, shower area and medical room, Administration building, laboratory, Resource center, Car & Vehicle parks, effluent treatment and recycle plant, Container storage yard, road network, peripheral drains, green buffer belt, site & street lighting, ESR, fire water system, borewell, ground water monitoring wells and plant fencing complying with the comply with the Solid Waste Management Rules, 2016. The total cost of the proposed SWM project is 248.50 crores which is proposed to be funded by Government of India, State Government and ULB and the Concessionaire under Design Build, Finance, Own and Transfer (DBFOT) basis.

1.10 Environmental Impact Assessment (EIA) Legislation

The Ministry of Environment and Forests (MoEF), Government of India has under the Environmental (Protection) Act 1986 promulgated an Environmental Impact Assessment Notification on 27 January 1994 making environmental clearance mandatory for expansion or modernization of any activity or for setting up news projects listed in Schedule I of the notification. Till 1994, EIA clearance was the administrative requirement for big projects undertaken by the Government or public sector undertakings. The EIA Notification dated 14th September, 2006 supersedes the earlier EIA Notification, 1994 and subsequent amendments thereto.

In supersession of the EIA Notification, 1994 all projects and activities are broadly categorized in to two categories – Category A and Category B, based on the spatial extent of potential Impacts and potential Impacts on human health and natural and manmade resources.

All projects or activities included as Category 'A' in the Schedule, including expansion and modernization of existing projects or activities and change in product mix, shall require prior environmental clearance from the Central Government in the Ministry of Environment and Forests (MoEF) on the recommendations of an Expert Appraisal Committee (EAC) to be constituted by the Central Government for the purposes of this notification.All projects or activities included as Category 'B' in the Schedule, including expansion and modernization of existing projects or activities with addition of capacity beyond the limits specified for the concerned sector, that is, projects or activities which cross the threshold limits given in the Schedule, after expansion or modernization or change in product mix in an existing manufacturing unit included in Schedule beyond the specified range, but excluding those which fulfil the General Conditions (GC) stipulated in the Schedule, will require prior environmental clearance from the State/Union territory Environment Impact Assessment Authority (SEIAA).

The SEIAA shall base its decision on the recommendations of a State or Union territory level Expert Appraisal Committee (SEAC) as to be constituted for in this notification. In the absence of a duly constituted SEIAA or SEAC, a Category 'B' project shall be treated as a Category 'A' project.

The environmental clearance process for new projects will complete in maximum of four stages. In first stage, Screening shall be done only for Category 'B' projects and activities. Further, Scoping, Public Consultation and Appraisal shall be done in sequential manner.

The public hearing at, or in close proximity to, the site(s) in all cases shall be conducted by the State Pollution Control Board (SPCB) or the Union territory Pollution Control Committee (UTPCC) concerned in the specified manner and forward the proceeding to the regulatory authority concerned within 45 (forty five) of a request to the effect from the applicant.

Clearance application shall be made in Form I and they shall be considered by the concerned Expert Appraisal Committee or State Level Expert Appraisal Committee within sixty days, who will decide on the due diligence necessary including preparation of EIA and public consultations and the application shall be appraised accordingly for grant of environmental clearance.

In the environmental clearance process, the documents to be submitted to MoEF are project report, public hearing report, site clearance for site specific projects, no objection certificate from State Pollution Control Board (SPCB), environmental appraisal questionnaire, EIA/EMP report, risk analysis for projects involving hazardous substance and resettlement plans, if more than 1000 people are likely to be displaced.

According to EIA notification, an legislation, primarily the 1994 MOEF Environmental Impact Assessment Notification, the AIDP may or may not require an Environmental Impact Assessment (EIA) or other type of environmental review. The necessary criteria for some type of environmental analysis would be met if the AIDP were to support construction of new or expansion of existing industrial facilities.

As per the EIA Notification issued by MoEF on 14th September 2006, proposed project is fall under the sector 7(i) and requires Environmental Clearance. The proposed project under the mentioned category of Common Municipal Solid Waste Management Facility (CMSWMF) fall under Category 'B' project. The summary of applicable statutory legislations for this sector listed in **Table 1.1**.

1.11 Terms of Reference (ToR) issued by SEAC

1.11A Revised Terms of Reference (ToR) for conducting Environmental Impact Assessment Study for Establishing a Municipal Solid Waste Management Facility (MSWMF) at Bainguinnim, Goa for 250+20% TPD

1.0 Background

This should include, profile of the Corporation of City of Panaji (CCP) as a Project Proponent (PP), contact address, implementing organization (Concessioner), Project Consultants for design of the plant as well as Environmental Consultants appointed, if any. (Supporting documents may be annexed).

1. The PP must furnish information on any/all similar projects handled/being handled by it in the State of Goa detailing the project stage and clearly spelling out the feasibility thresholds, feeding centres, probable commissioning dates.
2. A special mention must be made of judicial interventions/'Stop work orders', if any, in the ongoing projects of similar scope handled by it. Submissions made by the PP in this regard to the Appellate Authority

must be shared with the Goa-SEAC (hereinafter referred as 'Committee').

3. A statement on available/earmarked funding for the proposal must be shared with the Committee. Escalation costs, if any, envisioned through the project period must be accounted for.
4. A statement of justification and 'cost benefit analysis' of 'Saligao Solid Waste Management Facility (SSWMF)' vis-à-vis 'separate discrete facility proposed at Bainguinim' be prepared by the PP, defining the minimum threshold quantum and source of waste for operationalizing the facilities.
5. Chronologically provide sequence of the project from its initiation till date with reference to administrative approvals taken up by the PP. Describe the geographical location of the proposed facility and its surroundings, capacity, need, goal and objectives for proposed MSWMF, significance of the project both at local and regional level may be mentioned clearly.
6. Detailed demography/land-use/existing, proposed & approved residential colonies/archaeological sites/World Heritage Monuments/Hospitals (existing and proposed)/perennial lentic and lotic water-bodies surrounding the project-site as well as buffer area of 5 and 10 km radius around the site should be superimposed on a Google imagery at a decipherable scale.
7. A separate plan be prepared delineating the existing/TCP-approved residential colonies/settlement around the boundaries of the proposed facility within a radius of 3 km (i.e. zone of likely impact).
8. Adequate and rational sensitization of the local stakeholders by the PP on the proposed and sentiments of the local stakeholders towards the proposal, if any, be furnished
9. PP must furnish primary database on biodiversity inventories based on ground-truthing, and not secondary data available. The biological data shall have to be collected for one cycle covering all seasons.
10. Considering the rich bird diversity of Kadamba plateau region, PP shall study the 'Habitat value' of the proposed site for biodiversity with special reference to the avifaunal diversity
11. Discuss project location with reference to distance from major landmarks, policy, legal and administrative framework within which the project is set, major stakeholder(s)/Department(s) of the State and Central Government with their specific roles, applicable laws, clearance requirements at various levels of project execution and their current status
12. Describe in detail if any litigation(s) are pending against the proposed project and/or any directives or 'orders' passed by any court of law/statutory authority. In addition, the PP should inform its area of jurisdiction vis-à-vis Appellate Authority to resolve legal disputes, if any.

2.0 Project Description

Background information for implementation of the project and baseline studies taken up, if any, and overall scenario of the proposed facility in the context of Panaji's solid waste management issues and challenges, procedures adopted for selection of technology, criteria for site-selection should be discussed.

Following information should be included :

- Primary waste characteristics, physical, chemical in Municipalities and Panchayats catchment areas and comparison with waste characteristic at the existing facility at Calangute. This characterization shall be done for one season and the sheets with the dates, area of sampling, time, duly signed by the GWMC officials shall be submitted as part of the report. The sample size shall be arrived at based on the calculations shall be placed as part of the report
- Population/area covered under MSWMF
- Expected quality/quantity of solid waste (MSW) generated (based on the resident plus floating population)
- Quantity of MSW actually collected (average figure) – details of seasonal variation for actual collection (from secondary sources)
- Methodology for collection of MSW – doorstep collection, segregation at source, community bins, collection from commercial, hotels and office premises, etc.
- Transportation of MSW – type of vehicles (fast or slow moving), frequency of transportation and distance of transportation, Access to the solid waste mgt site (preferably alternate/multiple).

Details of the Proposed MSWMF

The information will be sourced from engineering and design studies conducted for the project. This section should contain the following details :

- Land requirement for the facility, including its optimization, break up for various purposes and its availability, if any.
- Details of the following may be furnished –
  - Each unit in the facility, with a brief description of its operations
  - Proposed protocol for waste acceptance (system for sampling, parameters, analysis methods, time lags, number of people, qualifications, manifest system, etc.)
  - Ultimate disposal of the waste – details of the methodology of disposal including life span and design of the existing/proposed site
  - Existing solid waste dumping scenario on the proposed site
  - Details of chosen waste treatment process/technology and whether it is in compliance with the applicable law (at present "Municipal Solid Wastes (Management and Handling) Rules, 2000")
  - Details of safety measures for occupational health

- Mass and Energy Balance flow diagram (step-by-step) for the process technology proposed
- Energy conversion technology should be clearly detailed out with specifications of the biogas engines and alternators used for this conversion process
- List of plant(s) and equipment(s) to be set up and vehicles to be used
- Details on expansion/up gradation of the existing processing facility, if any.
- Source of water and electrical power/ details about captive utility of in-plant power generation
- The quality of compost being generated from the existing facility
- Details of the laboratory facilities available for testing, analysis etc.
- Specific details on leachate collection system around the plant and around the facility, generation rates, treatment and disposal
- Details of the landfill operation – filling, layers, equipment, compaction levels, cross-checking mechanism, stability considerations, landfill gas monitoring, troubleshooting mechanism, etc. and analysis and report of the landfill at a similar existing plant in Goa
- Details pertaining to monitoring of test wells within and around the landfill site as per standard procedure, its locations, frequency of monitoring, parameters as prescribed by the CPCB norms, etc.
- Fire detection, suppression and safety & health protection measures during project design and operations
- Feasibility study for utilization of segregated combustible fuel (SCF) or Preparation of Refuse Derived Fuel (RDF) to produce electricity and/or replace traditional sources of fuel in local industries. Its production and quality (Calorific value and C/H ratio) as well as list of promising buyers
- Assessment of generation of horticulture waste, transportation plan and feasibility study for utilization of the same for manufacture of briquettes or other alternative treatment methodologies
- Assessment of generation of slaughter house waste, transportation plan and treatment methodologies

Provide a contour map on 1:1000 scale for the study area showing proposed breakup of the land. Detailed layout plan of proposed project development, communication facilities, access/approach roads, internal roads, landscape, sewage disposal facilities, and waste disposal etc. to be given. Layout plan of proposed development of built up areas with covered construction such as DG-Set rooms, Administrative buildings, Utilities such as Main and Stand-by Power, Water supply installations, location of STP, RWH structures & Green Belt area etc.

3.0 Description of the Environment in the Delineated Study Area

As a primary requirement of EIA process, the proponent should collect baseline data in the project area as well as in the area within 10 km of the proposed project boundary (buffer zone). Map of the study area clearly delineating the location of various monitoring stations (air/water/soil and noise) superimposed with location of habitats are to be shown. Primary data (baseline data), wherever feasible, should be collected for one season except rainy season. Secondary data should be collected for area within 10 km aerial distance from the project site-boundary, as specifically mentioned at column 9(iii) of Form-I of EIA Notification 2006.

The following components of the environment shall be studied :

3.1 Land Environment

a) **Land use / Land cover :** Data on the land use (conformity with existing development regulation), habitation, and forest cover around the proposed CMSWMF Ascertained from local authorities, revenue records etc.

b) **Topography :** Baseline data needs to be given on existing situation of the land at the proposed project area, including description of plateau features, terrain analysis, slope and elevation, microclimatic factors

c) **Geology :** Baseline data should be provided on rock types, regional tectonic setting and history of any seismicity and associated hazards. Information on distance of quarries/excavation, if any, from habitat, restrictions for cutting/filling, environmental controls, etc. should be provided

d) **Soil :** Data including type, stratification (soil profile), characteristics, soil properties, porosity and permeability, inherent fertility etc. are important from engineering considerations for designs of structures like landfills, green belt development, etc. should be submitted. The current level of soil and water contamination, if any, due to existing dumps need to be ascertained.

3.2 Water Environment

a) **Groundwater :** Baseline data on groundwater sources (springs, open-dug wells, bore wells), including data on depth (groundwater table), physico-chemical parameters is to be collected at least for one season

b) **Surface water:** Baseline data on location of surface lentic and lotic water sources details such as their present quality and utility, if any. Details of water bodies present within the project area and 5 kms. Surrounding the site-boundary should be provided

c) Prepare an existing **drainage map** on a toposheet of the site with 1.5 km surrounding with natural surface drainage flow points

d) Estimate **water intake requirements** for the project and identify the source of water to be used (provide water balance table). Ground water budgeting, if being used, has to be provided. Rainwater harvesting (if proposed) to be detailed out.

e) Quantity of **wastewater generated** during construction and operational phase and details of its treatment and disposal is to be provided.

3.3 Biological Environment

a) **Terrestrial Ecology:** Inventory of Flora and Fauna based on primary data in the study area as well as that within 10 km of its boundary, shall be included in the list of flora and fauna along with classification as per the schedule given in the Wildlife Protection Act, 1972 (for fauna) and in the Red Book Data (flora). Also, a statement clearly specifying whether the study area forms a part of an ecologically sensitive area should be provided. In the event of occurrence of any scheduled –I species, as per IWPA, 1972, a conservation plan be prepared in consultation with and authenticated by the Chief Wildlife Warden (CWW), Govt. of Goa

b) A particular emphasis be laid down on avifaunal diversity highlighting the raptors and scavenging birds at the existing site, besides the forest bird species of the general plateau around the area within a radius of 10 km.

c) In the water bodies within 5 kms. of crow-fly distance surrounding the site-boundary, excluding the marine realm; an inventory of fresh-water biodiversity to be compiled with emphasis on icthyofauna and waders, if any.

d) Inventory of Agro-biodiversity within 5 kms buffer zone highlighting local cultivars, if any.

e) Designated Wildlife protected areas/Natural habitat of any IWPA scheduled species, if any, within 10 km radius of project boundary be brought on record

3.4 Air Environment

Climatological data is to be obtained from nearest Indian Meteorological Department (IMD) station for one full year. Micro meteorological data consisting of wind speed, wind direction, temperature, cloud cover (amount and height), humidity, inversions, rainfall (peak and average daily rainfall) and wind rose patterns, from primary and secondary sources in the study area.

Baseline data of air pollutants parameters extending an area of 10 km from the project should be monitored at a number of locations. Description of base line data of ambient air parameters namely PM_{10} and $PM_{2.5}$, oxides of Nitrogen (NOx), Sulphur dioxide, and carbon monoxide are to be collected. One season data is to be monitored other than monsoon as per the CPCB Norms. Sampling locations are to be located as per CPCB norms.

3.5 Noise

Baseline data on noise pollution at the project area and the neighbourhood residential areas is to be monitored as per the CPCB norms.

3.6 Socio-Economic and Occupational Health Environments:

Baseline data at the project area shall include the demography of the village panchayat at the project site, existing residential projects around the proposed site, existing infrastructure facilities in the proposed area and anticipated area of impact

due to the proposed activity. This should be clearly demarcated on a map denoting the existing and proposed project within 1.5 km around the project site.

4.0 Anticipated Environmental Impacts and Mitigation Measures

This section should describe the likely impact of the project on each of the environmental parameters of Land Environment (Topography, Geology and Soil), Water Environment (Groundwater and surface water), Biological Environment, and Air Environment. The methods adopted/proposed to be adopted for assessing the impact such as model studies, empirical methods, reference to existing similar situations, and reference to previous studies should be discussed in detail. Details of specific mitigation methods to reduce adverse effects of the project, best environmental practices and conservation of natural resources should be detailed out of each of the parameters. A separate dedicated technical section on 'Odor emanation, mitigation & management' shall be written by an accredited domain-expert, defining the budgetary outlay for the purpose.

This should include proposed measures for fire detection, suppression and occupational safety and health protection measures during project design and operations, scheme for storm water management within and around the proposed facility, details on impacts of landfill gases and its preventive measures, as per CPCB norms and action plan for green belt development, including the details of species, width of plantation, height & density and planning schedule as per CPCB norms.

PP shall give special attention to the menace of insect and rodent vector breeding at the site and around it. In view of this apprehension; an inventory of arthropod and rodent species of pest/vector value shall be prepared by PP based on ground-truthing. Control measures shall be spelt out.

A detailed discussion should also be included for socio-economic and health environment for resident population anticipated living around the project site with detailing of specific details on odour, noise and transportation. Impact of the project on socio-cultural and tourism aspects should be assessed.

Environmental Monitoring Program

- Frequency, location, parameters of monitoring air, water, noise and soil during operation of SWMF
- Compilation and analysis of data and reporting system in a discrete EMP document

Institutional arrangement by PP to implement mitigation measures shall be identified and steps to strengthen or expand existing arrangements, if required, shall be proposed. A detailed responsibility chart to be included for mitigation measures for construction and operational phase of the project and for any disaster mitigation.

Project Benefits – This section should detail out the positive impacts of the CMSWMF including improvements in physical infrastructure, if any

5.0 Public Hearing and Stakeholder Consultations

Public hearing and stakeholder consultations shall be conducted, if applicable, including community consultations at the affected community levels. The

objective of the consultation sessions shall be to improve project components with regard to proper environmental management.

Issues identified by the public and other stakeholders during public hearing along with the issues raised by the public and the appropriate responses of the project proponent should be included in the final EIA report.

6.0 Environmental Management Plans (EMPs)

Based on the impacts predicted, EMPs shall be prepared to fulfil all requirements of GoI, MoEF and GoG. The scope of EMPs shall include:

- Recommendation of feasible and cost-effective measures to prevent or reduce significant negative impacts to acceptable levels.
- Description of implementation arrangement needed for the project
- Specification of environmental supervision, monitoring and auditing requirements, including the technical aspects of monitoring the effectiveness of mitigation measures (including measurement methodologies, data analysis, reporting schedules, emergency procedures, detailed budget & procurement schedules).
- Summary matrix of environmental monitoring, during construction and operation stages, along with the requirement of monitoring facilities, frequency, location, parameters of monitoring, compilation and analysis of data, comparison with base line data, compliance to accepted norms and reporting system, and plantation monitoring program
- Post-closure plan for landfill site, if any
- Listing of all the mandatory government clearance conditions, and the status of procuring clearances

7.0 Executive Summary (Summary EIA)

This should be a summary of the EIA report condensed to 10 A-4 size pages. It should necessarily cover in brief the following chapters of the EIA report. Introduction, Project Description and Description of the Environment, Anticipated Environmental Impacts and Mitigation Measures, Additional Studies, Environmental Monitoring Program/Project benefits, and Environmental Management Plan (EMP).

Such an Executive Summary may be required during public hearing process, as applicable, for distribution to public on demand. If required, it has to be translated into a local language(s).

8.0 Disclosure of Consultant Engaged

This shall include the names of the consultants engaged with their brief resume and nature of consultancy rendered.

The following general points should be noted :

- All documents should be properly indexed, page numbered.
- Period/data of data collection should be clearly indicated

- While preparing the EIA report, the instructions for the proponents and instruction for the consultants issued by MoEF vide O.M. No. J-11013/41/2006-IA.II(I) dated 4th August, 2009 and 5th October 2011, which are available on the website of the Ministry, should also be followed.
- The consultants involved in the preparation of EIA/EMP report after accreditation with Quality Council of India (QCI)/National Accreditation Board of Education and Training (NABET) would need to include a certificate in this regard in the EIA/EMP reports prepared by them and data provided by other organization/laboratories including their status of approvals etc. In this regard circular no. F.No.J-I1013/77/2004-IA-II(I) dated 2nd December, 2009, 18th March 2010, 28th May 2010, 28th June 2010 and 30th September 2011 posted on the Ministry's website http://www.moef.nic.in may be referred
- After the preparation of the draft (as per the generic structure prescribed in Appendix-III of the EIA Notification, 2006) covering the above mentioned ToRs', the project proponent shall get the Public Hearing conducted, if applicable, and take further necessary action for obtaining prior environmental clearance (EC) in accordance with the procedure prescribed under the EIA Notification, 2006.
- The copy of the letter received from Goa-SEAC on the TORs' prescribed for the project should be attached as an annexure to the final EIA-EMP report. The compliance statement of ToRs' prescribed should also be incorporated.

Figure 1.1 : Location Map of Bainguinnim, Goa

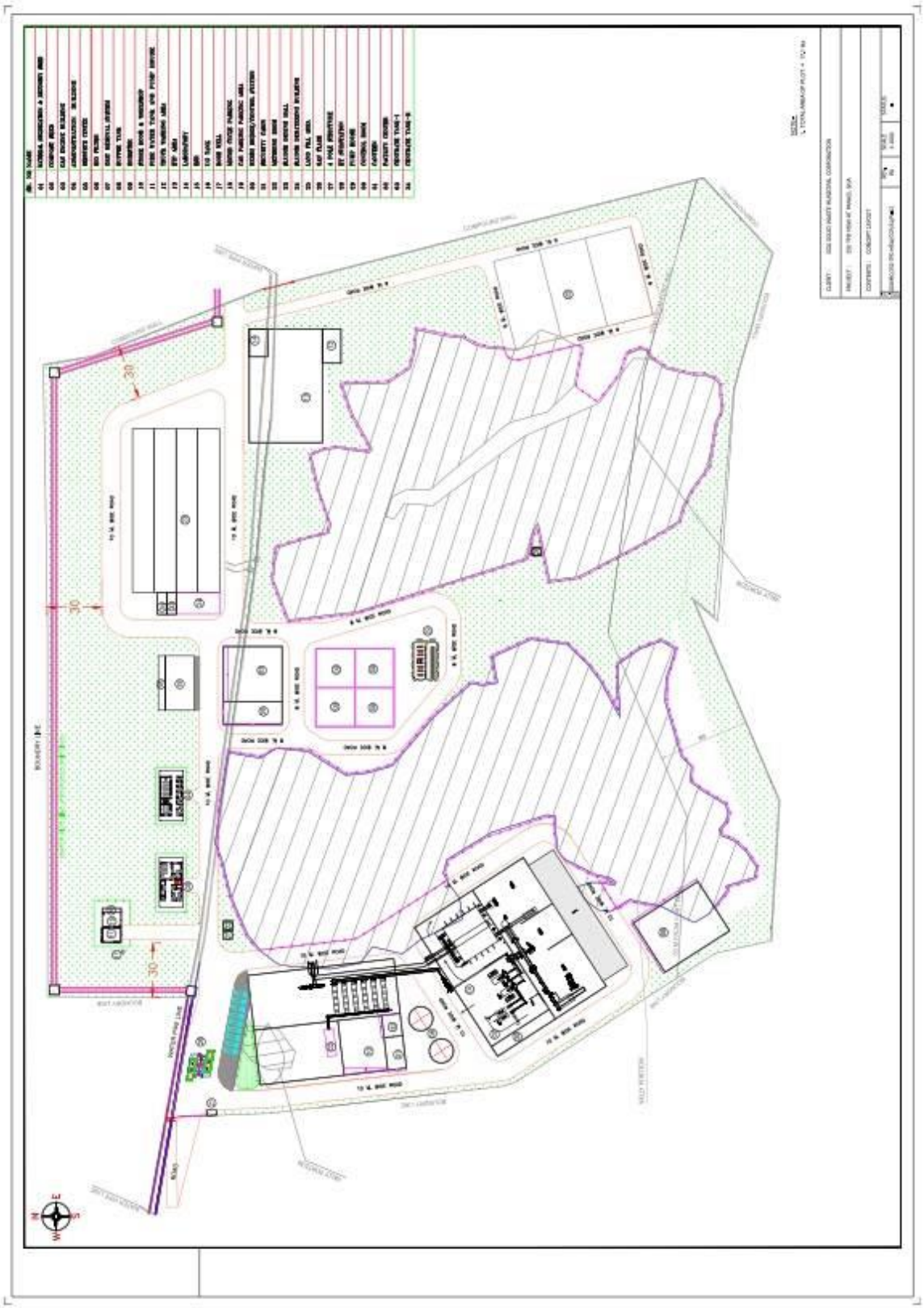


Figure 1.2 : Project Layout of Proposed IMSWMF at Bainguinnim, Goa

Table 1.1 : Applicable Statutory Legislations

Legislation/Acts	Objective
Environment (Protection) Act 1986 and its subsequent amendments	To protect and improve the overall environment
EIA Notification dated September 14th , 2006 and its subsequent amendments	Requirement of environmental clearance before establishment of or modernization / expansion of identified developmental projects.
Forest (Conservation) Act,1980 and its subsequent amendments	To protect forests.
Wildlife (Protection) Act, 1972 and its subsequent amendments	To protect wildlife
Water (Prevention and Control of Pollution) Act, 1974 and its subsequent amendments	For the prevention and control of water pollution and also maintaining or restoring the wholesomeness of water.
Air (Prevention and Control of Pollution) Act 1981 and its amendments	For the prevention, control and abatement of air pollution.
The Noise (Regulation and Control) Rules, 2000 The Environment (Protection) Second Amendment Rules, 2002 (Noise Limits for New Generator Sets)	For the prevention and control of noise pollution
Construction & Demolition Rule, 2016	Every waste resulting from construction, re-modelling, repair and demolition of any civil structure that generates construction and demolition waste such as building materials, debris, rubble.
Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008 and its subsequent amendments.	For Management & Handling of the hazardous wastes in environment friendly manner.

- Compliance to State Rules and Notifications will also be ensured.

Chapter 2

Project Description

Chapter 2
Project Description

Government of Goa has constituted Goa Waste Management Corporation (GWMC) to deal with all garbage related issues including dump sites in the Goa State. GWMC has taken over all the on- going Solid Waste Management Projects in Goa including Municipal Solid Waste Management Facilities at Saligao, North Goa & Cacora, South Goa and Bio-medical Waste Management Facility at Kundaim, North Goa. In their constant endeavor to the above, GWMC has proposed to set-up another integrated Common Municipal Solid Waste Management Facility (CMSWMF) at Bainguinim, Tiswadi, North Goa, in compliance with the Solid Waste Management Rules, 2016 prescribed by Ministry of Environment, Forests and Climate Change, Government of India.

Accordingly, GWMC has prepared a Detailed Project Report (DPR) for the same. The proposed facility will treat the municipal solid waste, after recovering all possible recyclables and segregating the same into the Wet (Organic) and Dry (Inorganic) fractions. Biogas will be generated from the Wet (Organic) fraction, which will be converted into electricity whereas the stabilized organic sludge shall be further processed to generate high quality Soil Conditioner and Compost. The Dry (Inorganic) fraction shall be cleaned and used to generate high quality Refused Derived Fuel (RDF). Only residual / inert fraction shall be landfilled in the Sanitary Landfill Facility.

2.1 Area and Population to be Covered by the MSWMF

Goa State covering an area of 3,702 Sq. km and stretched from North to South measuring a length 102 km and East to West measuring a width of 62 km. It is divided into two districts viz. North Goa and South Goa with their respective headquarters at Panaji and Margao. The details are presented in **Table 2.1**.

Table 2.1: Area and Population of Goa

Sr. No.	Description	UoM	North Goa	South Goa
1	Area	Sq. km	1,736	1,966
2	Taluka	No.	6	5
3	Towns	No.	47	23
	• Statutory Towns	No.	7	7
	• Non-Statutory Towns	No.	40	16
4	Villages	No.	194	140
5	Population as per Census 2011	No.	818,008	640,537

The proposed MSWMF will treat the waste generated in the following Talukas and Villages:

1. Taluka – Tiswadi

Sr. No.	Village	Population as per Census 2011
1	Ambarim	93
2	Chorao	5,268
3	Caraim	202
4	Capao	135
5	Navelim	1,133
6	Goltim	1,634
7	Malar	1,630
8	Naroa	487
9	Gandaulim	301
10	Ella	5,372
11	Bainguinim	1,501
12	Talaulim	972
13	Goalim Moula	441
14	Carambolim	5,179
15	Azossim	1,142
16	Mandur	3,113
17	Gancim	519
18	Batim	1,489
19	Curca	2,518
20	Siridao	2,417
21	Neura-O-Pequeno	563
22	Neura-O-Grande	1,440
23	Jua (Census Town)	4,134
24	Cumbarjua (Census Town)	4,917
25	Corlim (Census Town)	6,568
26	Chimbel (Census Town)	15,289
27	Murda (Census Town)	7,517
28	Calapor (Census Town)	14,077
29	Bambolim (Census Town)	6,885
30	Goa Velha (Census Town)	4,322
31	Mercurim (Census Town)	4,970
32	Panaji (Municipal Corp. + OG)	70,991
33	Panaji (Municipal Corp.)	40,017
	Total	217,236

2. Taluka- Bicholim

Sr. No.	Village	Population as per Census 2011
1	Cudnem	3,308
2	Amone	2,963
3	Navelim	2,703
4	Cotombi	591
5	Surla	3,818
6	Velguem	2,617
7	Pale (Census Town)	6,043
8	Sanquelim (Municipal Council)	13,651
	Total	**35,694**

3. Taluka - Satari

Sr. No.	Village	Population as per Census 2011
1	Podocem	966
2	Poriem	4,190
3	Ravona	1,165
4	Gonteli	1,634
5	Siroli	663
6	Anjunem	0
7	Quelaudem	0
8	Ponsuli	0
9	Choraundem	708
10	Ivrem-Buzruco	666
11	Ivrem-Curdo	218
12	Golauli	297
13	Surla	460
14	Satrem	176
15	Derodem	108
16	Codal	177
17	Rivem	154
18	Dongurli	1,534
19	Pale	1,157
20	Gululem	0
21	Querim	2,251
22	Morlem	3,290
23	Saleli	984
24	Zormen	635

Sr. No.	Village	Population as per Census 2011
25	Dabem	498
26	Compordem	1,093
27	Edorem	291
28	Naneli	294
29	Carambolim- Brama	445
30	Xelopo-Buzruco	244
31	Sigonem	189
32	Maloli	416
33	Nanorem	287
34	Vainguinim	32
35	Zarani	0
36	Ustem	346
37	Davem	862
38	Bombedem	37
39	Ambedem	272
40	Nagargao	549
41	Satorem	221
42	Mauzi	1,375
43	Buimpal	1,403
44	Cumarconda	525
45	Pissurlem	1,940
46	Sonus-Vonvoliem	764
47	Vaguriem	255
48	Codiem	71
49	Naguem	479
50	Ansolem	186
51	Cudcem	644
52	Sanvordem	897
53	Sonal	430
54	Codvol	5
55	Pendral	0
56	Caranzol	839
57	Carambolim-Bozruco	468
58	Velguem	1,310
59	Codqui	929
60	Sanvorcem	495
61	Advoi	609
62	Ponocem	496
63	Vantem	1,678

Sr. No.	Village	Population as per Census 2011
64	Padeli	657
65	Birondem	476
66	Damocem	596
67	Cotorem	624
68	Xelopo-Curdo	252
69	Siranguli	80
70	Sirsodem	245
71	Assodem	120
72	Govanem	161
73	Malpona	277
74	Ambeli	104
75	Melauli	1,636
76	Conquirem	397
77	Onda (Census Town)	5,863
78	Valpoi (Municipal Council)	8,532
	Total	**63,327**

4. Taluka – Ponda

Sr. No.	Village	Population as per Census 2011
1	Tivrem	1,878
2	Betqui	1,707
3	Volvoi	1,842
4	Adcolna	1,688
5	Boma	2,807
6	Candola (CT)	5,354
7	Orgao (CT)	4,602
	Total	**19,878**

5. Summary

Sr. No.	Taluka	Population as per Census 2011
1	Tiswadi	2,17,236
2	Bicholim	35,694
3	Satari	63,327
4	Ponda	19,878
	Total	**3,36,135**

2.2 Expected Quantity and Characteristics of the MSW

The solid waste is generated from households, commercial establishments like offices, hotels, restaurants, vegetable markets and slaughterhouses along with large fraction of street sweepings which will be collected and processed at ISWMF. It is estimated that approximately 250 Tonnes Per Day (TPD) of mixed MSW will be generated, collected and processed at the ISWMF. The quantity and characteristics of the MSW generated to be processed at Bainguinim is detailed in the **Table 2.2**.

Table 2.2: Quantity and Characteristics of MSW generated

Sr. No.	Description	%	Qty. (TPD)
A	**Total Solid Waste**	**100%**	**250**
B	**Composition of Solid Waste**		
1	Organic / Biodegradable Fractions	60.00%	150.0
2	Glasses	0.50%	1.25
3	Metals	0.50%	1.25
4	Papers, Cardboards, Tetrapacks	4.00%	10.0
5	Mixed Plastic comprising Bottles, Cups, Cartons, Food Packets, coated Plastics etc.	6.00%	15.0
6	Thermocoal, styrofoam	1.00%	2.50
7	Clothes, Rags & Textile	1.50%	3.75
8	Rubber Items	0.50%	1.25
9	Other Non- Biodegradable	10.00%	25.0
10	Mixed Waste	16.00%	40.0

2.3 Materials Flow and Waste Generation

An indication of how and where the solid wastes are generated in our technological society is shown in simplified materials flow diagram in fig. 2.1. Solid wastes (debris) are generated at the start of the process, beginning with mining of raw materials. It is apparent from figure that one of the best ways to reduce the amount of solid wastes that must be disposed off, is to limit the consumption of raw materials and increase the rate of recovery and reuse of waste materials. Although the concept is simple, effecting the change in a modem technological society has proved extremely difficult. Unlike water borne and air dispersed wastes, solid waste will not go away.

"Where the waste is thrown today, is. where it will be found in future" .

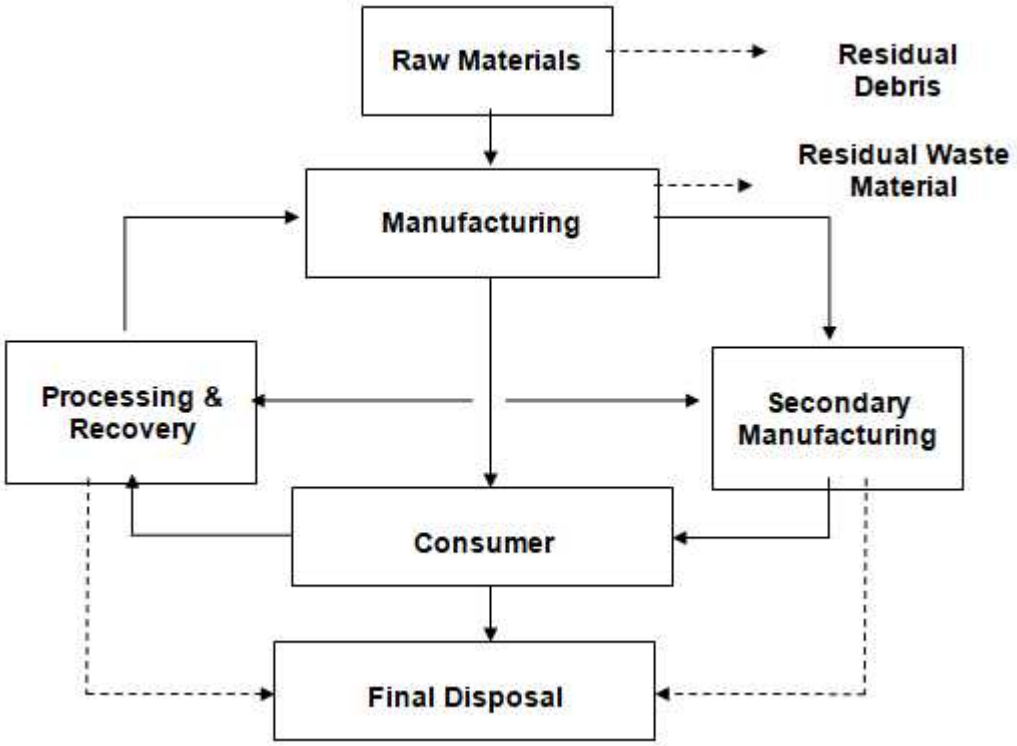


Figure 2.1 : Materials Flow & Generation of Solid Waste in a Technological Society

2.4 Details of IMSWMF and Equipment

The proposed IMSWMF shall comply with The Solid Waste Management Rules, 2016 prescribed by Ministry of Environment, Forests and Climate Change, Government of India. It shall be designed to be able to treat 250 MT waste daily and shall produce the output as mentioned in the **Table 2.3**.

Table 2.3: Different types of Products Generated at IMSWMF at Bainguinim

Sr. No.	Output	Utilization
1	Recyclables	Recyclables shall be recovered as much as possible and routed through appropriate recycling vendors.
2	Refused Derived Fuel (RDF)	The RDF shall be disposed in an environmentally safe and sustainable manner in the nearby Cement Plants for co-processing where it shall be combusted in Cement Kilns at a temperature >1100^0 C with no residues, thus eliminating the need for a Landfill for ash disposal.

Sr. No.	Output	Utilization
3	Electricity	• Electricity shall be utilized to run the entire facility. • Surplus electricity shall be exported to the Electricity Grid
4	Compost	• Compost shall be sold to local farmers and/or nearby Fertilizer Industry ***(Zuari Agro Chemicals, Goa)***. • Alternatively, the Dried Pallet shall be used as fuel to generate heat.
6	Inert	• Inert fraction shall be disposed in the Sanitary Landfill Facility (SLF). • Alternatively, Inert fraction shall be used as a filling material in reclamation of low-lying area.

Terminal Points

The Terminal Points / Battery Limits shall be specifically as given here under:

a) TP-1: Input Municipal Solid Waste

- Location: At the Tipping Floor of the proposed CMSWMF.

b) TP-2: 33 kV HT Power Supply

- Location: At the HT Sub-Station of the proposed CMSWMF.

c) TP-3: Potable Water Supply

- Location: At Underground Raw Water Tank of the proposed Common Municipal Solid Waste Management Facility (CMSWMF).

2.4.1 Treatment Philosophy

The proposed CMSWMF shall be designed in compliance with the following:

- The Solid Waste Management Rules, 2016 through Notification by Ministry of Environment, Forest and Climate Change, New Delhi i.e. S.O. 1357(E) dated 08-04-2016.
- Court Order by National Green Tribunal, Principal bench, New Delhi dated 22.12.2016: Almitra H. Patel v/s Union of India.
- Implementation of technical improvements, duly suggested by the Expert Committee as per Minutes of Meeting dated 23.08.2016 for the existing 100 TPD MSW Processing Facility at Saligao Village of Bardez Taluka in North Goa District.

Accordingly, the proposed CMSWMF shall be designed to treat the Mixed Waste, segregated Dry Waste and segregated Wet Waste separately and independently.

- The proposed CMSWMF shall be designed considering receipt of waste at the Facility for 365 days per year, but effective working days as 320 days per year so as to provide sufficient downtime and maintenance of the Plant. Also, the Facility shall be been designed considering operation of the Facility in 2 Shifts per day with 6 hours Operation Time + 2 hours Cleaning Time in each Shift i.e. effective Operation Time as 12 hours/day.
- The Facility shall have two (2) Weighbridges (One for Entry and one for Exit). The Tipper Trucks / Refuse Compactors will be visually inspected and if found in accordance with the Treatment and Operation Philosophy of the Plant, will be weighed and permitted into the Facility.
- The Mixed Waste, segregated Dry Waste and segregated Wet Waste, after visual inspection weighing at Weighbridge, shall be delivered to the dedicated Tipping Floors for each type of waste respectively. It shall be a totally enclosed structure with Entry/Exit of Garbage Compactors, Floor Washing Connections, Drainage System, Lighting, Ventilation and Odour Control System.

The process flow diagram of the proposed SWM facility is given in **Figure 2.2**. Various civil units and equipments required for the proposed solid waste management system is given in **Table 2.4 and 2.5** respectively.

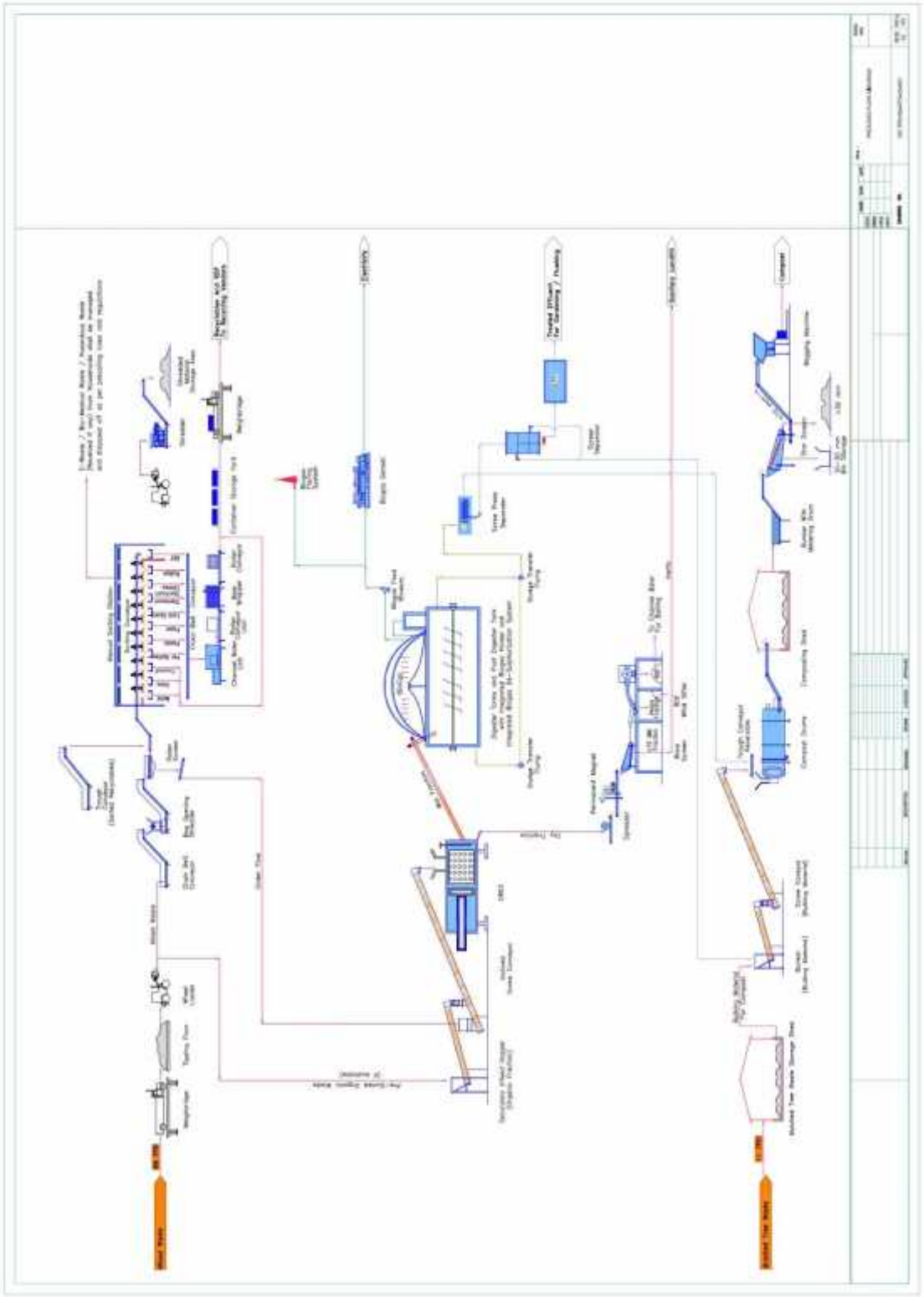


Figure 2.2: Process Flow Diagram of IMSWMF at Bainguinnim, Goa

Table 2.4 : Civil Units Required for the Proposed SWM System

Sr. No.	Unit	No.	Length m	Width (m)	Liquid Depth (m)
A	**Liquid Retaining Structures:**				
1	Buffer Tanks	2	13.000	Dia.	6.000
2	Digesters	4	21.000	21.000	8.000
3	Centrate Tanks-I/II	2	12.000	6.000	3.000
4	Landfill Leachate Sump	1	10.000	5.000	3.500
5	Underground Water Tank	1	5.000	5.000	2.000
6	Overhead Water Tank	1	3.000	3.000	2.000
7	Fire Water Tank	2	10.000	5.000	3.000
B	**Sheds:**				
8	**Material Segregation & Recovery Centre**				
	• TippingFloor	1	85.000	35.000	6.000
	• Material Segregation& Recovery Centre	1	85.000	35.000	6.000
9	**RDF Recovery Centre & Storage Facility**				
	• RDF RecoveryCentre	1	80.000	30.000	6.000
	• RDF StorageFacility	1	80.000	30.000	6.000
10	Bio-Filter	1	45.000	30.000	
11	Compost Turning cum Drying Facility	6	120.000	12.000	
C	**Buildings:**				
12	Security Terminal	1	9.000	2.000	3.000
13	Weighbridge Terminal	1	6.500	3.600	3.000
14	**HT Sub-station**				
	HT Panel Room + Transformer Room	1	30.000	6.000	5.500
	PCC Room	1	30.000	6.000	5.500
15	**Biogas Genset Building**				
	Biogas Desulphurization Area	1	24.000	15.000	6.000
	Biogas Genset Room	1	18.000	15.000	6.000
	Electrical Panel Room	1	10.000	6.000	6.000
	Operator's Room	1	6.000	5.000	6.000
16	Pump House-I (Decanter Centrifuge Feed Pumps)	1	12.000	6.000	4.500

Table 2.5 : List of Equipments Required for the Proposed SWM System

Sr. No.	Item	Capacity / Size / Specification	Unit	No.of Units
2.1	**Material Segregation & Recovery Centre:**			
2.1.1	**Sorting Line:**			
1	Input Feed Bunker with Metering Drum for Mixed Waste	25 TPH	No.	1
2	Bag Opening Shredder for Mixed Waste	25 TPH	No.	1
3	Disc Screen	25 TPH	No.	1
4	Universal Shredder	3 TPH	No.	1
5	Chanel Baler	3 TPH	No.	1
6	Input Feed Hopper with Bag Opener for Dry Waste	8 TPH	No.	1
7	Input Feed Hopper with Bag Opener for Wet Waste	8 TPH	No.	1
8	Organic Extrusion Press	11 TPH	No.	2
9	Plastic Separation System	11 TPH	No.	2
10	Grit Separation System	11 TPH	No.	2
11	Conveyors		Lot	1
2.1.2	**RFD Recovery Line:**			
1	Iron Separator	600 Kg/hr	No.	1
2	Flip-Flow Wave Screen	9 TPH	No.	1
3	RDF Drums	3.00 m Dia. x 18.00 m Length	No.	6
4	Multi-Deck Vibratory Screen	9 TPH	No.	1
5	Conveyors	25 TPH	Lot	1
2.2	**Bio-methanation System:**			
2.2.1(a)	**Equipment for Buffer Tanks:**			
	Mixers with Support Column and Auto-positioning System		Set	2
2.2.1(b)	**Equipment for Digesters:**			
	Mixers with Support Column and Auto-positioning System		Set	2
	Double Membrane Biogas Holder with Air Blowers (Mounted over Digesters)		No.	2
	In-Tank Biogas Desulphurization System		Set	2
	Biogas Safety Valves (Over / Under Pressure) with Flame Arrestors		Set	2

Sr. No.	Item	Capacity / Size / Specification	Unit	No.of Units
2.2.2	**Substrate Transfer Pumps:**			
	Digester Feed Pumps	20 m^3/hr @ 2.00 kg/cm^2	No.	4
	Centrifuge Feed Pumps: 1st Stage	15 m^3/hr @ 2.00 kg/cm^2	No.	3
	Centrifuge Feed Pumps: 2nd Stage	10 m^3/hr @ 2.00 kg/cm^2	No.	3
	Centrate Transfer Pumps	10 m^3/hr @ 1.50 kg/cm^2	No.	2
2.2.3	**Decanter Centrifuges:**			
	Decanter Centrifuges: 1st Stage	15 m^3/hr	No.	3
	Decanter Centrifuge: 2nd Stage	10 m^3/hr	No.	3
2.2.4	**Dewatering Polyelectrolyte Dosing Pumps**			
	Dewatering Polyelectrolyte Dosing Pumps: 1st Stage	6 m^3/hr @ 2.00 kg/cm^2	No.	3
	Dewatering Polyelectrolyte Dosing Pumps: 2nd Stage	2m^3/hr @ 2.00 kg/cm^2	No.	3
2.2.6	**Biogas Genset Based Power Plant and Accessories:**	2 x 800 kWe	Lot	1
2.3	**Composting Facility:**			
2.3.1	Compost Mixing cum Drying System	Dewatered Sludge: 72 MT/day Dry Solids: 18 MT/day	Lot	1
2.3.2	Input Feed Bunker with Metering Drum	4.50 TPH	No.	1
	Star Screen	4.50 TPH	No.	1
	Conveyors		Lot	1
2.3.3	Bagging Machine	3-4 Bag/minute	No.	1
2.4	**Miscellaneous:**			
2.4.1	Weighbridges	60 Ton	No.	2
2.4.2	Centrifugal Fans:			
	Centrifugal Fans for Tipping Floor	45,500 m^3/hr @ 300 mm WG	No.	6
	Centrifugal Fans RDF Drums	400 m^3/hr @ 25 mm WG	No.	6
	Air Cooling System for Manual Sorting Station	18.00 m L x 12.00 m W x 4.00 m H	No.	1
2.4.3	Air Compressors	70 m^3/hr @ 7 kg/cm^2	Lot	2
2.4.4	Electrical Hoist with Electric Travelling Trolley	3 MT	No.	5
2.5	**ETP:**			
2.5.1	Equalization + Physico-Chemical Treatment + SBR System + Filtration System		Lot	1

Sr. No.	Item	Capacity / Size / Specification	Unit	No.of Units
2.6	**Utility:**			
2.6.1	**Pumps:**			
	Raw Water Transfer Pumps	20 m^3/hr @ 15 mWC	No.	2
	Pressure Boosting Hydro-Pneumatic System	15 m^3/hr @ 40 mWC	Lot	1
	Hot Water Recirculation Pumps Main	18 m^3/hr @ 30 mWC	No.	2
	Hot Water Recirculation Pumps Individual	9 m^3/hr @ 30 mWC	No.	2
	Drain Pit Pumps	5 m^3/hr @ 15 mWC	No.	3
	Bio-filter Leachate Transfer Pumps	5 m^3/hr @ 15 mWC	No.	1
	Landfill Leachate Transfer Pumps	15 m^3/hr @ 15 mWC	No.	1
2.7	**Fire Fighting System:**			
2.7.1	Fire Hydrant Pump: Electric Motor Driven	2280 LPM @ 70 MWC	No.	1
	Fire Hydrant Pump: Diesel Engine Driven	2280 LPM @ 70 MWC	No.	1
	Jockey Pump	240 LPM @ 70 MWC	No.	1
2.7.2	Other Accessories		Lot	1
2.8	**Piping & Valves:**			
1	Pipe & Appurtenances		Lot	1
2	Valves		Lot	1
2.9	**Mobile Machinery:**			
2.9.1	Front End Loader	Model: Hindustan 2012 "Z" Bar Loader	No.	2
2.9.2	Skid Steer Loader	Model: Bobcat S450	No.	2
		Model: Bobcat S770	No.	2
2.9.3	Fork Lift	Model: DVX30 KAT BC HVT2125	No.	2
2.9.4 (a)	Tipper Trucks	Model: 1217C (4X2)with Fully Built 6.50 Cum Box Tipper + ComfortPack (A/C)	No.	4
2.9.4(b)	Tipper Trucks	Model: 1623C (4X2) with Fully Built 10.50 Cum Box Tipper + Comfort Pack (HVAC)	No.	2
2.9.5	Tractor	Model: Mahindra Sarpanch 575DI	No.	4
2.9.6	Two-Wheel Hydraulic Tipper Trolley	10' Long x 6' Wide x 3.50'	No.	20

Sr. No.	Item	Capacity / Size / Specification	Unit	No.of Units
		Height		
2.10	**Cleaning Machines:**			
1	High Pressure Washer	Model: HD 6/15C	No.	5
2	Wet & Dry Vacuum Cleaner	Model: NT 65/2 Tact^2 Tc	No.	5
3	Battery Operated Walk Behind Scrubber	Model: BD 50/50 C Bp Classic	No.	2
4	Hot Water High Pressure Jet Cleaner	Model: 69 Series 6970	No.	5
5	Battery Operated Ride on Scrubber Drier	Model: RootsScrub RB 950	No.	2
6	Diesel Operated Ride on Sweeper	Rhino RD 160	No.	2
2.11	**Laboratory Equipment:**			
1	Laboratory Instruments and Accessories		Lot	1
2	Laboratory Glassware		Lot	1
3	Laboratory Chemicals		Lot	1
4	Other Accessories		Lot	1

2.5 Methodology of MSW Collection and Transportation to the MSWMF

Door to Door Collection is proposed and Local bodies to implement the system in their respective areas/jurisdiction. The primary storage of solid waste Proposed for the Regional Area for the household is 10 liter (for bio-degradable waste) capacity bins of green colour and 20 liter (for non-biodegradable waste) capacity bin of black colour. Primary storage of solid waste Proposed for the Hotels, Restaurants etc., is 240 liter bins and 50 Liters Bins lined with colour coded bags for different waste fractions. Primary Storage of solid waste in Market Areas to be done in 240 liters capacity trolley bins. The Secondary Storage Proposed at the public places such as parks, ferry points and tourist places such as beach area etc. is 240 liter capacity trolley bins. In case of the household waste, the transfer of waste from the household to the nearest pick-up point to be done by means of 240 liters capacity trolley bins. Bio-degradable waste and non Bio-degerdable waste is to be collected on daily basis by separate vehicles and transported to the ISWMF facility at Bainguinim by the Local bodies. The location of transfer station along with the proposed site is shown in **Figure 2.3**. Its optimized transportation is provided in **Figure 2.4**.

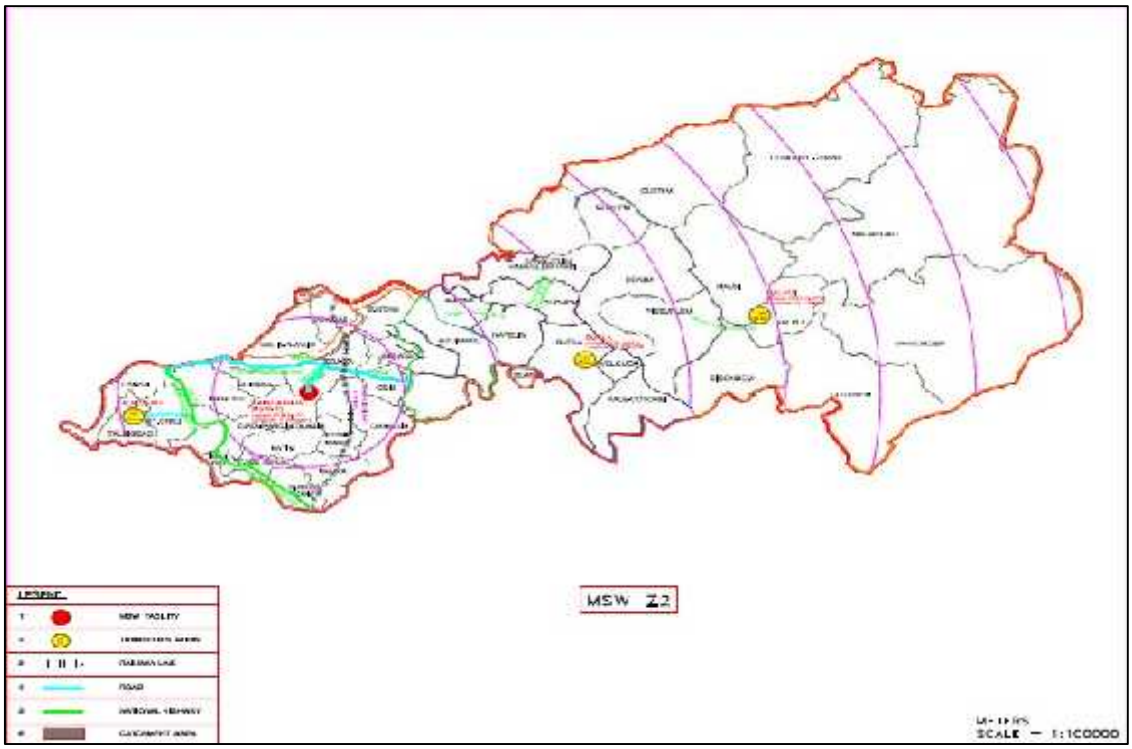


Figure 2.3 : Locations of Transfer Stations along with the Proposed Sites and Villages Considered for the Proposed MSW Treatment Facility

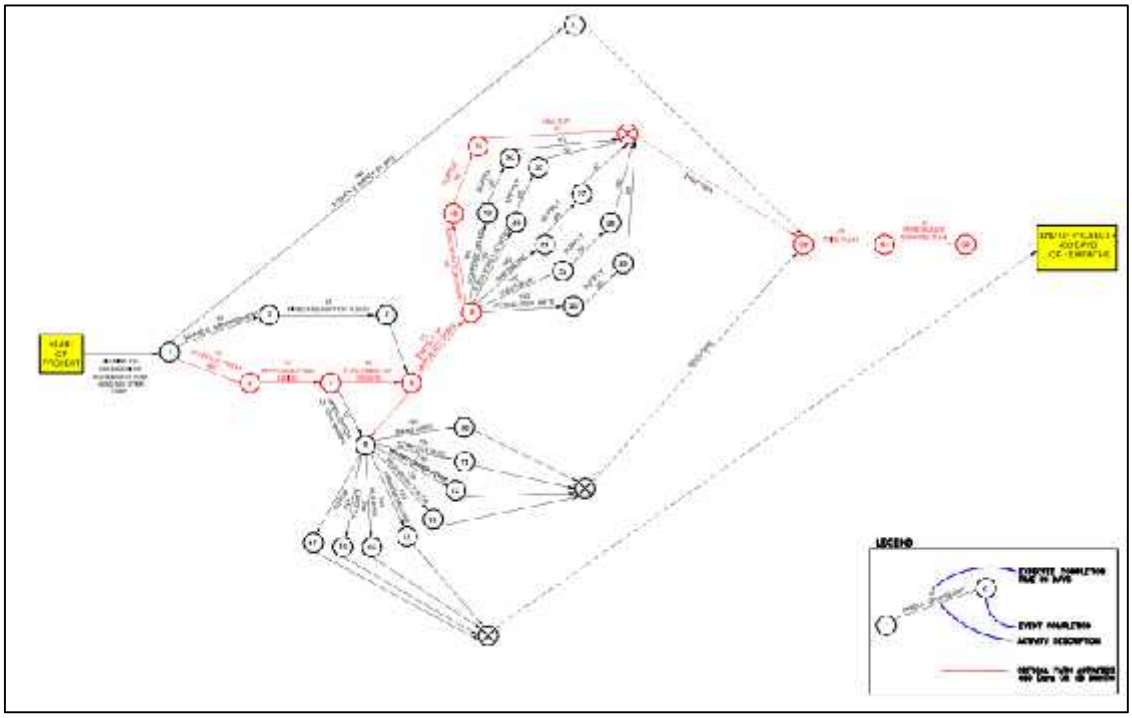


Figure 2.4 : Optimized Transportation Pathway of SWM

2.6 Treatment of Mixed Waste

2.6.1 Infeed Chain Belt Conveying Bunker, Pre-sorting Conveyor and Bag Opener

An Infeed Chain Belt Conveying Bunker shall be provided for feeding of Mixed Waste by Front End Wheel Loader for further processing. It shall have adequate Storage Volume at front end and rotating Drum Feeder at the other end so as to feed the waste uniformly to the downstream Pre-sorting Conveyor where pre-sorting of waste will be carried out and large, bulky material shall be removed from the waste. The Pre-sorting Conveyor will transport the waste to the Bag Opener which will open the waste bags and make the waste available for further sorting and recovery of Recyclables. The waste shall be then, taken to the Disc Screen.

2.6.2 Disc Screen

The Disc Screen shall have a Screen Deck of adequate opening. The underflow fraction shall be taken to the Organic Extrusion Press while the overflow fraction shall be taken to the Manual Sorting Station. A separate Conveyor with In-feed Hopper shall be provided, after the Disc Screen, to feed pre-sorted material, if any, to the Manual Sorting Conveyor directly.

2.6.3 Manual Sorting Station

The Manual Sorting Station shall be an elevated structure with Belt Conveyor and Hand Picking Stations and Chutes on both sides of the Belt at the 1st floor and Compartments at the ground floor under the Chutes to collect the sorted-out material.

2.6.4 Baler

The recyclables sorted-out in the Manual Sorting Station shall be baled (as per requirement) using an efficient Automatic Baler Press into Bales / Pallets for effective transportation to the Recycling Vendors.

2.6.5 Shredder

A Multi-Purpose Shredder shall be provided to shred the sorted Recyclables, Wood, Rubber, Cloths etc.

2.6.6 Organic Extrusion Press

The Organic Extrusion Press will separate the waste into two fractions – an Organic Wet Fraction and an Inorganic Dry Fraction. It will squeeze-out the organic matter through an Extrusion Matrix at a very high pressure. After the pressing process, the residue referred to as the Dry Fraction shall be discharged and taken to a **RDF Line** comprising Iron Separator, Flip Flow Wave Screen and Wind Shifter to remove Metals and Inert and to recover RDF. The Wet Fraction, after removal of Plastic and Grit in **Plastic and Grit Removal System**, shall be conveyed to the **Biomethanation System**.

2.6.7 RDF Line for Treatment of Dry Fraction from Organic Extrusion Press

a) Iron Separator

The Permanent Magnet type Iron Separator shall be provided, at the start of the RDF Line, suspended over the Conveyor carrying the dry fraction from the Organic Extrusion Press to the Flip Flow Wave Screen to remove ferro-magnetic material from the waste. The Iron Separator shall be so installed as to drop the collected metal pieces directly into the Bin below and then stored for further transportation to the recycling Vendors.

b) Flip-Flow Wave Screen

The Dry Fraction from Organic Extrusion Presses, after removal of ferrous material by a suspended Iron Separator, shall be conveyed to the Flip Flow Wave Screen. The heavy/finer under-fraction which is inert shall be collected and disposed to the Sanitary Landfill Facility whereas the large/light over-fraction shall be taken to the Wind Shifter for further separation.

c) Wind Shifter

The large/light over-fraction from Flip Flow Wave Screen shall be passed to the Wind Shifter where it will be separated into heavy and light fractions. The light fraction which is good quality RDF shall be stored into the RDF Storage Shed whereas the heavy fraction shall be fed to the RDF Drums for further drying before storing into the RDF Storage Shed.

2.6.8 Plastic & Grit Removal System for Treatment of Wet Fraction from Organic Extrusion Press

a) Plastic Removal System

The Wet (Organic) Fraction extracted by the existing Organic Extrusion Press as well as Liquid Fraction separated by the proposed Organic Separator contains physical contaminants including glass, stones, grit, plastic, plastic film, paper and other floatable fibers which build-up in the Digesters over time as either settled material or as a floating layer.

The Plastic Removal System shall be provided to remove low density contaminants such as plastics, paper and other fibers by centrifugal force where a high speed rotating cylindrical screen ejects organics radially outward. High density contaminants such as fine glass and grit shall be then removed by the Grit Removal System.

b) Grit Removal System

The Grit Removal System shall be provided for further polishing of the Wet Fraction by removing small inert contaminants such as glass and grit which would otherwise impact not only digester functionality but also digestate quality. These particles typically have a specific gravity greater than 2.5 and are within 100 microns to 2 mm in size.

The removed grit shall be washed to recover organics back into the process and produce clean, drained grit for disposal whereas the de-gritted substrate shall be

collected and pumped to a Buffer Tank from where it will be transferred to the existing as well as proposed Digesters.

2.6.9 Bio-methanation System

1. Buffer Tank

The Wet (Organic) Fraction extracted by the existing Organic Extrusion Press as well as Liquid Fraction separated by the proposed Organic Separator, after removal of plastic by Plastic Removal System and grit by Grit removal System, shall be pumped to a Buffer Tank. It shall act as a Storage Tank to receive the de-gritted substrate and pump to the existing as well as the proposed Digesters at a uniform rate. It will be equipped with Mixer and Biogas Extraction System.

2. Digester

The proposed Digester shall be provided with Mixer and Heating System to ensure digestion of the contents in a thermophilic range of 45-55 degree Celsius. The fermentation of organics in an anaerobic atmosphere will generate biogas, which will contain 50-70% methane. The biogas shall be stored in the double membrane type Biogas Holder, anchored on the top of the Digester. After completion of the digestion process, the digested substrate shall be pumped to the Sludge Dewatering System.

2.6.10 Biogas Genset based Power Plant

This biogas, stored in the Biogas Holder, shall be cleaned for removal of Hydrogen Sulphide (H_2S) by Biogas desulphurization System and Moisture by Biogas Dehumidification System to suit the Biogas Gensets. Electricity as generated shall be utilized to run the entire Facility including Process Units, Lighting, Ventilation and various auxiliaries of the Biogas Gensets. The surplus electricity shall be exported to the Electricity Grid. A part of thermal energy (waste heat) generated shall be used for heating the content of the Anaerobic Digesters so as to maintain thermophilic conditions.

A Biogas Flaring System shall be provided to flare biogas in the event of any emergency. Quantity of biogas and power generation from the proposed SWM system is given in **Table 2.6**.

Table 2.6 : Quantity of Biogas and Power Generation from the Proposed SWM System

2.1	**Biogas generated**			
	Wet fraction from Organic Extrusion Press			
1	Inorganic or Non VSS content	=	3.00	TPD
2	Organic or VSS content	=	13.0	TPD
3	Moisture content	=	49.0	TPD
4	Total wet fratcion from OREX		65.00	TPD
5	Total wet fratcion		65.00	TPD
6	VSS destroyed	=	50%	
		=	6.50	TPD
7	Balance Solids after Digestion	=	9.50	TPD

8	Biogas generated	=	0.90	m^3/Kg VSS destroyed
		=	5850	m^3/day
		=	244	m3/h
2.2	**Potential Power Generation**			
	Biogas generated	=	5850	m^3/day
	Methane Content of Biogas	=	55	%
	Power Generation Potential of Methane	=	10.4	kW.hr/m^3
	Power Generation Potential of Biogas	=	5.72	kW.hr/m^3
	Power Generation Potential	=	33462	kW.hr/day
	Electrical Efficiency of Biogas Genset	=	35	%
	Potentail Power Generation	=	11711.7	kW.hr/day
		=	487.9875	kW

2.6.11 Sludge Dewatering System

The digested substrate from the Digesters shall be pumped to the Sludge Dewatering System (2-Stage Decanter Centrifuges) for separation into Solid (Dewatered Sludge) and Liquid (Centrate) phases. The dewatered sludge shall be then conveyed to the Composting Facility. A part of the Centrate shall be recycled into the Digesters for dilution and part of the Centrate shall be pumped to the Effluent Treatment Plant (ETP) or further treatment.

2.6.12 Composting Facility

The dewatered sludge from Sludge Dewatering System shall be conveyed to the Compost Turning cum Drying Facility to produce Compost. Suitable Bulking Material (e.g. Wood Chips) shall be added, if required to achive desired C:N Ration, Moisture and Bulk Density. After drying, the compost shall be screened using a Multi Deck Vibratory Screen.

2.6.13 Effluent Treatment Plant (ETP)

All the wastewater generated from various sources e.g. washing of floors/mobile machinery and centrate from sludge de-watering eequipment's etc. shall be treated into the proposed Effluent Treatment Plant (ETP) comprising Ammonia Stripping System, Equalization, Physico-chemical Treatment, Biological Treatment and Filtration System. The treated effluent shall be reused for cleaning, floor washing and gardening etc.

2.6.14 Sanitary Landfill Facility

Only inert material, removed in RDF Line from Flip Flow Wave Screen, shall be landfilled in the Sanitary Landfill Facility constructed as per The Solid Waste Management Rules, 2016 through Notification by Ministry of Environment, Forest and Climate Change, New Delhi i.e. S.O. 1357(E) dated 08-04-2016.

2.7 Treatment of Segregated Dry Waste

2.7.1 Infeed Chain Belt Conveying Bunker and Bag Opener

An Infeed Chain Belt Conveying Bunker shall be provided for feeding of segregated Dry Waste by Front End Wheel Loader for further processing. It shall have adequate Storage Volume at front end and rotating Drum Feeder at the other end so as to feed the waste uniformly to the downstream Bag Opener which will open the waste bags and make the waste available for further sorting and recovery of Recyclables.

The waste shall be then, taken to the Manual Sorting Station. The Manual Sorting Station shall be an elevated structure with Belt Conveyor and Hand Picking Stations and Chutes on both sides of the Belt at the 1st floor and Compartments at the ground floor under the Chutes to collect the sorted-out material.

The recyclables sorted-out in the Manual Sorting Station shall be baled (as per requirement) using an efficient automatic Baler into Bales / Pallets for effective transportation to the Recycling Vendors.

2.8 Treatment of Segregated Wet Waste

2.8.1 Infeed Chain Belt Conveying Bunker and Bag Opener

An Infeed Chain Belt Conveying Bunker shall be provided for feeding of segregated Wet Waste by Front End Wheel Loader for further processing. It shall have adequate Storage Volume at front end and rotating Drum Feeder at the other end so as to feed the waste uniformly to the downstream Bag Opener which will open the waste bags and make the waste available for further processing.

The waste shall be then, taken to the **Organic Extrusion Press.** The Organic Extrusion Press will separate the waste into two fractions – an Organic Wet Fraction and an Inorganic Dry Fraction. It will squeeze-out the organic matter through an Extrusion Matrix at a very high pressure.

After the pressing process, the residue referred to as the Dry Fraction shall be discharged and taken to a **RDF Line** comprising Iron Separator, Flip Flow Wave Screen and Wind Shifter to remove Metals and Inert and to recover RDF. The Wet Fraction, after removal of Plastic and Grit in Plastic and Grit Removal Sytem, shall be conveyed to the Biomethanation System.

The fermentation of organics in an anaerobic atmosphere in Bio-methanation System will generate biogas, which will contain 50-70% methane. The biogas shall be stored in the double membrane type Biogas Holder, anchored on the top of the Digester and fed to the **Biogas Genset based Power Plant**.

After completion of the digestion process, the digested substrate shall be pumped to the **Sludge Dewatering System**. The dewatered sludge shall be then conveyed to the **Composting Facility**. A part of the Centrate shall be recycled into the Digesters for dilution and part of the Centrate shall be pumped to the Effluent Treatment Plant (ETP) or further treatment.

Buildings, Sheds & Other Infrastructure Works

The Scope of Work under Buildings and Sheds shall consist of the following Units.

- Security Terminal
- Weighbridge Terminal
- Administration Building
- Resource Centre
- Facility Centre
- Shed for Material Segregation & Recovery Centre including separate dedicated Tipping Floors for each type of Waste and Main Processing Area
- Shed for Recovery of RDF and Storage for Recyclables & RDF
- Bio-filter
- Composting Turning cum Drying Facility
- HT Sub-station Building
- Biogas Genset Building
- Sludge Dewatering Building
- Pump House for Fire Fighting Pumps

The Scope of Work under Infrastructure shall consist of the following Units / Works:

- Main Gate.
- Parking Facility for 2-Wheeler, Cars and Trucks
- Parking & Maintenance Area for Earthmovers and other Mobile Machinery
- Internal Water Distribution System including Underground Water Tank with Pumps, Overhead Water Tank, Network Piping & Valves and all other Accessories complete
- Service / Flushing Water System including Recycle Water Tank, Hydro-pneumatic System, Network Piping & Valves and all other Accessories complete
- Fire Fighting System including Fire Hydrant Pumps, Network Piping & Valves, Fire Hydrants and all other Accessories complete
- Internal Roads & Pathways with Storm Water Drains
- Internal Sewerage Network
- Landscaping

Control & Automation Philosophy:

1. The complete Plant shall be designed for automatic operation through a Programmable Logic Control (PLC) and Supervisory Control and Data Acquisition (SCADA). All the Equipment shall be necessarily connected to PLC for monitoring and control
2. This shall be achieved by PLC of individual equipment's, Digital Controllers with Human Machine Interface (HMI). These individual PLCs or Digital Controllers shall be integrated with main PLC and SCADA for centralized control and monitoring
3. The main PLC will be located in central Control Room
4. The Plant shall have provision for operations in following modes:
   - Automatic: Auto operation through PLC/Digital Controller
   - Manual: Operator intervention through SCADA/HMI
   - Local: Local operation through local Control Panel located near Equipment
   - It is essential that the all PLCs and Digital Controllers shall communicate to central PLC and SCADA. For communication, a cable can be used, depending upon its signal carrying distance. However, if cabling distance between two systems is more than its signal carrying capacity or 80 meters (whichever is less), fiber optic cables shall be used
   - All pre-set time shall be editable in HMI/SCADA

ERP:

An Enterprise Resource Progamme (ERP) Module shall be used for capture of data and daily plant operation.

Remote Monitoring:

The SCADA shall be equipped with provision of remote monitoring to enable the plant monitoring from any remote location.

Emergency and Isolation of Equipment:

Emergency Push Buttons shall be provided in the proximity of each equipment for emergency stop of the equipment. The automation system shall generate Audio- Visual Alarms in case any of the emergency Push Buttons are activated. These emergency Push Buttons will also be used for isolation of various equipment during maintenance mode.

CCTV System:

Key Locations e.g. Main Gate, Weighbridge, Tipping Floor, MSRC Shed, Manual Sorting Station, Compost Shed, Fermenters, Biogas Genset Building, ETP, Store etc. shall be provided with high resolution CCTV Cameras with adequate storage of Historical Data in the central Control Room.

Mass balance for the proposed SWM system is given in **Figure. 2.5**.

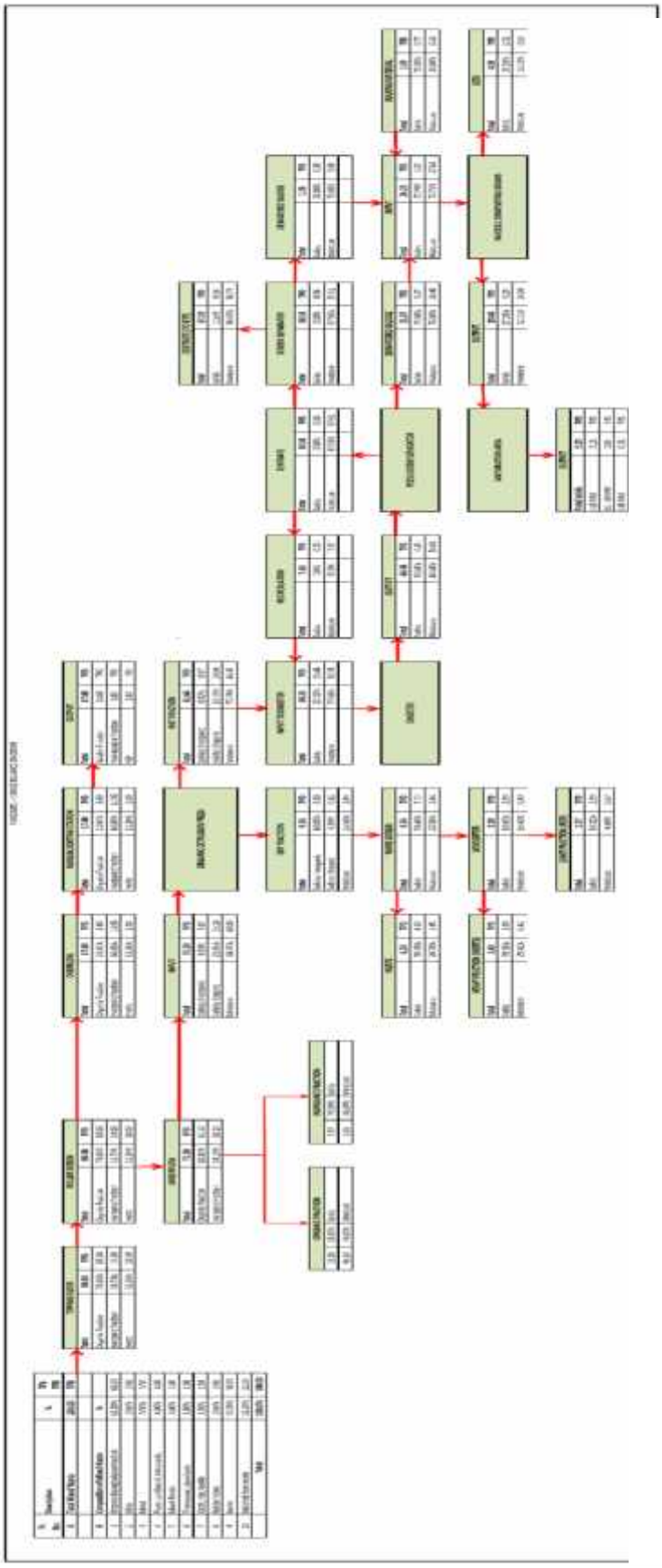


Figure 2.5 : Mass balance for the proposed solid waste treatment facility (Mass balance for a capacity of 100 TPD)

2.9 Capital Cost

Capital cost required for the implementation of the project is calculated as:

Sr. No.	Particulars		Amount Rs. Cr	Input GST Rs. Cr.	Total Amount Rs.Cr
1	Civil Works		46.98	7.18	54.17
2	Mechanical Works		155.49	25.85	181.34
3	Electrical & Instrumentation Works		11.35	1.65	12.99
4	**Sub Total…..(1) + (2) + (3)**		**213.82**	**34.68**	**248.50**
5	Adding Output GST @ 12% on "Sr. No. 4" above	12%			29.82
6	Input GST Available as per “Sr. No. 4” Above			34.68	
7	Since Input GST (Sr. No. 4) available is more than Output GST (Sr. No. 5), the applicable Output GST shall be zero.				0.00
9	**Grand Total…..(4) + (7)**				**248.50**

Chapter 3

Baseline Environmental Status

Chapter 3
Baseline Environmental Status

The baseline status of environmental quality in the vicinity of project site serves as a basis for identification and prediction of impacts. The baseline environmental quality is assessed through field studies within the impact zone for various components of environment, viz. air, noise, water, land, biological and socio-economic. The baseline environmental quality of Post-monsoon season has been assessed based on primary data generated during field survey and secondary data available for the proposed project site. The impacts due to the proposed project have been identified through network method involving cause-condition-effect relationship between an activity and environmental parameters. The cause-condition-effect networks are devised for individual environmental components as well as overall impacts.

3.1 Ambient Air Quality

The knowledge of quality of ambient air plays an important role in assessing the environmental scenario of the locality. The ambient air quality status in the vicinity of the project site forms an indispensable part of the Environment Impact Assessment studies. The quality of ambient air depends upon the concentrations of criteria pollutants, the emission sources and meteorological condition. Data collected during Post-monsoon season (January, 2017) has been analysed and presented herewith.

The baseline studies on air environment include identification of criteria air pollutants and assessing their existing levels in ambient air within the study zone. The existing status of air environment with respect to the identified air pollutants is assessed through air quality surveillance programme with scientifically designed ambient air quality monitoring network. Micrometeorological data collection is an indispensable part of any air pollution study. The meteorological data collected and is used for proper interpretation of existing air pollution status. The ambient air quality monitoring was carried out through reconnaissance followed by air quality surveillance programme and micrometeorological study.

3.1.1 Reconnaissance

Reconnaissance was undertaken to establish the existing status of air environment in the study region. Ambient Air Quality Monitoring (AAQM) locations were selected based on guidelines of network siting criteria based on meteorological data of Post-monsoon season (January, 2017). The ambient air quality monitoring was carried out in the study area of 10 km radial distance around the proposed site, details of these locations are presented in **Figure 3.1.1** & **Table 3.1.1**.

3.1.2 Ambient Air Quality Monitoring Network and Analytical Methods

The ambient air quality status in the study zone is assessed through a network of ambient air quality monitoring locations. The studies on air environment include identification of criteria air pollutants for assessing the impacts of proposed CMSWMF operations. The existing status of air environment is assessed through a systematic air quality surveillance program, which is planned based on the following criteria:

- Topography/terrain of the study area
- Regional synoptic scale climatological normals
- Densely populated areas within the region
- Representation of valid cross-sectional distribution in downwind direction of proposed site

As per NAAQS (2009) the pollutants viz., particulate matters (PM_{10} and $PM_{2.5}$), sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), Ozone (O_3) and ammonia (NH_3) were stipulated parameters for air quality monitoring. All the parameters were monitored on 24 hourly basis while CO and O_3, were monitored on hourly basis. Furthermore, particulate matter associated metals (As, Ni & Pb) were analyzed. Standard analytical procedures were used for analysis and quantification of air quality parameters and the details are given in **Table 3.1.2**. The photographs showing sampling stations/locations are given in the **Plate 3.1.1**.

Ambient Air Quality Monitoring (AAQM) was carried out in Post-monsoon season (Jan 2017). The regulatory pollutants like Particulate Matter (PM_{10} and $PM_{2.5}$), Sulphur Dioxide (SO_2), Nitrogen Dioxide (NO_2), Ammonia (NH_3), Ozone (O_3), particulate associated toxic pollutants like traces of heavy metals such as Lead (Pb), Arsenic (As) and Nickel (Ni) were identified as significant parameters for air quality monitoring within the study area.

Five AAQM locations were selected based on guidelines of network siting criteria. The five identified sampling locations for AAQM are depicted in **Figure 3.1.1** and details of which is given in **Table 3.1.1**.

In all sampling locations, High Volume Samplers (HVS) and Fine Particulate Samplers (FPS) designed by Envirotech Pvt. Ltd. were installed for continuous sampling of PM_{10}, $PM_{2.5}$ and gaseous pollutants. All the samples collected at the site were brought to the laboratory for further assessment for some concrete results.

3.1.3 Micrometeorology

The study of micro-meteorological conditions of a particular region is important to understand the variations in ambient air quality status in that region. The prevailing micrometeorology at project site plays a crucial role in transport and dispersion of air pollutants released from the plant. The persistence of the predominant wind direction and wind speed at the project site will decide the direction and extent of the air pollution impact zone. The principal variables which affect the micrometeorology are horizontal transport and dispersion (average wind speed and directions), convective transport and vertical mixing (atmospheric stability) and also topography of the area towards local influences.

The hourly record of wind speed and wind direction during study period was used for computing the relative percentage frequencies of wind occurrences in various directions. The windrose diagrams were prepared by the meteorological data collected for winter (October to December 2017) and presented in **Figures 3.1.2, 3.1.3 and 3.1.4**.

The 24 hourly windrose diagrams for Post-monsoon season indicate that the predominant winds were from NE and NNE directions. Accordingly the impact zone will be spread in W and NW sector with respect to proposed project site during Post-monsoon season respectively. The predominant wind speed class has been 1.0 to 5.0 m/s during Post-monsoon season.

3.1.4 Baseline Air Quality Status

Particulate matter is ubiquitous component of the atmosphere and has become a persistent and pervasive environmental problem that imposes significant health risk. The sources, characteristics and potential health effects of the larger or coarse particle (>2.5 µm in diameter) and smaller or fine particles (<2.5 µm in diameter) are very different. The fine airborne particles have a high probability of deposition deeper into the respiratory tract and likely to trigger or exacerbate respiratory diseases. These particles also have higher burdens of toxins, which when absorbed in the body can result in health consequences other than respiratory health effects. Therefore, the US environmental Protection Agency promulgated a new $PM_{2.5}$ National Air Quality Standards to effective control the aerosol problem[1]. Sources vary for gaseous pollutants viz. major source of SO_2 and NO_2 include burning of fossil fuels like coal and other petroleum products. For NH_3, sources include industrial processes, vehicular emissions. Ozone is formed in the air when nitrogen oxides (from motor vehicles, power plants and industrial sources) mix with volatile organic compounds (from motor vehicles, chemical processes, etc.) in the presence of heat and sunlight. The highest concentrations of ozone occur in the summer.

Particulate Matter:

- The 24 hourly total PM_{10} concentrations were recorded in the range of 27.2-53.6 µg/m^3 in the study area during monitoring. The arithmetic mean and 98th percentiles were found in the ranges of 28.6-51.7 µg/m^3 and 29.5-53.5 µg/m^3 respectively in the study area (**Table 3.1.3 & 3.1.4**)
- The 24 hourly total $PM_{2.5}$ concentrations were recorded in the range of 7.6-20.5 µg/m^3 in the study area during monitoring. The arithmetic mean and 98th percentiles were found in the ranges of 8.0-19.6 µg/m^3 and 8.3-20.5 µg/m^3 respectively in the study area (**Table 3.1.3 & 3.1.4**)

The levels of PM_{10} and $PM_{2.5}$ at all sampling locations in the study area have found well below the prescribed limit of 100 & 60 µg/m^3 respectively air quality standards for industrial area, residential, rural and other areas as well as industrial area.

Gaseous Pollutants:

The average concentrations of SO_2 and NO_x in the study area during post-monsoon season were in the range of 6.2-9.4 µg/m^3 and 5.9-13.7 µg/m^3 respectively (**Table 3.1.3 & 3.1.4**) whereas the 98th percentile values varied from 6.2-9.4 µg/m^3

abd 6,4-13.7 µg/m^3 (**Table 3.1.3 & 3.1.4**). The cumulative percentile levels of SO_2 and NOx did not exceed the prescribed limit of 80 µg/m^3 for industrial area, residential, rural and other areas at any station.

The concentrations of metals (Pb, AS & Ni) have found either BDL or in trace in the study area. Details of metals along with their respective concentrations are given in **Table 3.1.5**.

The spot concentration of VOCs as well as NH_3 and CO are converted into three hourly averages following the standard method. Most of times, these gases have found in the range of BDL in the study area. Various constituents of VOCs and NH_3 & CO along with their respective concentrations are given in **Table 3.1.6** and **Table 3.1.7**.

The overall prevailing ambient air quality status during study priod represents urban air quality, however the gaseous pollutants within the impact zone around proposed MSW site are complying with prescribed NAAQS standards for industrial as well as residential areas (**Annexure-I**)

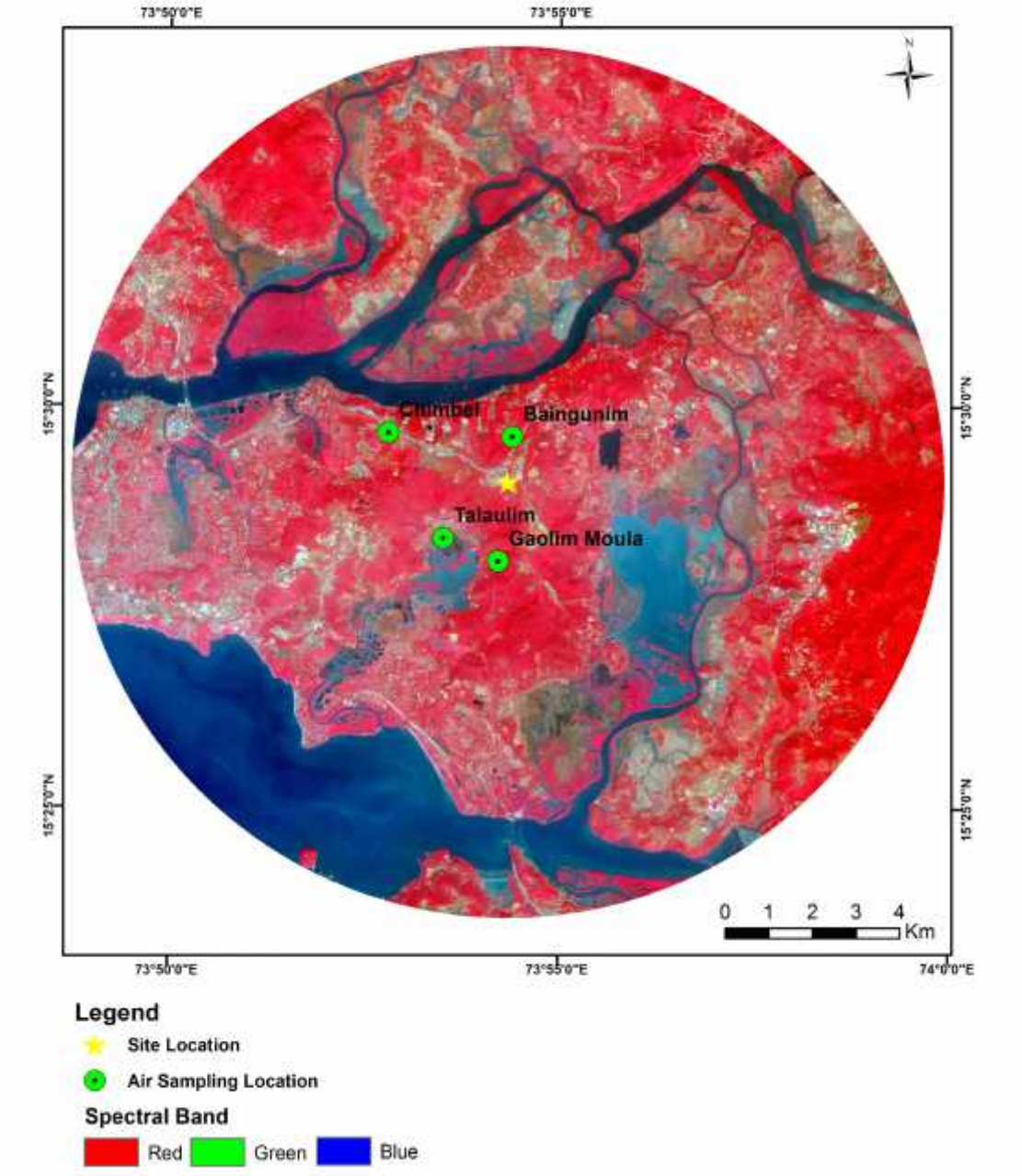
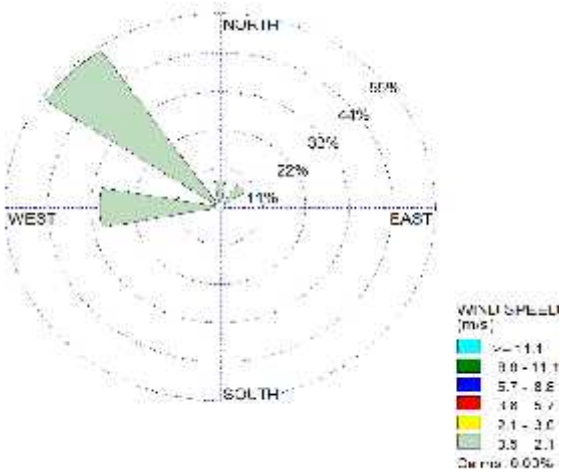


Figure 3.1.1 : Ambient Air Quality Monitoring Locations around the Project Site

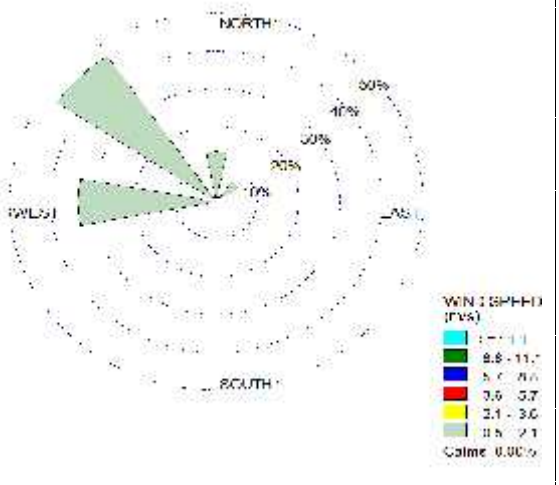
Year	Month	Day	WD	WS(m/s)
2017	12	1	45	0.56
2017	12	2	270	0.83
2017	12	3	315	1.11
2017	12	4	360	0.56
2017	12	5	315	1.11
2017	12	6	315	1.11
2017	12	7	270	0.83
2017	12	8	270	1.11
2017	12	9	315	1.11
2017	12	10	315	1.11
2017	12	11	360	0.56
2017	12	12	315	1.11
2017	12	13	315	1.11
2017	12	14	270	1.11
2017	12	15	315	0.83
2017	12	16	270	1.11
2017	12	17	270	0.83
2017	12	18	315	1.11
2017	12	19	315	1.11
2017	12	20	315	1.11
2017	12	21	45	0.56
2017	12	22	315	0.83
2017	12	23	270	0.83
2017	12	24	315	1.11
2017	12	25	315	1.11
2017	12	26	270	0.83



Predominant air is in NW and its impact will be in opposite direction SE

Figure 3.1.2 : 24-hourly Windrose Diagram for Winter Season December 2017

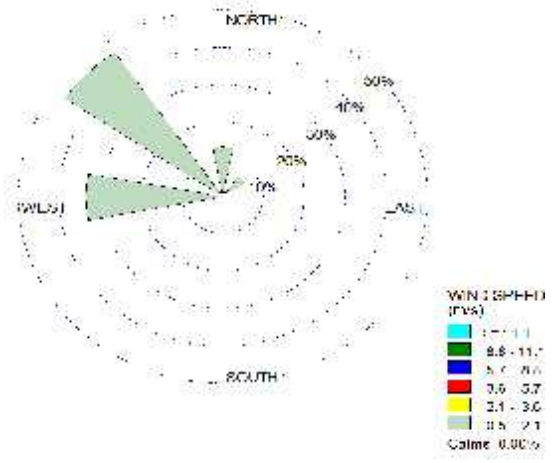
Year	Month	Day	WD	WS(m/s)
2017	11	1	315	1.39
2017	11	2	270	0.83
2017	11	3	315	1.11
2017	11	4	315	1.11
2017	11	5	270	0.56
2017	11	6	315	1.11
2017	11	7	315	1.11
2017	11	8	360	0.56
2017	11	9	315	1.11
2017	11	10	270	1.11
2017	11	11	270	1.39
2017	11	12	315	1.11
2017	11	13	315	1.11
2017	11	14	270	0.56
2017	11	15	315	1.11
2017	11	16	360	0.56
2017	11	17	360	0.56
2017	11	18	45	0.83
2017	11	19	270	0.56
2017	11	20	270	1.11
2017	11	21	315	1.11
2017	11	22	315	1.39
2017	11	23	270	1.11
2017	11	24	315	1.11
2017	11	25	270	0.83
2017	11	26	45	0.56
2017	11	27	270	1.11
2017	11	28	315	1.39
2017	11	29	360	0.56
2017	11	30	315	1.11



Predominant air is in NW and its impact will be in opposite direction SE

Figure 3.1.3 : 24-hourly Windrose Diagram for Winter Season November 2017

Year	Month	Day	WD	WS(m/s)
2017	10	1	270	1.11
2017	10	2	315	1.39
2017	10	3	360	0.56
2017	10	4	315	1.11
2017	10	5	315	1.39
2017	10	6	270	1.11
2017	10	7	315	0.83
2017	10	8	315	1.11
2017	10	9	270	0.83
2017	10	10	315	0.83
2017	10	11	315	1.11
2017	10	12	270	0.56
2017	10	13	315	1.11
2017	10	14	315	1.11
2017	10	15	315	1.39
2017	10	16	270	0.83
2017	10	17	360	0.56
2017	10	18	315	1.11
2017	10	19	360	0.56
2017	10	20	270	0.83
2017	10	21	45	0.56
2017	10	22	360	0.56
2017	10	23	315	1.11
2017	10	24	315	1.11
2017	10	25	270	1.39
2017	10	26	270	1.11
2017	10	27	315	0.83
2017	10	28	45	0.56
2017	10	29	315	1.11
2017	10	30	315	1.11
2017	10	31	270	0.83



Predominant air is in NW and its impact will be in opposite direction SE.

Figure 3.1.4: 24-hourly Windrose Diagram for Winter Season October 2017

Table 3.1.1 : Ambient Air Quality Monitoring Locations

Sr. No.	Monitoring Location	Sampling Height above ground level (m)	Direction	Aerial distance (km)	Monitoring Seasons
			From Proposed MSW site		
	Study Area				
1.	Bainguinim AT house near transformer	8.0	North	1.2	Post-monsoon
2.	Bramhapuri B/h KVK near Templer	2.0	NE	1.3	Post-monsoon
3.	Chimbel Nr Jhoola Ghar	2.5	W-NW	2.9	Post-monsoon
4.	Talaulim Children Plan ground, Near Lake	2.0	SW	2.5	Post-monsoon
5.	Gaolim Moula At GPS	2.5	South	1.8	Post-monsoon

Table 3.1.2 Analytical Methods used for Quantification of Air Quality Parameters in the Ambient Air

Sr. No.	Air Quality Parameter	Unit	Analytical Method used for Testing/Analysis	Analytical Measure-ment Range	Standard value as per NAAQs, 2009 and Monitoring duration
1.	Particulate Matter size < 10 microns or PM_{10}	µg/m³	Gravimetric IS-5182: Part-23, 2006	5-5000	100 (24 h)
2.	Particulate Matter size < 2.5 microns or $PM_{2.5}$	µg/m³	Gravimetric U.S.EPA EQM-0308-170	5-500	60 (24 h)
3.	Sulphur Dioxide (SO_2)	µg/m³	EPA Improved West and Gaeke Method IS-5182: Part-2, 2001	5-1000	80 (24 h)
4.	Nitrogen Dioxide (NO_2)	µg/m³	Modified Jacobs-Hachheiser Method IS-5182: Part-6, 2006	7-750	80 (24 h)
5.	Carbon Monoxide (CO)	mg/m³	Non Dispersive infra red (NDIR) Spectroscopy	50-1000	2.0 (8 h) 4.0 (1 h)
6.	Ozone (O_3)	µg/m³	In-situ Monitoring using O_3 Analyzer	5-1000	100 (8 h) 180 (1 h)
7.	Ammomia (NH_3)	µg/m³	Indophenol Blue method Method 401: Methods of Air Sampling and analysis, James P. Lodge	5-1000	400 (24 h)
8.	Lead (Pb)	µg/m³	AAS/ICP method for sampling on EPM 2000 IS-5182: Part-22, 2004	0.04-10	1.0 (24 h)
9.	Arsenic(As)	ng/ m³	AAS/ICP Method for sampling on EPM 2000 or equivalent filter paper Method 822: Methods of Air Sampling and analysis, James P. Lodge	0.01-10	6.0 (Annual)
10.	Nickel (Ni)	ng/ m³	AAS/ICP Method for sampling on EPM 2000 or equivalent filter paper	0.01-10	20.0 (Annual)
11.	Vanadium (V)	ng/m³	ICP Method for sampling on EPM 2000	0.01 – 10	0.1 (24 h)
12.	Benzene (C_6H_6)	µg/m³	GC based continuous analyzer IS-5182: Part-11, 2006	0.01-10	5.0 (Annual)
13.	Benzo-a-Pyrene (BaP)	ng/ m³	Solvent extraction followed by GC analysis IS-5182:Part-12,2004	0.001-10	1.0 (Annual)
14.	VOCs	µg/m³	U.S. EPA Method TO17: 1999	0.01-10	0.01-500 (Annual)
15.	Hydrocarbons	µg/m³	HC Analyzer for Spot Conc.	0.01 – 10	-

Table 3.1.3 : Ambient Air Quality Status (Post Monsoon 2017)

Unit : µg/m^3 Average : 24 hourly

Sr. No.	Sampling Location	PM_{10}	$PM_{2.5}$	SO_2	NOx
		Average ± Standard Deviation (Range)			
	Study Area				
1.	Bainguinim At house near transformer	51.6±2.2 (49.2-53.6)	19.2±0.6 (18.6-19.8)	6.6±0.2 (6.4-6.8)	11.6±1.1 (10.5-12.7)
2.	Bramhapuri B/h KVK near Templer	36.0±1.6 (34.9-38.1)	9.4±0.4 (9.1-9.8)	6.3±0.1 (6.2-6.3)	6.8±0.2 (6.5-6.9)
3.	Chimbel Nr Jhoola Ghar	47.4±1.1 (46.2-48.4)	16.9±0.5 (16.4-17.3)	8.1±0.3 (7.8-8.3)	14.3±1.4 (12.9-15.6)
4.	Talaulim Children Plan ground, Near Lake	43.4±1.7 (41.8-45.2)	16.4±1.6 (14.5-17.6)	6.8±0.3 (6.5-7.1)	13.9±0.6 (13.2-14.3)
5.	Gaolim Moula At GPS	33.9±1.1 (32.8-34.9)	9.3±0.4 (8.9-9.6)	6.2±0.1 (6.1-6.3)	5.8±0.4 (5.4-6.1)

Table 3.1.4 : Cumulative Percentiles (Post Monsoon 2017)

Unit : µg/m^3 Average : 24 hourly

Sr. No.	Sampling Location	98th Percentile			
		PM_{10}	$PM_{2.5}$	SO_2	NOx
	Study Area				
1.	Bainguinim At house near transformer	53.5	19.8	6.8	12.6
2.	Bramhapuri B/h KVK near Templer	38.0	9.8	6.3	6.9
3.	Chimbel Nr Jhoola Ghar	48.4	17.3	8.3	15.5
4.	Talaulim Children Plan ground, Near Lake	45.1	17.6	7.1	14.3
5.	Gaolim Moula At GPS	34.9	9.6	6.3	6.1

Table 3.1.5 : Ozone, Carbon Monoxide and Ammonia (Post Monsoon 2017)

Grab Samples

Sr. No.	Sampling Location	Ozone µg/m^3	Carbon µg/m^3	Ammonia µg/m^3
	Study Area			
1.	Bainguinim At house near transformer	<0.1	92.3	0.5
2.	Bramhapuri B/h KVK near Templer	<0.1	36.51	1.7
3.	Chimbel Nr Jhoola Ghar	<0.1	137.8	2.0
4.	Talaulim Children Plan ground, Near Lake	<0.1	114.8	1.2
5.	Gaolim Moula At GPS	<0.1	36.5	0.8

Table 3.1.6 :Metals-Lead, Arsenic and Nickel (Post Monsoon 2017)

Grab Samples

Sr. No.	Sampling Location	Ozone µg/m^3	Carbon µg/m^3	Ammonia µg/m^3
	Study Area			
1.	Bainguinim At house near transformer	<0.1	<0.001	<0.001
2.	Bramhapuri B/h KVK near Templer	<0.1	<0.001	<0.001
3.	Chimbel Nr Jhoola Ghar	<0.1	<0.001	<0.001
4.	Talaulim Children Plan ground, Near Lake	<0.1	<0.001	<0.001
5.	Gaolim Moula At GPS	<0.1	<0.001	<0.001

Table 3.1.7 :VOC (Post Monsoon 2017)

Grab Samples

Sr. No.	Sampling Location	Benzene µg/m^3	Benzo(~) µg/m^3
	Study Area		
1.	Bainguinim At house near transformer	<0.1	<0.0001
2.	Bramhapuri B/h KVK near Templer	<0.1	<0.0001
3.	Chimbel Nr Jhoola Ghar	<0.1	<0.0001
4.	Talaulim Children Plan ground, Near Lake	<0.1	<0.0001
5.	Gaolim Moula At GPS	<0.1	<0.0001

3.2 Noise Environment

Noise pollution, the excessive or annoying degree of unwanted sound in a particular area has become a significant environmental issue for many CMSWM facilities. Noise can interfere with sleep, communication and privacy: aggravate stress, result in irritability and reduce working efficiency. Prolonged exposure to high levels of noise can lead to serious issues such as cardiovascular disease, cognitive impairment, tinnitus and hearing loss.

According to the World Health Organization (WHO), noise pollution is the third most hazardous type of environmental pollution after air and water pollution. CMSWMF are characterized by several operations, which contain several noise sources with different characteristics from each other, such as segregation operations, loading-unloading vehicles and conveyor system, and auxiliary services.

3.2.1 Methodology and Baseline Environmental Status

The objective of the survey of noise pollution in and around the proposed CMSWMF at Baingunim, Goa was to assess the impact of noise, being generated by the facility and other related activities. The Data collection is one of the most crucial exercises for noise assessment and noise prediction; therefore sound pressure level assessment, measurement and calculation were performed in accordance with International standard regulations ISO 1996:2 2003 and compared with accepted standard CPCB Delhi.

Noise survey was conducted in and around the project area within a 10Km radius of the site. Sound pressure levels were measured as 'A' weighted average in the identified locations by using integrated digital sound level meter Cirrus CR:172B having mounted on tripods at the height of approximate 1.3-1.5 meters above ground level in a free field location. The noise meter was ensured to be placed at least 3-4 meter distance from the reflective surfaces on all sides to avoid capturing reflected sound. The measurements at each site were averaged over the 20-minute measurement period using the equivalent noise levels Leq dB(A) setting, which shape is similar to the response of the human ear at the lower level.

The environmental sound stimulus parameters were carried out as per CPCB guidelines such as weather conditions including wind speed and direction, temperature, relative humidity, and cloud cover were also monitored and recorded by anemometer during each measurement. Noise monitoring stations were identified within a 10 Km radius of the site and subsequently, 5 locations were monitored within the study area.

Investigations were carried out in the following steps:

- Reconnaissance survey
- Identification and characterization of noise sources in the proposed site
- Measurement of baseline noise levels in the study area
- Measurement of prevailing noise levels due to vehicular movement

(1) Reconnaissance Survey

A reconnaissance survey was carried out in a 10 Km radius and potential noise sources were identified, viz. due to plant operations and vehicular traffic on human settlements.

(2) Identification and Characterization of Noise Sources

The noise sources in the port areas can be broadly grouped into two major categories: CMSWMF activities and traffic related activities and other activities are commercial activities.

(3) Measurement of Baseline Noise Levels in the Study Area

Noise level monitoring is performed with help of a well calibrated sound level meter. The baseline noise measurements were carried out to assess the current ambient noise levels in the study area. For noise levels measured over a given period of time interval, it is possible to describe important features of noise using statistical quantities [hourly Leq, Lday and Lnight]. This is calculated using the percentage of the time certain noise levels exceed the time interval. During each hour, Leq is directly computed by the instrument based on the sound pressure levels. Monitoring was carried out a 'A' response (slow mode) and at fast mode. All values are recorded in dB (A). The ambient noise levels were monitored at selected locations in the villages in and around the project site only during the day [0700 to 2200 hours] covering residential, commercial/ industrial areas.

Table 3.2.1 : Ambient Noise Levels (Average)

Sr. No.	Sampling Location	Distance (km) with respect to MR	Direction	Day Time Leq.(dBA)	Night Time Leq.(dBA)
	Residential				
1.	**Pontemol** At GPS, Mirabag	1.0	West	45.0	-
2.	**Mugoli** Nr. House of Mr. Devgaonkar	2.3	NW	32.8	-
3.	**Karmaliwada** At GPS, Bethamoddi	1.8	NE	47.3	-
4.	**Tilamola** Sirvoi Road, Egypt D'souza	2.5	South	42.6	-
5.	**Sirvoi** Shri Paikdev Sansthan, Kumbharwada	2.2	E-NE	40.6	-

Table 3.2.2 : Ambient Noise Levels (Average)

Time	Noise Level				
	Bainguinim	**Bramhapuri**	**Chimbel**	**Talaulim**	**Gaolim Moula**
07.00 hr	40.8	31.9	42.2	40.3	39.6
08.00 hr	43.3	30.9	44.5	42.1	40.8
09.00 hr	44.1	32.7	46.1	43.8	42.1
10.00 hr	47.7	33.5	49.3	44.2	45.7
11.00 hr	49.1	34.1	50.4	44.9	43.3
12.00 hr	48.5	34.6	49.7	44.1	44.8
13.00 hr	46.9	33.2	49.2	43.7	39.2
14.00 hr	45.4	31.4	50.1	42.8	41.6
15.00 hr	47.3	34.3	49.4	41.5	42.5
16.00 hr	44.6	34.7	48.6	42.3	40.9
17.00 hr	43.7	32.5	47.8	42.7	38.7
18.00 hr	44.1	32.1	46.1	41.4	37.1
19.00 hr	42.5	32.8	45.5	41.5	36.4
20.00 hr	41.9	31.3	43.	41.1	35.3
Minimum	40.8	30.6	42.2	40.3	35.3
Maximum	49.1	34.7	50.4	44.9	45.7
Average	45.0	32.8	47.3	42.6	40.6

3.3 Water Environment

3.3.1 Reconnaissance

The facility of Municipal Solid waste Management Facility at Bainguinim, Tiswadi Taluka in North Goa district, Goa is proposed to have a capacity of 100 metric ton per day of mixed municipal solid waste. The plant is designed to receive waste 365 days per year, although effective working of the plant will be for 320 days per annum.

The study area comprises of 10 km radius from the site boundary. There is one major water reservoir that fall within study area; namely Zuwari River fed pond and a river, Ribarder (river Mondavi).

3.3.2 Methodology of Water Quality Assessment

Based on the reconnaissance, the type of water bodies and their relative importance with the project site; grab water sample were collected in post monsoon season 2017. Water samples were collected from 14 locations; which includes samples from Zuwari River fed pond and Ribarder (river Mondavi) and ground water samples.

Sampling, preservation and transport of water samples from the field was done as per of guidance manual ISO (ISO 5667-1; 1980 water quality sampling part I: ISO 5667-11: 1993 part II) for surface and groundwater sources. Samples were analyzed for physico-chemical characteristics including physical, inorganic, nutrient demand parameters and heavy metals as per Standard methods for examination of water & Wastewater (APHA).

The locations of water quality monitoring stations for water sources are listed in Table 3.3.2.

3.3.3 Physico-chemical Characteristics

Physico-chemical parameters have been identified for monitoring of water environment within study area. To assess the water quality, standard methods (APHA, AWWA 22nd edition 2012 and IS 3025) were followed for sample collection, preservation and analysis in the laboratory.

The physico-chemical characteristics of water samples in post-monsoon 2017 are summarized in the **Tables 3.3.3** to **3.3.6**. The pH was observed as 4.65-6.91; whereas Total alkalinity as CaCO3 was 12.85-170.78 mg/l. The total dissolved solids and chlorides were observed as 76-47328 and 15.53-28341 mg/l respectively and sulphate was found to be 18.36-270.94 mg/l.

Nutrients in terms of nitrates as NO_3 and total phosphate were found to be 0.78-42.21 mg/l and 0.04-1.46 mg/l respectively. Heavy metals concentrations were found as Cadmium: ND-0.001 mg/l, Chromium: 0.01-0.033 mg/l, Copper: 0.008-0.04 mg/l, Iron: 0.567-1.866 mg/l, Manganese: 0.005-0.052 mg/l, Nickel: 0.002-0.017 mg/l, Lead: ND-0.017 mg/l and Zinc: 0.033-0.482 mg/l; whereas, Cobalt was found to be not detectable.

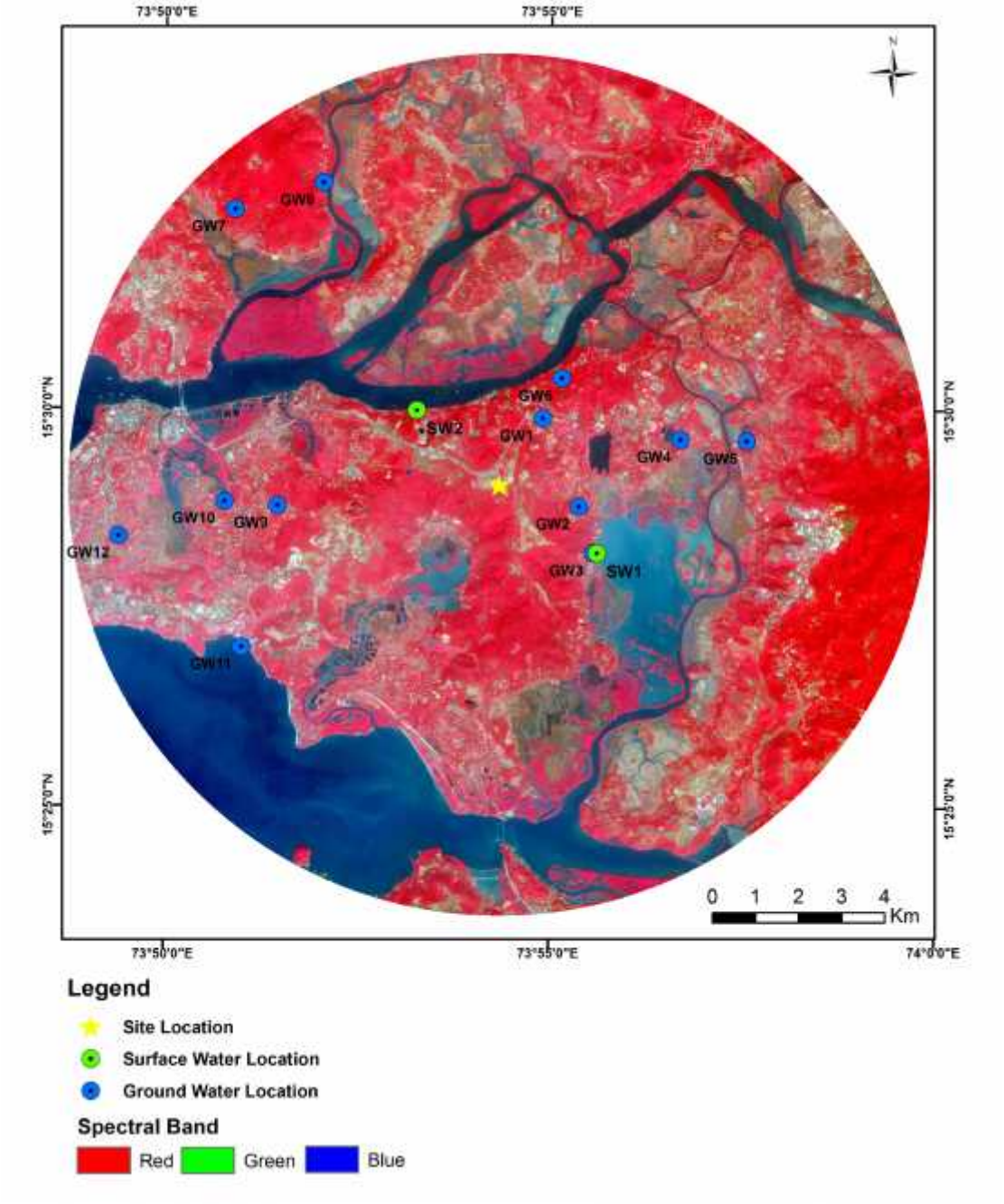


Figure 3.1.1 : Sampling Locations for Water Quality Monitoring

Table 3.3.1 : Water Quality Monitoring Parameters and Analytical Methods

Sr. No.	Parameter	Method of analysis (APHA/ IS Standard)
1.	pH	APHA-4500-H^+ B, 22ND Edition 2012
2.	TDS (mg/L)	APHA 2540 C, 22ND Edition 2012
3.	Total Alkalinity as $CaCO_3$ (mg/L)	IS 3025-23 (1986)
4.	Total Hardness as $CaCO_3$ (mg/L)	APHA - 2340 C, 22ND Edition 2012
5.	Calcium Hardness as $CaCO_3$ (mg/L)	APHA - 2340 C, 22ND Edition 2012
6.	Chlorides (mg/L)	APHA -4500 B, 22ND Edition 2012
7.	Sulphates (mg/L)	IS 3025-24 (1986)
8.	Sodium (mg/L)	APHA - 3500 B, 22ND Edition 2012
9.	Potassium (mg/L)	APHA - 3500 B, 22ND Edition 2012
10.	Nitrates as NO3 (mg/L)	APHA - 4500 B, 22ND Edition 2012
11.	Total Phosphates (mg/L)	IS 3025-31 (1988)
12.	Heavy Metals (mg/L)	APHA - 3030 E, 22ND Edition 2012 using ICP-OES

Table 3.3.2 : Water Quality- Sampling Location Details

Sr. No.	Location/ Village	Coordinates		Elevation
1	Zuwari river fed pond	N15°28’12.0”	E73°55’36.9”	1m
2	Ribarder(river mondavi)	N15°29’59.4”	E73°53’16.2”	5m
3	Harmakalchal, old Goa, MrVermappa Masthae	N15°29’53.8”	E73°54’54.3”	17m
4	St John the baptist church, Karambolim	N15°28’47.2”	E73°55’22.8”	15m
5	Mr. Leo Cardazso, Carambolim, Zorichembaht	N15°28’12.0”	E73°55’33.7”	9m
6	Mr Santhosh Naik, Dulapi	N15°29’37.9”	E73°56’41.4”	4m
7	Mr.Inacio Fernandez, Adkonda, Banastharim	N15°29’36.9”	E73°57’33.1”	7m
8	Mr. Anil, Dauji road, Old Goa Downstream of St Francis Zawior Church, old goa	N15°30’23.9”	E73°55’08.9”	5m
9	Mahadev Temple primisis, Britona	N15°31’90.8”	E73°50’54.0”	6m
10	Ekosibhat, Umesh thari	N15°32’51.03”	E73°52’02.8”	5m
11	Mr. Subhash Naik, Mercc Goa (old goa)	N15°28’47.3”	E73°51’27.8”	10m
12	Mr. Barnard Lawrence, Santa Cruze	N15°28’50.4”	E73°50’46.5”	15m
13	Mr. Azith Naik, Bambolim	N15°27’00.3”	E73°51’00.1”	77m
14	Mrs. ClarinaAlmaida, Taligao	N15°28’24.1”	E73°49’24.3”	16m

Table 3.3.3: Water Quality – Physical Parameters

Sl. No	Sample	pH	TDS
			mg/l
1	Zuwari River fed pond	6.74	47328
2	Ribarder(river mondavi)	6.88	33269
3	Harmakalchal, old Goa, Mr Vermappa Masthae	5.91	229
4	St John the baptist church, Karambolim	5.6	119
5	Mr. Leo Cardazso, Carambolim, Zorichembaht	4.98	136
6	Mr Santhosh Naik, Dulapi	5.57	121
7	Mr.Inacio Fernandez, Adkonda, Banastharim	5.94	1028
8	Mr. Anil, Dauji road, Old Goa Downstream of St Francis Zawior Church, old goa	6.88	161
9	Mahadev Temple premises, Britona	5.99	115
10	Ekosibhat, Umesh thari	4.65	78
11	Mr Subhash Naik, Mercs Goa (old Goa)	5.92	332
12	Mr. Barnard Lawrence, Santa Cruze	6.91	141
13	Mr Azith Naik, Bambolim	5.11	76
14	Mrs. Clarina Almaida, Taligao	6.06	345

Table 3.3.4: Water Quality – Inorganic Parameters

Sl. No.	SAMPLE	Alkanity	Chlorides	Sodium	Potassium	Total hardness	Ca Hardness
		mg/l					
1	Zuwari River fed pond	156.25	28341	14680	277	884	378
2	Ribarder(river mondavi)	121.88	20102	11180	214	744	258
3	Harmakalchal, Old Goa, Mr Vermappa Masthae	165	23.29	18	5.5	144	66
4	St John the baptist church, Karambolim	62.5	18.12	13.21	0.56	63	27
5	Mr. Leo Cardazso, Carambolim, Zorichembaht	29.7	49.17	30.16	1.49	36	4
6	Mr Santhosh Naik, Dulapi	52.38	18.82	18.43	1.35	48	26
7	Mr.Inacio Fernandez, Adkonda, Banastharim	49.5	454.57	398.4	9.24	48	14

Sl. No.	SAMPLE	Alkanity	Chlorides	Sodium	Potassium	Total hardness	Ca Hardness
		mg/l					
8	Mr. Anil, Dauji road, Old Goa Downstream of St Francis Zawior Church, old goa	108.9	20.7	14.2	0.55	104	40
9	Mahadev Temple premises, Britona	31.25	37.28	20.79	0.89	39	21
10	Ekosibhat, Umesh thari	12.85	18.11	15.7	0.53	18	8
11	Mr Subhash Naik, Mercs Goa (old Goa)	170.78	36.23	55.95	10.09	184	54
12	Mr. Barnard Lawrence, Santa Cruze	79.2	18.11	15.76	3.66	80	14
13	Mr Azith Naik, Bambolim	17.33	15.53	13.75	0.55	22	4
14	Mrs. Clarina Almaida, Taligao	127.5	64.69	58.59	16.11	148	40

Table 3.3.5: Water Quality – Nutrient Demand Parameters

Sl. No	Sample	Nitrate	Total phosphate	Sulphate
		mg/l		
1	Zuwari River fed pond	4.68	0.26	266.09
2	Ribarder(river mondavi)	3.32	0.15	270.94
3	Harmakalchal, old Goa, Mr Vermappa Masthae	4.39	0.34	27.13
4	St John the baptist church, Karambolim	1.36	0.07	20.66
5	Mr. Leo Cardazso, Carambolim, Zorichembaht	0.84	0.04	24.22
6	Mr Santhosh Naik, Dulapi	0.78	0.07	28.15
7	Mr.Inacio Fernandez, Adkonda, Banastharim	5.97	1.46	60.1
8	Mr. Anil, Dauji road, Old Goa Downstream of St Francis Zawior Church, old goa	1.42	0.16	22.01
9	Mahadev Temple premises, Britona	0.9	0.06	18.36
10	Ekosibhat, Umesh thari	7.8	0.06	19.06
11	Mr Subhash Naik, Mercs Goa (old Goa)	42.21	0.04	20.55
12	Mr. Barnard Lawrence, Santa Cruze	5.16	0.19	25.67
13	Mr Azith Naik, Bambolim	4.34	0.04	20.8
14	Mrs. Clarina Almaida, Taligao	4.5	0.08	69.73

Table 3.3.6 : Water Quality- Heavy Metals

Sl. No.	Sample	Cd	Co	Cr	Cu	Fe	Mn	Ni	Pb	Zn
		mg/l								
1	Zuwari River fed pond	0.001	ND	0.023	0.026	1.002	0.052	0.017	0.017	0.088
2	Ribarder(river mondavi)	ND	ND	0.012	0.015	0.589	0.009	0.003	0.003	0.068
3	Harmakalchal, old Goa, Mr Vermappa Masthae	ND	ND	0.011	0.009	0.643	0.008	0.006	ND	0.047
4	St John the baptist church, Karambolim	ND	ND	0.019	0.04	1.866	0.013	0.005	0.01	0.054
5	Mr. Leo Cardazso, Carambolim, Zorichembaht	ND	ND	0.033	0.008	0.684	0.011	0.003	0.01	0.046
6	Mr Santhosh Naik, Dulapi	ND	ND	0.014	0.016	0.739	0.01	0.01	0.005	0.112
7	Mr.Inacio Fernandez, Adkonda, Banastharim	ND	ND	0.013	0.014	0.802	0.014	0.003	0.01	0.166
8	Mr. Anil, Dauji road, Old Goa Downstream of St Francis Zawior Church, old goa	ND	ND	0.012	0.015	0.573	0.005	0.006	ND	0.033
9	Mahadev Temple premises, Britona	ND	ND	0.022	0.014	1.459	0.011	0.005	0.011	0.482
10	Ekosibhat, Umesh thari	ND	ND	0.015	0.024	0.693	0.034	0.007	0.011	0.07
11	Mr Subhash Naik, Mercs Goa (old Goa)	ND	ND	0.03	0.01	0.688	0.02	0.002	0.008	0.087
12	Mr. Barnard Lawrence, Santa Cruze	ND	ND	0.012	0.024	0.705	0.01	0.003	0.007	0.09
13	Mr Azith Naik, Bambolim	ND	ND	0.01	0.018	0.62	0.023	0.002	0.009	0.048
14	Mrs. Clarina Almaida, Taligao	ND	ND	0.01	0.008	0.567	0.008	0.002	0.005	0.065

ND : Not detected

3.4 Land Environment

The impacts of any projects on land environment primarily depend on type/category of project. The impacts on the land environment would be in the form of permanent change in land use pattern as well as direct and indirect impacts on surrounding land due to the discharge of wastes on the land and unscientific means of disposal. The waste from industries has potential to contaminate soils, reduce agricultural productivity and delink the delicate microbial food-web in topsoil. In major perspective, long-term implications would be change in land use pattern. In order to assess the impacts of project activity, initially, the quality of soils such as physical, chemical, microbiological parameters on land need to be determined so that it can be possible to assess the impact of project-specific pollutants on the soil quality. By considering the importance of these soil related issues, the soil quality with reference to fertility and productivity are evaluated as per the standard procedures. The soil quality parameters in the study area i.e., 10 km radius from the project site.

3.4.1 Soil Quality

3.4.1.1 Reconnaissance

The location identified for proposed development of Municipal Solid Waste Management Facility (MSWMF). The project is located at Banguinim in Tiswadi taluka in North Goa.

As per MoEF guidelines, an area of 10 km radius surrounding the proposed site was considered as the study area.

3.4.1.2 Soil Sampling and Analysis

The data related to nature & quality of soil was collected through field survey and available data source.

Fourteen (14) soil samples were identified and collected from the 10 km study area during the Post-monsoon season (2017). Location of soil sampling is summarized in **Table 3.4.1.** Representative soil samples from depth (15 - 30 cm) were collected from these villages around the project site for estimation of the physicochemical characteristics of the soil.

In order to carry out physical and chemical characteristics of soil, the samples were air dried and then passed through a sieve of 2 mm and stored in HDPE bottle for further analysis. Heavy metals in the soil were determined by extracting soil with acid mixture nitric acid and perchloric acid (1:2, v/v) and the obtained soil samples were analysed on ICP-OES (APHA, 2012). The chemical characteristics of soil were determined by preparing a saturated extract of soil with distilled water in 1:2 ratio (as per Jackson procedure, 1967). Organic matter was determined in terms of organic carbon by Walkely & Black method (1972). Fertility status of soil in terms of available nitrogen was determined by the Kjeldahl method, available phosphorus was determined by chlorostannous reduced molybdo phosphorus blue color (Olsen's method, 1954)), and available potassium was determined by flame photometer method (Jackson M. L. 1967). The Hydrometer Method was adopted for determination of particle size analysis. The textural diagram was generated using "SEE soil Class 2.0 version software based on United States Department of

Agriculture (USDA) classification of soils. Physical parameters such as bulk density, porosity, and water holding capacity were determined by KR Box Method (Keen and Raczkowski, 1921). Details of Standard methods followed for the analysis of soil samples are given in **Table 3.4.2.**

3.4.1.3 Soil Characteristics

(a) Physical Properties:

Physical characteristics of the soil are delineated through specific parameters, viz., particle size distribution, texture, bulk density, porosity and water holding capacity. Air-dried and sieved samples have been used for determination of physical properties of soil. The particle size distribution in terms of percentage of sand, silt, and clay showed the dominance of sand and loamy sand in nature (**Table 3.4.3**).

The bulk density was observed to be varying from 0.81–1.36 g/cm³ which is considered to be moderate to high. The porosity and water holding a capacity of soils are in the range of 34.30-52.86 % and 32.96–49.96 % respectively. (**Table 3.4.4**)

(b) Chemical Properties:

The soil samples were analyzed for various chemical properties. The parameters selected were pH, electrical conductivity, soluble cations, cation exchange capacity (CEC).

- The pH of soil was observed to be in the range of 5.61-6.48 indicates slightly acidic to neutral in nature (**Table 3.4.5**).
- The soluble salt was determined from soil extract (1:2) and is expressed in terms of electrical conductivity (EC). Electrical conductivity is in the range from 0.032-0.179 dS/m. (**Table 3.4.5**)
- The most important cations present in soluble state in the soil are calcium and magnesium (**Table 3.4.5**). It was observed that calcium and magnesium are in the range of BDL-10 meq/l and 2.06 – 10.28 meq/l respectively. The sodium and potassium are in the range of 1.988-4.739 meq/l and 0.132-1.496 meq/l respectively. In general, the soil in the region has low, moderate and very high adsorption capacity as evident from the cations exchange capacity to be in the range of 1.49-7.001 cmol(p+) kg^{-1}. Amongst the exchangeable cations, Ca^{+2} and Mg^{+2} were observed in the range of 0.02-3.55 and 0.05-4.59 cmol(p+) kg^{-1} whereas sodium and potassium are in the range of 0.003-0.024 and 0.03-0.64cmol(p+) kg^{-1} respectively.
- Exchangeable sodium percentage ranged from 0.09-1.42% indicating that the soil in the study area is non-sodic in nature **(Table 3.4.6)**.
- The classification of soil and their relationship between productivity and absorptivity based on cations exchange capacity which indicates very low and low adsorptivity in the study area (**Tables 3.4.7 and 3.4.8**).
- Organic carbon, available nitrogen, available phosphorus and available potassium are found to be in the range of 1.307-18.21 %, 163.07-652.29 kg/ha, 5.02-21.34 kg/ha, and 97.56-342.02 kg/ha respectively which

shows that the soils are poor to high in organic carbon content. The concentration of available Nitrogen and Available Potassium shows nature of the land is poor to fertile in study area whereas the level of concentration of available Phosphorous shows poor to the medium fertile soil (**Table 3.4.9**).

- **Heavy Metals:** Soil samples were analysed for heavy metals such as Arsenic (As), Cadmium (Cd) Chromium (Cr), Cobalt (Co), Copper (Cu), Iron (Fe), Lead (Pb), Manganese (Mn), Mercury (Hg), Nickel (Ni), Zinc (Zn) and their concentrations are presented in **Table 3.4.10**.

(b) Soil Microbiology:

- Azotobactor is non-symbiotic nitrogen-fixing microorganism and improves soil fertility by fixing nitrogen in the soil. Fungi also constitute an important part of the micro-flora of normal soil. They are active in initial stages of decomposition of plant residues and actively participate in the process of soil aggregation. Microorganisms present in soil samples are presented in the **Table 3.4.11**.
- Total viable microbial population per gram of soil varied from 31 x $10^6$to 54 x 10^6 CFU. Different microflora observed per gram of soil were fungi (2 x 10^4 to 6 x 10^4CFU), actinomycetes (2 x 10^4 to 4x10^4 CFU), rhizobium (2 x 10^4 to 6 x 10^4 CFU) and azotobacter (3 x10^4 to 6 x 10^4 CFU).

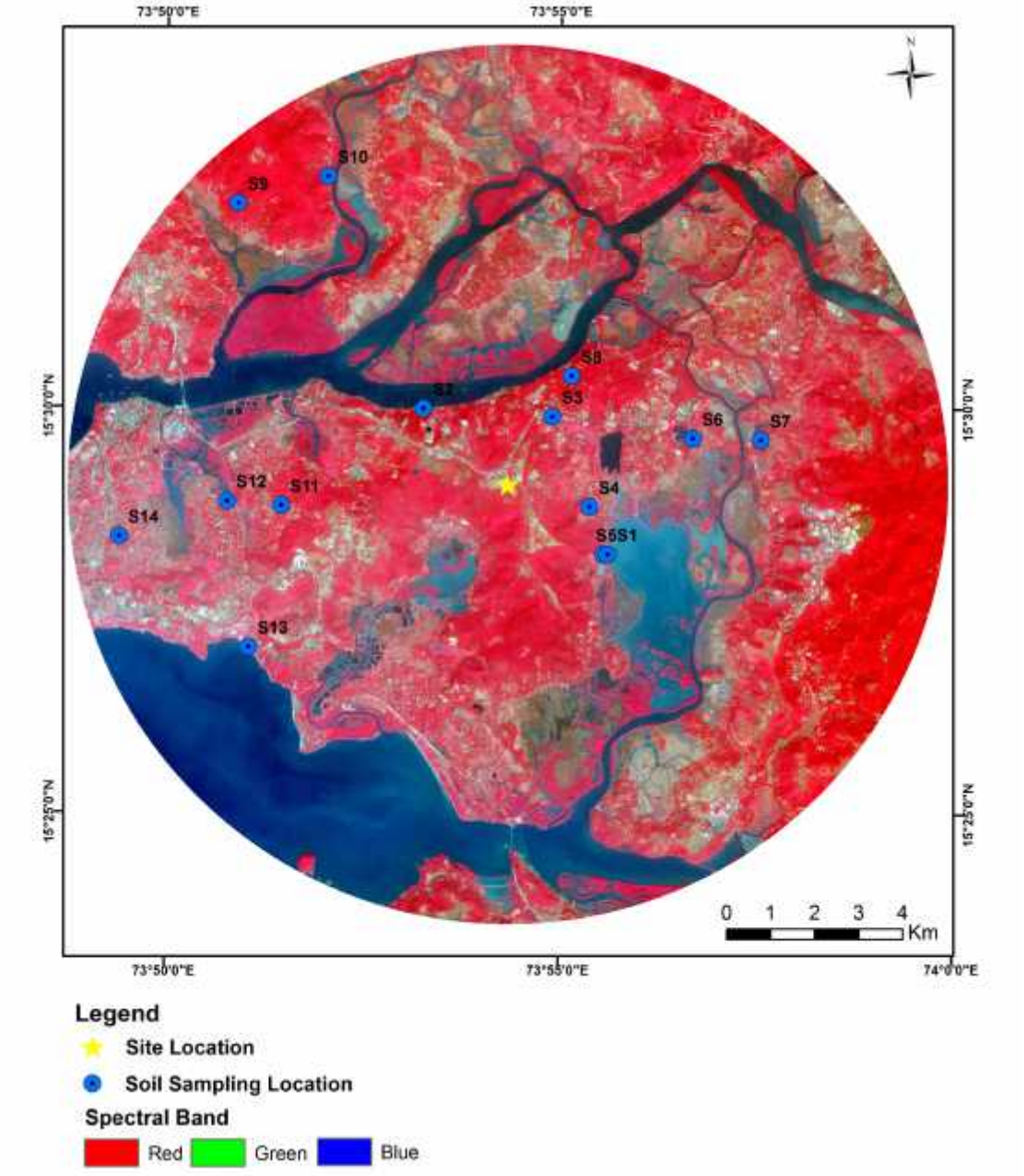


Figure 3.4.1 : Soil Sampling Locations

Table 3.4.1 : Soil Sampling Locations

Sr. No.	Location/ Village	Coordinates		Elevation
1	Zuwari river fed pond	N15°28’12.0”	E73°55’36.9”	1m
2	Ribarder(river mondavi)	N15°29’59.4”	E73°53’16.2”	5m
3	Harmakalchal, old Goa, MrVermappaMasthae	N15°29’53.8”	E73°54’54.3”	17m
4	St John the baptist church, Karambolim	N15°28’47.2”	E73°55’22.8”	15m
5	Mr. Leo Cardazso, Carambolim, Zorichembaht	N15°28’12.0”	E73°55’33.7”	9m
6	Mr Santhosh Naik, Dulapi	N15°29’37.9”	E73°56’41.4”	4m
7	Mr.Inacio Fernandez, Adkonda, Banastharim	N15°29’36.9”	E73°57’33.1”	7m
8	Mr. Anil, Dauji road, Old Goa Downstream of St Francis Zawior Church, old goa	N15°30’23.9”	E73°55’08.9”	5m
9	Mahadev Temple primisis, Britona	N15°31’90.8”	E73°50’54.0”	6m
10	Ekosibhat, Umesh thari	N15°32’51.03”	E73°52’02.8”	5m
11	Mr. Subhash Naik, Mercc Goa (old goa)	N15°28’47.3”	E73°51’27.8”	10m
12	Mr. Barnard Lawrence, Santa Cruze	N15°28’50.4”	E73°50’46.5”	15m
13	Mr. Azith Naik, Bambolim	N15°27’00.3”	E73°51’00.1”	77m
14	Mrs. ClarinaAlmaida, Taligao	N15°28’24.1”	E73°49’24.3”	16m

Source: Primary data collected by CSIR-NEERI team, Post Monsoon Season, 2017

Table 3.4.2 : Soil Quality Analysis: Standard Methods and Procedures

Sr. No.	Specific Tests or Types of Tests Performed	Specification, Standard (Method), or Technique used	Range of Testing/ Limit of Detection	Measurement Uncertainty
1	pH	IS:2720 (Pt–26)	1-14	8.04 ± 0.04
2	Electrical Conductivity (EC), dS/cm	IS: 14767	0.1–1000	239±33
3	Ammonical Nitrogen, kg/ha	IS: 14684	25–1000	136±10
4	Available Phosphorous, kg/ha	Oslen Method	10-1000	17.3±2.2
5	Available Potassium, kg/ha	Ammonium Acetate Method	5-1000	50.1±3.3
6	Organic Carbon, %	IS:2720 (Pt-22) Walky and Black Method	0.1-1.5	0.888±0.4
7	Particle Size Distribution (PSD) A.Total Sand, % B.Silt, % C.Clay, %	IS: 2720 (Pt-4) Hydrometer Method	5-90	A. 57.3±0.35 B. 9.3±0.50 C. 3.4±0.38
8	Bulk Density (BD), gm/cm³	K.R. Box Method	0.7-2.5	1.473±0.15
9	Porosity, %	K.R. Box Method	5-80	52.5±7.2
10	Water Holding Capacity (WHC), %	K.R. Box Method	5-70	35.9±5.9
11	Soluble cations (meq/L)			
	A. Calcium (Ca)	USDA Titrimetric Method		A.26.18±1.26
	B. Magnesium (Mg)			B.6.4±1.06
	C. Sodium (Na)	Flame Photometric Method		C.0.0167±0.071
	D. Potassium (K)			D.0.0692±0.071
	Calcium (Ca)	USDA Titrimetric Method	1-30	
	Magnesium (Mg)			
	Sodium (Na)	Flame Photometric Method		
	Potassium (K)			
12	Cation Exchange Capacity (CEC), meq/100g	IS: 2720 (Pt-24) Ammonium Acetate Method	5-50	34.6±2.49

Source: Primary data collected by CSIR-NEERI team, Post-monsoon Season, 2017

Table 3.4.3 : Textural Class of Soil

Sl. No	Sample	Particle Size distribution (%)				Textural class
		Fine sand	Core Sand	Silt	Clay	
1	Zuwari river fed pond	18.1	28.3	20.4	23.1	Sandy Clay Loam
2	Ribarder(river mondavi)	19.3	33.4	21.8	25.5	Sandy Clay Loam
3	Harmakalchal, old Goa, MrVermappaMasthae	34.8	45.8	12.6	6.8	Loamy Sand
4	St John the baptist church, Karambolim	34.5	48.9	14.4	3.2	Loamy Sand
5	Mr. Leo Cardazso, Carambolim, Zorichembaht	28.6	33.6	20.5	17.3	Sandy Loam
6	Mr Santhosh Naik, Dulapi	35.3	49.6	11.5	3.6	Loamy Sand
7	Mr.Inacio Fernandez, Adkonda, Banastharim	32.7	59.3	6.8	1.2	Sand
8	Mr. Anil, Dauji road, Old Goa Downstream of St Francis Zawior Church, old goa	44.1	40.8	10.6	4.5	Loamy Sand
9	Mahadev Temple primisis, Britona	43.9	44.9	6.4	5.2	Sand
10	Ekosibhat, Umesh thari	42.1	45.9	6.1	4.9	Sand
11	Mr. Subhash Naik, Mercc Goa (old goa)	44.3	39.8	11.2	3.8	Sand
12	Mr. Barnard Lawrence, Santa Cruze	34.8	47.2	12.3	3.7	Loamy Sand
13	Mr. Azith Naik, Bambolim	27.1	32.6	18.4	17.7	Sandy Loam
14	Mrs. ClarinaAlmaida, Taligao	41.3	44.2	6.4	5.8	Sand

Source: Primary data collected by CSIR-NEERI team, Post-monsoon Season, 2017

Table 3.4.4 : Physical Characteristic of Soil

Sl. No	Sample	Bulk density (gm/cm3)	Porosity %	Water Holding Capacity
1	Zuwari river fed pond	0.81	34.30	39.87
2	Ribarder(river mondavi)	0.96	38.14	40.67
3	Harmakalchal, old Goa, MrVermappaMasthae	1.09	40.58	41.32
4	St John the baptist church, Karambolim	1.18	40.92	38.45
5	Mr. Leo Cardazso, Carambolim, Zorichembaht	1.31	43.13	32.96
6	Mr Santhosh Naik, Dulapi	1.06	48.46	49.96

Sl. No	Sample	Bulk density (gm/cm3)	Porosity %	Water Holding Capacity
7	Mr.Inacio Fernandez, Adkonda, Banastharim	1.11	48.62	45.25
8	Mr. Anil, Dauji road, Old Goa Downstream of St Francis Zawior Church, old goa	1.30	51.06	40.8
9	Mahadev Temple primisis, Britona	1.36	52.86	39.36
10	Ekosibhat, Umesh thari	1.25	50.29	41.02
11	Mr. Subhash Naik, Mercc Goa (old goa)	1.35	51.02	40.3
12	Mr. Barnard Lawrence, Santa Cruze	1.21	51.23	40.6
13	Mr. Azith Naik, Bambolim	1.31	49.87	42.5
14	Mrs. ClarinaAlmaida, Taligao	1.09	47.89	43.21

Source: Primary data collected by CSIR-NEERI team, Post-monsoon Season, 2017

Table 3.4.5 : Chemical Characteristics of Soil Extract

Sl. No.	Sample	pH	EC dS/m	Calcium	Magnesium	Sodium	Potassium
				meq/L			
1	Zuwari river fed pond	6.1	0.041	1.9	7.41	1.988	0.541
2	Ribarder(river mondavi)	5.9	0.045	BDL	10.28	2.774	0.659
3	Harmakalchal, old Goa, MrVermappaMasthae	5.61	0.053	5	8.23	3.477	0.132
4	St John the baptist church, Karambolim	6.17	0.055	2.5	4.11	4.739	0.318
5	Mr. Leo Cardazso, Carambolim, Zorichembaht	5.76	0.04	BDL	8.23	3.464	0.252
6	Mr Santhosh Naik, Dulapi	6.48	0.108	8.75	4.11	2.831	0.750
7	Mr.Inacio Fernandez, Adkonda, Banastharim	5.91	0.179	10	8.23	4.259	1.496
8	Mr. Anil, Dauji road, Old Goa Downstream of St Francis Zawior Church, old goa	6.28	0.072	6.25	2.06	3.464	0.184
9	Mahadev Temple primisis, Britona	6.48	0.039	1.25	8.23	2.684	0.509
10	Ekosibhat, Umesh thari	5.96	0.047	2.5	6.17	2.985	1.008
11	Mr. Subhash Naik, Mercc Goa (old goa)	6.20	0.041	2.7	7.85	3.589	0.451

Sl. No.	Sample	pH	EC dS/m	Calcium	Magnesium	Sodium	Potassium
				meq/L			
12	Mr. Barnard Lawrence, Santa Cruze	5.91	0.032	3.1	5.32	2.661	0.783
13	Mr. Azith Naik, Bambolim	6.31	0.152	BDL	9.41	3.129	0.457
14	Mrs. ClarinaAlmaida, Taligao	5.82	0.147	6.2	6.11	3.568	0.987

Source: Primary data collected by CSIR-NEERI team, Post-monsoon Season, 2017

Table 3.4.6 : Cation Exchange Capacity of Soil

Sl. No	Sample	Ca++	Mg++	Na+	K+	CEC	ESP (%)
		cmol(p+)/kg					
1	Zuwari river fed pond	0.04	4.15	0.005	0.48	5.17	0.16
2	Ribarder(river mondavi)	0.06	4.58	0.008	0.53	5.29	0.15
3	Harmakalchal, old Goa, MrVermappaMasthae	0.56	1.93	0.010	0.06	2.71	0.39
4	St John the baptist church, Karambolim	0.21	0.98	0.019	0.12	1.49	1.42
5	Mr. Leo Cardazso, Carambolim, Zorichembaht	0.02	2.29	0.024	0.13	4.83	0.49
6	Mr Santhosh Naik, Dulapi	2.08	0.05	0.009	0.19	2.38	0.39
7	Mr.Inacio Fernandez, Adkonda, Banastharim	3.55	2.83	0.010	0.54	7.001	0.14
8	Mr. Anil, Dauji road, Old Goa Downstream of St Francis Zawior Church, old goa	1.86	0.08	0.007	0.03	2	0.36
9	Mahadev Temple primisis, Britona	0.5	4.59	0.012	0.35	5.481	0.22
10	Ekosibhat, Umesh thari	1.2	3.23	0.018	0.64	5.09	0.35
11	Mr. Subhash Naik, Mercc Goa (old goa)	3.23	1.97	0.005	0.47	6.74	0.09
12	Mr. Barnard Lawrence, Santa Cruze	1.26	0.05	0.003	0.04	1.4	0.31
13	Mr. Azith Naik, Bambolim	0.8	3.92	0.011	0.24	5.114	0.17
14	Mrs. ClarinaAlmaida, Taligao	1.1	2.32	0.017	0.51	4.19	0.31

Source: Primary data collected by CSIR-NEERI team, Post-monsoon Season, 2017

Table 3.4.7 : Relationship of CEC with Productivity

CEC	Range (cmol (p+) Kg^{-1})	Productivity	Location Sr. Nos.
Very low	<10	Very low	1-14
Low	10-20	Low	
Moderate	20-50	Moderate	
High	>50	High	

Source: Primary data collected by CSIR-NEERI team, Post-monsoon Season, 2017

Table 3.4.8 : Relationship of CEC with Adsorptivity

CEC	Range (cmol (p+) Kg^{-1})	Adsorptivity	Location Sr. Nos.
Limited or Low	<10	Limited or Low	1-14
Moderate	10-20	Moderate	
High	20-30	High	
Very High	>30	Very High	

Source: Primary data collected by CSIR-NEERI team, Post-monsoon Season, 2017

Table 3.4.9 : Fertility Status of Soil in Study Area

Sl.No	Sample	Organic carbon %	N	P_2O_5	K_2O
			Kg/Ha		
1	Zuwari river fed pond	6.301	320.25	11.09	163.61
2	Ribarder(river mondavi)	6.444	331.39	13.06	171.68
3	Harmakalchal, old Goa, MrVermappaMasthae	6.029	338.69	16.36	232.52
4	St John the Baptist church, Karambolim	5.938	363.77	13.85	202.53
5	Mr. Leo Cardazso, Carambolim, Zorichembaht	3.035	429.3	15.64	162.22
6	Mr Santhosh Naik, Dulapi	7.678	512.59	17.38	342.02
7	Mr.Inacio Fernandez, Adkonda, Banastharim	18.21	652.29	21.34	335.26
8	Mr. Anil, Dauji road, Old Goa Downstream of St Francis Zawior Church, old goa	10.05	204.35	16.86	212.24
9	Mahadev Temple primisis, Britona	1.307	163.07	11.03	117.61
10	Ekosibhat, Umesh thari	2.519	202.12	5.02	98.68
11	Mr. Subhash Naik, Mercc Goa (old goa)	12.25	401.21	16.31	141.78
12	Mr. Barnard Lawrence, Santa Cruze	7.56	351.23	16.51	113.21
13	Mr. Azith Naik, Bambolim	5.98	301.25	14.23	143.25
14	Mrs. ClarinaAlmaida, Taligao	4.25	197.54	17.54	97.56

Source: Primary data collected by CSIR-NEERI team, Post-monsoon Season, 2017

Table 3.4.10 : Heavy Metals in Soil

Sl. No.	Sample	Cd	Co	Cr	Cu	Fe	Mn	Ni	Pb	Zn
		mg/kg								
1	Zuwari river fed pond	0.031	1.95	18.23	3.16	1745	71.14	2.01	1.09	12.1
2	Ribarder(river mondavi)	0.048	1.92	16.18	4.29	2113	72.81	3.08	1.75	11.3
3	Harmakalchal, old Goa, MrVermappaMasthae	0.051	1.237	9.441	8.01	1958	67.25	2.462	3.711	18.26
4	St John the Baptist church, Karambolim	0.066	1.167	14.36	6.39	2265	80.83	2.671	3.32	23.1
5	Mr. Leo Cardazso, Carambolim, Zorichembaht	0.056	0.82	18.17	7.17	2147	46.05	1.92	2.42	8.89
6	Mr Santhosh Naik, Dulapi	0.082	1.39	14.95	8.93	2217	49.9	3.12	2.6	25.8
7	Mr.Inacio Fernandez, Adkonda, Banastharim	0.052	2.14	8.97	8.02	1779	43.6	2.639	3.008	17.14
8	Mr. Anil, Dauji road, Old Goa Downstream of St Francis Zawior Church, old goa	0.057	0.845	9.54	5.62	2154	22.4	2.575	3.776	11.62
9	Mahadev Temple primisis, Britona	0.064	1.068	23.98	3.602	2526	39.17	3.124	3.2	4.38
10	Ekosibhat, Umesh thari	0.078	1.78	13.39	2.628	2579	69.4	3.084	1.474	4.65
11	Mr. Subhash Naik, Mercc Goa (old goa)	0.068	1.25	12.45	5..41	1758	58.7	1.421	1.29	3.85
12	Mr. Barnard Lawrence, Santa Cruze	0.072	1.78	8.47	3.72	2156	41.6	3.015	1.87	7.85
13	Mr. Azith Naik, Bambolim	0.057	1.68	14.29	4.59	2697	38.9	2.07	2.103	6.23
14	Mrs. ClarinaAlmaida, Taligao	0.089	1.97	9.89	2.85	1458	42.7	2.85	2.945	11.29

Source: Primary data collected by CSIR-NEERI team, Post-monsoon Season, 2017

Table 3.4.11 : Microbiological Characteristic of Soil

Sl.No	Sampling Location	TVC	Fungi	Actinomycetes	Rhizobium	Azotobacter
		CFU/g				
1	Zuwari river fed pond	$32x10^6$	$3x10^4$	$2x10^4$	$3x10^4$	$3x10^4$
2	Ribarder(river mondavi)	$32x10^6$	$5x10^4$	$2x10^4$	$6x10^4$	$5x10^4$
3	Harmakalchal, old Goa, MrVermappaMasthae	$41x10^6$	$2x10^4$	$3x10^4$	$6x10^4$	$5x10^4$
4	St John the Baptist church, Karambolim	$31x10^6$	$3x10^4$	$3x10^4$	$2x10^4$	$5x10^4$
5	Mr. Leo Cardazso, Carambolim, Zorichembaht	$31x10^6$	$2x10^4$	$3x10^4$	$2x10^4$	$6x10^4$
6	Mr Santhosh Naik, Dulapi	$51x10^6$	$2x10^4$	$2x10^4$	$4x10^4$	$3x10^4$
7	Mr.Inacio Fernandez, Adkonda, Banastharim	$42x10^6$	$6x10^4$	$4x10^4$	$3x10^4$	$6x10^4$
8	Mr. Anil, Dauji road, Old Goa Downstream of St Francis Zawior Church, old goa	$38x10^6$	$3x10^4$	$4x10^4$	$2x10^4$	$3x10^4$
9	Mahadev Temple primisis, Britona	$32x10^6$	$3x10^4$	$4x10^4$	$3x10^4$	$3x10^4$
10	Ekosibhat, Umesh thari	$36x10^6$	$3x10^4$	$2x10^4$	$3x10^4$	$5x10^4$
11	Mr. Subhash Naik, Mercc Goa (old goa)	$44x10^6$	$2x10^4$	$2x10^4$	$2x10^4$	$5x10^4$
12	Mr. Barnard Lawrence, Santa Cruze	$44x10^6$	$5x10^4$	$2x10^4$	$2x10^4$	$4x10^4$
13	Mr. Azith Naik, Bambolim	$42x10^6$	$2x10^4$	$3x10^4$	$4x10^4$	$3x10^4$
14	Mrs. ClarinaAlmaida, Taligao	$54x10^6$	$4x10^4$	$3x10^4$	$4x10^4$	$4x10^4$

TVC: Total Viable Count; CFU: Colony Forming Unit
Source: Primary data collected by CSIR-NEERI team, Post-monsoon Season 2017

3.4.2 Land Use / Land Cover using Remote Sensing

Remote Sensing Analysis

Remote sensing technology offers an efficient and timely data to map not only the current land use and land cover (LULC) distribution and pattern, but also to monitor such changes and trends in the LULC over a period of time. Land use refers to "man' activities and various uses which are carried on land. Land cover refers to "natural vegetation, water bodies, rock/soil, artificial cover and other resulting due to transformation" the term land use and land cover is closely related and interchangeable.

The methodology for remote sensing analysis of satellite images comprised of the following:

- õ acquisition of satellite data
- õ collection of Ground truth (GT) and Ground Control Points (GCPs)
- õ pre-processing of data

- Image classification
- accuracy assessment

For this, the satellite image was procured from National Remote Sensing Center (NRSC), Hyderabad. The metadata of the images are presented in **Table 3.4.12**.

Table 3.4.12 : Details of satellite data

Satellite	Sensor	Resolution, m	Date of pass
R2A	LISS IV	5.8	17November 2017

The national LULC classification system was designed as a reconnaissance scheme applicable in Indian environment with varying needs and perspectives. The LULC Classification Scheme is presented in **Annexure-I** as per NRSC/ISRO (2006)

The satellite data from the compact disc is loaded on the hard disk and by visual interpretation (the sampled image of the appropriate area); the sub-scene of the study area is extracted. Indian Remote Sensing images procured from NRSC are already georeferenced and ortho-rectified. A detailed survey is being carried out using Global Positioning System (GPS) and digital camera for collection of ground truth and Ground Control Point (GCP) in and around the study area for LULC analysis. The remote sensing analysis is performed using Erdas Imagine.Study area is considering 10km buffer from the Baingunim, Goa,2017 (15°29'03.3" N and 73°54'20.5" E).

False Colour Composite (FCC)

Based on the above methodology, pre-processing of the image was carried out in terms of geo-referencing, rectification and preparation of FCC map. The image was subset for required study area of 10 km buffer zones from location of the Baingunim, Goa (15°29'03.3" N and 73°54'20.5" E). **Figure 3.4.2** show False Colour Composite (FCC) of the study areaof Baingunim, Goa for year2017.The ground truth points collected for accuracy assessment are superimposed over FCC image (2017) of the study area.FCC is combination of near infra-red, red and green spectral bands. This FCC images was further used for remote sensing analysis along with the extensive ground truth survey for precise estimation and assessment of LULC classification. In the FCC image, vegetation appears red, agriculture in pink, built-up in cyan, barren land in bright white, mining in ash colour and water body appears black in colour. Attributes such as colour, tone, texture, shape and size are used for visual image interpretation. Based on the visual interpretation of the FCC images, the study area is majorly occupied by forest/vegetation followed by waterbody, agriculture, mangrove, coastal wetland, built up, barren landand mining.

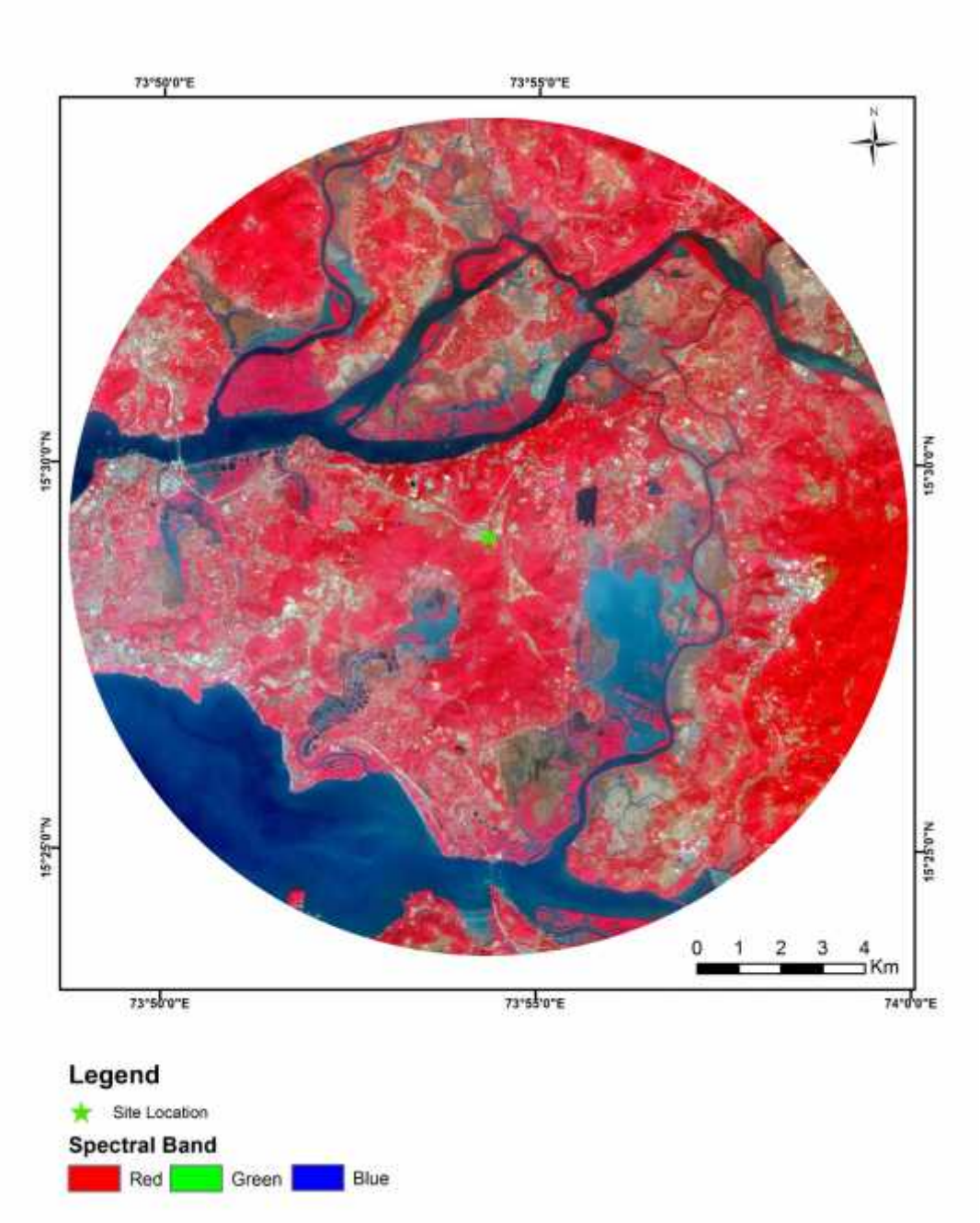


Figure 3.4.2: False Color Composite (FCC) of the study area (Bainguinim,November 2017)

Ground truth verification locations

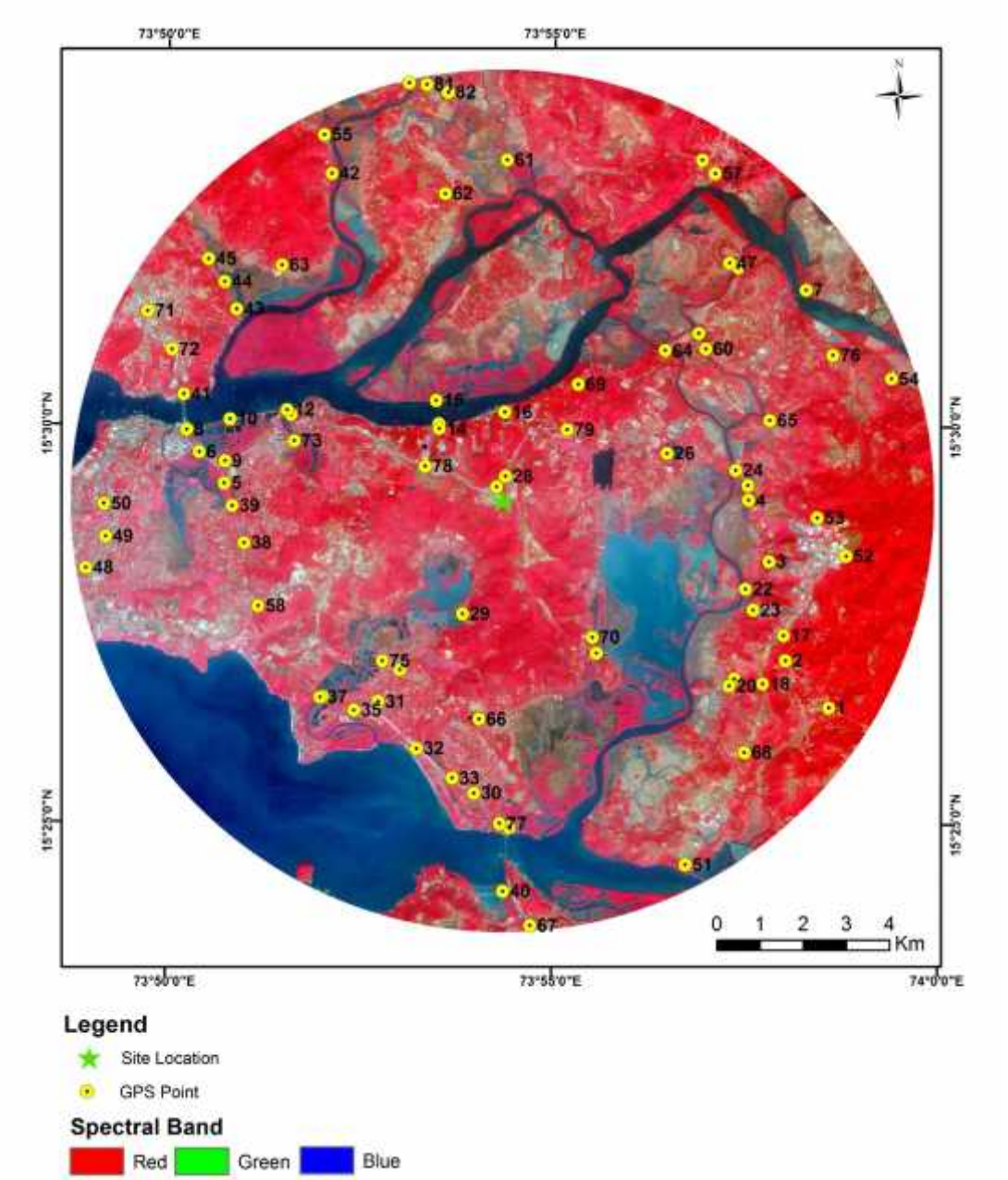


Figure 3.4.3 : Ground verification locations of the study area (Bainguinim, November 2017)

The detail of GT points in study area ofBainguinim is presented in **Table 3.4.13.**

Table 3.4.13 : Details of GT points

Sr.No.	Name	Description	Latitude	Longitude
1	1	Forest	15°26' 27.869" N	73°58' 35.003" E
2	2	Forest	15°27' 3.504" N	73° 58' 0.987" E
3	3	Vegetation	15°28' 18.000" N	73° 57' 47.900" E
4	4	Vegetation	15°29' 4.450" N	73°57' 31.895" E
5	5	Mangrove	15°29' 15.488" N	73°50' 44.218" E
6	6	Wetland	15°29' 39.113" N	73°50' 24.506" E
7	7	Mangrove	15°31' 43.263" N	73°58' 15.771" E
8	8	Built up	15°29' 55.976" N	73°50' 14.865" E
9	9	Mangrove	15°29' 32.319" N	73°50' 44.800" E
10	10	Waterbody	15°30' 4.090" N	73°50' 48.393" E
11	11	Wetland	15°30' 7.458" N	73°51' 35.719" E
12	12	Mangrove	15°30' 11.126" N	73°51' 32.754" E
13	13	Waterbody	15°30' 1.075" N	73°53' 30.961" E
14	14	Vegetation	15°29' 57.615" N	73°53' 31.191" E
15	15	Mangrove	15°30' 18.730" N	73°53' 28.528" E
16	16	Built up	15°30' 10.100" N	73°54' 22.100" E
17	17	Forest	15°27' 22.177" N	73°57' 59.665" E
18	18	Forest	15°26' 45.726" N	73°57' 43.511" E
19	19	Vegetation	15°26' 49.352" N	73°57' 21.265" E
20	20	Agriculture	15°26' 44.065" N	73°57' 17.407" E
21	21	Wetland	15°27' 8.550" N	73°55' 34.134" E
22	22	mangrove	15°27' 57.304" N	73°57' 29.833" E
23	23	Built up	15°27' 41.534" N	73°57' 35.793" E
24	24	Mangrove	15°29' 27.009" N	73°57' 21.698" E
25	25	Agriculture	15°29' 15.504" N	73°57' 31.345" E
26	26	waterbody	15°29' 39.454" N	73°56' 28.428" E
27	27	built up	15°29' 13.563" N	73°54' 15.870" E
28	28	vegetation	15°29' 21.739" N	73°54' 22.635" E
29	29	wetland	15°27' 37.587" N	73°53' 49.846" E
30	30	Agriculture	15°25' 22.315" N	73°53' 59.402" E
31	31	vegetation	15°26' 31.185" N	73°52' 44.455" E
32	32	Agriculture	15°25' 55.818" N	73°53' 14.597" E
33	33	Built up	15°25' 33.541" N	73°53' 42.420" E
34	34	mangrove	15°24' 56.889" N	73°54' 26.842" E
35	35	Agriculture	15°26' 24.507" N	73°52' 25.896" E
36	36	wetland	15°26' 34.668" N	73°52' 1.801" E
37	37	mangrove	15°26' 34.322" N	73°51' 59.425" E
38	38	Agriculture	15°28' 30.574" N	73°50' 59.808" E
39	39	Mangrove	15°28' 58.612" N	73°50' 50.512" E
40	40	wetland	15°24' 8.498" N	73°54' 22.265" E
41	41	Forest	15°30' 22.819" N	73°50' 12.480" E
42	42	mangrove	15°33' 9.772" N	73°52' 6.787" E
43	43	wetland	15°31' 27.140" N	73°50' 53.257" E
44	44	Agriculture	15°31' 47.691" N	73°50' 43.709" E

Sr.No.	Name	Description	Latitude	Longitude
45	45	wetland	15°32' 4.978" N	73°50' 31.037" E
46	46	Mangrove	15°31' 59.932" N	73°57' 22.947" E
47	47	Vegetation	15°32' 3.458" N	73°57' 16.197" E
48	48	Agriculture	15°28' 11.268" N	73°48' 56.840" E
49	49	Agriculture	15°28' 35.015" N	73°49' 12.236" E
50	50	Built-up	15°28' 59.734" N	73°49' 10.604" E
51	51	Mangrove	15°24' 29.310" N	73°56' 43.911" E
52	52	Forest	15°28' 22.543" N	73°58' 47.767" E
53	53	Forest	15°28' 51.282" N	73°58' 25.304" E
54	54	Forest	15°30' 36.586" N	73°59' 22.656" E
55	55	Mangrove	15°33' 39.041" N	73°52' 0.808" E
56	56	Forest	15°33' 20.991" N	73°56' 54.682" E
57	57	Built-up	15°33' 11.051" N	73°57' 4.680" E
58	58	Forest	15°27' 43.004" N	73°51' 11.034" E
59	59	Mangrove	15°31' 10.300" N	73°56' 52.478" E
60	60	Mangrove	15°30' 58.496" N	73°56' 57.932" E
61	61	Mangrove	15°33' 20.526" N	73°54' 22.970" E
62	62	Vegetation	15°32' 54.729" N	73°53' 34.920" E
63	63	Forest	15°32' 0.324" N	73°51' 28.353" E
64	64	Mangrove	15°30' 57.132" N	73°56' 26.530" E
65	65	Agriculture	15°30' 4.711" N	73°57' 48.114" E
66	66	Wetland	15°26' 18.234" N	73°54' 3.103" E
67	67	Mangrove	15°23' 42.825" N	73°54' 43.516" E
68	68	Forest	15°25' 53.811" N	73°57' 29.353" E
69	69	Forest	15°30' 31.394" N	73°55' 19.120" E
70	70	Mangrove	15°27' 20.414" N	73°55' 30.919" E
71	71	Built-up	15°31' 25.355" N	73°49' 43.890" E
72	72	Forest	15°30' 56.485" N	73°50' 3.145" E
73	73	Mangrove	15°29' 47.778" N	73°51' 38.483" E
74	74	Agriculture	15°26' 55.255" N	73°53' 1.510" E
75	75	Wetland	15°27' 1.966" N	73°52' 47.714" E
76	76	Forest	15°30' 54.156" N	73°58' 36.960" E
77	77	Mangrove	15°24' 59.459" N	73°54' 19.293" E
78	78	Built-up	15°29' 29.037" N	73°53' 20.410" E
79	79	Forest	15°29' 57.020" N	73°55' 10.439" E
80	80	Mangrove	15°34' 18.324" N	73°53' 6.515" E
81	81	Agriculture	15°34' 17.360" N	73°53' 20.235" E
82	82	Mangrove	15°34' 11.391" N	73°53' 36.895" E

Field photographs are attachd in Annexure II.

c) Supervised classification

Based on the procured satellite data, the supervised classification is performed for satellite imagery of November2017.The image is classified under the LULC classes of forest/vegetation followed by waterbody, agriculture, mangrove,

coastal wetland, built up, barren land and mining.The LULC classification map is shown in **Figure 3.4.4**.

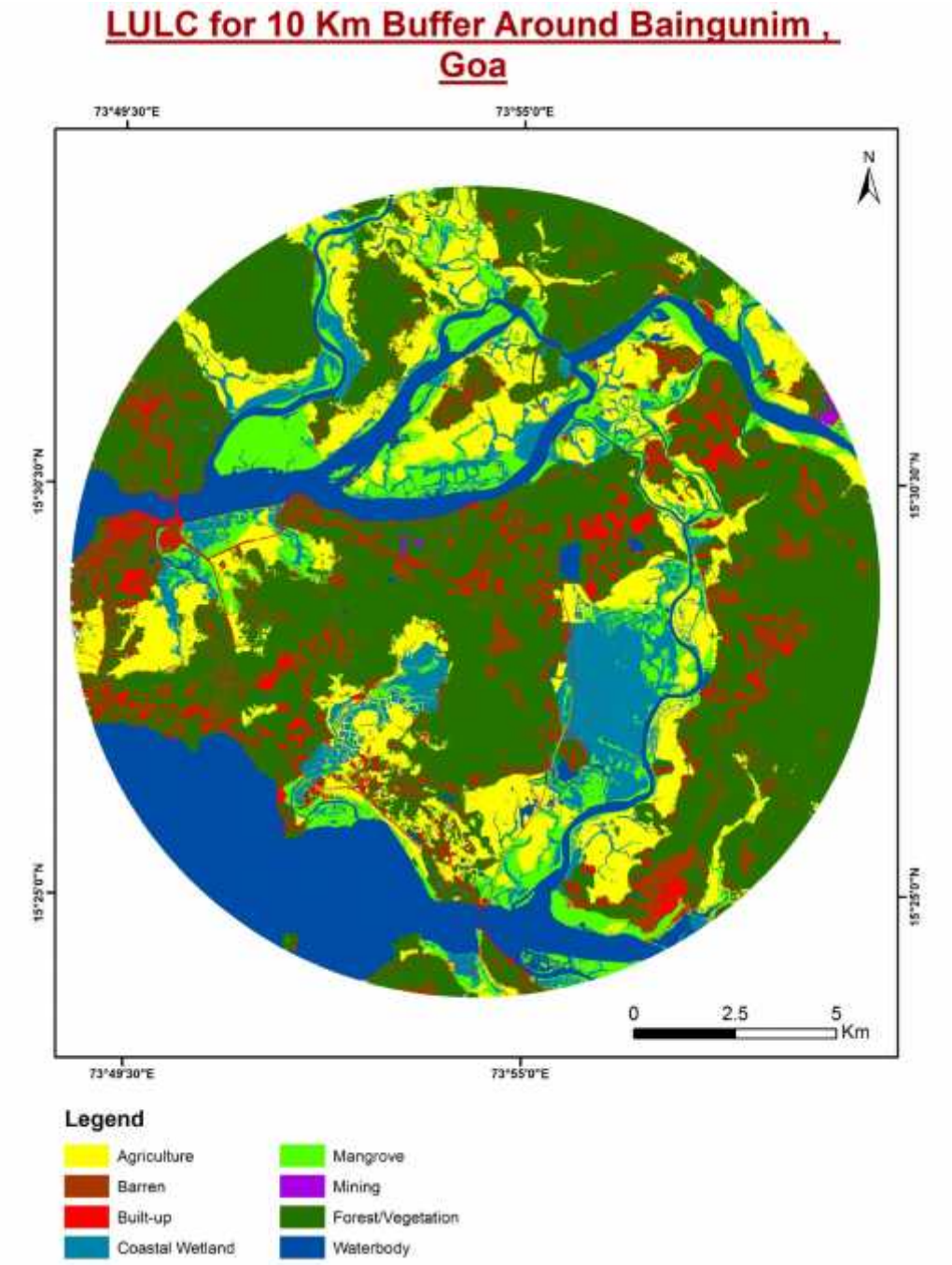


Figure 3.4.4 : LULC classification of Baingunim, Goa, November 2017

The inventory of LULC of Bainguinim, Goa is presented in **Table 3.4.14** and graphically represented in **Figure 3.4.5**.

Table 3.4.14 : Inventory of LULC classes of Bainguininm,Goa

Name	Area (sq.Km)	Area (%)
Agriculture	47.05	14.99
Barren	7.15	2.28
Built-up	19.65	6.26
Coastal Wetland	24.32	7.75
Mangrove	25.87	8.24
Mining	0.35	0.11
Vegetation	135.98	43.31
Waterbody	53.69	17.10

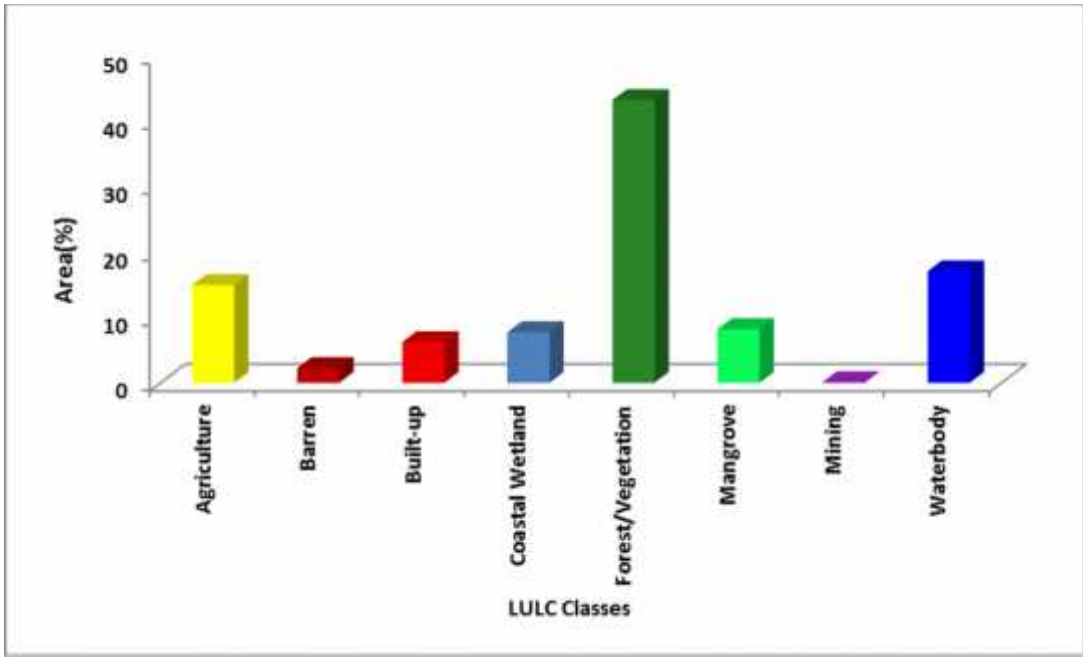


Figure 3.4.5 : Graphical Representation of LULC Inventory of Bainguinim, Goa

The total geographical area coming under with 10km cluster is 314 sq.km. The highest spatial extent of LULC class is observedforest/vegetation followed by waterbody, agriculture, mangrove, coastal wetland, built up, barren land and miningand with percentage share of 43.31%,17.10%, 14.99%,8.24%, 7.75%, 6.26%, 2.28% and 0.11%respectively.

This above classified images of November 2017 was used for post classification accuracy assessment as current practices of area usage and coverage as recorded during ground truth survey. Based on the spatial extent of classes and variability of distribution across the study area, a suitable sample size of 82was used for the accuracy assessment. Accordingly, an error matrix was generated to assess the overall accuracy. The overall accuracy of supervised classification is found to be 87.3%.

Annexure-I

Classification scheme as per NRSC/ISRO

Sr. no	Description-1	Description-2	Classes
1	Built-up	Urban	Residential, Mixed built-up, Public / Semi-Public, Communication, Public utilities/facility, Commercial, Transportation, Reclaimed land, Vegetated Area, Recreational, Industrial, Industrial / Mine dump, Ash / Cooling pond
		Rural	Rural
		Mining	Mine / Quarry, Abandoned Mine Pit, Landfill area
2	Agriculture	Cropland	Kharif, Rabi, Zaid, Two cropped, More than two cropped
		Plantation	Plantation - Agricultural Horticultural, Agro Horticultural
		Fallow	Current and Long Fallow
		Current Shifting cultivation	Current Shifting cultivation
3	Forest	Evergreen / Semi evergreen	Dense / Closed and Open category of Evergreen / Semi evergreen
		Deciduous	Dense / Closed and Open category of Deciduous and Tree Clad Area
		Forest Plantation	Forest Plantation
		Scrub Forest	Scrub Forest, Forest Blank, Current & Abandoned Shifting Cultivation
		Swamp / Mangroves	Dense / Closed & Open Mangrove
4	Grass/ Grazing	Grass/ Grazing	Grassland: Alpine / Sub-Alpine, Temperate / Sub Tropical, Tropical / Desertic
5	Barren/ unculturable /Wastelands	Salt-Affected Land	Slight, Moderate & Strong Salt Affected Land
		Gullied / Ravenous Land	Gullied, Shallow ravine & Deep ravine area
		Scrubland	Dense / Closed and Open category of scrub land
		Sandy area	Desertic, Coastal, Riverine sandy area
		Barren rocky	Barren rocky
		Rann	Rann
6	Wetlands /Water Bodies	Inland Wetland	Inland Natural and Inland Manmade wetland
		Coastal Wetland	Coastal Natural and Coastal Manmade wetland
		River / Stream / canals	Perennial & Dry River/stream and line & unlined canal drain
		Water bodies	Perennial, Dry, Kharif, Rabi & Zaid extent of lake/pond and reservoir and tanks
7	Snow and Glacier	-	Seasonal and Permanent snow

Annexure-II

Agriculture

Built up

Forest

Mangrove

Vegetation

Waterbody

Wetland

3.4.3 Geological Features of the Study Area

3.4.3.1 Introduction

The study area falls under Bainguinim Village, Tiswadi taluka in North Goa district **(Figure 3.4.6)**. North Goa district lies in the northern part of Goa state. The geographical area of the district is 1,736 sq.km, and is situated between north latitudes 15^{o} 16' 30" and 15 48' 15" and between east longitudes 73^{o} 40' 30" & 74^{o} 17' 15". The district is bounded by Sindhudurg district of Maharashtra in the north, Belgaum district of Karnataka in the north – east, Uttara Kannada district of Karnataka in the east, South Goa district in the south and in the west by the Arabian Sea.

General lithological characteristics of the area are beach sand, laterites, quartz-sericite schist, and greywacke with conglomerate. The main geomorphological unit in the study area are coastal plains, islands, dissected table land, low cut terraces, laterite mesas, lineaments/dykes, estuary, beach, tidal flat, tidal river, channel spit, beach ridge, salt pans, mangroves, estuary island and exposed rocks. Major soil types are laterites, alluviums, sandy coastal soils, saline soils and marshy soils. The area is surrounded by the Mandovi River and Zuari River, both having estuarine characteristics. Primarily the underlying rocks govern the drainage system in the area. The drainage pattern is generally dendritic type. The study experiences a tropical & humid climate. Rain occurs due to the south-west monsoon winds from June to September. The average annual rainfall (1971-2013) is about 2,932 mm, bulk of which is received during monsoon months of June to September. Almost 32% of the annual rainfall is received in the month of July. The maximum temperature recorded is 36°C and the minimum is 23°C during May and January respectively. Total population of Tiswadi Taluk is 177,219 living in 42,241 houses, spread across total 20 villages and 20 panchayats.

3.4.3.2 Geology and Geotectonic

Major part of the Goa State is underlain by rocks of Pre-Cambrian age comprising of banded biotite gneisses, Meta-volcanic, phyllites, biotite and chlorite schists, greywacke, conglomerate (tilloid), pink phyllites with associated banded ferruginous quartzite and chart breccia. These rocks are intruded by ultra basic, basic sills and dykes, followed by granites and pegmatites. Dolerite dykes and quartz veins form the youngest intrusive in the area. The Deccan Trap basalts of Late Cretaceous to Early Eocene age occupy a small portion in the north-eastern part in the high altitudes. Geological map is presented in **(Figure 3.4.7).**

North Goa district is dominantly covered by the formation of Goa Group belonging to Dharwar Super Group of Archaean to Proterozoic age. Deccan Trap of Upper Cretaceous occupies a narrow strip along the northeastern corner to Lower Eocene age. The Goa Group comprises of metamorphic rocks of green schist facies, and is divided into Barcem, Sanvordem, Bicholim and Vageri formation in the ascending order of superposition. The Goa Group of rocks has been intruded by granite gneiss, feldspathic gneiss, hornblende gneiss and porphyritic granite, followed by basic intrusive.

During the Sub – Recent and Recent times, the rocks have been subjected to lateritisation of varying thickness. Thus, laterite occurs extensively covering almost

all the formations in North Goa district. Coastal alluvium occurring along the coastal plains consists of fine to coarse sands with intercalations of sandy loam, silt and clay.

Geologically, Major part of the study area is covered by the formation of Goa Group belonging to Dharwar Super-Group of Archaean to Proterozoic age. The **Figure 3.4.8** shows Geological Map of Tiswadi taluka. The rock types representing the Dharwars are quartzites, quartz-sericite schist, and meta-greywacke with conglomerate, which is distributed in a general NW-SE direction. The rock types of Goa Group have suffered considerable faulting; all the faults are not exposed on surface owing to the extensive cover of laterite. The rocks have been subjected to lateritisation of varying thickness during the recent times. Laterites and lateritic soils are found to occur capping the rocks forms the high plateaus of the Sahyadri down to the sea level. Thus, laterite occurs extensively covering almost all the formations in area. Beach sand occurring along the coastal plains consists of fine to coarse sands.

3.4.3.3 Stratigraphy

The stratigraphic succession of rocks in North Goa district is illustrated in given below **Table 3.4.15.**

3.4.3.4 Structural Geology

The Goa group of rocks is disposed in a general NW – SE direction. The rock types indicate three cycles of folding. The straight coastline suggests the major fault along the west coast. Associated with this fault a number of weak planes have developed. Along these weak planes Terekhol, Chapora, Mandovi and Zuari rivers flow to meet the Arabian Sea. Western Ghats, which extends in NS to NNW – SSE direction represent a prominent fault zone. Even though the rock types of Goa Group have suffered considerable faulting, all the faults are not exposed on surface owing to the extensive cover of laterites.

3.4.3.5 Physiography and Drainage

Physiographically, North Goa district can be broadly divided into four distinct morphological units from west to east namely,

(i) Coastal plain with marine land forms on the west,

(ii) Vast stretch of plains adjoining the coastal plain,

(iii) Low dissected denudational hills & tablelands towards the east, and

(iv) Deeply dissected high Western Ghats denudational hills along the Eastern most part of the district.

Principal perennial rivers draining through the district are, Terekhol, Chapora, Mandovi & Zuari and non – perennial (seasonal) river Baga **(Figure 3.4.9)**. The river basin of all these westerly flowing short rivers originate from Western Ghats and drain in the Arabian Sea in the west under estuarine environment. Primarily the underlying rocks govern the drainage system in the area. The drainage pattern is generally dendritic type. The major river Zuari follows the major NW synclinal axis. The river valleys are ‘V’ shaped in the western high hill ranges, but broadens in central midlands and become ‘U’ shaped in the low lands and coastal plains.

The study area is drained by a network of two estuarine rivers, namely Mandovi, and Zuari River **(Figure 3.4.10)**. These rivers originate in the Western Ghats, but soon lose their energy as they wander through the midlands and the coastal plains to discharge into the Arabian Sea. They are characterized by imperceptible gradients in the lower reaches resulting in the tidal waters entering several km inland.

3.4.3.6 Coastal Geomorphology

In general, the coastline of Goa shows characteristics of both submergence and emergence. The coast of Goa consists of a combination of beaches, rocky shores and headlands, which protrude into the sea. The coasts of Bardez, Salcete and much of Pernem are made up of long sandy beach stretches, and therefore can be comfortably classified as emerging. While, crenulated and indented coasts of Canacona-Quepem and Marmagoa could well be classified as submerging.

The morphology of the coastal zone of Goa is complex. In the north, less than 100 m high lateritized plateau topped hills generally termed as dissected tablelands occur within the coastal zone. Some of the plateaus form headlands, which continue, till the shoreline. In between the headlands, there are sandy beaches. On the land ward side of these beaches coastal plains continue. The coastal plains include beaches, sand dunes, estuaries, alluvium, tidal mudflats, marshes, mangroves, saltpans and low-lying cultivated fields. Settlements occur in the coastal plain and upper regions. In the south, namely at Quepem and Canacona, the coast is more hilly and mountainous. In this region, hill ranges of the Western Ghats extend up to the sea as headlands with sea-cliffs abound, and therefore sandy beaches and coastal plains are limited in size.

3.4.4 Hydrogeology

Occurrence and movement of ground water depends upon the type of rock formation, structure, topography, rainfall, recharge etc. Ground water in the North Goa district occurs in rocks having primary porosity and permeability or in those having secondary porosity acquired due to weathering, leaking, tectonics, solutions etc. Ground water bearing formations in the district are laterite, alluvium, granite, metavolcanics and metasedimentaries. Hydrogeological map is illustrated in **Figure 3.4.11**.

3.4.4.1 Occurrence of Ground Water and Aquifer Characteristics of various Formations

a) Laterites:

Laterites are the important water bearing formations. Laterites are of two types, viz. insitu, occurring in plateau areas or of detrital origin generally occupying valley portions. Besides inherent porosity, the laterites are highly jointed and fractured, which control their water bearing capacity. The topographic settings of laterites control its ground water potential. The thickness of laterites extends up to 30 m. Ground water occurs under water table condition in lateritic formation. In the plateau area and high grounds, depth of wells range from 9.40 to 26.60 m bgl and depth to water level varies between 8.20 – 21.90 m bgl, whereas wells located in topographic lows range in depth from 3.10 – 11.95 m bgl and depth to water level varies from 1.5 – 8.40 m bgl. Specific capacities vary between 1.73 to 3205

m^3/day/m. promising ground water bearing areas are located near Malpen and Tuem in Pernem taluk, Advalpal and Mayem in Bicholim Taluk.

b) Alluvium:

Alluvium constitutes good aquifers and is restricted to banks of rivers, viz. Zuari and Mandovi. Thickness of the coastal alluvium varies from 5 – 22 m, and comprise of fine to coarse sand with intercalations of sandy loam, silt and clay. Depth range of 1.42 to 7.7 m bgl is being tapped by dug wells. Exploratory tube wells constructed in alluvium vary in depth from 15.50 – 22m. Depth to water level in these formations varies from 1.4 to 5.85 m bgl. The discharges recorded from these aquifers are between 1.88 – 3 lps. Specific capacities vary between 27.10 & 200.78 m^3/day/m and transmissivity varies from 25.44 – 177.50 m^2/day.

c) Granite:

Ground water occurs under unconfined, semi – confined and confined conditions in weathered and fractured zones of granite and granite gneiss. Depth to water level in these formations in open wells varies from 3.8 to 6.25 m bgl, and specific capacities between 14.4 to 77.30 m^3 /day/m. Exploratory bore holes drilled in granite are in the depth range of 70.70 to 124 m bgl. Discharge recorded is between 0.77 to 8.8 lps. Specific capacities in exploratory wells recorded, vary from 2.27 to 43 m^3/day/m and transmissivity from 0.87 to 34.60 m^2/day.

d) Metavolcanics:

In unaltered state, metavolcanics are very poor in ground water. However, ground water is found to occur in zones having secondary porosity and permeability imparted due to weathering, joints and fractures. Ground water occurs both under water table and confined conditions. Water bearing zones extend up to depth of 40 to 100 m. Irrigation dug wells having diameter from 2.2 to 6.1 m are found to tap the weathered zone up to 9.25 m bgl. Depth to water level in dug wells varies from 1.48 to 6.26 m bgl. Specific capacity varies from 10.60 to 228.70 m^3/day/m.

e) Metasedimentaries:

Metasedimentaries comprise shales, phyllites, schists, metagreywackes, argillites and quartzites. The irrigation dug wells tapping weathered zones extending from 8.5 to 19.85 m bgl in these rock units with varying well diameters from 2.2 to 6.1 m. Depth to water level during post and pre–monsoon periods are recorded respectively in the range between 0.48 to 12.06 m bgl and 1.79 to 14.88 m bgl with fluctuations between 0.86 to 8.0 m. Specific capacities vary from 0.85 to 82.80 m^3/day/m.

References:

- Ground Water Information Booklet North Goa district, Goa (2013), Government of India, Ministry of Water Resources, Central Ground Water Board, South Western Region Bangalore.
- Ground Water Information Booklet Goa state (2017), Government of India, Ministry of Water Resources, River Development and Ganga Rejuvenation, Central Ground Water Board, South Western Region Bangalore.
- Kuldeep Pareta1* and Upasana Pareta2, Shoreline Changes Analysis and Coastal Geomorphology of Tiswadi Taluka of Goa State in India.
- Shodhgandha 11 Chapter 3

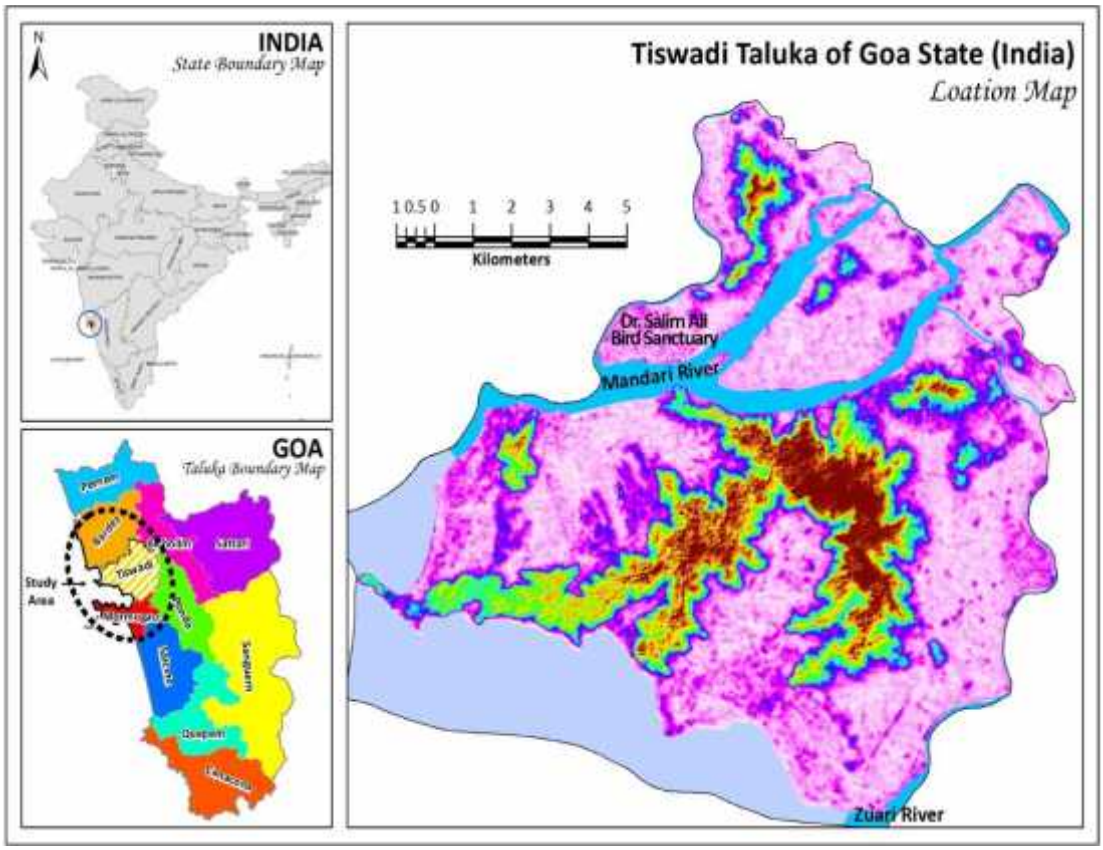


Figure 3.4.6: Location Map of Tiswadi Taluka, North Goa District.

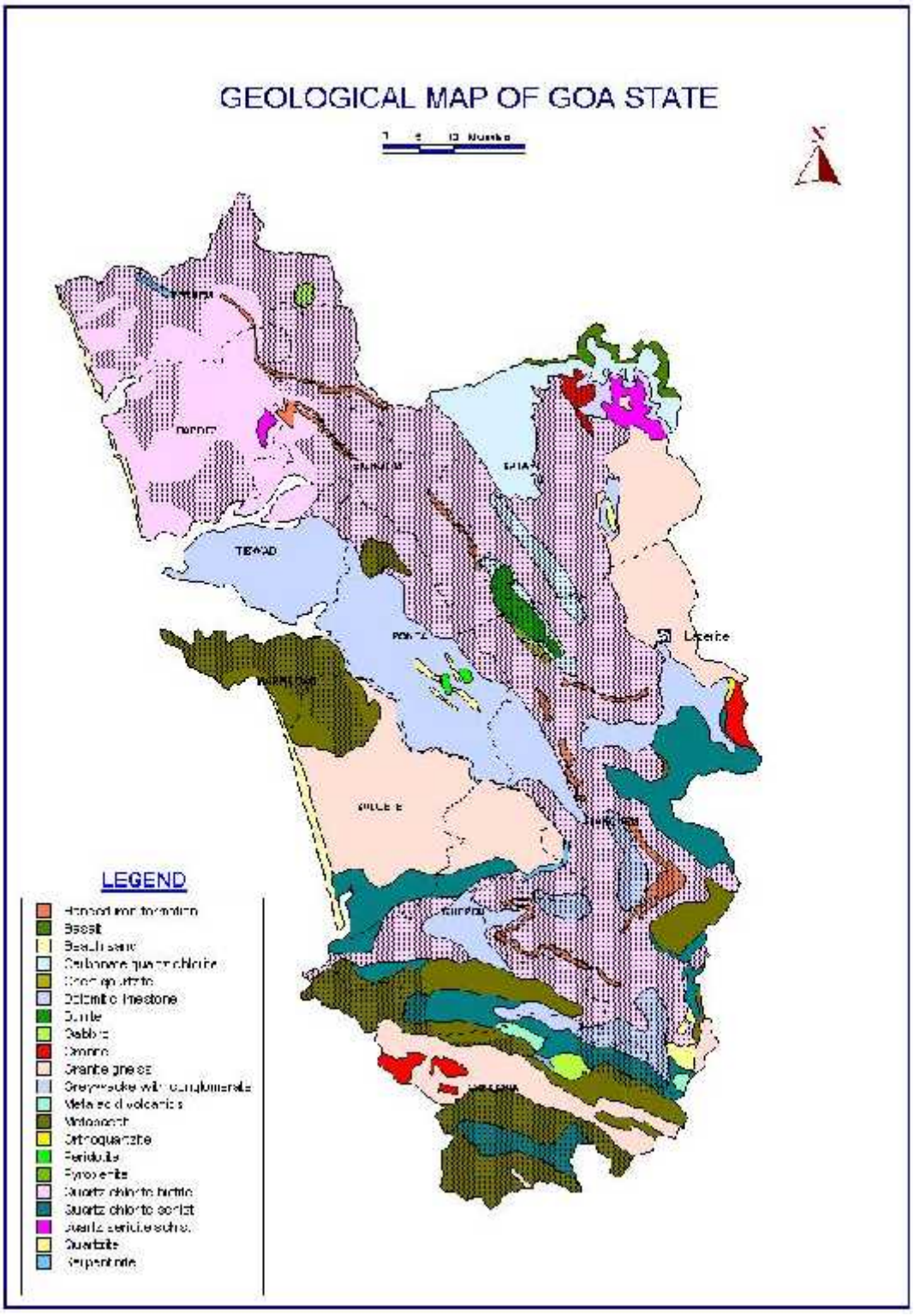


Figure 3.4.7: Geological Map of Goa State

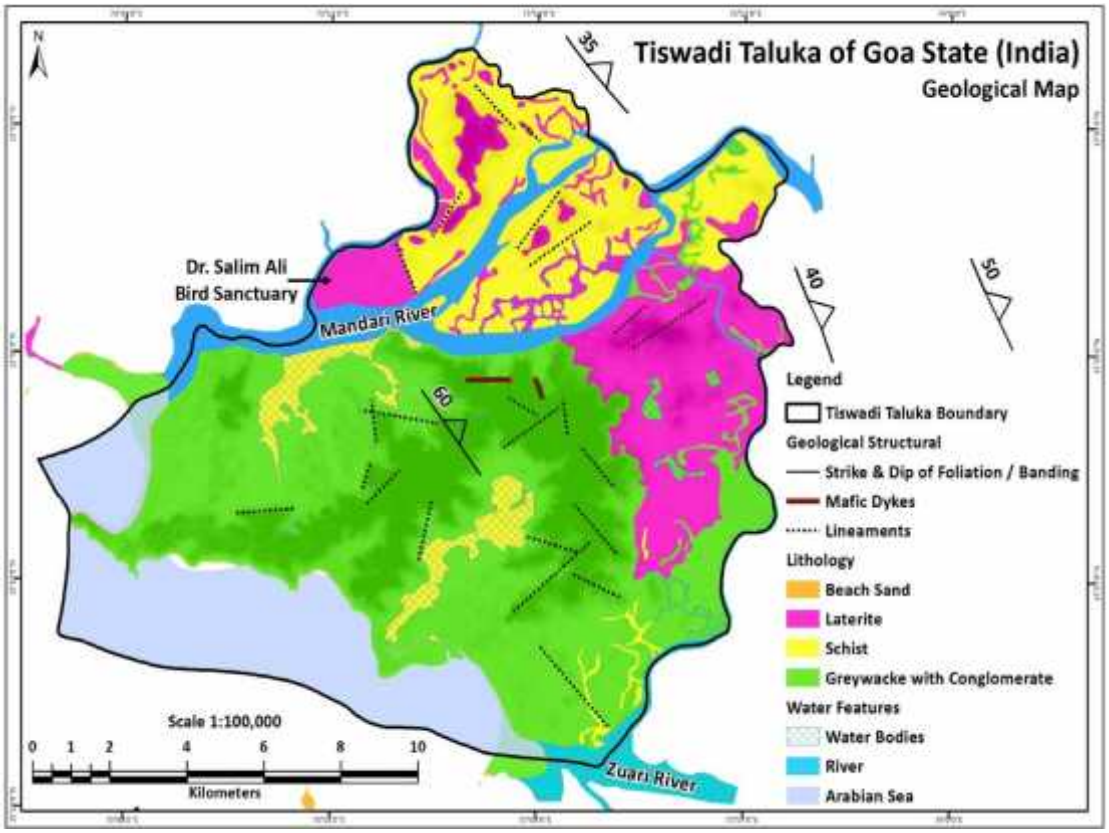


Figure 3.4.8: Geological Map of Tiswadi Taluka

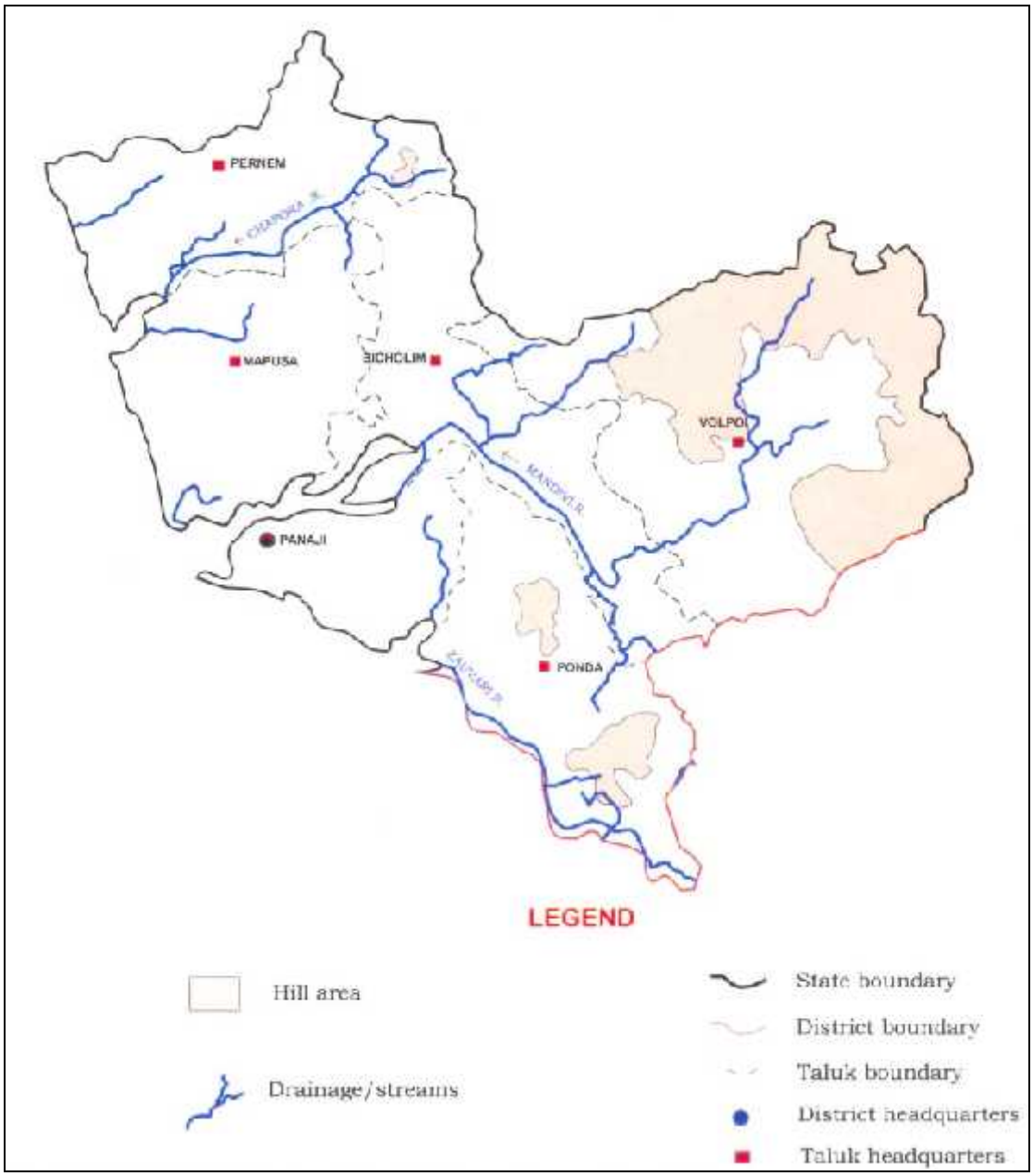


Figure 3.4.9: Drainage Map of North Goa District

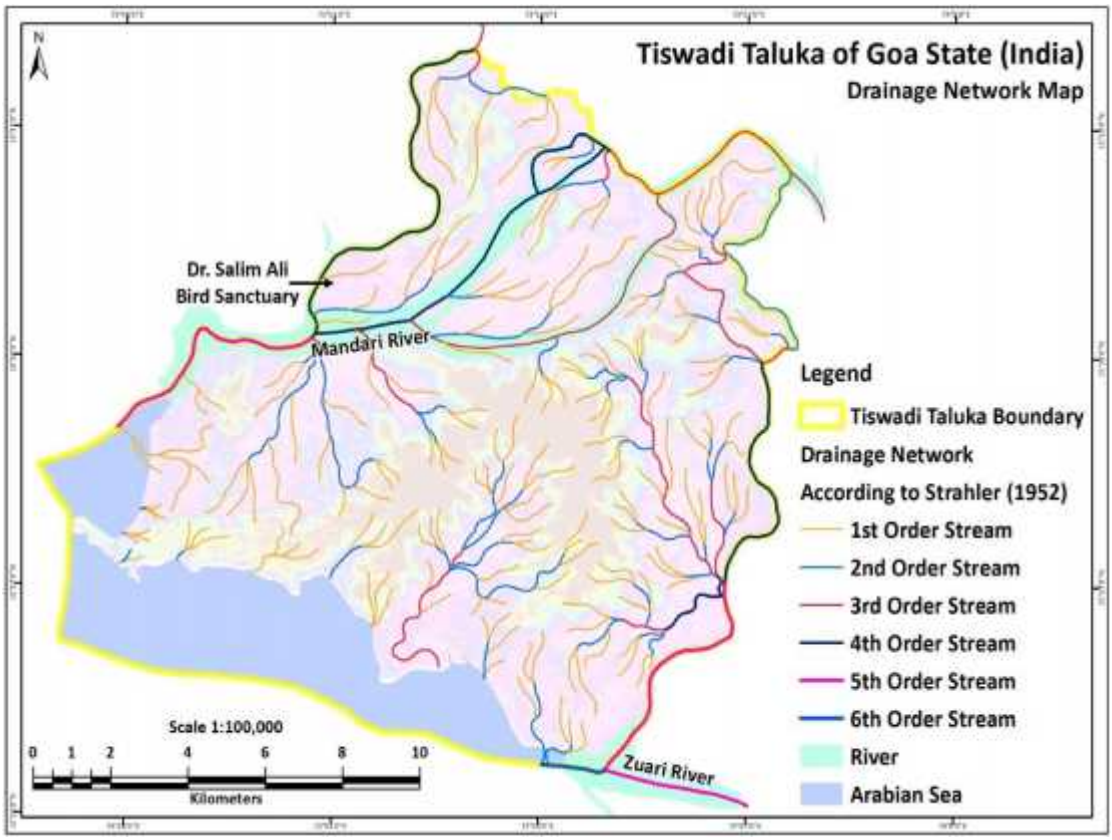


Figure 3.4.10: Drainage Map of Tiswadi Taluka, North Goa District

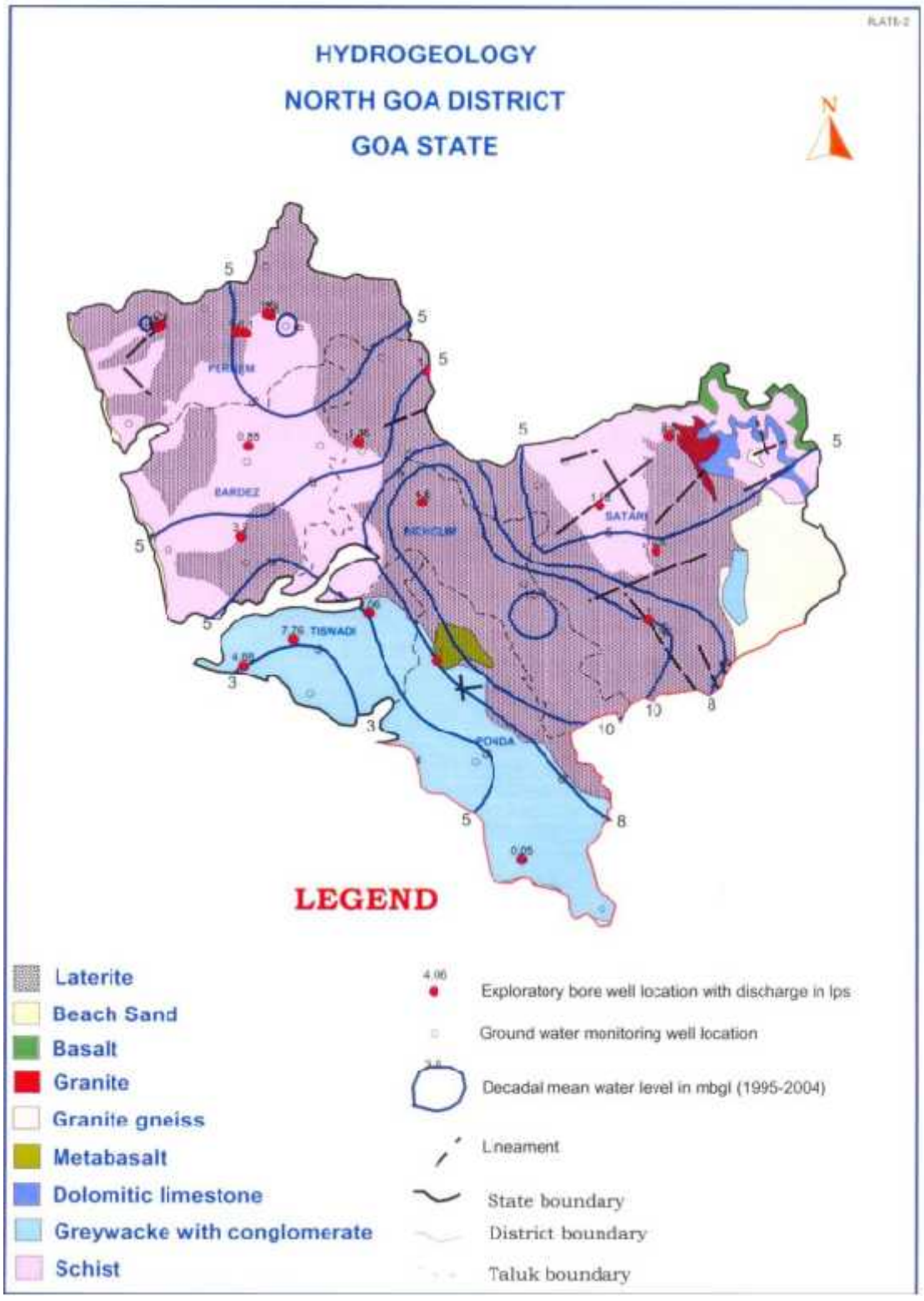


Figure 3.4.11: Hydrogeological Map of North Goa District

Table 3.4.15: Stratigraphic Succession of North Goa District

Age	Group	Formation	Rock type
Quaternary			Beach Sand
Cenozoic			Laterites
Upper Cretaceous to Eocene	Deccan Trap		Basalt
Lower Proterozoic	Clospet Granite		Granite
		Peridotite, Gabbro, Norite	Pyroxenite, Peridotite, Serpentinite, Gabbro
Archaean to Lower Proterozoic	Goa Group	Vageri Formation	Carbonate-quartz-chlorite schist with Greywacke
		Bicholim Formation	Dolomitic limestone
			Quartz- Sericite schist
			Banded iron formation
			Chert and quartzite
			Quartz-chlorite-biotite schist with layers of chert, iron oxide, carbonate, metabasalt and meta gabbro
		Sanvordem Formation	Greywacke with conglomerate
			Quartzite
		Barcem Formation	Quartz-chlorite schist
			Meta-acid volcanics
			Meta-basalt
			Orthoquartzite
Archaean	Peninsular Gneissic complex		Granite Gneiss, Migmatites and Granites

3.5 Biological Environment

3.5.1 Introduction

Study of biological environment is one of the most important aspects for Environmental Impact Assessment, in view of the need for conservation of environmental quality and biodiversity. Ecological systems show complex inter-relationships between biotic and abiotic components including dependence, competition and mutualism. Biotic components comprises of both plant and animal communities which interact not only within and between themselves but also with the abiotic components viz. Physical and chemical components of the environment.

Generally, biological communities are the good indicators of climatic and edaphic factors. Studies on biological aspects of ecosystems are important in Environmental Impact Assessment for safety of natural flora and fauna. Information on the impact of environmental stress on the community structure serves as an inexpensive and efficient early warning system to check the damage to a particular ecosystem. The biological environment includes mainly terrestrial ecosystem and aquatic ecosystem.

A change in the composition of biotic communities is reflected by a change in the distribution pattern, density, diversity, frequency, dominance and abundance of natural species of flora and fauna existing in the ecosystem. These changes over a span of time can be quantified and related to the existing environmental factors. The specific parameters in the study of biological environment are biological characteristics through quadrate method. The sensitivity of animal and plant species to the changes occurring in their existing ecosystem can therefore, be used for monitoring Environmental Impact Assessment studies of any project.

3.5.2 Reconnaissance

Natural flora and fauna are important features of the environment. They are organized into communities with mutual dependencies among their member families and show various responses and sensitivities to outside influences. A biological system comprises of both plant and animal communities, which interact not only among themselves but also with abiotic components; viz. physical and chemical characteristics of the environment. Therefore, nature of developments and baseline characteristics of terrestrial and aquatic flora and fauna around the proposed activities is required to be assessed.

Plants and animals are more susceptible to environmental stress. A change in the composition of biological communities is reflected by a change in the distribution pattern, frequency, density and abundance of natural species of flora and fauna existing in the ecosystem. These changes over a span of time can be quantified and related to the existing environmental factors. The natural vegetation in the study area comprises of moist deciduous vegetation, dense shrubs, and herbs and the agricultural fields. The human population is dependent on fishing and allied activities for their livelihood. The grazing activity by livestock is a common in hilly area.

3.5.3 Sampling Location and Methodology

Assessment of the study area surrounding the proposed Municipal Solid Waste Management Facility site at North Goa for flora and faunal species is carried out by field reconnaissance and collection of primary data during Post-Monsoon Season, 2017. Selection of Sampling Locations has been made with reference to topography, Land use and vegetation pattern. The baseline survey of flora and fauna provides sufficient data to allow a complete identification, prediction and evaluation of potential impacts of proposed developments upon that flora and fauna. Several field studies were undertaken in order to gather authentic information on enumeration and distribution of plant biodiversity in the study region. Listing of flora as well as visual observations was carried out to understand the diversity and composition of vegetation present within the study area and also in the vicinity. During site study, habitat, morphological characters, fruit structure and phenological aspects of trees, shrubs and herbs were taken into consideration

3.5.4 Biodiversity in Study Area

Based on the reconnanisaance survey, the study area comprises of *Mangifera indica*, *Delonix regia* and *Azadirachta indica* as the dominant tree species with *Bombax ceiba*, *Eucalyptus sps* and *Cocos nucifera* in association and phytosociological order. Among herbs, *Mimosa pudica, Cassia tora, and Agave americana* were observed to be dominant species; whereas, the dominant climber species is observed to be *Asparagus racemosus*. Presence of mangroves i.e. *Avicennia alba* and *Avcennia marina* is also observed in the vicinity of the study area, *A. marina* is observed to the dominant species (**Table 3.5.1**).

3.5.5 Floristic Structure and Composition

A total of 36 tree species, 15 shrub species, 8 species of herbs, 1 species of climbers and 2 species of mangroves were recorded in the study area (**Table 3.5.1**). The study area comprises of mixed vegetation with uneven-aged deciduous species. Grasses were observed on open land in the study area. Herbs and shrubs are abundant only during monsoon, whereas during rest of the year when the land turn dry, herbs cannot survive and become dry, wither and get wiped away from the vicinity.

Generally trees observed here have low stunted branches, diffuse crown and are mostly younger plants. Dependency of local residents on natural vegetation in this region is more for timber and firewood. Some medicinal plants such as *Ricinus cummunis*, *Mimosa pudica*, *Vitex negundo* were found, amongst which *Azadirachta indica*, *Cassia fistula and Syzygium cumini* etc. are important one (**Table 3.5.2)**. Commercial exploitation of medicinal plants is not the regular practice in this region. Only local inhabitants use the medicinal plants for curing the various ailments for their own sake.

3.5.6 Mangroves

Mangroves generally are small trees and shrubs that grow in saline coastal habitats in the tropics and subtropics. Plants in mangrove swamps are a diverse group which have been able to exploit a habitat (The intertidal zone) because they have developed a set of physiological adaptations to overcome the problems of anoxia, salinity and frequent tidal inundation. Pneumatophores are specialized root-like

structures, which stick up out of the soil like straws for breathing, which are covered in lenticils. Mangrove flora in vicinity of the study area comprised of 2 species i.e. *Avicennia alba* and *Avicennia marina*, with *A. marina* as the dominant species (**Table 3.5.1)**.

3.5.7 Medicinal Plants in Study Area

The ethnologically or commercially important medicinal plant species are considered from environmental point of view. In the study area presence of medicinal plants in terms of quantity is insignificant, as there is less vegetation cover in the region. The medicinal plants observed in the study area comprises of *Cassia fistula, Azadirachta indica, Ricinus cummunis, Asparagus racemosus, Hibiscus rosa-sinensis, Mimosa pudica, Syzygium cumini* and *Vitex negundo* (**Table. 3.5.2**). Among which, *Cassia fistula, Azadirachta indica* and *Syzygium cumini* are the important species.

3.5.8 Fauna

The study area surrounding the proposed site for Municipal Solid Waste Management Facility site at North Goa was surveyed for avifaunal diversity during the study period. The list of avifauna observed during three season sampling is mentioned in the **Table 3.5.3**.

Thirteen avifauna and five mammal species were observed in the study area. No rare and endangered avifaunal species is recorded (**Table 3.5.3**). Among avifauna, Blue Rock Pigeon, Cattle Egret, Common Crow, Common Myna, House Sparrow, Indian Cuckoo, Pond Heron, Common Kingfisher, Little Cormorant, Indian Shag are commonly observed. Whereas, Bonnet Macaque, Common Mongoose, Squirrels, Indian Field Mouse, and Common House Rat are cmmonly observed in the study area.

Table 3.5.1 : List of Flora observed by CSIR-NEERI in the study area

Sr. No.	Botanical Name	Common Name	Family
Trees			
1.	*Achras sapota*	Chickoo	Sapotaceae
2.	*Aegle marmelos*	Bel	Rutaceae
3.	*Ailanthus excels*	Ghodneem	Simaroubaceae
4.	*Albizzia lebbeck*	Shiris	Mimosaceae
5.	*Annona squamosal*	Sitaphal	Annonaceae
6.	*Anacardium occidentale*	Kaju	Anacardiaceae
7.	*Areca catechu*	Supari	Palmae
8.	*Artocarpus heterophyllus*	Phanas	Moraceae
9.	*Azadirachta indica*	Neem	Meliaceae
10.	*Bombax ceiba*	Katesawar	Bombacaceae
11.	*Callistemon sp*	Bottlebrush	Myrtaceae
12.	*Carica papaya*	Papayi	Caricaceae
13.	*Cassia fistula*	-	Caesalpiniaceae
14.	*Casuarina equisetifolia*	Suru	Casuarinaceae
15.	*Cocos nucifera*	Naal	Palmae
16.	*Delonix regia*	Gulmohor	Caesalpiniaceae
17.	*Dendrocalamus strictus*	Bamboo	Poaceae
18.	*Emblica officinalis*	Awla	Euphorbiaceae
19.	*Eucalyptus hybrid*	Nilgiri	Myrtaceae
20.	*Ficus benghalensis*	Wad	Moraceae
21.	*Ficus religiosa*	Pimpal	Moraceae
22.	*Leucana leucocephala*	Subabhul	Mimosaceae
23.	*Mangifera indica*	Ambo	Anacardiaceae
24.	*Mimusops elengii*	Bakul	Sapotaceae
25.	*Moringa oleifera*	Shewga	Moringaceae
26.	*Murraya koenigii*	Godneem	Rutaceae
27.	*Pithocelobium dulce*	Chichbulai	Mimosaceae
28.	*Plumaria alba*	Chafa	Apocynaceae
29.	*Polyalthia longifolia*	Ashok	Annonaceae
30.	*Syzygium cumini*	Jamun	Myrtaceae
31.	*Tamarindus indica*	Chinch	Caesalpiniaceae
32.	*Tectona grandis*	Sagwan	Verbenaceae
33.	*Terminalia catappa*	Badam	Combretaceae
34.	*Terminalia crenulata*	Matti	Combretaceae

Sr. No.	Botanical Name	Common Name	Family
35.	*Thevetia sp.*	Bitti	Apocynaceae
36.	*Zizyphus jujube*	Boram	Rhamanaceae
Shrubs			
37.	*Adhatoda vasica*	Adulasa	Acanthaceae
38.	*Barleria prionitis*	Koranti	Acanthaceae
39.	*Calatropis gigantia*	Rui	Asclepiadaceae
40.	*Cassia alata*	-	Caesalpiniaceae
41.	*Garcinia indica*	Kokum	Guttifferae
42.	*Hibiscus rosa-sinensis*	Jaswanda	Malvaceae
43.	*Lantana camara*	Haladi-kunku	Verbenaceae
44.	*Musa paradisiacal*	Keli	Musaceae
45.	*Nerium indicum*	Kanher	Apocynaceae
46.	*Prosopis juliflora*	Jangali Babhul	Mimosaceae
47.	*Opuntia elator*	-	Cactaceae
48.	*Ricinus cummunis*	Erandi	Euphorbiaceae
49.	*Tabernaemontana divaricate*	Swastik	Apocynaceae
50.	*Vitex negundo*	Nirgudi	Verbenaceae
51.	*Woodfordia fruticose*	Dhayati	Lythraceae
Herbs			
52.	*Achyranthes aspera*	-	Amaranthaceae
53.	*Agave Americana*	Ghaypat	Agavaceae
54.	*Cassia tora*	-	Fabaceae
55.	*Cyanadon dactylon*	Durwa	Poaceae
56.	*Datura alba*	Dhotra	Solanaceae
57.	*Mimosa pudica*	Lajalu	Mimosaceae
58.	*Pandanus sp.*	Kewda	Pandanaceae
59.	*S. acuta*	Chikna	Malvaceae
Climbers			
60.	*Asparagus racemosus*	Shatawari	Liliaceae
Aquatics			
61.	*Colocassia esculanta*	Alu	Arecaceae
Mangroves			
62.	*Avicennia alba*	-	Avicenniaceae
63.	*Avicennia marina*	-	Avicenniaceae

Table 3.5.2 : List of Medicinal Plants Observed by CSIR-NEERI Team in the Study Area

Sr. No.	Family Name	Botanical Name
1.	Caesalpiniaceae	*Cassia fistula*
2.	Meliaceae	*Azadirachta indica*
3.	Euphorbiaceae	*Ricinus cummunis*
4.	Liliaceae	*Asparagus racemosus*
5.	Malvaceae	*Hibiscus rosa-sinensis*
6.	Mimosaceae	*Mimosa pudica*
7.	Myrtaceae	*Syzygium cumini*
8.	Verbenaceae	*Vitex negundo*

Table 3.5.3 : List of Fauna observed by CSIR-NEERI team in the study area

Sr. No.	Common Name	Zoological Name
Mammals		
1.	Bonnet Macaque	*Macaca radiata*
2.	Common Mongoose	*Herpestes edwardsi*
3.	Squirrels	*Funambulus palmarum*
4.	Indian Field Mouse	*Mus booduga*
5.	Common House Rat	*Rattus rattus*
Avifauna		
6.	Black Drongo	*Dicrurus adsimilis*
7.	Blue Rock Pigeon	*Columba livia*
8.	Brahminy Kite	*Maliastur indus*
9.	Cattle Egret	*Babulous ibis*
10.	Common Crow	*Corvus splendens*
11.	Common Myna	*Acridotheres tristis*
12.	Crow-Pheasant	*Centropus sinensis parroti*
13.	House Sparrow	*Passer domesticus*
14.	Indian Cuckoo	*Geculus micropterus*
15.	Jungle Myna	*Acridotheres fufscus*
16.	Koel	*Eudynamys scolopacea scolopacea*
17.	Pond Heron	*Ardeola grayee*
18.	Rufous Woodpecker	*Micropternus brachyurus jerdonii*
19.	Little Cormorant	*Microcarbo niger*
20.	Indian shag	*Phalacrocorac fuscicollis*

21.	Grey heron	*Ardea cinerea*
22.	Asian openbill	*Anastomus oscitans*
23.	Western reef Heron	*Egretta gularis*
24.	Lesser Sand Plover	*Charadrius mongolus*
25.	Greater Sand Plover	*Charadrius leschenaultii*
26.	Whimbrel	*Numenius phaeopus*
27.	Brown-headed Gull	*Larus brunnicephalus*
28.	Whiskered Tern	*Chlidonias hybrida*
29.	Common Kingfisher	*Alcedo atthis*

	
Widow Skimmer (*Libellula luctuosa*)	**red-whiskered bulbul (*Pycnonotus jocosus*)**
	
Jungle babbler (*Argya striata*)	**pond heron (*Ardeola grayii*)**
	
Coconut tree (*Cocos nucifera*)	**Big sage(*Lantena Camera*)**

Plate 3.5.1 : Terrestrial Biodiversity Observed in the Study Area

Ber(*Ziziphus mauritiana*)

Crown flower(*Calatropis gigantia*)

Erandi(*Ricinus cummunis*)

Badam(*Terminalia Cattapa*)

Katesawar(*Bombyx Ceiba*)

Chinch(*Tamarindus Indica*)

Plate 3.5.2 : Terrestrial Biodiversity Observed in the Study Area

3.6 Socio-economic Environment

3.6.1 Introduction

A prosperous nation needs well-developed industries to provide the amenities of life to its citizens. Industrial development has had an important role in the socio -economic growth of countries. Rapid economic growth is often essential for achieving a reduction in absolute poverty. Industrialization is often essential for economical and social growth.

Poverty reduction the pattern of industrialization, however, impacts remarkably on how the poor benefit from growth. Pro-poor economic and industrial policies focus on increasing the economic returns to the productive factors that the poor possess, e.g. raising returns to unskilled labour, whereas policies promoting higher returns to capital and land tend to increase inequality, unless they also include changes in existing patterns of concentration of physical and human capital and of land ownership. Use of capital-intensive methods instead of labour-intensive ones tends to increase employment, labour regulation, social protection, health, education, etc.

Where the level of education is low and human capital concentrated. Income disparities, as does the employment of skill-based technologies, especially Also, the location of industrial facilities has an impact on overall poverty reduction and inequality. As enterprises are often concentrated in urban areas. The industrial revolution led to the development of factories for large-scale production, with consequent changes in society like Growth and structure of employment, impact of Socio-economic reforms and globalization trade and employment, labour regulation, social protection, health, education, etc. In this manner all developmental projects have direct as well as indirect relationship with socio-economic aspect, which also include public acceptability for new developmental projects. Thus the study of socio-economic component incorporating various facets related to prevailing social & cultural conditions and economic status of the project region is an important part of EIA study.

The Urban Solid Waste Management (USWM) is one of the challenges faced by modern urban societies. Solid wastes are the most visible form of pollution. It is argued that the source of most of the environmental problems lies in the inability of the economic system to take account of the valuable services the natural environment provides us. Solid wastes are generally disposed by incineration, land filling, and composting.

Population & Waste Generation:

Goa State covering an area of 3,702 Sq. km and stretched from North to South measuring a length 102 km and East to West measuring a width of 62 km. It is divided into two districts viz. North Goa and South Goa with their respective headquarters at Panaji and Margao.

3.6.2 Demography and Socio-economic (secondary data description)

This section illustrates the prevailing socio-economic aspects of villages in the 10 km radius of proposed project site.The Government of Goa State Industrial Development Corporation Limited(GSIDCL) has plans to proposed CMSWMF shall be constructed at Bainguinim Village of Tiswadi Taluka in North Goa District. The site acquired for the same, admeasuring approx. 17 hectare

The following pages attempts to comprehend the social phenomenon so as to represent the demographic, occupational, gender and diversity among the project area villages, thereby postulate impactful developmental interventions.

3.6.3 Methodology Adopted for the Study

Afore mentioned, the Socio-economic study covers villages in the 10 km radial distance from the periphery of the proposed project site at Bainguinim Village in tehsil Tiswadi, North Goa Dist of Goa. The socio-economic data is collected from 28 villages, 10 towns and 02 wards from 05 tehsil of North Goa district, namely Tiswadi, Bardez, Ponda, Bicholim and Pernem. (Sixteen villages, six towns and two wards are falling from Tiswadi tehsil, two villages & one town are falling from Bardez tehsil, six villages and three towns from Ponda tehsil, three villages from Bicholim tehsil and one village is falling from Pernem tehsil)

The study also adopts a two-fold methodology for data collection, namely, review of Published secondary data and analysis of primary data. Secondary data was collected from district census statistics of 2011, which includes demography, occupational structure, literacy profile and Employment structure etc. Similarly, the primary data was collected through a range of research techniques and tools like: transact walk, structured questionnaire, Focus group discussions, observations and key Stakeholder interactions. The primary data was also collected through random survey covering a sample of 20% of households in the core project area villages.

The salient features of the demographic and socio-economic aspects in study area have been described in the following sections. Similarly, village wise demographic data as per 2011 census is presented in subsequent sections. Study area map of 10km radial distance with demarcated survey location is given in **Figure 3.6.1**.

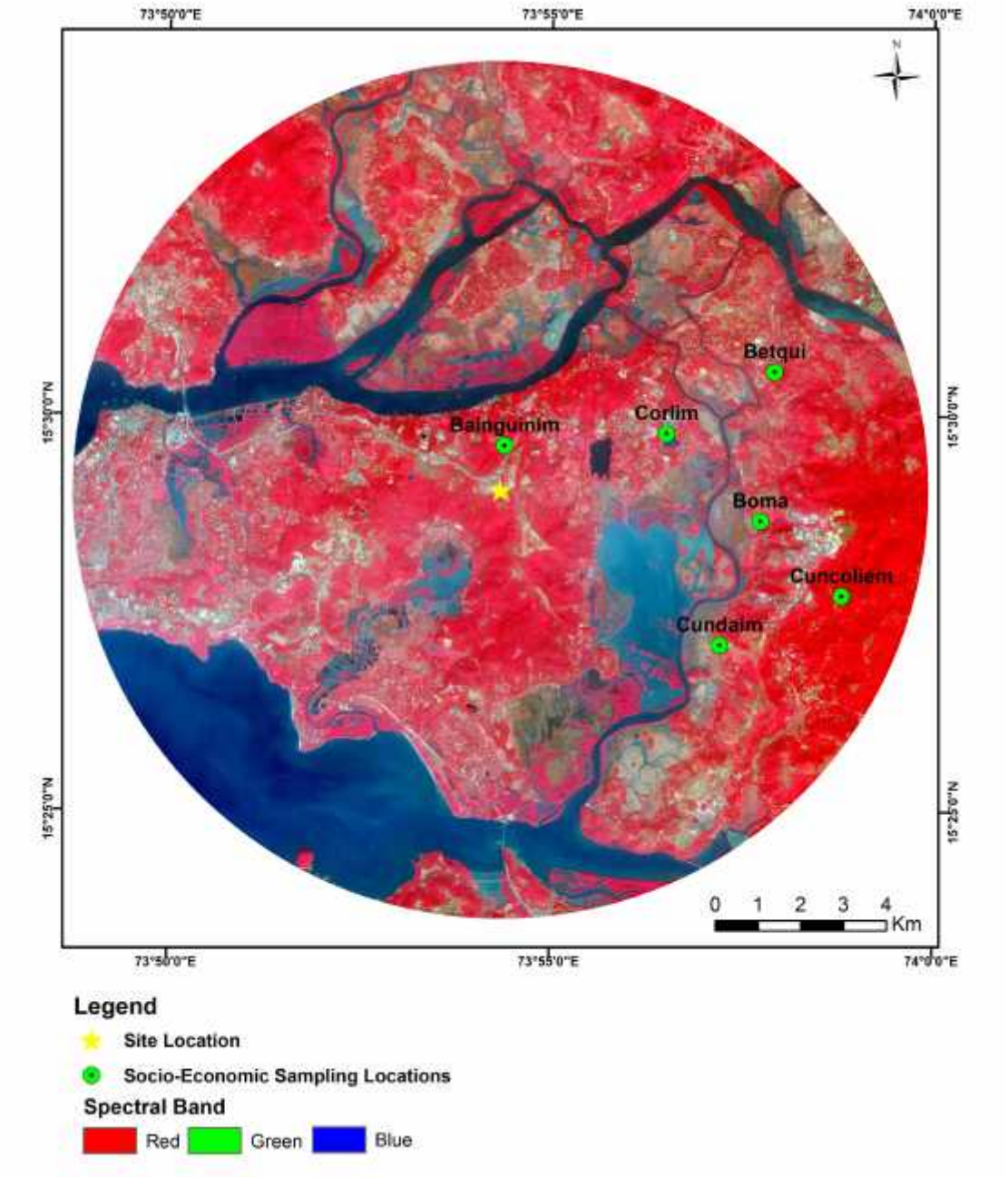


Figure 3.6.1: Socio-economic Survey Locations in the Study Area

3.6.4 Socio-economic Profile of the Study Area

3.6.4.1 Demographic Aspects

Distribution of Population:

As per 2011 census the study area consists of 223316 and the distribution of population in the study area.

The gender diversity, as percentage of men and women constitute about 114255(51.16%) and 109061 (48.84%) in the study area respectively. 0-06 under chid population of the study area is 20746(9.29%).The study also observed that the study area is more urban in setting as population as many as 58.89% are living in 10 towns namely Goa Velha, Panjim, Chimbel, Bambolim, Salvador do mundo, Marcaim Orgao, Candola, Cumbarjua and Corlim which are located within 10 km radius of the project site.

3.6.4.2 Average Household Size

According to the Census data of 2011, study area had an average family size of 4.21 persons per household. This represents normal family size and also in similarity with other parts of the district. Majority of the households have three generations living under one roof, representing traditional Indian joint or extended family system.

3.6.4.3 Population Density

It is estimated that total geographical area of 28 villages is 151.0167sqkm and the average density of population of the study area is 439 persons/km2.

3.6.4.4 Sex Ratio

To reiterate; the male and female constitute 51.16% and 48.84% respectively and number of females per 1000 males is 955. The gap in sex ratio is alarming and reveals certain sociological aspects with regards female birth rate in rural areas. This is a result of growing infant mortality among female children, single child family structure and also migration of industrial workers.

This scenario necessitates immediate developmental interventions in terms of sensitization and provision of good ANC and Pre-natal health care services for women.

3.6.5 Social Structure

The Socio-economic study observed that 13.91% of people belong to scheduled category, in which 11.83% belongs to Scheduled Tribes (ST), and Scheduled Castes (SC) comprises 2.08% of total population.

The distribution of population in the study area by social structure is illustrated in **Table 3.6.1** and **Figure 3.6.2**.

Table 3.6.1 Tehsil / Village wise Details of Population

Sr. No.	Town/ Village	Name	TRU	Households	Total Population			0-06 Child Population	SC	ST
					Total	Male	Female			
Tehsil-Tiswadi, District-North Goa, Goa										
1	626715	Bainguinim	Rural	388	1501	754	747	162	1	10
2	626714	Ella	Rural	1258	5372	2702	2670	629	62	386
3	626712	Naroa	Rural	119	487	239	248	34	0	31
4	626710	Goltim	Rural	423	1634	755	879	125	8	262
5	626713	Gandaulim	Rural	73	301	144	157	32	0	0
6	626705	Ambarim	Rural	27	93	44	49	8	0	0
7	626706	Chorao	Rural	1202	5268	2604	2664	462	87	440
8	626707	Caraim	Rural	44	202	103	99	13	0	4
9	626723	Curca	Rural	560	2518	1232	1286	256	11	497
10	626724	Siridao	Rural	578	2417	1179	1238	218	0	1265
11	626725	Neura-O-Pequeno	Rural	131	563	278	285	52	4	0
12	626726	Neura-O-Grande	Rural	330	1440	729	711	113	0	109
13	626718	Carambolim	Rural	1195	5179	2518	2661	491	62	2299
14	626719	Azossim	Rural	270	1142	574	568	103	0	237
15	626721	Gancim	Rural	113	519	263	256	39	0	0
16	626717	Goalim Moula	Rural	97	441	235	206	39	0	0
17	626729	Corlim (CT)	Urban	1583	6568	3386	3182	718	36	1207
18	626728	Cumbarjua (CT)	Urban	1121	4917	2557	2360	426	45	686
19	626734	Goa Velha (CT)	Urban	1055	4322	2129	2193	427	20	116
20	803243	Panaji (M Corp. + OG)	Urban	17807	70991	35988	35003	6180	1707	4586
21	626730	Chimbel (CT)	Urban	3093	15289	7688	7601	1894	371	2592
22	626733	Bambolim (CT)	Urban	1165	6885	4812	2073	525	172	839
23	803243	Taleigao (OG) (Part) WARD NO.-0036 (Rural MDDS CODE:645598)	Ward	6003	24201	12402	11799	2356	1097	2869

24	803243	Cujira (OG) WARD NO.-0035 (Rural MDDS CODE:626740)	Ward	296	1229	601	628	122	4	1
Sub-total				**38931**	**163479**	**83916**	**79563**	**15424**	**3687**	**18436**
Tehsil-Bardez, District-North Goa, Goa										
25	626687	Pomburpa	Rural	757	3095	1554	1541	222	16	8
26	626670	Tivim	Rural	2244	9076	4552	4524	807	291	22
27	626702	Salvador do Mundo (CT)	Urban	1516	6373	3228	3145	531	201	150
Sub-total				**4517**	**18544**	**9334**	**9210**	**1560**	**508**	**180**
Tehsil-Ponda, District-North Goa, Goa										
28	626844	Betqui	Rural	382	1707	871	836	151	80	698
29	626848	Boma	Rural	653	2807	1467	1340	284	8	710
30	626855	Cundaim	Rural	913	3859	1988	1871	371	79	904
31	626854	Velinga	Rural	444	1921	1001	920	145	7	725
32	626849	Cuncoliem	Rural	323	1385	711	674	134	0	671
33	626847	Adcolna	Rural	385	1688	883	805	188	10	457
34	626866	Orgao (CT)	Urban	1156	4602	2264	2338	383	0	578
35	626865	Candola (CT)	Urban	1280	5354	2742	2612	532	26	806
36	626867	Marcaim (CT)	Urban	1408	6215	3143	3072	523	23	2252
Sub-total				**6944**	**29538**	**15070**	**14468**	**2711**	**233**	**7801**
Tehsil-Bicholim, District-North Goa, Goa										
37	626752	Maem	Rural	1728	7544	3763	3781	710	76	0
38	626753	Vainguinim	Rural	156	706	347	359	58	0	1
39	626754	Aturli	Rural	112	467	234	233	47	0	0
Sub-total				**1996**	**8717**	**4344**	**4373**	**815**	**76**	**1**
Tehsil-Pernem, District-North Goa, Goa										
40	626636	Querim	Rural	**693**	**3038**	**1591**	**1447**	**236**	**133**	**0**
Grand-total				**53081**	**223316**	**114255**	**109061**	**20746**	**4637**	**26418**

Source: Primary Census Abstract 2011, North Goa district, Goa

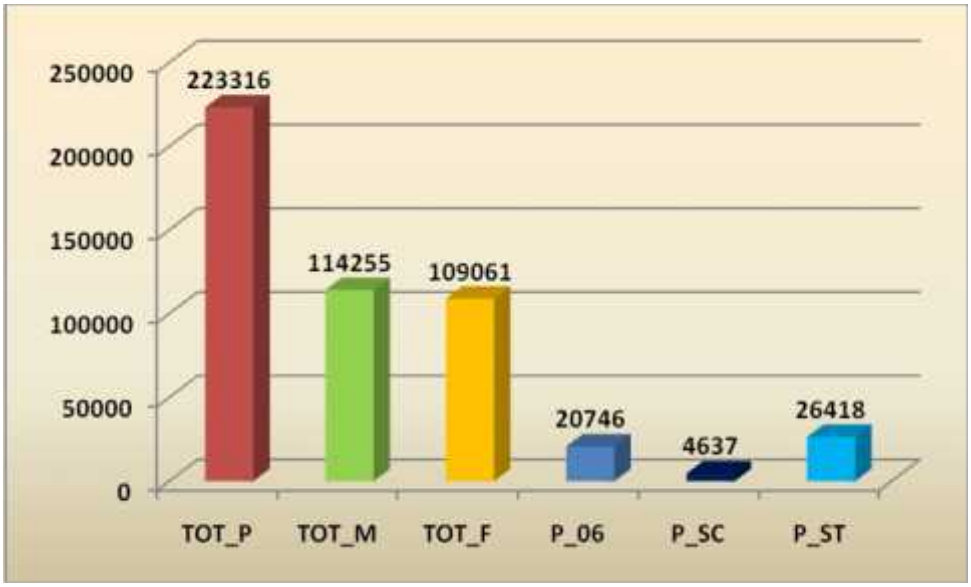


Figure 3.6.2: Population Details

3.6.6 Literacy Levels

The analysis of the literacy levels in selected villages of study area, reveals that an average literacy rate of 81.71% (182472) as per 2011 census data. However, the male literacy of the study area is 53.01% (96722), whereas literacy rate among women, which is an important indicator for social change, is estimated to be as low as 46.99% (85750). Total Illiteracy rate of the study area is 18.29% (40844), out of this illiterate Male and Female is 17533(42.93%) & 23311(57.07%) respectively. The distribution of literates and literacy rates in the study area is illustrated in **Table 3.6.2** and **Figure 3.6.3**.

Table 3.6.2: Tehsil / Village wise Details of Literacy

Sr. No.	Town/ Village	Name	TRU	Literate			Illiterate		
				Total	Male	Female	Total	Male	Female
Tehsil-Tiswadi, District-North Goa, Goa									
1	626715	Bainguinim	Rural	1212	615	597	289	139	150
2	626714	Ella	Rural	4272	2226	2046	1100	476	624
3	626712	Naroa	Rural	411	212	199	76	27	49
4	626710	Goltim	Rural	1390	676	714	244	79	165
5	626713	Gandaulim	Rural	255	122	133	46	22	24
6	626705	Ambarim	Rural	78	37	41	15	7	8
7	626706	Chorao	Rural	4235	2185	2050	1033	419	614
8	626707	Caraim	Rural	181	94	87	21	9	12
9	626723	Curca	Rural	1952	1014	938	566	218	348
10	626724	Siridao	Rural	1786	929	857	631	250	381
11	626725	Neura-O-Pequeno	Rural	473	251	222	90	27	63
12	626726	Neura-O-Grande	Rural	1213	644	569	227	85	142

Sr. No.	Town/ Village	Name	TRU	Literate			Illiterate		
				Total	Male	Female	Total	Male	Female
13	626718	Carambolim	Rural	4079	2123	1956	1100	395	705
14	626719	Azossim	Rural	922	473	449	220	101	119
15	626721	Gancim	Rural	428	217	211	91	46	45
16	626717	Goalim Moula	Rural	361	207	154	80	28	52
17	626729	Corlim (CT)	Urban	5245	2819	2426	1323	567	756
18	626728	Cumbarjua (CT)	Urban	4076	2183	1893	841	374	467
19	626734	Goa Velha (CT)	Urban	3473	1779	1694	849	350	499
20	803243	Panaji (M Corp. + OG)	Urban	60071	31090	28981	10920	4898	6022
21	626730	Chimbel (CT)	Urban	10774	5644	5130	4515	2044	2471
22	626733	Bambolim (CT)	Urban	5971	4362	1609	914	450	464
23	803243	Taleigao (OG) (Part) WARD NO.-0036 (Rural MDDS CODE:645598)	Ward	19755	10441	9314	4446	1961	2485
24	803243	Cujira (OG) WARD NO.-0035 (Rural MDDS CODE:626740)	Ward	1033	516	517	196	85	111
Sub-total				133646	70859	62787	29833	13057	16776
Tehsil-Bardez, District-North Goa, Goa									
25	626687	Pomburpa	Rural	2660	1375	1285	435	179	256
26	626670	Tivim	Rural	7519	3895	3624	1557	657	900
27	626702	Salvador do Mundo (CT)	Urban	5341	2755	2586	1032	473	559
Sub-total				15520	8025	7495	3024	1309	1715
Tehsil-Ponda, District-North Goa, Goa									
28	626844	Betqui	Rural	1321	726	595	386	145	241
29	626848	Boma	Rural	2165	1201	964	642	266	376
30	626855	Cundaim	Rural	3102	1677	1425	757	311	446
31	626854	Velinga	Rural	1579	858	721	342	143	199
32	626849	Cuncoliem	Rural	1090	597	493	295	114	181
33	626847	Adcolna	Rural	1288	710	578	400	173	227
34	626866	Orgao (CT)	Urban	3893	1971	1922	709	293	416
35	626865	Candola (CT)	Urban	4353	2312	2041	1001	430	571
36	626867	Marcaim (CT)	Urban	4967	2717	2250	1248	426	822
Sub-total				23758	12769	10989	5780	2301	3479
Tehsil-Bicholim, District-North Goa, Goa									
37	626752	Maem	Rural	6127	3220	2907	1417	543	874
38	626753	Vainguinim	Rural	613	308	305	93	39	54
39	626754	Aturli	Rural	362	199	163	105	35	70
Sub-total				7102	3727	3375	1615	617	998
Tehsil-Pernem, District-North Goa, Goa									
40	626636	Querim	Rural	2446	1342	1104	592	249	343
Grand-total				182472	96722	85750	40844	17533	23311

Source: Primary Census Abstract 2011, North Goa district, Goa

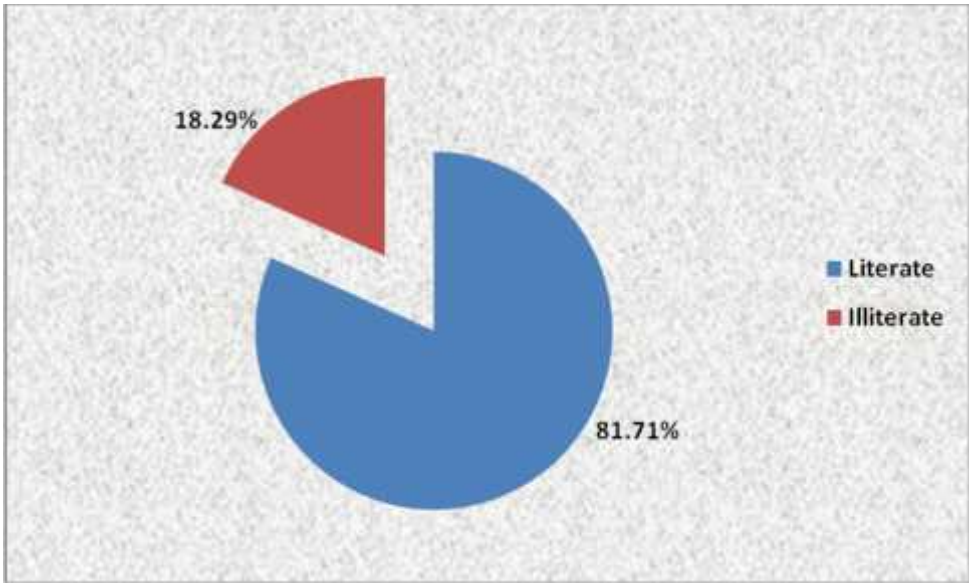


Figure 3.6.3: Literacy Details

3.6.7 Occupational Structure

3.6.7.1 Workers Pattern

Economic resource base of any region mainly depends upon its economically active group i.e. the working population involved in productive work. Work may be defined as participation in any economically productive activity. Such participation may be physical or mental in nature. Work not only involves actual work but also effective supervision and direction of work. It also includes unpaid work on farm or in family enterprise.

There are different types of workers that may be classified as - those persons who had worked for at least six months or 183 days are treated to be Main Workers, on the other hand if person categorized as worker has participated in any economic or productive activity for less than six months or 183 days during the last one year is treated as Marginal Worker. Non–workers are those who have not worked any time at all in the year preceding the enumeration.

The workers coming under the main and marginal workers category are those involved in activities such as cultivation, agriculture, livestock, forestry, fishing, hunting, plantations, orchards and allied activities, mining and quarrying, manufacturing, processing, servicing and repairs in household industry, construction, trade and commerce, transport, storage and communication and other services.

- æ According to 2011 Census, total worker population in the study area is 93657 (41.94%).
- æ Main workers were 81840(36.65%) and marginal workers were 11817(5.29%).Total non-working population was 129659(58.06%)

Tehsil and village wise details of employment pattern are given in **Table 3.6.3** and **Figure 3.6.4**.

Table 3.6.3: Tehsil / Village Wise Details of Employment Pattern

Sr. No.	Town/ Village	Name	TRU	Total Workers	Workers Pattern		
					Main	Marginal	Non-workers
Tehsil-Tiswadi, District-North Goa, Goa							
1	626715	Bainguinim	Rural	685	622	63	816
2	626714	Ella	Rural	2073	1709	364	3299
3	626712	Naroa	Rural	144	124	20	343
4	626710	Goltim	Rural	573	563	10	1061
5	626713	Gandaulim	Rural	96	80	16	205
6	626705	Ambarim	Rural	38	35	3	55
7	626706	Chorao	Rural	2010	1666	344	3258
8	626707	Caraim	Rural	68	57	11	134
9	626723	Curca	Rural	925	877	48	1593
10	626724	Siridao	Rural	867	676	191	1550
11	626725	Neura-O-Pequeno	Rural	229	182	47	334
12	626726	Neura-O-Grande	Rural	513	464	49	927
13	626718	Carambolim	Rural	2058	1825	233	3121
14	626719	Azossim	Rural	401	362	39	741
15	626721	Gancim	Rural	230	188	42	289
16	626717	Goalim Moula	Rural	214	153	61	227
17	626729	Corlim (CT)	Urban	2960	2462	498	3608
18	626728	Cumbarjua (CT)	Urban	2171	1789	382	2746
19	626734	Goa Velha (CT)	Urban	1771	1506	265	2551
20	803243	Panaji (M Corp. + OG)	Urban	30220	27709	2511	40771
21	626730	Chimbel (CT)	Urban	5856	5227	629	9433
22	626733	Bambolim (CT)	Urban	4429	4252	177	2456
23	803243	Taleigao (OG) (Part) WARD NO.-0036 (Rural MDDS CODE:645598)	Ward	10437	9582	855	13764
24	803243	Cujira (OG) WARD NO.-0035 (Rural MDDS CODE:626740)	Ward	481	409	72	748
Sub-total				**69449**	**62519**	**6930**	**94030**
Tehsil-Bardez, District-North Goa, Goa							
25	626687	Pomburpa	Rural	1200	1003	197	1895
26	626670	Tivim	Rural	3421	2780	641	5655
27	626702	Salvador do Mundo (CT)	Urban	2618	2188	430	3755
Sub-total				**7239**	**5971**	**1268**	**11305**
Tehsil-Ponda, District-North Goa, Goa							
28	626844	Betqui	Rural	633	366	267	1074

29	626848	Boma	Rural	1359	1118	241	1448
30	626855	Cundaim	Rural	1577	1191	386	2282
31	626854	Velinga	Rural	838	739	99	1083
32	626849	Cuncoliem	Rural	522	421	101	863
33	626847	Adcolna	Rural	677	577	100	1011
34	626866	Orgao (CT)	Urban	1938	1522	416	2664
35	626865	Candola (CT)	Urban	2223	1946	277	3131
36	626867	Marcaim (CT)	Urban	2597	2068	529	3618
Sub-total				**12364**	**9948**	**2416**	**17174**
Tehsil-Bicholim, District-North Goa, Goa							
37	626752	Maem	Rural	2878	2358	520	4666
38	626753	Vainguinim	Rural	239	188	51	467
39	626754	Aturli	Rural	186	148	38	281
Sub-total				**3303**	**2694**	**609**	**5414**
Tehsil-Pernem, District-North Goa, Goa							
40	626636	Querim	Rural	**1302**	**708**	**594**	**1736**
Grand-total				**93657**	**81840**	**11817**	**129659**

Source: Primary Census Abstract 2011, North Goa district, Goa

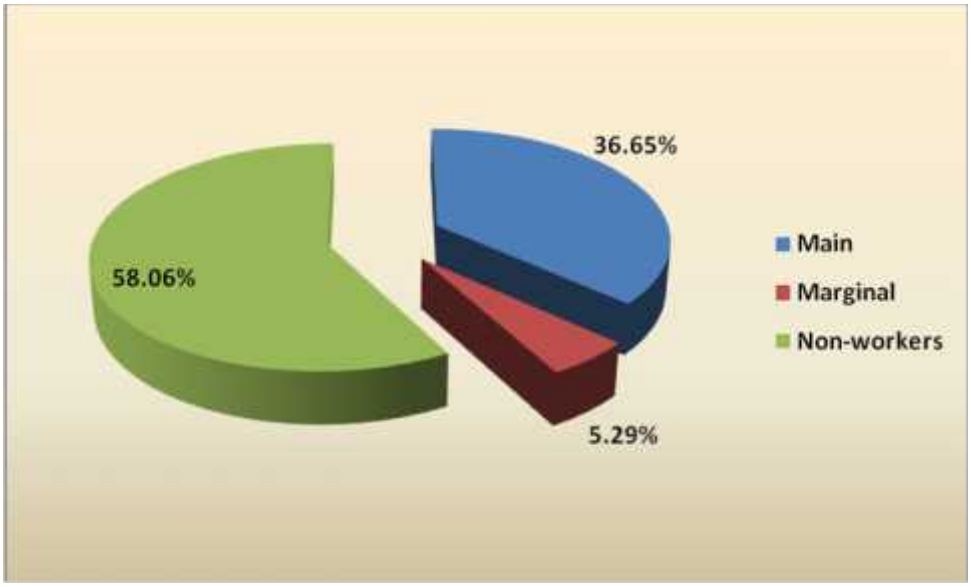


Figure 3.6.4: Employment Details

3.6.7.2 Main Workers Employment Pattern

According to Census Department of India, the main workers include 4 categories of workers - cultivators, agricultural laborers, those engaged in manufacturing, processing and repairs in household industry; and others including those engaged in household industry, construction, trade and commerce, transport and communication and all other services.

As per 2011 Census, Out of total 81840 main workers in the study area, there were total 2468 cultivators (3.02%), 817 agricultural workers (1%), 1513 household industry workers (1.85%) and other workers 77042 (94.13%). Mostly in main workers population other workers were highly found in study area. Tehsil and village wise details of main workers employment pattern, is given in **Table 3.6.4** and **Figure 3.7.5**

Table 3.6.4: Tehsil / Village wise Details of Main Workers Employment Pattern

Sr. No.	Town/ Village	Name	TRU	Main Worker Employment Pattern			
				Cultivator	Agriculture	Household	Other
Tehsil-Tiswadi, District-North Goa, Goa							
1	626715	Bainguinim	Rural	23	3	20	576
2	626714	Ella	Rural	124	16	10	1559
3	626712	Naroa	Rural	11	0	0	113
4	626710	Goltim	Rural	39	18	7	499
5	626713	Gandaulim	Rural	7	4	0	69
6	626705	Ambarim	Rural	4	0	5	26
7	626706	Chorao	Rural	115	52	112	1387
8	626707	Caraim	Rural	5	0	0	52
9	626723	Curca	Rural	58	9	6	804
10	626724	Siridao	Rural	69	13	15	579
11	626725	Neura-O-Pequeno	Rural	13	1	1	167
12	626726	Neura-O-Grande	Rural	51	9	6	398
13	626718	Carambolim	Rural	154	32	31	1608
14	626719	Azossim	Rural	29	2	5	326
15	626721	Gancim	Rural	25	1	1	161
16	626717	Goalim Moula	Rural	3	5	6	139
17	626729	Corlim (CT)	Urban	70	40	134	2218
18	626728	Cumbarjua (CT)	Urban	173	33	39	1544
19	626734	Goa Velha (CT)	Urban	29	21	137	1319
20	803243	Panaji (M Corp. + OG)	Urban	206	77	299	27127
21	626730	Chimbel (CT)	Urban	54	79	137	4957
22	626733	Bambolim (CT)	Urban	33	4	8	4207
23	803243	Taleigao (OG) (Part) WARD NO.-0036 (Rural MDDS CODE:645598)	Ward	67	36	111	9368
24	803243	Cujira (OG) WARD NO.-0035 (Rural MDDS CODE:626740)	Ward	5	2	7	395
Sub-total				**1367**	**457**	**1097**	**59598**
Tehsil-Bardez, District-North Goa, Goa							
25	626687	Pomburpa	Rural	55	27	27	894
26	626670	Tivim	Rural	199	43	49	2489
27	626702	Salvador do Mundo (CT)	Urban	21	28	41	2098
Sub-total				**275**	**98**	**117**	**5481**
Tehsil-Ponda, District-North Goa, Goa							
28	626844	Betqui	Rural	42	18	7	299

Sr. No.	Town/ Village	Name	TRU	Main Worker Employment Pattern			
				Cultivator	Agriculture	Household	Other
29	626848	Boma	Rural	67	58	105	888
30	626855	Cundaim	Rural	89	9	22	1071
31	626854	Velinga	Rural	62	22	4	651
32	626849	Cuncoliem	Rural	34	6	2	379
33	626847	Adcolna	Rural	52	5	22	498
34	626866	Orgao (CT)	Urban	16	10	56	1440
35	626865	Candola (CT)	Urban	37	19	9	1881
36	626867	Marcaim (CT)	Urban	37	16	30	1985
Sub-total				**436**	**163**	**257**	**9092**
Tehsil-Bicholim, District-North Goa, Goa							
37	626752	Maem	Rural	270	90	34	1964
38	626753	Vainguinim	Rural	18	1	1	168
39	626754	Aturli	Rural	12	0	3	133
Sub-total				**300**	**91**	**38**	**2265**
Tehsil-Pernem, District-North Goa, Goa							
40	626636	Querim	Rural	**90**	**8**	**4**	**606**
Grand-total				**2468**	**817**	**1513**	**77042**

Source: Primary Census Abstract 2011, North Goa district, Goa

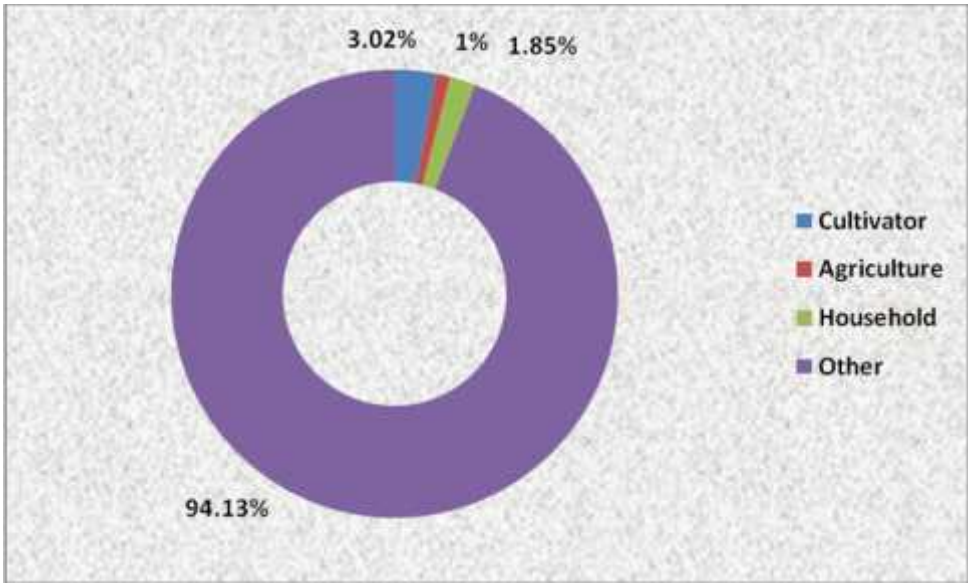


Figure 3.6.5: Main Worker Employment Details

3.6.8 Infrastructure Resource Base

The infrastructure resources base of the eleven study areas with reference to education, medical facility, water supply, post and telegraph, transportation, communication facility, power supply and existence of nearest town etc. according to the Village Directory Census CD 2011.

The significant features of these important parameters for each study area are discussed as follows and summarised at **Table 3.6.5**

Education: As per 20011 village directory record, almost all villages having education facility in the form of primary schools, and middle school, **Medical/Primary Health Care** :Medical facilities in terms of community health workers are available in some of the villages. Only primary health sub centers are available in few villages. **Drinking Water:** The water supply in the region is through dug wells, hand pumps, taps and other allied sources. **Drainage and Sanitation Facilities:** Drainage and sanitation facilities were not adequate in the study area. Mostly Open drainage, and open kuccha drainage observed in the village. **Communication:** Communication facility is fairly good in this region. Near about 50% villages having telephone connectivity and having post office. **Transportation:** A well planned and efficient network of transport is an essential component for a developing country. In the absence of efficient network of transport, a State's economy would suffer from major grid lock in terms of overall growth potential of that area. In village public bus facility was availed and other facilities were private bus. **Road Approach:** Roads are the basic means of communication for the development of any economy. All type of roads was present in the study area. **Bank Facilities:** Banking and credit society facility was not found in village. Self help group activities were performed by the women groups. **Power Supply:** Almost all villages are electrified in the region and electricity is available for both domestic and agriculture.

3.6.9 Town Details

There are 04 towns are came under 10km range of the study area of namely Goa Velha, Panjim, Chimbel, Bombolim Cumbarjua & Corlim are falling under Tiswadi tehsil. Salvador do mundo towns are falling under Bardez tehsil and Marcaim, Orgao & Candola towns are falling under Ponda tehsil District of North Goa in Goa State. As per Town Directory 2011 State of Goa, details are described at **Table 3.6.6**.

Table 3.6.5: Infrastructure Resource Base in Study Area

Education Facilities										
Govt. Pre - Primary School (Nursery/LKG/UKG) (Numbers)	Private Pre - Primary School (Nursery/LKG/UKG) (Numbers)	Govt. Primary School (Numbers)	Private Primary School (Numbers)	Govt. Middle School (Numbers)	Private Middle School (Numbers)	Govt. Secondary School (Numbers)	Private Secondary School (Numbers)	Private Senior Secondary School (Numbers)	Govt. Polytechnic (Numbers)	Private School For Disabled (Numbers)
20	20	46	14	4	18	2	18	3	1	1
Health Care facilities						Sanitation Facilities				
Primary Health Centre (Numbers)	Primary Health Sub Centre (Numbers)	Maternity And Child Welfare Centre (Numbers)	TB Clinic (Numbers)	Dispensary (Numbers)	Non Government Medical facilities Out Patient (Numbers)	Closed Drainage	Open Drainage	No Drainage	Open Pucca Drainage Uncovered	Open Kuccha Drainage
1	13	1	1	1	13	15	25	3	20	20
Drinking Water Facilities										
Tap Water-Treated	Tap Water Untreated	Covered Well	Uncovered Well	Hand Pump	Tube Wells/Borehole	Spring	River/Canal	Tank/Pond/Lake		
28	2	11	27	1	8	8	15	21		
Communication Facilities						Road Approach Facilities				
Post Office	Sub Post Office	Post And Telegraph Office	Telephone (landlines)	Public Call Office /Mobile (PCO)	Private Courier Facility	Black Topped (pucca) Road	Gravel (kuchha) Roads	All Weather Road	Navigable Waterways (River/Canal)	Footpath
4	11	5	28	25	1	28	28	19	8	28
Transportation Facilities						Banking Facilities				
Public Bus Service	Private Bus Service	Railway Station	Auto/Modified Autos	Taxi	Vans	Sea/River/Ferry Service	Commercial Bank	Cooperative Bank	Agricultural Credit Societies	Self - Help Group (SHG)
19	26	1	10	13	13	7	9	5	2	18
Power Supply Facilities										
Power Supply For Domestic Use	Power Supply For Agriculture Use	Power Supply For Commercial Use	Power Supply For All Users							
28	24	25	22							

Source: District Census Handbook 2011, Goa State

Table 3.6.6. Towns Details

Sr. No.	Sub District Name	Town Code	Town Name	Class	Total Households	Total Population of Town	Total Scheduled Castes Population of Town	Total Scheduled Tribes Female Population of Town	Area (sq. km.)	Growth Rate Town (Census 2011)	Density (Census 2011)	Sex Ratio (Census 2011)
1	Tiswadi	626729	Corlim (CT)	V	1583	6568	36	604	5.7	36.7	1144.3	940
2		626728	Cumbarjua (CT)	VI	1121	4917	45	347	2.4	9.3	2048.8	923
3		626734	Goa Velha (CT)	VI	1055	4322	20	57	10.1	-19.9	427.9	1030
4		803243	Panaji (M Corp. + OG)	II	17807	70991	1707	2286	53.7	0.01	1321.99	973
5		626730	Chimbel (CT)	IV	3093	15289	371	1341	3.3	27.6	4633	989
6		626733	Bambolim (CT)	V	1165	6885	172	431	7.6	19	905.9	431
7	Bardez	626702	Salvador do Mundo (CT)	V	1516	6373	201	75	11.59	25.3	549.9	974
8	Ponda	626866	Orgao (CT)	VI	1156	4602	0	301	3.5	3.7	1314.9	1033
9		626865	Candola (CT)	V	1280	5354	26	407	8.52	27.2	628.4	953
10		626867	Marcaim (CT)	V	1408	6215	23	1183	12.5	0.1	497.2	977

Source: Town Handbook 2011, Goa State

3.6.10 Land Use Pattern of the Study Area

3.6.10.1 Land use as per Census Records

As per 2011 Census records, land use pattern in different villages falling within 10 km radial distance from the project site has been classified under the following categories:

- Forest Area
- Area under Non-Agricultural Uses
- Barren & Un-cultivable Land Area
- Permanent Pastures and Other Grazing Land Area
- Land under Miscellaneous Tree Crops etc. Area
- Culturable Waste Land Area
- Fallows Land other than Current Fallows
- Current Fallows Area
- Net Area Sown

Village-wise details of land use are summarized in as this. Out of the total geographical area (15101.67hector), Minor part of the study area is dominated by forest area (0%) followed by 51% of total net sown land area. Total Area under non-agricultural uses area and total culturable waste land area is 16% and 9% respectively. Barren and un-cultivable lands are confined to 12%. The study area is covered with 1% permanent pasture and other grazing land. and total land under miscellaneous tree crops etc. land area is 1% of the total land area. Fallows land other than current fallows area and current fallows area is 9% and 1% respectively. The percentage distribution of land under different categories is depicted in **Table 3.6.7** and **Figure 3.6.6**.

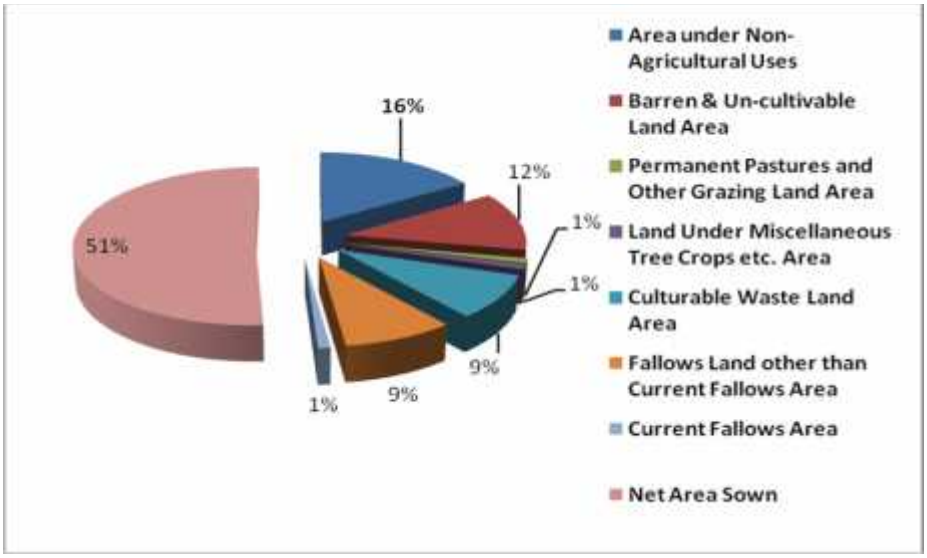


Figure 3.6.6 : Land use Pattern

3.6.10.2 Main Commodities

Main commodities details have been taken from DCHB 2011 of Goat. Cotton is major crop in the study area **Table 3.6.8**

Table 3.6.7 : Land use Pattern In Hectares

Sr. No.	Sub District Name	Village Code	Village Name	Total Geographical Area	Area under Non-Agricultural Uses	Barren & Un-cultivable Land Area	Permanent Pastures and Other Grazing Land Area	Land Under Miscellaneous Tree Crops etc. Area	Culturable Waste Land Area	Fallows Land other than Current Fallows Area	Current Fallows Area	Net Area Sown
1	Tiswadi	626714	Ella	634.46	130	0	0	0	29.3	0	0	475.16
2	Tiswadi	626715	Bainguinim	293.94	81	0	0	0	1.82	0	0	211.12
3	Tiswadi	626712	Naroa	100.27	37.03	0	0	0	7	0	0	56.24
4	Tiswadi	626713	Gandaulim	134.04	1	30	0	8.04	0	0	0	95
5	Tiswadi	626710	Goltim	352.09	106	0	0	0	30.07	0	0	216.02
6	Tiswadi	626705	Ambarim	13.88	3	0	0	0	5	0	0	5.88
7	Tiswadi	626706	Chorao	1467.7	527	0	0	0	15	16.33	0	909.37
8	Tiswadi	626707	Caraim	54.2	0	0	0	0	0	10.1	4.1	40
9	Tiswadi	626723	Curca	270.1	78	0	0	0	14	0	0	178.1
10	Tiswadi	626724	Siridao	669.66	500.43	0	0	0	8.43	0	0	160.8
11	Tiswadi	626725	Neura-O-Pequeno	104.9	12.74	0	0	0	4.08	0	0	88.08
12	Tiswadi	626726	Neura-O-Grande	635.44	197.08	0	0	0	20.27	0	0	418.09
13	Tiswadi	626717	Goalim Moula	318.78	0	132.34	0	0	0.4	9.04	0	177
14	Tiswadi	626718	Carambolim	1333.89	130.09	0	0	6.8	40	0	0	1157
15	Tiswadi	626719	Azossim	329.84	22.73	0	0	0	16.04	0	0	291.07
16	Tiswadi	626721	Gancim	300.76	14.52	0	0	9.2	0	2.03	0	275.01
17	Bardez	626687	Pomburpa	500.73	26.83	370.1	0	0	71.17	0	0	32.63
18	Bardez	626670	Tivim	1937.01	104.44	523.15	0	40.86	536.99	716.45	0	15.12
19	Ponda	626844	Betqui	629	220	0	0	0	100	0	0	309
20	Ponda	626848	Boma	394.6	0	0	0	0	67	106	0	221.6
21	Ponda	626854	Velinga	315	0	0	0	0	48	90	0	177
22	Ponda	626855	Cundaim	778.35	0	4	0	0	115.55	232.2	5	421.6
23	Ponda	626847	Adcolna	371	0	0	0	0	112.75	146.55	0	111.7
24	Ponda	626849	Cuncoliem	517	0	0	0	0	111	0	175	231
25	Bicholim	626752	Maem	2104.07	40	755.56	167.3	30	5	15.21	20	1071
26	Bicholim	626753	Vainguinim	67.81	0	12.87	8.61	2	0	0	0	44.33

27	Bicholim	626754	Aturli	67.94	0	6.37	2.17	2	3.4	0	0	54
28	Pernem	626636	Querim	405.21	199.45	0	0	0	6.51	0	0	199.25
Total				**15101.67**	**2431.34**	**1834.39**	**178.08**	**98.9**	**1368.78**	**1343.91**	**204.1**	**7642.17**

Source: **District Census Handbook 2011, Goa State**

Table 3.6.8: Main Commodities

Sr. No.	Sub District Name	Village Code	Village Name	Agricultural Commodities (First)	Manufacturers Commodities (First)	Agricultural Commodities (Second)	Agricultural Commodities (Third)
1	Tiswadi	626714	Ella	MANGOES	ICE	PADDY	NA
2	Tiswadi	626715	Bainguinim	COCONUTS	BACKERY PRODUCT	MANGOES	NA
3	Tiswadi	626712	Naroa	FISH	NA	MANGOES	BEANS
4	Tiswadi	626713	Gandaulim	PADDY	NA	CHILLIES	COCONUTS
5	Tiswadi	626710	Goltim	FISH	NA	MANGOES	BEANS
6	Tiswadi	626705	Ambarim	PADDY	NA	MANGOES	CHILLIES
7	Tiswadi	626706	Chorao	PADDY	WEIGHING MACHINE	MANGOES	CASHEW NUTS
8	Tiswadi	626707	Caraim	PADDY	NA	MANGOES	CHILLIES
9	Tiswadi	626723	Curca	CASHEW NUTS	COUNTRY LIQUOR	VEGETABLES	NA
10	Tiswadi	626724	Siridao	VEGETABLES	ICE	NA	NA
11	Tiswadi	626725	Neura-O-Pequeno	VEGETABLES	ICE	NA	NA
12	Tiswadi	626726	Neura-O-Grande	MANGOES	FURNITURE	NA	NA
13	Tiswadi	626717	Goalim Moula	RICE	CASHEW FENI	COCONUTS	CHILLIES
14	Tiswadi	626718	Carambolim	COCONUTS	NA	NA	NA
15	Tiswadi	626719	Azossim	NA	BACKERY PRODUCT	NA	NA
16	Tiswadi	626721	Gancim	RICE	CASHEW FENI	CASHEW NUTS	MANGOES
17	Bardez	626687	Pomburpa	RICE	NA	CASHEW NUTS	COCONUTS
18	Bardez	626670	Tivim	PADDY	ICE	CHILLIES	ONION
19	Ponda	626844	Betqui	ARECANUTS	COUNTRY LIQUOR	RICE	NA
20	Ponda	626848	Boma	FRUITS	COUNTRY LIQUOR	CASHEW NUTS	BETALNUT
21	Ponda	626854	Velinga	COCONUTS	NA	ARECANUTS	PINEAPPLE
22	Ponda	626855	Cundaim	RICE	STEEL	COCONUTS	CASHEW NUTS
23	Ponda	626847	Adcolna	FRUITS	COUNTRY LIQUOR	CASHEW NUTS	NA
24	Ponda	626849	Cuncoliem	COCONUTS	NA	ARECANUTS	PINEAPPLE
25	Bicholim	626752	Maem	PADDY	COUNTRY LIQUOR	COCONUTS	CASHEW NUTS
26	Bicholim	626753	Vainguinim	PADDY	COUNTRY LIQUOR	CASHEW NUTS	BEANS
27	Bicholim	626754	Aturli	COCONUTS	COUNTRY LIQUOR	CASHEW NUTS	NA
28	Pernem	626636	Querim	RICE	COUNTRY LIQUOR	CHILLIES	CASHEW NUTS

Source: District Census Handbook 2011, Goa State

3.6.11 Infrastructure and accessibility, Primary Observations in the Core Zone

The following paragraphs illustrate the current Infrastructural details in project area villages which include presence of educational institutions, working profile and housing typology. This data was collected through interactions and Focus Group Discussions (FGDs) with primary stakeholders in the Core Zone project area villages.

Site visit was done by National CSIR- Environmental Engineering Research Institute (NEERI) consultant for socio-economic studies in the month of September 13th to 16th September 2017 for 3 days. Survey team performed the survey in villages with socio- economic study format. In Study area villages by random sampling in total 06 villages. Surveyed villages are given bellowing **Table 3.6.9** and public capsulation photographs are showing at **Plate 3.6.1 & 3.6.2**

Table 3.6.9 List of Survey Villages .

Tehsil	Town/Village	Name	TRU
Tiswadi	626715	Bainguinim	Rural
	626729	Corlim (CT)	Urban
Ponda	626844	Betqui	Rural
	626848	Boma	Rural
	626855	Cundaim	Rural
	626849	Cuncoliem	Rural

3.6.11.1 Health Care Facilities and Accessibility

The data collected from the field revealed that only 80% of the villages surveyed have access to Govt. hospitals, Community Health centers, Primary Health care Sub centers. However, no villages have access to Private hospitals. Many of the villagers travel to Panjim, Corlim and Ponda in case of chronic illness and other diseases.

According to Primary Health Centre of Corlim, in last three years (2013 to 2016) is describing at following **Table 3.6.10.**

Table 3.6.10 : Health Status of Last 3 Years

No. PHC/Corlim/2017-18/1443
Government of Goa
Directorate of Health Services,
Date: 27/09/2017

Department of Health (Last 3 Years)

To assess the existing Health Status, complete last 3 years data related to following parameters is required.

Year	2013-14	2014-15	2015-16
Birth Rate	12 %	11%	12%
Mortality Rate			
Death Rate	NIL	NIL	NIL

Infant Mortality Rate	3%	3.7%	3.5%
Still Birth Rate	NIL	NIL	NIL
Child Mortality Rate	NIL	NIL	NIL
Maternal Mortality Rate	NIL	NIL	NIL
Morbidity Pattern (No. of Registered Patient)			
Diarrheal Disease	264	280	196
Dengue Fever	NIL	NIL	NIL
Malaria Fever	39	29	24
Eye Disease	266	177	120
Respiratory Disease	1635	1677	1467
Tuberculosis	63	75	77
Skin Disease	375	330	291
STI/RTI/HIV/AIDS	40	34	66
Other if any specify	NIL	NIL	NIL

(Dr. Kedar Raikar)
Medical Officer In-charge,
Primary Health Centre, Corlim

Source: Primary Health Centre Corlim, North Goa.

According to the health data of Corlim PHC, it is observed that most of the patients are suffering from diarrheal Disease, respiratory disease and skin diseases.

3.6.11.2 Accessibility to Educational Institutions

It was observed during study that 90% of villages have pre-primary, primary schools; whereas only 20% villages have also accessible to secondary education to children. For higher Secondary and colleges were available at Panjim, Ponda at10 to 20 km range.

3.6.11.3 Water Resources

Major water sources in surveyed, villages are tap water, tube wells, tanks and bore wells.

3.6.11.4 Housing Typology

The study noted that 90% of houses are Pucca and very few near about 10% are Kutcha houses in the project area villages.

3.6.11.5 Communication facilities

It has been observed that only few villages in the core project area has Post offices, however all villages, has availability of private couriers and other communication services.

3.6.11.6 Transportation:

For transportation purpose Auto, Public and Private Bus services were available. Transportation facilities were frequently available in the study area and connecting major cities. Private vehicles like Bicycles & Motor Cycles were mostly used by villagers for transportation purpose.

3.6.11.7 Road Connectivity

Most of the roads were pucca and connecting to villages. Dambar and cement roads were commonly seen inside the villages

3.6.11.8 Market Facility

Study area was predominantly semi urban type. In villages, small shops were available for daily needs. Weekly market facility was available in some villages. Wholesale markets were available at town place.

3.6.11.9 Electricity

All villages are accessed with electricity supply.

3.6.12 Awareness about Government schemes and programmers

Most of the villages surveyed are benefitted by government schemes such as MGNREGA (Mahatma Gandhi National Rural Employment Guarantee Act), SWATCH BHARAT MISSION, and convergence programs through community participation etc. Alongside, the villagers are also aware of the developments so far as the welfare schemes and programs of the State Government.

3.6.13 Other Observations

The socio-economic study revealed that the youth in the project area are devoid of employment opportunities. They can be a potential source of workers with minimum handholding and vocational education skills. The youth have expressed their willingness to setting up of industries in the area as it provides them gainful employment opportunities. Similarly, this would also trigger many direct and indirect benefits for economic advancement and social development of project area.

3.6.14 CSR and Developmental Activities

The proposed project would take a pivotal role in developing health, education, skill development, environmental management of the villages in the project area.

3.6.15 Suggestions for improvement of Socio-Economic Status

The socio-Economic status of the population in the project area shall be improved through CSR and focused community development interventions. Some of the salient activities are illustrated below:

- Youth empowerment programs through awareness creation about various government schemes, providing appropriate opportunities with relevance to their qualification and skills, conducting skills inculcating programs etc.,
- Periodical health checkup camps need to be conducted
- Sensitization and awareness programs on child and mother health, sanitation and personal hygiene, HIV/AIDS etc.
- Mother-child care awareness programs and need based health camps

- Veterinary camps and Para-Vet services to enhance the milk production of existing milk producing households.
- A number of CSR activities can be initiated in the project area villages on convergence mode whilst partnering with exiting Government schemes and financial support from developmental institutions like NABARD.

Plate 3.6.1 : Public Consultation Photographs at Study Area

Interaction with Villagers

Plate 3.6.2 : Public Consultation Photographs at Study Area

Interaction with Sarpanch and Other Government Offices

Church and Proposed Project Site Area

3.6.16 Quality of Life Assessment

Quality of life (QoL) indicates overall status of socio-economic aspects in a given area. Quality of life (QoL) is defined as a function between "objective conditions" and "subjective attitudes" involving a defined "area" of concern.

The "objective conditions" are numerically measurable artifacts of a physical, sociological event or economic event. Objective conditions may be defined as any number, which stands for a given quantity of a variable of interest so long as it is independent of subjective opinion.

Subjective attitude" is primarily concerned with effective and cognitive dimensions. It is specifically concerned with 'how aspects of cognition vary as objective conditions vary'.

Once objective measures are obtained for each factor they are transformed to a normal scale varying from 0 to 1 (value function curve) in which 0 corresponds to the lowest or least satisfactory measure, and 1 corresponds to the highest. The weights are assigned to each factor by ranked-pair wise technique (by the expert group) based on the secondary data and general observations.

For each objective measure, a corresponding subjective measure is developed for each individual of the sample population by asking him to rate his satisfaction scale (value function curve). It is used such that 0 corresponds to the lowest level of attitudinal satisfaction and 1 corresponds to the highest level of satisfaction. Weights are assigned to each factor using ranked - pair wise comparison techniques.

The socio-economic indicators used for computation of QoL are:

• Employment	• Housing
• Income	• Health
• Transportation	• Recreation
• Education	• Agriculture
• Medical Facilities	• Cost of Living
• Communication	• Business
• Power	• Per Capita Income
• Sanitation	• Pollution

Subjective, objective and cumulative quality of life is estimated as :

(I) Subjective QoL Calculations:

$$QoLs = 1/p \sum_{i=1} \sum_{j=1} QIij \times Wi$$

Where,

QoLs = Subjective quality of life index

p = No. of respondents, j = 1, ..., p

m = No. of factors, i = 1, ..., m

QIij = Subjective quality index for ith factor assigned by jth respondent

$\sum$ Qiij = Subjective quality index for ith factor assigned by all respondents in an area

Wi = Relative weightage of the ith factor

(II) Objective Quality of Life

$$QoLo = \sum_{i=1}^{i=n} QIi \times Wi$$

Where,

QoLo = Objective quality of life index

n = No. of QoL Factors

i = 1, ..., n

QIi = Satisfaction level (assigned by the expert group) for the ith objective indicator

Wi = Normalized weight for its factor

(II) Quality of Life (Cumulative Index)

$$QoLc = \frac{QoLo + QoLs}{2}$$

The subjective and objective QoL indices prior to commissioning of the project are presented in following

The average QoL index values are estimated as:

QoL (s) = 0.60

QoL (o) = 0.61

QoL (c) = 0.62

The average QoL index value for the study area is leading to satisfactory level due to satisfactory status like, educational facilities, roads also availability of basic needs viz., food, clothing & housing. Medical and communication facilities were not adequate in the study area; Improvement in these fields will help to increase quality of life of the study area.

Chapter 4

Anticipated Environmental Impacts and Mitigation Measures

Chapter 4
Anticipated Environmental Impacts & Mitigation Measures

4.1 Identification of Impacts

The identification and assessment of impacts over various environmental attributes in the study area due to proposed CMSWMF are discussed in this chapter. The major element involved in the process of environmental impact assessment is identification of impacts as it leads to other elements such as quantification and evaluation of impacts. Although, in general, character of impacts have been identified while describing existing environmental status, it is necessary at this stage to identify the critical likely impacts, due to proposed construction of berths for various components of environment, in the context of regional scenario.

Various techniques are available for identification of impacts. In the present case Network Method is used for the activities related to the proposed CMSWMF at Baingunim, Goa which involves understanding of cause-condition-effect relationship between an activity and environmental parameters for identification of impacts has been found to be most appropriate methodology.

The method accounts for the project activity and identifies the types of impacts, which would initially occur. The next step related to analysis of each impact and identifies the secondary and tertiary impacts, which are induced as a result. This process is repeated until all possible impacts are identified.

4.2 Prediction of Impacts

Prediction of impacts is the most important component in environmental impact assessment process. Several mathematical/statistical techniques and methodologies are available for predicting impacts due to developmental activities on physico-ecological and socio-economic environment. The results obtained from predictions are superimposed over the baseline (pre-project) status of environmental quality to derive the ultimate scenario of environmental conditions. The quantitative prediction of impacts is also essential to delineate pragmatic environmental management plan (pollution control measures) for implementation during and after the commissioning of proposed activities for minimizing the adverse impacts on environmental quality. Major impacts on environment during construction and operation phase of the proposed integrated solid waste management system are given in **Table 4.1**.

Table 4.1 : Identification of Impacts during Construction and Operation Phase

S.No.	Component	Aspect	Potential Impact
Construction phase			
1.	Ambient Air Quality	Dust emissions from site preparation, excavation, material handling and other construction activities at site.	Minor negative impact inside plant premises. No negative impact outside plant site. Short term
2.	Noise	Noise generation from construction activities, construction equipment and vehicular movement	Minor negative impact near noise generation sources inside premises. No significant impact on ambient noise levels at sensitive receptors. Short term
3.	Water quality	Surface runoff from project site Oil/fuel and waste spills. Improper debris disposal	No significant negative impact. However hazardous chemicals should be handled properly Short term
4.	Land use and aesthetics	Land development	**Positive impact. Development of integrated plant will increase the aesthetics of the area.**
5.	Topography and geology	Site development	No significant impacts
6.	Soils	Construction activity leading to topsoil removal and erosion.	No impact as plant site is currently being used for dumping of waste. Soil of the area is already degraded.
7.	Ecology Flora and fauna	Habitat disturbance during construction activity	No impact as the area as the proposed project area is devoid of any vegetation.
8.	Socio-economy	Increased job opportunity for locals	Overall positive impact
9.	Traffic pattern	Haul truck/construction vehicle movement	Minor negative impact
Operational phase			
1.	Ambient air quality	Particulate emissions from material handling. Nox emission from stack	Minor negative impact
2.	Noise	Noise from plant operation and vehicular movement	Minor negative impact
3.	Water quality	Oil/fuel and waste spills.	No significant adverse

S.No.	Component	Aspect	Potential Impact
		Wastewater from plant processes Discharge of waste water and contaminated storm water from site	impact as storm water and other waste water generated from the plant site will be treated and reused for floor washings etc.
5.	Soils	Storage of solid wastes fuel and material spills	No negative impact
6.	Ecology flora and fauna	Land use change	No negative impact
7.	Traffic pattern	Slight increase in traffic	No negative impact due to proposed plant as increase in traffic is insignificant in comparison to the vehicles currently plying and the fleet of vehicle for transportation of MSW will remain unchanged

4.2.1 Air Environment

Construction Phase

During the construction phase, PM_{10} & $PM_{2.5}$ is expected to be the main pollutant associated with on-site roads (paved and unpaved), stockpiles and material handling. The proposed activities during construction phase would primarily involve development of site and construction of new plant.

During the construction phase, pollution emission sources shall be distributed throughout the project site and shall fall under the category of area source. The project area is flat, so extensive formation work is not expected during this phase. In addition, due to the confined nature of heavy construction activity during this limited period, tailpipe emissions from construction equipment are assumed to be negligible.

In the absence of information regarding the quantity and type of construction equipment to be deployed at any particular time, emission factors for construction activities were used for emissions estimates. Overall SPM emissions were estimated using the emission factor of 1.2 tons SPM/month of activity/acre as per AP-42 Section 13.2.3.3 (U.S.EPA, 1995). This emission factor is most useful for developing estimates of overall emissions from construction throughout a geographical area and most applicable to construction operations with medium activity level, moderate silt contents, and semiarid climate (U.S. EPA, 1995). The derivation of the factor assumes that construction activity occurs 30 days per month, making the above estimate somewhat conservatively high for total suspended particulate (U.S. EPA, 1995).

The total area of the site is approximately 1,71,312 sq.m . The entire site will not be simultaneously under heavy construction, with different sections of the site generating PM in a progressive manner. Thus, it is conservatively assumed that the PM emission would not be significantly high to warrant any impact prediction.

Operation Phase

4.2.2 Impact due to Proposed CMSWMF

In the proposed **CMSWMF**, biogas generated from biomethanation of organic fraction of MSW after sorting is planned to be used as fuel / feed to the **Biogas Genset based Power Plant** to generate electric power. The fuel and feed requirement for the above Biogas Genset is 300 m^3/hr of biogas. The expected air emissions from CMSWMF are primarily from the combustion of biogas for power generation. Since the biogas will be purified before combustion, the sulphurous emissions are not expected.

Thus, in the present study, the major source has been considered as the stack attached to the Biogas Genset. The major pollutant identified is NO_x only, as H_2S, the source for sulphur and finally the SO_2 will be removed during purification of biogas, prior to routing the biogas to combustion chamber of Biogas Genset and since the biogas is devoid of particulate, SO_2 and SPM are not considered in prediction exercise. The estimation of emission rates based on rate of fuel consumption and characteristics has been calculated. Also, the meteorological data at the site has been collected during study period. After compilation of data and computing the emission load (g/sec), assessment of impact on ambient air quality using ISCST3 model of

USEPA for emissions from existing plant have been carried out. The Meteorology data are presented in **Table 4.2**. Predicted NOx Concentration in Ambient Air as per Gaussian Model is Described below:

4.2.2.1 Air Quality Model Description

The impact on air quality due to emissions from single source or group of sources is evaluated by use of mathematical models. When air pollutants are emitted into the atmosphere, they are immediately diffused into surrounding atmosphere, transported and diluted due to winds. The air quality models are designed to simulate these processes mathematically and to relate emissions of primary pollutants to the resulting downwind air. The inputs needed for model development are emission load and nature, meteorology and topographic features, to predict the GLCs.

The **Industrial Source Complex – Short Term Version 3 (ISCST-3)** models has been developed to simulate the effect of emissions from the point sources on air quality. The **ISCST-3** model was adopted from the USEPA guidelines which are routinely used as a regulatory model to simulate plume dispersion and transport from and up to 100 point sources and 20000 receptors. **ISCST–3** is extensively used for predicting the Ground Level Concentrations (GLCs) of conservative pollutants from point, area and volume sources. The impacts of conservative pollutants were predicted using this air quality model keeping in view the plain terrain at and around the project site. The micrometeorological data monitored at project site during study period have been used in this model. The **ISCST-3** model is, an hour-by-hour steady state Gaussian model which takes into account the following:

- Terrain adjustments
- Stack-tip downwash
- Gradual plume rise
- Buoyancy-induced dispersion
- Complex terrain treatment and consideration of partial reflection
- Plume reflection off elevated terrain
- Building downwash
- Partial penetration of elevated inversions
- Hourly source emission rate, exit velocity, and stack gas temperature

The **ISCST-3** model, thus, provides estimates of pollutant concentrations at various receptor locations.

The ISC short term model for stacks uses the steady-state Gaussian plume equation for a continuous elevated source. For each source and each hour, the origin of the source's coordinate system is placed at the ground surface at the base of the stack. The x axis is positive in the downwind direction, the y axis is crosswind (normal) to the x axis and the z axis extends vertically. The fixed receptor locations are converted to each source's coordinate system for each hourly concentration calculation. The hourly concentrations calculated for each source at each receptor are summed to obtain the total concentration produced at each receptor by the combined source emissions.

4.2.2.2 Air Quality Modeling and Predictions

Hourly wind speed, wind direction, atmospheric stability, temperature and mixing height data recorded for post-monsoon season at project site are used for predictions. The topography around the proposed project site represents flat and undulated terrain, vegetation, rural to semi-urban structure. Prediction of impact due to proposed project was carried out for computing GLCs on 24 hourly bases in the study area of 5 km radius. The GLCs of NO_x were predicted over an area of 5 km x 5km. The GLCs of NO_x are computed due to operation of Biogas Genset.

The 24 hourly maximum GLCs of NO_x due to Biogas Genset power plant computed from the model is 1364.92µg/m^3 at 1.26 km in the NE direction. The isopleths of incremental GLCs of, NO_x due to due to Biogas Genset power plant are shown in **Figure 4.1 and Table 4.3**. In the study area, the ground level concentrations of NOx air pollutants have crossed the permissible limits set by the CPCB (National Ambient Air Quality Standards - NAAQS)Though the aggregate value is not within stipulated NAAQ Standard appropriate measures viz. controlled combustion using lox NO_x burners and well designed stacks (with requisite height and diameter) as per the standards prescribed by the regulatory agencies should be considered at the time of designing and commissioning of facility. Regular monitoring of scrubbing system for purification of biogas provided by the equipment vendors for power generation shall be should be monitored to ascertain for absence of SO_2 emissions.

In the present study, the major source has been considered as the stack attached to the Biogas Genset. The major pollutant identified is NO_x only, as H_2S, the source for sulphur and finally the SO_2 will be removed during purification of biogas, prior to routing the biogas to combustion chamber of Biogas Genset and since the biogas is devoid of particulate, SO_2 and PM are not considered in prediction exercise. The estimation of emission rates based on rate of fuel consumption and characteristics has been calculated. Also, the meteorological data at the site has been collected during study period. After compilation of data and computing the emission load (g/sec), assessment of impact on ambient air quality using ISCST3 model of USEPA for emissions from existing plant have been carried out. The Meteorology data are presented in **Table 4.2**. Predicted NOx Concentration in Ambient Air as per Gaussian Model is Described below.

4.2.3 Impact due to Transportation

Apart from the stack emissions the pollutants may also emit by mobile sources (trucks) and fugitive sources viz. land fill area. Around 15-16 truck trips are in operation per day to transport MSW materials into the project site to dispatch compost from the project site and no significant increase in envisaged as the same number of trucks will be operated after commissioning and operating of proposed CSWMF.

4.2.4 Impact of Fugitive Emissions

Fugitive odour emissions from MSW handling operations and biological processes are the major concerns for all such facilities worldwide. The main sources of fugitive emissions from the CSWMF include minor leaks from the process equipment viz., vessels, valves & pumps and connectors. In the proposed facility it is

planned that all the working /storage sheds and biological systems will be provided with adequate number of blowers, vent and ducts to suck the odours emissions and pass it through bio-scrubbers for efficient odour control. Hence, the fugitive emissions of VOCS, and odorous compounds and particulate matter are expected to be negligible.

Table 4.2 : Meteorological Data used for Predictions (Winter-2017)

Date	Temperature		Humidity (%)			Wind	
	Min.	Max.	08.00 AM	02.00 PM	08.00 PM	Direction	Speed kmph
01-Oct-17	23.8	31	98	37	96	W	4
02-Oct-17	22.9	32	90	34	88	NW	5
03-Oct-17	23.8	33	91	34	89	N	2
04-Oct-17	23.8	33	93	35	91	NW	4
05-Oct-17	23.8	33	95	36	93	NW	5
06-Oct-17	27.8	31.5	90	34	88	W	4
07-Oct-17	23.8	32.5	98	37	96	NW	3
08-Oct-17	27.8	30.1	90	34	88	NW	4
09-Oct-17	29.4	31.2	98	37	96	W	3
10-Oct-17	24.2	32.2	95	36	93	NW	3
11-Oct-17	24.8	32.7	82	30	80	NW	4
12-Oct-17	24.6	31.7	92	34	90	W	2
13-Oct-17	24.8	32.7	98	37	96	NW	4
14-Oct-17	25.3	32.7	90	34	88	NW	4
15-Oct-17	25.2	32.8	89	33	87	NW	5
16-Oct-17	24.9	33.4	97	36	95	W	3
17-Oct-17	25.9	35.3	95	36	93	N	2
18-Oct-17	25.5	38.8	92	34	90	NW	4
19-Oct-17	25.5	38.8	89	33	87	N	2
20-Oct-17	26.5	37.2	98	37	96	W	3
21-Oct-17	23.8	31	100	39	100	NE	2
22-Oct-17	28.5	38.2	95	36	93	N	2
23-Oct-17	28.8	38.4	98	37	96	NW	4
24-Oct-17	28.2	34.4	89	33	87	NW	4
25-Oct-17	28.5	33.9	100	39	100	W	5
26-Oct-17	28.4	32.8	98	37	96	W	4
27-Oct-17	28.4	32.8	97	36	95	NW	3
28-Oct-17	28.4	32.8	96	36	94	NE	2
29-Oct-17	27.4	33.8	94	35	92	NW	4
30-Oct-17	28.4	32.8	98	37	96	NW	4
31-Oct-17	23.8	31	90	34	88	W	3

Cont.….

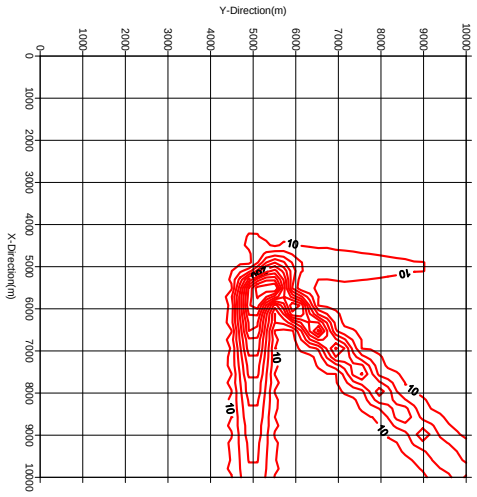
Date	Temperature		Humidity (%)			Wind	
	Min.	Max.	08.00 AM	02.00 PM	08.00 PM	Direction	Speed kmph
01-Nov-17	21	30	96	39	92	NW	5
02-Nov-17	23	29	99	40	95	W	3
03-Nov-17	23	29	96	39	92	NW	4
04-Nov-17	22	30	92	37	88	NW	4
05-Nov-17	23	30	100	40	96	W	2
06-Nov-17	22	29	89	36	85	NW	4
07-Nov-17	23	30	86	34	82	NW	4
08-Nov-17	22	30	99	40	95	N	2
09-Nov-17	23	30	95	38	91	NW	4
10-Nov-17	22	29	96	39	92	W	4
11-Nov-17	24	30	92	37	88	W	5
12-Nov-17	24	31	100	40	96	NW	4
13-Nov-17	24	30	97	39	93	NW	4
14-Nov-17	26	33	92	37	88	W	2
15-Nov-17	24	27	88	35	84	NW	4
16-Nov-17	23	27	92	37	88	N	2
17-Nov-17	22	26	78	31	74	N	2
18-Nov-17	22	26	75	29	71	NE	3
19-Nov-17	24	31	100	40	96	W	2
20-Nov-17	23	31	92	37	88	W	4
21-Nov-17	23	31	86	34	82	NW	4
22-Nov-17	24	30	92	37	88	NW	5
23-Nov-17	22	34	86	34	82	W	4
24-Nov-17	22	34	88	35	84	NW	4
25-Nov-17	23	31	88	34	84	W	3
26-Nov-17	19	33	78	31	74	NE	2
27-Nov-17	19	33	78	31	74	W	4
28-Nov-17	20	33	76	30	72	NW	5
29-Nov-17	18.5	33.5	69	27	65	N	2
30-Nov-17	19	34	70	27	66	NW	4

Cont.….

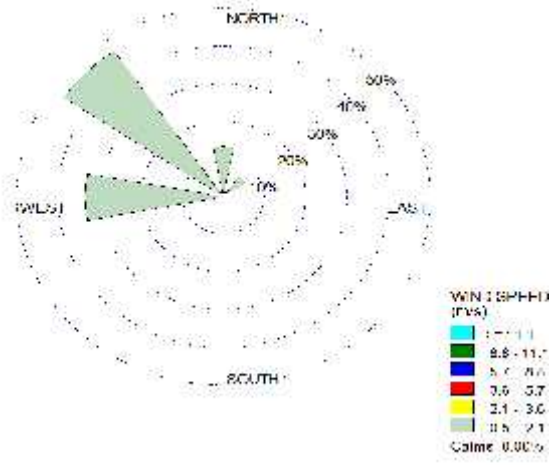
Date	Temperature		Humidity (%)			Wind	
	Min.	Max.	08.00 AM	02.00 PM	08.00 PM	Direction	Speed kmph
01-Dec-17	22	34.5	81	26	79	NE	2
02-Dec-17	21	35	86	28	84	W	3
03-Dec-17	21	34	62	18	60	NW	4
04-Dec-17	21	33.5	78	24	76	N	2
05-Dec-17	18.5	34	94	31	92	NW	4
06-Dec-17	18	33	92	30	90	NW	4
07-Dec-17	19	33	90	29	88	W	3
08-Dec-17	20	33	95	31	93	W	4
09-Dec-17	23	34	95	31	93	NW	4
10-Dec-17	23.5	33	95	31	93	NW	4
11-Dec-17	24	32	87	28	85	N	2
12-Dec-17	22	28.5	96	32	94	NW	4
13-Dec-17	22.5	32	96	32	94	NW	4
14-Dec-17	23	33	100	33	98	W	4
15-Dec-17	23	33	87	28	85	NW	3
16-Dec-17	22	32	85	27	83	W	4
17-Dec-17	22	34	88	28	86	W	3
18-Dec-17	24	31	90	29	88	NW	4
19-Dec-17	24	32	85	27	83	NW	4
20-Dec-17	22	33	89	29	87	NW	4
21-Dec-17	21	32	83	26	81	NE	2
22-Dec-17	18	31	86	28	84	NW	3
23-Dec-17	20	33	74	23	72	W	3
24-Dec-17	19	30	80	25	78	NW	4
25-Dec-17	19	30	88	28	86	NW	4
26-Dec-17	18	29	89	29	87	W	3

Table 4.3 : Final GLCs (Ground level concentrations) predicted by using ISCST3

Pollutant	Conc(ug/m3)	(x,y)km	Dist(km)	Direction
NOx	599	(5.5,5.5)	6.36	SE



Isopleths of GLCs predicted by using surfer software



windrose plotted by using 24-hourly met data

Figure 4.1 : Isopleths of incremental GLCs of, NOx due to due to Biogas Genset power plant

4.3 Noise Environment

The assessment of the impacts of noise on the surrounding community depends upon i) Characteristics of noise source (instantaneous, intermittent, or continuous in nature, with the latter contributing the least to noise pollution); ii) Time of day at which noise occurs; and iii)Location of noise source with respect to noise sensitive receptor.

Hence, the noise emission sources were examined during construction and operational phases of CMSWMF for predicting noise emissions impacts from the site.

Construction phase

Sources of noise emissions are expected from various construction machineries/equipments. General noise levels generated from the operation of equipment and machinery as per literature indicates variations between 94 dBA (concrete pumper) to 124 dBA (Pile driver) at a distance of 1 m, which gets reduced to 70 and 94 dBA respectively at 16 m.

However, since the construction phase is expected to be minor in nature and would be for a limited period, the possibility of all the equipments working together is ruled out, rather it will be used intermittently. Hence, the noise generated at a given time is not anticipated to be exceeding the permissible limit.

Moreover, inbuilt measures incorporated in the equipment and the precautionary measures such as use of personal protection equipment (PPE) by the respective operator and /or by other workers in the close vicinity would mitigate the impact.

Operational Phase

During the operational phase, the major sources of noise are:

- Noise from blowers, shredders, conveyer belts, etc.
- Noise from (Biogen set) power generator, compressor and other rotating equipments of the power plant
- Noise due to vehicular movement for loading / unloading inside the plant premises and on approach roads, national high ways etc.

All the noise producing equipments such as blowers, generator, and compressors would be housed in an acoustic enclosure; hence the ambient noise is not anticipated to be very high. The noise level outside the acoustic enclosure for different equipments would not exceed the prescribed standards (75 dB(A) at 1 m distance from the equipment).

Equipment will be statically and dynamically balanced to eliminate any vibration that can lead to noise generation. Blow off valves; discharge pipes, relief valves and other noise producing static equipment will be equipped with silencers. Pipelines will be suitably sized to avoid excess velocities that can lead to noise generation. Wherever necessary, insulation will be provided for reducing noise pollution.

The increase in noise levels due to vehicular movement for loading / unloading inside the plant premises, on approach roads, national high ways etc., is not anticipated from the proposed CMSWMF, as the same site is presently being used for the disposal of MSW generated in north Goa and the fleet of vehicles deployed on transportation of MSW would remain same. Further,the precautionary measures suggested in EMP would improve upon the present situation.

Equivalent sound pressure level, 8 hrs average, (L_{eq} 8 hrs), is used to describe exposure to noise in workplaces. The damage risk criteria for hearing loss, enforced by Occupational Safety and Health Administration, (OSHA), USA and stipulated by other organizations, is that noise levels upto 90 dB(A) are acceptable for eight hour exposure per day. Ministry of Labour, Government of India has also recommended similar criterion vide factories Act, Schedule No. XXIV (Government Notification FAC/1086/CR-9/Lab-4, dated 8/2/1988).

The main sources of noise generation will be compressors, ID fans, FD fans, blowers, etc. Around 8 hour workers are expected to work in a single shift, out of which 20 workers would be intermittently exposed to equipments generating noise levels of more than 90 dBA for about 30-60 minutes at a given time during the shift of 8 hrs with due precautions of using PPE. Thus, maintaining their noise-level-exposure and duration will be well within the stipulated standards of OSHA.

Hence, the overall noise impact because of the project activities appears to be insignificant.

Table 4.4 : Typical Noise Generating Sources

Description	Noise Levels dB(A) at 1 m from Source
Earth Movers	
Excavator	90-95
Crane	90-95
Trucks (10t and 16t)	84-88
Dozer	85-90
Dumpers	87-91
Wheel loader	89-94
Tractors	76-96
Scrapers, Graders	80-93
Pavers	86-88
Trucks	82-94
Material Handlers	
Concrete mixers	75-88
Cranes (movable)	75-86
Impact Based Equipment	
Pneumatic Wrenches	83-88
Cranes (derrick)	86-88
Stationary Equipment at Storage Terminals	
Pumps	69-71
Generators	71-82
Compressors	74-86

4.4 Water Environment

The potential impacts during construction and operation phase are assessed based on the various project activities.

Construction Phase

Construction activities for the proposed development can have minor impact on hydrology and water quality of the area as the construction waste will not be leached into ground or any surface water body. Potential impacts on the hydrology and water quality have been discussed as under.

- Soil runoff from the site leading to off-site contamination (particularly during rainy season).
- Improper disposal of construction debris leading to off-site contamination of water resources.
- Unaccounted disposal of domestic wastewater from temporary labour camps.
- Spillage of oil and grease from the vehicles and wastewater stream generated from onsite activities such as vehicles washing, workshop etc.

Development of the proposed site could lead to stockpiling and excavation activity on site, thereby causing erosion of base soil. The run off from the site may contain high quantity of suspended solids (SS). The impact of runoff may not be very significant except during rainy season. Further construction of garland drains will reduce the runoff from the stockpiles.

During construction phase, wastewater shall be generated from labour activities on site. Wastewater generated would be characterized by high levels of BOD, SS, Nitrogen and E. Coli. Significant water quality impact will occur, if the sewage is disposed without any prior treatment. Since most of the people would be deployed locally, impact from labour colony is not anticipated to be very high. Temporary soak pits and septic tanks shall be constructed on the site during construction phase to mitigate the impact.

The project implementation would involve various construction activities. The following section summarizes the water requirement, its sources and management of wastewater.

Operational Phase

The existing raw water requirement for proposed CMSWMF is estimated to be 10 m^3/d. The processes adopted at CMSWMF are mechanical segregation of various fractions of MSW, high pressure pulping of organic fraction, biomethanation of pulp and invessel composting of residue. These observations do not require any addition fresh water and hence the requirement is limited to domestic use. The wastewater generated from the facility is mostly MSW leachat, floor washings and domestic wastewater. The proponent has made the provision to treat the combined wastewater in a separate effluent treatment plant (ETP) equipped with reverse osmosis (RO) system to ensure efficient recycle of water with in the CMSWMF. Wastewaters generated from non-plant use washing and other processes are treated at

ETP and shall be used in floor washing, dust suppression, if required and development of green belt.

4.5 Land Environment

The proposed facility will occupy 22422 sq m. The prediction of related impact on land environment help in identifying and implementing relevant environment management plan during and after the execution of the development activities to minimize the deterioration of the quality of land environment. The likely impacts have been presented here under appropriate categories. No additional land will be required for proposed addition.

4.5.1 Impacts on Land use & Aesthetics

The proposed project will be developed on the existing waste disposal site; hence, no change in the land use of the site due to the proposed project is anticipated. With the development of the proposed plant, green belt would be developed and other aesthetic changes would be made to the plant site, thereby creating overall positive impact on the aesthetics of the site.

4.5.2 Impacts on Topography & Geology

The proposed site being plain land, hence the topography as well as geology is not anticipated to change due to proposed project. No additional environmental stresses will be imposed by the project on these parameters and hence no significant impacts are expected.

4.5.3 Impact on Soils

Impact on soil owing to the project construction activity includes soil erosion, compaction, physical and chemical desegregations and pollution of soil in case of waste discharge on land. The proposed plant will be developed on the existing waste dumping site; hence no negative impact due to the development is anticipated.

No significant impact is expected on the soils on and around the site, due to the following management measures:

- All solid wastes and hazardous wastes received in the facility will be collected properly, sorted out, segregated as inert and organics, and disposed off based on the merit of the waste segregated either for land filling or biomethanation to generate biogas
- The entire plant site area will have a underground pipe drainage and runoff facilities and thus, there will be no leaching of any substances in case of spills, which are well confined and decontaminated.
- Reject Treatment

Hence, no negative impact on soil quality on the project site is expected due to the proposed project activities.

4.5.4 Impacts due to waste disposal

During the construction phase, the typical solid waste will be generated from the project includes waste from land clearing activities and construction waste. Impact from construction waste may arise owing to storage on site, transportation,

workshops, etc. Proposed mitigation plan suggest maximum reuse / recycle of construction waste on site or removal of waste at the site and proper disposal, which would reduce the impact significantly.

During the operations phase, one of the project activities would comprise of manual segregation of waste. The waste will be collected segregated and will be disposed off in the CMSWMF.

The wastewater generated from project will be treated in the proposed ETP and will be used for floor washing and to irrigate land earmarked for raising vegetation / plantation / green belt.

All the solid waste generated in the CMSWMF including treatment system will be routed to the facility for treatment and disposal by mixing with incoming MSW.

Agriculture and Forest

The construction phase will not have any impact on the activity as the project site is the existing MSW disposal site near the industrial area. During operation phase, compost will be available for agriculture and horticulture purposes and the impact will be beneficial. Treated wastewater, can be safely used for irrigation on the surrounding areas and also for development of plantation and greenbelts on the project premises. Thus, the impact would be favorable one. No change in the land use, soil productivity and cropping pattern is expected.

Since the proposed CMSWMF will be developed on the existing MSW disposal land itself and since there exist no forest lands of any category around the proposed project site, no adverse impact on any forest during construction or operation phase will arise. Rather, by way of green belt development by the **Concessionaire** on the other hand will improve the Vegetative / Green cover of the region.

Solid / Hazardous waste

The practice adopted for the management of various solid / hazardous waste and sludge generation at the effluent treatment plant must be adequate in order to prevent contamination of ground water due to leachate generated during rainy season.

The hazardous wastes mixed with the MSW as could be observed during sorting can be disposed of as per the hazardous waste (management and handling) Rule Amendment 2008, published by MoEF Government of India. Proper authorization from state pollution control Board is obtained for handling, storage and disposal of the above categories of hazardous waste.

The non–hazardous (solid) waste at project site is sludge from STP / ETP and the domestic solid waste from plant area and dried sludge from plant area and effluent treatment plant is used as filler or can be used as manure in the greenbelt development (maintenance).

4.6 Biological Environment

Construction Phase

Terrestrial

The existing land cover and physiognomy support plant species typical of habitats and having a low plant diversity and simple structure. Due to commonness of the species recorded and small area of habitats for herbs and shrubs to be lost, potential impacts to flora are considered minor. During the construction stage; removal of understory (shrubs and herbs) will reduce the habitat for a few faunal species. It will be temporary and suitable alternatives are available in nearby areas. The proposed peripheral greenbelt will provide a much better habitat for those species than earlier.

Air, noise and visual disturbance may be generated during the site development that can affect the behavior of fauna (especially bird, butterflies and other insects, reptiles and very small mammalian species) of the adjacent habitats. Small mammalian species such as mongoose and palm squirrel were recorded from the site premises. These species will be temporarily affected and may be migrated to nearby areas. However, alternative habitats are available in nearby areas, and disturbance is going to confine to the construction period only. Besides, these activities and the resulting impact on the existing ecology would be suitably compensated and mitigated adopting comprehensive EMP. Hence; the potential impacts to faunal groups from this source are ranked minor.

Aquatic

River flows at a distance five kilometers from the project site. The project authority is neither drawing water from the nearby water resources for construction purposes nor discharging any kind of sewage and debris into it, hence no impact is anticipated from the construction related activities.

Operation Phase

The potential impacts of project during the operation on terrestrial ecology and potential sources of impact include air, noise pollution, wastewater and other disturbances.

Potential impacts of project operation on terrestrial ecology include long-term air and noise pollution and disturbance generated by area lighting and traffic. Based on the limited fauna community and important flora observed in the buffer zone and the existing land use pattern of the surroundings, potential impacts to fauna from this source are ranked as minimal.

Since most terrestrial fauna recorded or reported to occur in the study area are disturbance tolerant and some are dwellers of typical rural setting hence, operational impacts are ranked as minimal. In addition, a green belt will be included in the development plan. This will provide habitats for a few faunal groups. No impact on the local ecology is expected from the background sources during the operational stage.

There would not be any adverse impacts on the biological environment as the treated effluents will be used in the facility itself and there is no discharge of

wastewater into sea or onto land environment. Dust, gaseous emissions as a result of fuel combustion, fugitive emissions (VOCs) will be well within prescribed Standards of CPCB and will hardly affect the biological environment

4.7 Socio-economic Environment

A census and socio- economic survey was carried on month of September 2017. A structured questionnaire was used to collect detailed information on village information income, livelihood etc to understand the impact due to the project activities. The major findings and magnitude of impacts are discussed in the following sections.

The social impacts due to the proposed project is studied and given in 3 stages.

- Impact during pre - construction phase
- Construction phase
- Operation phase

Impact during Pre-construction Phase

Land clearing, digging for construction activities etc will be performed during pre construction phase of the project. Local labour force will get direct employment for this phase. During land clearing noise from machines and dust generation during clearing at the site will affect nearest village at some extent.

Positive Impact in Construction phase

- **Solid waste management plant construction Increased employment opportunities**

Construction for the solid waste plant would encompass the following key activities removal of vegetation and general site grading, construction of administrative, control and other support buildings and Installation of utilities. These all type of works need manpower, local population will get employment opportunities in construction phase.

- **Increased business opportunities in local market**

During construction of plant, local market will be benefited by supplying the raw material for the construction, Small hotels, shops will benefited by the project.

- **Public service and utilities**

The proposed project will require infrastructural facilities e.g. Road, power, communication facility, water etc. will improve in the project area; these facilities will be a positive impact for the population living in surrounding villages

- **Impact on historical monuments**

In the project area as well as in the study area there is no historical monuments, therefore there is no impact on any monuments.

Negative impact in construction phase

- **Increased transportation**

For construction activity, loading unloading of material will increased transportation activities in the study area, heavy vehicles will use village road for transportation purpose it will increased load on village roads.

- **Impact on noise**

Noise and vibration generated by road traffic, and other vehicles activities also cause nuisances to local people.

Positive impact in operation phase

- **Employment generation**

In operation phase employment generation will help to increase contractual employment pattern in the study area.

- **Impact on village development**

Plant will contribute in village development activities in the field of CSR, in needy areas development/welfare activities will performed

- **Generation of waste will be decreased**

Negative impact in operation phase

- **Impact on transportation**

In operation phase, loading unloading of material will increased transportation activities in the study area, heavy vehicles will use village road for transportation purpose it will increased load on village roads. In operation phase there will be increased transportation activities, transportation of material activities can disturbed day to day life of villagers

4.8 Mitigation Measures

Mitigation measures are presented below.

- **Construction of boundary wall**

  Before start any construction activity, boundary wall construction surrounding the plant site is needed to restrict the entry of children and animals.

- **Preference to local workforce in construction/operation phase**

  During construction and operation phase preference to local workforce will help to increase employment and income of surrounding villages

- **Proper provisions for labour during construction phase**

  During construction activities proper provisions like water, sanitation, rest room etc. Should avail on site.

- **Medical camps in surrounding villages(once in 3 months)**

  Arrange Free ambulance service, medical camps in surrounding villages, free medicine distribution in medical camps.

- **Preventive measures to cover truck while transportation**

  During material loading unloading, transporting trucks should cover by sheets to reduce air pollution if any

- **Awareness programme**

  Awareness of safety and environment trough the plant authority for surrounding villages

Chapter 5

Environmental Monitoring Program

Chapter 5
Environmental Monitoring Program

Based on the baseline data collected on various environmental parameters and with the prediction of impacts, it is desirable to have an environmental monitoring program to establish the trend of various environmental parameters and their compliance with the emission/ discharge limits specified by the regulating agencies. The details of the proposed environmental monitoring program are summarized below:

5.1 Monitoring Schedule and Parameters

To evaluate the effectiveness of environmental management program, regular monitoring of the GSPCB stipulated environmental parameters as per the schedule should be done. Monitoring of various environmental parameters will be carried out on a regular basis to ascertain the following;

- æ Pollution status within the CMSWMF and in its vicinity
- æ Generate data for predictive or corrective purpose in respect of pollution
- æ Effectiveness of pollution control measures and control facilities
- æ To assess environmental impacts
- æ To follow the trend of parameters which have been identified as critical.

Monitoring is as important as pollution control since the efficiency of the control measures can only be determined by monitoring. The schedule, duration and parameters are to be monitored as per GSPCB/MoEFCC directives. A table showing environmental parameters proposed to monitor are given in **Table 5.1**.

The various components of the environment need to be monitored on regular basis as per the requirements of regulating agencies as well as for trend monitoring of the pollutants levels in various environmental matrices. Regularly meetings will review the effectiveness of the EMP implementation. The data collected on various EMP measures would be reviewed and if needed corrective action will be formulated for implementation. EMS will form short term and long-term plans for environmental issues, which require monitoring and effective implementation.

The environmental quality-monitoring program will be carried out in the impact zone with suitable sampling stations and frequency for environmental parameters with respect to different environmental components. Conventional parameters will be monitored by CMSEMF and analyzed at NABL approved laboratory and also other laboratories approved by MoEF/NABL will be consulted for

third party study. For conventional pollutants, the standard methods prescribed in "Standard Methods for Water and Wastewater Analysis" published by APHA (American Public Health Association), AWWA (American Water Works Association) & WPCF (Water Pollution Control Federation) will be adhered with and will follow procedures prescribed by GSPCB/CPCB.

5.2 Air Quality Monitoring

The following measures needs to be followed like procedures, time schedule and monitoring would be followed for air quality monitoring on a regular basis after the CMSWMF activities become operational:

- Ambient Air Quality is being monitored at 5 locations in and around the CMSWM Facility for all the parameters stipulated in MoEFCC Notification, 2009
- Sampling and monitoring of gaseous pollutants effluents as per the requirements of Goa State Pollution Control Board (GSPCB/CPCB).
- Ambient air quality monitoring for conventional pollutants such as Particulate Matter 2.5 ($PM_{2.5}$), Particulate Matter 10 (PM_{10}), Oxide of Sulfur (SOx) and Oxides of Nitrogen (NOx) and hydrocarbons as per the requirements of GSPCB/CPCB.
- Monitoring of micrometeorological data such as wind data, air temperature, relative humidity, rainfall and hydrography of the site (wave height, currents, cyclones etc.)

5.3 Water Quality Monitoring

- Ground and surface water quality is being monitored in and CMSWMF jointly along with Goa State Pollution Control Board (GSPCB) on monthly basis.
- Effluent Treatment Plant performance needs to be evaluated at least once in six months time interval.

5.4 Noise Monitoring

Noise monitoring is being carried out inside the CMSWMF area once in six months and outside the Facility on monthly basis to ascertain the prevalent noise levels as per the CPCB and OSHA guidelines, identify the noise generation sources and if required, take suitable measures to mitigate the noise generation.

5.5 Solid & Hazardous Wastes

Hazardous waste is being disposed/sold only to the GSPCB/CPCB authorized Coprocessors, Recyclers, Incinerators or TSDF in compliance with the provisions of the Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016.

5.6 House Keeping

The house keeping at the project site and residential complex will be effective and monitored on a regular basis.

5.7 Environmental Management Cell

A full-fledged Environment Management Cell needs to be established with multidisciplinary team of professionals, technical staffs and all necessary infrastructures; and the Cell is headed by Group Manager. This team will be also responsible for all environment management activities including environmental monitoring, greenbelt development, ensuring good housekeeping, ensuring statutory compliance as well as creating environmentally aware work forces in the facility including the proposed project.

The said team will be responsible for:

- Monitoring and Analysis of air quality, noise levels, meteorology, water quality and other environmental parameters.
- Implementation and monitoring of the pollution control and protective measures/ devices etc.
- Co-ordination of the environment related activities within the project as well as with outside agencies.
- Green belt development.
- Monitoring the progress of implementation of the environmental management program.
- Compliance to statutory provisions, norms of State Pollution Control Board, Ministry of Environment Forests and Climate Change (MoEF&CC) the conditions of the environmental clearance as well as the consents to establish and consents to operate.

5.8 Budgetary Provisions

The budgetary provisions towards environmental monitoring program for the proposed project shall be maintained.

5.9 Submission of Monitoring Reports to GSPCB/MoEF&CC

As per the requirements, the status of environmental clearance stipulation implementation will be submitted to MoEF&CC in hard and soft copy as per the prescribed period. The conventional pollutants will be monitored on monthly basis and reports will be submitted to GSPCB, as per the requirements.

Table 5.1 : Environmental Monitoring

Sr. No.	Environmental Component	Parameters to be Analyzed
1	Meteorology	Wind Speed, Wind direction, Temperature, Relative Humidity, Rainfall
2	Ambient Air Quality	Parameters as per MoEF&CC notification 2009
3	Fugitive Emission	PM, SO_2, NO_X, CO
4	Water quality of surface and ground water	Physical and chemical parameters as per GSPCB norms
5	Liquid effluents	Parameters as per GSPCB consent
6	Noise	Sound Pressure Levels (Leq) as per CPCB guidelines

Chapter 6

Project Benefits

Chapter 6
Project Benefits

A centralized Integrated Solid Waste Management Facility (ISWMF) proposed includes a Material Recovery Facility (MRF) for sorting and recovery of recyclables of the dry fraction and non-recyclable fraction, Waste-to-Energy plant based on bio-methanation & composting , electricity generated to be used for in-house plant operation, Reuse of mulched tree waste as structure material in composting activity, Facility for Storage and safe disposal of the E-waste and Engineered sanitary land fill facility for disposal of inert waste. Following are the advantages of this system.

- æ A Centralized Integrated Solid Waste Management Facility (ISWMF) provisions for MRF Facility, Bio-methanation system along with gas engines, In-Vessel Composting system, Sanitary Landfill, Mobile vehicles, workshop, Facility centre for operators, having canteen, shower area and medical room, Administration building, laboratory, Resource centre, Car & Vehicle parks, effluent treatment and recycle plant, Container storage yard, road network, peripheral drains, green buffer belt, site & street lighting, ESR, fire water system, borewell, ground water monitoring wells and plant fencing. The ISWM facility shall comply with the Solid Waste Management Rules, 2016.
- æ Complete facility to have automatic operation and a PLC/Scada control from a central control station.
- æ State-of Art, centralized Material recovery facility for recovering recyclables out of the nonbiodegradable component of city waste with provisions for screening, manual sorting on a conveyor belt, magnetic separator, bailing, packing and storage facilities.
- æ Biodegradable fraction shall be extruded, and converted into bio-gas/ electricity using anaerobic bio-methanation technology. The residue/Sludge shall be composted using completely enclosed rotating in-vessel composting drums followed by storage, screening and bagging operation.
- æ Engineered Sanitary Landfill facility with provisions for leachate management to scientifically landfill the reject component from the MRF as well as the inert residue from the bio-degradable fraction.
- æ Electricity generated from the plant to be used to run in-house plant operations and reduce operation cost.
- æ Sale of various recycled products, compost and RDF to provide a revenue source reducing the plant operating cost .

- Local manpower to be trained in operating the facilities to improve skill sets and competence.
- A special inhouse Resource centre to exhibit the potential of converting waste into useful products and also conducting regular tours for visitors, students and other academicians involved in sustainable waste management solutions.
- The DPR proposes for compliance of Solid Waste Management Rules 2016 by local bodies for Primary, Secondary collection and transportation.
- For the design of sanitary landfill, important issues like waste to be handled, access road, land area, evaluation of geology and hydrology of the site, surface drainage, operational plan, layout of MSW landfill, completed waste fill features, estimation of landfill capacity, embankment, foundation, selection of liner systems, selection leachate control facilities, selection of landfill gas control facilities, aesthetic consideration, post closure care, ground water protection, monitoring facility, determination of equipment requirement, estimated cost of the project design life have been carefully analysed and a rational concept has been developed.
- Design has also been developed for the processing facility, material recovery facility and other facilities. The cost estimates are prepared an area requirements worked out accordingly.

The Integrated Solid Waste Management Facility has been designed to treat and Process solid waste as generated in the Regional Area. The Main Fractions for resource recovery are :

A. Non-biodegradable or Dry fractions

1. **Recyclables collected from households, commercial establishments (**Paper – Cardboard, newspaper, office paper, Tetra packs, Plastic – HDPE, LDPE, Coated foils, PET, Metal – ferrous and non-Ferrous, Glass – White, Green and Brown colored, Cloth & textile, Styrofoam and Thermocoal)

B. Bio-degradable Fractions

a. Electricity generated from bio-methanation of organic fraction
b. Compost

The total quantum of dry waste is 24 TPD. Out of which 10% is considered to be inerts i.e 2.4 TPD and the balance Dry fraction would consist of Recyclables and Non Recyclables. It is assumed that out of the total 21.6 TPD of this waste 30% will be recyclables and 70% will be non-recyclable material. Revenue potential of each items are given in **Table 6.1** (for 100 TPD capacity).

Table 6.1 : Revenue Generation Potential of Proposed Integrated Solid Waste Management Facility

Si. No.	Particulars	Quantity of generation	Unit Rate	Amount Rs./day
1.	Recyclables	11000 kg/day	Rs. 2/kg	22000
2.	Electricity Generation	5855.76 Kwh/day	Rs. 7/unit	40990
3.	Compost	11.4 Tons/day	Rs. 1.5 /kg	17,100
			Total	**80090**

Refer **Table 6.2**, which indicates the Operation & Maintenance cost v/s Resource recovery and net income to the operator.

Table 6.2 : Income from Plant Operation

	Income from Plant Operation	
Sr.no.	**Parameter**	**Rs/Ton**
	Operations & Maintenance Cost	
a	Operations and Maintenance of the facility	2725
1	Total O&M cost	2725
	Resource Recovery	
2	Resource recovery from operations to the operator	800
3	Net income to the operator (2-1)	-1925
4	Operators % Loss Margin	-70.65%

Under such a situation, in case the Capital investment is also made by the operator, the tipping fee as charged by the operator will be very high and make the project unviable for the ULB's to sustain. As it has been observed in the SWM segment, operators do not invest proper capital outlay in building modern and proper ISWM facility as the tipping fee burden is high and unviable for corporations to pay, as a consequence hardly any treatment takes place at site and in most cases waste is dumped in a unscientific and unacceptable manner. Hence, in order to have a proper, viable and environmentally safe ISWM approach, it is recommended to seek funds under SBM as a central grant in order to build up the facility.

6.1 Social Cost-benefit Assessment

The proposed plan for Solid Waste Management in the Regional Area is based on 4R principal (Reduce, Reuse, Recycle and Recover). The plan is developed in lines with the requirements of SW Rules 2016 and ensures well-being of the society at large.

The SW management plan proposes up-gradation of the existing infrastructure and development of new infrastructure as per the current status of SW management facilities in Regional Area, In the proposed plan, infrastructure has been proposed to ensure that collection, transportation. Treatment and disposal of SW in Regional Area is done properly. The proposed approach will have positive and negative environmental, social and economic benefits to SW workers and the overall society.

The benefits and adverse impacts from the proposed SW management plan are summarized below in **Table 6.3**:

Table 6.3 : Impacts from Proposed SW Management Plan

Sr. No.	Benefit Description	Comments	Quantitative Impacts (wherever possible) & Underlying Assumptions
Benefits to ULBs/ other SW workers			
1.	Improved working conditions	- Provision of wheelbarrow with covered containers & brakes - Provision of PPEs - No manual handling of waste proposed	- Workers will be given infrastructure for waste collection and handling as per the design - Workers will be given appropriate competence training
2.	Improved workers morale	- Ability to perform activities as desired - Improved efficiency	- Infrastructure standard is maintained.
3.	Improved health & safety	- Reduction to waste exposure as waste to be covered at all stages of handling - Segregation of waste at source – biomedical and industrial hazardous waste not mixed with the MSW - Provision of appropriate PPEs - No manual handling of waste	- Workers given appropriate training on waste handling - Infrastructure facilities maintained as per the proposed design.
4.	Employment opportunities	- PPP proposed for MSW management - New infrastructure facilities (MRF, Compost Plant and Sanitary landfill) proposed	- PPP model is successful - Infrastructure facilities are run efficiently
5.	Reforms driven economic sustainability	- Grants are being provided on the condition that CCP would undertake suitable reforms in Management Accounting and other areas so as to maintain sustainability of the project in the long run	- Reforms Implemented
Benefits to the Society			
6.	Easy access to SW infrastructure facilities	- Door-to-door collection facility in all the localities in covered vehicles	- Door-to-door waste collection from all households
7.	Clean and Hygienic conditions resulting reduction in number of infectious and other diseases such as bronchitis, hepatitis, diarrheal, parasitic	- 100% door-to-door collection of waste proposed - SW handling in covered containers - Daily cleaning of roads and secondary waste storage depots - Waste transportation in covered vehicles	- Provided SW collection from all households

Sr. No.	Benefit Description	Comments	Quantitative Impacts (wherever possible) & Underlying Assumptions
	infection and pulmonary diseases		
8.	Environmental Improvement	- No dumping of waste on ground - Covered waste handling, so no foul odour at collection points - No open burning of waste - Recycling of waste - Composting of biodegradable waste - Development of Engineered Sanitary Landfill	- Provided SW management is done as per the design
9.	Improved quality of life	- Improved surroundings - Clean environment - Access to infrastructure	-
10	Improved awareness and civic sense in people	- Training and awareness of people for MSW management	- Dissemination to information, education and communication as per the design
Adverse Impacts			
1	Environmental impacts during construction of new infrastructural facilities	- Dust pollution during construction - Air pollution from vehicles - Water pollution due to construction activities - Noise from material transportation vehicles	- Adverse impacts from construction activities will be minimized by due care -
2	Reduced green cover	- Construction of landfill site and compost plant on a large piece of land	- Alternate green cover will be developed as per the norms to compensate for the loss
3	Labour Redundancy	- PPP proposed for most of the SW services - Under-utilization of labour presently employed with ULBs	- Number of redundant employees with ULBs will reduce over a period of time as the employees get retired - New employees to be appointed only as per the requirement
4	Possible unplanned development around integrated waste management facility	- Integrated Solid Waste Management Facility will have necessary infrastructure in place - Integrated Solid Waste Management Facility will generate employment	- Land use around the project site to be well defined - Plan for temporary and permanent workers engaged in project site to be developed

The negative and positive impacts summarized above indicate that positive impacts can be maintained and enhanced and negative impacts can be minimized with a properly planned approach. To achieve the broader objective of well-being of the society, the above aspects need to be inculcated in the project implementation plan

and its long-term operation and maintenance. The actual benefits to the society can only be realized after a period of successful implementation of the proposed plan.

6.2 Advantages of the Proposed System

- A Centralized Integrated Solid Waste Management Facility (ISWMF) provisions for MRF Facility, Biomethantion system along with gas engines, In-Vessel Composting system, Sanitary Landfill, Mobile vehicles, workshop, Facility centre for operators, having canteen, shower area and medical room, Administration building, laboratory, Resource centre, Car & Vechile parks, effluent treatment and recycle plant, Container storage yard, road network, peripheral drains, green buffer belt, site & street lighting, ESR, fire water system, borewell, ground water monitoring wells and plant fencing. The ISWM facility shall comply with the Solid Waste Management Rules, 2016.
- Complete facility to have automatic operation and a PLC/Scada control from a central control station.
- State-of Art, centralized Material recovery facility for recovering recyclables out of the non-biodegradable component of city waste with provisions for screening, manual sorting on a conveyor belt, magnetic separator, bailing, packing and storage facilities.
- Biodegradable fraction shall be extruded, and converted into bio-gas/ electricity using anaerobic bio-methantion technology. The residue/Sludge shall be composted using completely enclosed rotating in-vessel composting drums followed by storage, screening and bagging operation.
- Engineered Sanitary Landfill facility with provisions for leachate management to scientifically landfill the reject component from the MRF as well as the inert residue from the bio-degradable fraction.
- Electricity generated from the plant to be used to run in-house plant operations and reduce operation cost.
- Sale of various recycled products, compost and RDF to provide a revenue source reducing the plant operating cost .
- Local manpower to be trained in operating the facilities to improve skill sets and competence.
- A special inhouse Resource centre to exhibit the potential of converting waste into useful products and also conducting regular tours for visitors, students and other academicians involved in sustainable waste management solutions.

The DPR proposes for compliance of Solid Waste Management Rules 2016 by local bodies for Primary, Secondary collection and transportation.

For the design of sanitary landfill, important issues like waste to be handled, access road, land area, evaluation of geology and hydrology of the site, surface drainage, operational plan, layout of MSW landfill, completed waste fill features, estimation of landfill capacity, embankment, foundation, selection of liner systems,

selection leachate control facilities, selection of landfill gas control facilities, aesthetic consideration, post closure care, ground water protection, monitoring facility, determination of equipment requirement, estimated cost of the project design life have been carefully analysed and a rational concept has been developed.

Design has also been developed for the processing facility, material recovery facility and other facilities. The cost estimates are prepared an area requirements worked out accordingly.

Chapter 7

Environmental Management Plan

Chapter 7
Environmental Management Plan

Environmental Management Plan (EMP) describes the process that an organization will follow to maximize its compliance and minimize harms to the environment. The Environmental Management Plan (EMP) provides an essential link between predicted impacts and mitigation measures during implementation and operational activities. EMP outlines the mitigation, monitoring and institutional measures to be taken during project implementation and operation to avoid or mitigate adverse environmental impacts, and the actions needed to implement these measures.

The likely impacts on various components of environment due to the project during developmental activities have been identified and measures for their mitigation are suggested. The EMP lists all the requirements to ensure effective mitigation of every potential biophysical and socio-economic impact identified in the EIA. These actions will be incorporated into the **Concessionaire (GSIDC - GST&E - Successful Bidder)'s** management system and integrated into the implementation at various stages of project development.

- æ A comprehensive listing of the mitigation measures
- æ Parameters that will be monitored to ensure effective implementation of the action
- æ Timing for implementation of the action to ensure that the objectives of mitigation are fully met

The EMP comprises a series of components covering direct mitigation and environmental monitoring and a project site restoration plan. Therefore, environmental management plan has been prepared for each of the proposed developmental activities.

7.1 EMP During Construction Phase

Environmental impacts during construction phase, will be mainly due to civil works such as site preparation, RCC foundation, construction etc.; material and machinery transportation, fabrication and erection etc.; storage and handling of different kinds of flammable/hazardous materials etc. The construction phase impacts are of temporary nature and localized phenomena, except the permanent change in local landscape and landuse pattern at the project site and are expected to reduce gradually on completion of the construction activities. However, they require due consideration with importance during project execution and also wherever applicable

detailed protocol / procedures (in case of dismantling of existing units / infrastructure) shall be implemented to prevent / mitigate adverse impacts and occupational hazards.

a) Site Preparation

The site preparation and plant erection activities during construction phase should be carried out with proper preventive measures for pollution control as well as restoration of dismantled units / infrastructure and proper disposal of existing containments. At the time of civil works for proposed project units, it is necessary to control SPM levels through dust suppression methods.

- Usually, preparation of site will involve excavation, site grading and stockpiling of backfill materials. Due care shall be taken through slope stabilization to avoid water pollution problems during rainy season
- During dry weather conditions, it is necessary to control the dust emissions arising out of the excavation, leveling, transportation and stockpiling activities by proper water sprinkling.
- Temporary tin sheets of sufficient height (3m) will be erected around the site of dust generation or all around the project site as barrier for dust control.
- The top soil removed from construction areas if suitable, may be preserved to reuse for development of land-scapes and horticulture in the later part of construction phase
- Tree plantations around the project boundary will be initiated at the early stages by plantation of 2 to 3 years old saplings using drip irrigation or by regular watering so that the area will be moist for most part of the day
- All vehicles carrying raw materials will be instructed to cover with tarpaulin / plastic sheet, unloading and loading activity will be stopped during windy period.

b) Basic Facilities

- The work force during construction phase would be significant.
- The manpower required for these activities should preferably be employed from nearby areas so that avenues of employment will be open to local people.
- The construction work force may also required to be temporarily migrated to the project site, some may be with families. Sites for construction and workers camp should be clearly demarcated to prevent occupational hazard.
- Project proponents shall ensure provision for necessary basic needs and infrastructure facilities to the families of construction workforce.

c) Occupational Health

Project proponent shall take due care to include necessary clauses in respective construction tender / work awards for maintaining strict compliance of

occupational health standards for workers during duty period including provision and usage of personal protective equipment (PPE) to mitigate occupational health hazards.

- æ Since the proposed is CMSWMF to be created within the existing land fill area, gases or fumes (CO, CH_4, NH_3, H_2S, etc.) due to biomethanation of MSW are likely to be come across, while laying foundations, sufficient mechanical / artificial ventilation shall be provided to protect the health and safety of persons working there.
- æ If necessary, the personnel working in poorly ventilated work places shall be provided with respiratory protective equipment. Fire hazard safety norms are required to be strictly followed.

d) Construction Equipment and Waste

- Both diesel and gasoline powered construction machinery, vehicles etc. put in to operation at project site shall be properly maintained to minimize exhaust emissions as well as noise generation
- Efforts should be made to prevent accidental spillage of any oil / grease from construction equipment maintenance activities, and empty containers, rubber & plastic materials etc generated during construction is expected to be properly disposed off and CMSWMF authorities should take care of these issues
- Though the effect of noise on the nearby inhabitants due to construction activity will be marginal, major noise prone activities should be restricted to only daytime
- The construction machinery should be maintained to minimize the noise generation

e) Storage of Hazardous Materials

Hazardous materials such as petrol, diesel, lubricating oil, compressed gases, paint and varnishes as also explosives for blasting operations, if required at the construction site shall be stored and handled strictly in accordance with the prevailing safety regulations. Thus, **Concessionaire** authorities need to ascertain these aspects.

7.1.1 Design/Detailed Engineering

- æ The proposed project site is situated in medium seismic zone as per seismic zone map of India. Hence, all critical/major structures shall be designed and constructed as earthquake proof/resistant structures
- æ Selection of suitable fuel combustion technology, major equipment like GTs, compressors, pumps, fans etc. for strict compliances of specifications related to noise generation shall be considered
- æ Utmost precautionary measures / high level of safety measures shall be adhered to while commissioning / test run / startup of individual modules in each phase of proposed CMSWMF

- A comprehensive post-project environmental monitoring shall be carried out as outlined in **Annexure–X** after commissioning the proposed unit process / unit operations to assess the cumulative impacts

General measures proposed to be undertaken for mitigating adverse environmental impacts during various activities of construction phase are discussed. However environmental component wise mitigation measures are discussed below.

7.1.2 Air Environment

During the construction phase, chronic gaseous emissions are expected from the heavy machineries deployed for construction. All other emission sources are intermittent and include emissions from heavy vehicles. Though the gaseous emissions are not expected to contribute significantly to the prevailing ambient air quality, some generic measures to reduce fugitive and gaseous emissions during construction phase from point, area and line sources shall include the following:

- Water sprinkling on main haul roads in the project area will be done, this activity will be carried out at least twice a day, if need arises frequency will be increased on windy days
- Those sections of the working area that are being trafficked over will be damped by controlled application of water sprays (e.g. by water dowsers) as conditions dictate
- All vehicles meant for loading / unloading of construction materials to the site or removing soil / debris shall be enclosed and covered to prevent escape of dust
- Vehicles or equipments will be checked against stipulated norms for pollutant emissions
- Exhausts of other equipments used for construction (e.g. generators) will be positioned at a sufficient height to ensure dispersal of exhaust emissions and meet the standards set by CPCB (**Annexure – XI**.)
- Engines and exhaust systems of all vehicles and equipments will be maintained so that exhaust emissions do not breach statutory limits (set for that vehicle / equipment type and mode of operation by CPCB) and that all vehicles and equipment are maintained in accordance with manufacturers' guidance
- Dust masks should be provided to construction workers, while carrying out operations that may entail potential for dust inhalation

7.1.3 Noise Environment

The following measures are recommended to mitigate adverse impacts on noise environment during construction phase:

- Personal protective equipment like earmuffs, helmets covering ears should be provided to the onsite workers, working near noise generating equipment and should be seen that, workers use the protective gadgets regularly.

- Earth movers and construction machinery with low noise levels should be used
- Periodic maintenance of construction machinery and transportation vehicles should be undertaken

7.1.4 Water Environment

Measures for Supply of Water

The project developer should not extract fresh water from any waterbodies (surface or groundwater) for the construction phase of the project. No existing resources / fresh water sources (surface / groundwater), which are currently being used as drinking water and / or water for irrigation or other purposes should be tapped into. The water shall be supplied from the existing water resources of GSIDC for construction purpose.

Drinking water requirements during the construction phase should be met from packaged water / water transported through tankers to the construction sites. Construction laborers should be provided with adequate quantity of drinking water of potable quality.

Mitigation Measures for Prevention of Water Pollution

The only two credible sources of potential impacts arise from uncontrolled run-offs from the labor camps and accidental spills of oil etc. into surface and groundwater bodies. During site development necessary precautions will be taken, so that the runoff water from the site gets collected to working pit and if any over flow is, will be diverted to nearby greenbelt / plantation area

The selected contractor should be obligated to follow the procedures, so as not to pollute groundwater. Sufficient and appropriate sanitary facilities should be provided in order to maintain hygienic conditions in the camps of construction laborers. The domestic wastewater generated from temporary toilets used by the work force will be diverted to septic tank followed by soak pit. Therefore, impact on water quality due to proposed unit would be insignificant.

The solid waste generated should be collected and disposed off in an appropriate manner. The existing workshop areas at the complex should be used for the maintenance of vehicles and construction machineries so as to avoid accidental spills of oil/oily wastes. The waste generated from the site work shop will be segregated like used oil, lubricants, etc and disposed to authorized recyclers.

7.1.5 Land Environment

The solid waste generated during construction period being predominantly inert in nature, construction and demolition waste does not create chemical or biochemical pollution. However maximum effort would be made to reuse and recycle them. The most of the solid waste material will be used for filing/ levelling of low-laying areas, as road construction material, if any excess given to local contractors for lifting and dumping in low lying areas.

On completion of construction works, all temporary structures, surplus materials and wastes should be completely removed. Dumping of construction waste on agricultural land should be prohibited.

The solid wastes such as paints, lubricants, oil, diesel containers or any other non-biodegradable wastes that have leaching characteristics should be disposed off as per the "Authorization' received from Goa state PCB.

A waste management plan should be prepared or integrated with existing plan before the commissioning of activity, implemented and monitored for all land-based construction operations.

. During construction period, there could be clearing of vegetation in order to prepare the site for construction, the top soil from the construction area shall be collected and be stored separately for greenbelt development. A comprehensive green belt program shall be planned to improve the ecological condition of the region.

7.1.6 Socio-economic Environment

Workers engaged during construction phase should preferably be provided with temporary housing facilities at planned labor colonies located nearer to project site.

The project and related developments like construction camps should not be dependent on local resources (power, water), during both construction and operation phases.

The only likely impact on infrastructure would be on the roads, during the construction phase. A traffic management scheme should be developed to avoid congestion on the nearby and local roads.

7.1.7 Health and Safety

Adequate security arrangement would be made to ensure that the local inhabitants and the stray cattle are not exposed to the potential hazards of construction activities. Round the clock security personnel shall be appointed to restrict entry of unwanted people to the site.

The movement of heavy equipments should be done with proper precaution to prevent any accidents on the road. Occupational risk should be minimized at the project site through safety measures. Movement of vehicles with 20-40 km/hr imposed speed limits on internal roads will reduce risks of accidents or injuries.

Safety training should be provided to all construction workers on operation of equipment. Security should also be extended during non-working hours to ensure there is no uncontrolled access to the machinery and equipment.

The contractors should also be vigilant to detect workers showing symptoms of communicable diseases. All illness and incidents shall be reported and recorded.

7.2 Environmental Management Plan During Operation Phase

The dumped MSW at the site has been lying for the past many years, and exposed to the atmosphere conditions. Therefore the characteristics of this waste is

likely to exhibit considerable variation especially with respect to organic fraction which should be on much lower side owing to natural degradation over the years. It is therefore proposed to mix this waste daily in a defined proportion with the fresh waste and process in all the 3 shifts. The mixing proportions of dumped MSW will be decided on the basis of the characteristics of fresh MSW received to achieve consistent waste characteristics, which will ensure smooth operation of the plant.

This waste shall be removed from the dumping site using mobile machineries like, backhoe Loaders. The same will be mixed with the fresh waste on the tipping floor and will be subjected to further processing in different units such as Screens, Sorting Station, Organic Extrusion Press, Wave Screen, Wind sifter, Digesters, In-vessel Composting Drums and Star Screen etc. The upcoming plant is capable of treating the existing waste also as it has all the facilities for segregation and recycle of useful non-biodegradable fractions. Therefore the non-biodegredable fraction from the dumped MSW shall also be segregated, recycled and no additional units are required to be added in order to treat the existing waste.

7.2.1 Disposal of Inert Fraction Generated During Treatment

At present the Sanitary landfill cells are designed to store 10% of the inert fraction over a period of 10 years in the existing land fill cells. The inerts generated from the processing of existing dump waste shall be disposed along with the inerts generated from the plant. A total of 1.41 hectares of land has been allocated to the sanitary landfill cells, this area (Fourteen thousand one hundred sq. mts.) shall be used to make a sanitary land fill cells, which will include inerts from both the fresh waste as well as the existing waste lying in the dumpsite. The total land acquired for the project is 12.1580 hectares (One lakh twenty one thousand five hundred and eighty sq. mts.), out of which the main plant occupies only 4.2 hectares (Forty two thousand sq mts.) and the sanitary landfill occupies another 1.41 hectares (Fourteen thousand one hundred sq. mts.) i.e a total of only 5.61 hectares of (Fifty six thousand one hundred sq. mts) is being used by the overall facility, to treat the new as well as the old waste. This area is much less than the overall occupied land area and further once the treatment of the old waste starts, more area will become available at the site.

7.2.2 Procedure for extraction of waste and harvesting of methane and other Land fill gases

The existing waste in the dump area is partially lying of the ground and partially inside the quarries. Two different approaches shall be used to extract the waste depending upon the aboveground waste and the old waste lying in quarries.

A “Peripheral Extraction Method” shall be employed starting from outer most edge of the waste heap to extract the waste in smaller layers with the help of mobile machineries e.g. Backhoe Loaders etc. As this waste is already exposed to the air, it is not likely to yield any significant quantities of gases like NH_3, H_2S, and CH_4 etc. Therefore this waste shall be mixed with the fresh waste in small fractions and processed during all the 3 operating shifts. The proportion in which the existing waste can be mixed with the fresh waste will be decided during the plant operation depending upon the characteristics of the same. However, all the safety precautions such as providing Personal Protective Equipment to workers shall be taken.

The waste lying in the quarries is much older in nature; it is likely that most of the biodegradable fraction has been degraded over a period of time and its methane potential might be much lesser compared to fresh organic load. However, as it has been covered by the waste, it is possible that the landfill gases (LFG) gases such as NH_3, H_2S, CH_4 and other Volatile Organic Compounds (VOCs) are present in variable concentrations and quantities and therefore due precautions are necessary to reduce the quantities of emissions by trapping and safe disposal (burning). Hence, prior to the removal of this waste, it is necessary to harvest the landfill gases. For harvesting of landfill gases, a GI pipe grid shall be erected at the dump yard to extract the methane and other gases. The emitting gases will be flared. Depending on quantities of emissions generated, one of the generators of appropriate capacity can be deployed to generate electricity to make the process more ecofriendly. Flaring can lead to global warming, but generation of electricity reduces this fractional warming.

As part of the dumped waste is lying open to the atmosphere, extraction and harvesting of methane gas for generation of power from the waste lying on the open ground may not be effective. This method is more suitable when the dumpsite is properly capped and closed, as the top capped surface creates an effective barrier and prevents the gas from being directly released in to the atmosphere. In a capped dump site the pipe grid is effective in capturing 60-80% of the gas, which can be then directed into the gas engines for power generation. In this case at the most a top cover of 10 to 15 mm soil layer can be used to cover the waste prior to harvesting of the gas if found necessary.

For the waste lying above ground, the pressure, concentration and quantity of landfill gases is expected to be low and hence it is recommended to extract the LFG and flare the same. The handling of the landfill gases shall be done by daily monitoring of Lower Explosive Limit (LEL) of methane (CH_4), hydrogen sulphide (H_2S) and ammonia gas (NH_3) to ensure that no spontaneous fire is generated at site. However the strategy of extracting LFG for power generation can be employed for extracting the gas from the waste lying the quarry area, in which case the pipe grid shall be connected to the existing biogas holder instead of the flare stack, and the gas shall be used for power generation.

Necessary control measures will be undertaken at the design stage to meet the statutory requirements and towards minimizing environmental impacts. During project implementation period, special emphasis will be made on measures to minimize lechate / effluent generation and dust control at source. The specific control measures related to air emissions, liquid effluent discharges, noise generation, solid waste disposal etc. due to proposed CMSWMF are recommended as follows:

7.2.2.1 Air Environment

The main activities from the proposed project which cause air pollution are, dust particulates due to movement of vehicles and road sweepings, temperature & Odour from Compost plant, Odour & Gas generation from secured landfill and combustion products from Biogen sets or flaring of biogas under emergency situations emitted through the respective stacks. The incremental predicted GLCs of major air pollutants viz., NOx due to the proposed activities over the baseline air quality are within stipulated standards of CPCB for residential / rural regions, i.e.

80 µg/m^3. However, there will be marginal increase in total NOx emissions. The following measures are recommended to mitigate adverse impacts on air environment:

- **Regular monitoring of scrubbing system for purification of biogas** provided by the equipment vendors prior to utilize in **Biogas Genset,** for power generation shall be should be monitored to ascertain for absence of SO_2 emissions.
- Biogas Genset and flare (during emergency condition) shall be operated with minimum excess air (controlled combustion using lox NOx burners), so that fuel combustion is optimized and emission of NOx is minimized
- Ambient air quality with respect to PM_{10}, $PM_{2.5}$, SO_2, NOx, Ammonia, VOC's and CO should be monitored regularly at different sampling stations selected in consultation with Goa UTPCB within the impact zone. The sampling stations should be selected based on the maximum ground level concentration anticipated and keeping maximum stations in the downwind direction and at least one in the upwind direction
- Port holes and sampling facilities should be provided at proper location in all the stacks for monitoring of flue gas at regular intervals
- A weather monitoring station shall be operated continuously and regular data logging shall be done
- Proper moisture, oxygen and C:N ratio shall be maintained to minimize the odour and to maintain adequate temperature in compost plant
- Gas management system in secured landfill shall be provided
- Green belt shall be provided along the internal roads and plant boundary.
- To control fugitive emissions of VOCs / Odors, over and above the inbuilt measures of **Bio-Scrubbers** provided by the vendor along with the plant equipment , following steps should be taken :
  - Provision of internal floating roof tanks with flexible double seal for storage tanks
  - Provision of mechanical seals in pumps
  - Regular inspection of floating roof seals and proper maintenance of floating roof seals for existing tanks
  - Preventive maintenance of valves and other equipments
  - Fugitive emissions monitoring at regular intervals
  - Strengthening / Maintaining existing plantation
  - Use of high grade gasket material for packing
  - Implementation of Leak Detection and Repair (LDAR) programme using a portable VOC detection instrument
- Inventory of odorous compounds should be maintained and release of such compounds due to leakages should be prevented by following strictly the relevant guidelines for storage and handling of such materials

- æ To minimize occupational exposure / hazards, the practice of using personal protective facilities like helmets, safety (gas) mask / safety dress, shoes etc. be followed for all workers, engaged in operation of process units within the facility
- æ The health checkups (diagnostic) for all regular employees at the facility to be maintained along with the corresponding health records at scheduled intervals
- æ Gas powered or low sulphur diesel and unleaded petrol in conventional vehicles may be used within the project area and for MSW dumping and evacuation of finished product (Compost)
- æ Idling of vehicles should also be minimized during transport and handling activities
- æ Loading / unloading and storage areas should be paved to reduce dust emissions
- æ All access roads (internal as well external) to be used by the project authorities shall be covered either with concrete or bitumen to suppress the dust generation along the roads
- æ Fuel leaks should be prevented from on-land equipment. Further, installation of leak detection systems and conduction of leak detection tests on fuel systems shall be done including distribution lines and tanks
- æ Emissions from individual stacks should comply with the emission standards stipulated by MoEF / CPCB for proposed units

7.2.2.2 The Odour Management

The main aim is to minimize the number of sources of odour generation which exist in site. To undertake direct management of odour generating sources that give rise to odour problems. The mitigation measures proposed to minimize and control odour are as follows:

- æ Maintaining proper air and moisture in the compost plant area.
- æ Dilution of odourant by odour counteraction or neutralize by spraying Ecosorb (organic and biodegradable chemical) around odour generation areas at regular intervals.
- æ Covering the landfill area under operation daily with layer of earth, clay or a similar material.
- æ Covering by using heavy duty hessian, plastics and foams

7.2.2.3 Noise Environment

Restricted areas will be those locations, where it is not reasonably practicable to reduce the noise level below the work area limit. Wherever practicable, attempts shall be made to reduce the noise level below 85 dB (A). The noise levels will not exceed 60 dB (A) at the perimeter of the project area. The equipment will be chosen in such a way that the above noise limit is not exceeded. The noise levels at the nearest habitation after proposed expansion will be less than the stipulated standards

of CPCB. However, as a good operational procedure, the following generic measures will be implemented in addition to the existing plantation:

- æ The major areas of concern for noise generation shall be adequately addressed by considering it during procurement of the machinery from vendors at project implementation stage. Further feedback from the monitored noise levels at sensitive locations will be taken to ensure that the impact due to high noise levels is practically minimized
- æ Monitor job and location specific noise levels for compliance with SHE regulations by verifying acceptability of noise levels caused by the project activities and comparison with noise criteria
- æ Conduct periodic audiometric tests for employees working close to high noise levels, such as compressors, Biogen sets, the loading and unloading sections, conveyor belts, etc.
- æ Provision of Personal Protection Equipments (PPEs) need to be done and their proper usage should be ensured for eardrum protection of the workers as well as visitors
- æ It should be ensured that low noise (generating) equipment are procured wherever feasible for proposed project
- æ Acoustic laggings, and silencers should be used in equipment wherever necessary
- æ Sound proofing/ glass panelling should be provided at critical operating stations/ control rooms
- æ Either Acoustic barriers/ shelter shall be developed in noisy workplaces or acoustic enclosures shall be provided for the high noise generating equipment
- æ Noise generating sources in the areas of SWMF should be monitored regularly. Monitoring of ambient noise levels should also be carried out regularly both inside the facility as well as outside the greenbelts, boundary wall.

7.2.2.4 Water Environment

- æ The main wastewater generation sources in the proposed project are domestic wastewater, leachate generation from compost plant and secured land fill area.
- æ It is recommended that top priority should be given to provide a well drainage facility at each process and unit operations for handling MSW to take care of any leachate formed even as rare possibility during unloading, sorting, transportation to biomethaanation unit etc. of MSW, so that it is ensured that will not contaminate none of the surface and ground water resources
- æ The wastewater generated from the facility is mostly MSW leachate, floor washings and domestic wastewater. The proponent has provision to treat combined wastewater in a separate effluent treatment plant

equipped with Reverse Osmosis (RO) system to ensure efficient recycle of water with in the CMSWMF.

- æ An ETP has been planned in the proposed project however, CMSWMF authorities should ascertain at planning stage and further evaluate at commissioning stage of ETP, so that the treated effluent would have characteristics of prescribed limits of Goa PCB/CPCB. The performance of ETP should be continuously monitored and any deviation in performance should be corrected on priority
- æ Reuse of treated effluent should be attempted to the maximum possible extent. Treated effluent should be used for washing floors etc.
- æ The detailed record of raw water intake and wastewater generation from different sources shall be maintained on daily / regular basis w.r.t. flow rates and characteristics.
- æ Performance evaluation of effluent treatment plant should be undertaken at regular intervals for all relevant parameters covered under this study
- æ Storm water drainage system should consists of well-designed network of open surface drains and rainwater harvesting pits along the drains, so that all the storm water is efficiently drained off without any water logging

7.2.2.5 Land Environment

- æ Plantation and greenery in and around the SWMF may be strengthened and maintained
- æ Effective drainage pattern to avoid contamination by leachates from any point of MSW handling especially during monsoon is mandatory throughout the proposed facility
- æ A record with respect to quantity, quality and treatment / management of MSW / hazardous waste shall be maintained
- æ All hazardous waste generated shall be segregated as per its category and be stored, handled and disposed off as per hazardous waste (Management & Handling) Rulers, 2003
- æ Under the Biomedical Waste (BMW) Rules 1998, revised up to the year 2003, the Generators / Occupiers of the medical facility are directly responsible for implementation, developing agency has to monitor that the BMW does not get mixed with MSW and shall help the generator in BMW management

Post Operation of Landfill

A final landfill cover is usually composed of several layers, each with a specific function. The surface cover system must enhance surface drainage, minimise infiltration, support vegetation and control the release of landfill gases. The landfill cover to be adopted will depend on the gas management system. As recommended by the MoEFCC and CPHEEO the final cover system must consist of a vegetative layer

supported by a drainage layer over barrier layer and gas vent layer. The details of the landfill cover are given below.

7.2.2.6 Biological Environment

In order to mitigate the impacts due to operation of proposed SWMF, following measures are recommended to mitigate adverse impacts on biological environment:

- Development of green belt with carefully selected (tolerant to air pollution) plant species is of prime importance due to their capacity to reduce noise and air pollution impacts by attenuation/assimilation and for providing food and habitat for local macro and micro fauna.
- For developing the greenbelt in and around proposed project site care need to be taken to plant the evergreen species. The planting of evergreen species may have certain advantages that may reduce the environmental pollution.
- Survival rate of the planted trees should be closely monitored and the trees, which could not survive should be replaced by more tolerant species.
- The rainwater harvesting shall be practiced to the maximum possible extent. Treated wastewater should be used for greenbelt development.
- Provision of land and adequate funds for strengthening of existing as well as additional plantation to create green belt of appropriate width as per CPCB guidelines should be made in the proposed project
- Social awareness programme about the importance of conservation of flora and fauna need to be conducted. The tourists should be strictly warned to avoid throwing of non-degradable waste materials in the project area, so that ecosystem should not get harmed

Development of Greenbelt Green/Plantation

- The main objective of the green belt is to provide a barrier between the source of pollution and the surrounding areas. The proposed greenbelt development should be of a suitable width along the periphery of plant and space between the units located within the plant, along the roads, the areas of unloading / loading and storage of MSW and Compost respectively
- The green belt helps to capture the fugitive emission odours and to attenuate the noise generated apart from improving the aesthetics. Development of green belt and other forms of greenery shall also prevent soil erosion and washing away of topsoil, besides helping in stabilizing the functional ecosystem and further to make the climate more conducive and to restore water balance.
- While making choice of plant species for cultivation in green belts, weight age has to be given priority to the natural factor of bio-climate. It is also presumed that the selected plants will be grown as per normal horticultural (or forestry) practice and authorities responsible for

plantation will also make sure that adequate provision for watering and protection of the saplings exists at site.

Criteria for selection of Plant Species

The plant species suitable for green belt development should be selected based on the following characteristics.

- æ It should have thick canopy cover
- æ They should be perennial and evergreen
- æ They should have high sink potential for pollutants
- æ They should be efficient in absorbing pollutants without significantly affecting their growth.

The list of selected evergreen plants species for development of green belt is given in **Table 7.2.**

7.2.2.7 Socio-economic Environment

In order to mitigate the adverse impacts likely to arise out of proposed SWMF as well as for its smooth initiation and functioning, the following measures are suggested:

- æ Authority should undertake regular environmental awareness programs to bring forth the beneficial aspects of the projects and environmental management measures being undertaken for improving their Quality of Life
- æ Social welfare activities should be undertaken by the project authorities in collaboration with the local bodies and the information regarding the project activity and its plans, social welfare programme etc. should be circulated in the form of booklets and shown as audio-visually
- æ In order to improve socio-economic status in slum area, the authorities should consider extending welfare measures to the local people under the community development programme
- æ In order to minimize impact due to traffic conjunction, scheduling for the movement of vehicles should be done in order to avoid peak traffic condition, to the extent possible
- æ Road side plantation on both side of the approach road to the project site may be undertaken by the project authorities.
- æ Continuous Awareness & involvement of occupants and floating population in SWM shall be organized for total success.
- æ **Enforcement**- prohibition of littering, separate collection at source, door to door collection and other modes as specified by the implementing authority; Environment protection force shall be organized for corrective action and disciplining of the residents, employees, occupiers, visitors and tourists.

Occupational Health Management

There will be routine observation of health as certain sufferings are likely to appear as result of exposure by the workers during operations of various facilities. All the employees shall be required to undergo a medical checkup before joining the facility. Medical checkup will be conducted on regular basis and the health conditions will be monitored. First aid facilities required to attend immediately for meeting emergency situations shall be made available at the facility.

Fire Protection System

The fire protection system will protect the entire site area from fire hazards happening accidentally.

This fire protection system comprises of a ground level water storage tank to store the anticipated requirement of water. One electric motor driven pump and one diesel high pressure pumps will be provided to pump the water to a high pressure header from where the water is distributed to various high pressure hydrants provided at selected locations. Necessary fire hoses terminated with spouts will be kept ready at each hydrant location to facilitate fire fighting. The header also caters to a multi fire system to automatically sprinkle water through sprinklers provided.

7.3 Post-Project Environmental Monitoring

In order to study the effectiveness of implemented measures suggested in EMP, and to achieve the conditions stipulated in EC for prevention of environmental degradation likely to occur due to proposed developmental activity, it is required to monitor the environmental quality status during construction and operational phase of the project. Thus, the project proponent has to form 'Environmental Management Cell', operative right from construction of approach roads and site preparation. The required instrumentation to facilitate the monitoring of environmental quality with respect to the major environmental components like air and water are presented. The environmental quality monitoring such as number of samples, parameters, frequency, duration and associated standards should be followed strictly as specified in the NOC, CFE/CFO and Environmental Clearance etc. by Goa PCB/CPCB and MoEF respectively. An overall guidance in selecting sampling locations and frequency is provided in **Table 7.3**.

7.3.1 Air Pollution

Following monitoring systems are proposed:

- Ambient air quality monitoring stations should be installed at four locations within and a few representative location around the CMSWMF Particulate matter (PM_{10} and $PM_{2.5}$), SO_2, NOx, CO, VOCs and Odour should be continuously monitored. The ambient air quality data should be transferred and processed in a centralized computer facility equipped with required software. Trend and statistical analysis should be done to asses the performance of control measures adopted and overall changes in ambient air quality

- Micro Meteorological parameters (namely wind speed, wind direction, temperature, relative humidity and rainfall) need to be monitored at the station having minimum interference from structures
- Work zone monitoring should be carried out near the sources of fugitive emissions i.e. storage tanks. Total hydrocarbons (Methane and non-methane) and VOCs should be monitored in work zone at regular intervals, as stipulated by loading unloading facilities etc.

7.3.2 Noise

Monitoring of the noise levels and exposures is essential to assess the effectiveness of Environmental Management Plan implemented to reduce noise levels. Audiometric tests should be conducted periodically for the employees working close to the high noise sources.

7.3.3 Water Resources

Sampling and analysis of wastewater from ETP may be carried out. Composite samples should be collected by flow weighted hourly samples for characterizing wastewater. Methods of sample collection and preservation should be as per ISO: 5667-1-11.

Methods prescribed in "Standard Methods for Examination of Water and Wastewater" and Book on “Water and Wastewater Analysis” are recommended, to be followed for analysis.

7.3.4 Land Resources

The soil (land area) under plantation / greenbelt should be monitored for soluble ions and pH. Condition of the various plant species should be recorded simply by visual observations with respect to vegetation growth, flowering etc. This may help in identifying affected plants. The efficacy of the solid waste management based on various indicative parameters should also be evaluated periodically, preferably once in a year.

Table 7.1 : Mitigation Measures during Construction Phase

Activity	Environmental Impact	Mitigation Measures	Institutional Responsibility
Site clearing	Particulate emissions	- Water sprinkling - Face masks	- Contractors
	Noise generation from construction equipment and vehicles	- Noise specifications for earthmovers, construction equipments etc. to be well within the permissible limit - Personal protection equipment - Periodic maintenance of machinery	- Contractors
	Loss of flora and fauna	- Revegetation at least in twice the no. of felling of flora of existing vegetated area	- Project developer with assistance from local Forest Department

Activity	Environmental Impact	Mitigation Measures	Institutional Responsibility
	Increased soil erosion from cleared area	- Stockpiling - Soil protection measures	- Contractors
Soil excavation/ quarrying	Particulate emissions	- Water sprinkling - Face masks - Transport of materials through covered containers/trucks in dense populated zone such as town centre	- Contractors
	Noise generation from excavating equipment / explosives	- Noise specifications for equipment - Personal protection equipment - Periodic maintenance of machinery	- Contractors
	Soil erosion from excavated site / quarries	- Stabilization of quarries - Vegetation over excavated site	- Contractors - Quarry owners, collectors
Transportation of construction materials	Particulate and gaseous emissions (CO, HC, NOx)	- Covered transport of construction material - Maintenance of vehicles	- Truck owners/contractors
	Noise generation	- Maintenance of vehicles	- Truck owners/contractors
Construction activities	Particulate and gaseous (CO, HC, SO_2, NO_x) emissions	- Water sprinkling - Maintenance of construction, vehicles engine/machineries and use of clean fuel	- Contractors
	Noise generation	- Maintenance of vehicles	- Contractors
	Sewage generation in labour camps	- Provision of sanitation facilities and sewage treatment plant	- Contractor
	Cutting of trees for usage of wood as fuel	- Provision of alternate fuel	- Contractor
DG sets for power generation	Gaseous emissions (SO_2, HC, CO, NO_x)	- DG set maintenance to meet stipulated standards - Use of quality fuel	- Contractor Diesel suppliers
Trenching for laying pipelines/sewers/cables	Soil erosion	- Top soil preservation - Backfilling within a few days after removal, well before monsoon	- Contractor
Land reclamation	Impact on soil quality and erodibility	- Soil compaction	- Contractor

Table 7.2 : List of Plant Species Suggested for Green Belt

Sr. No.	Name of Plants Species
Trees	
1.	*Acacia auriculoformis (16 m)*
2.	*Acacia nilotica (8 m)*
3.	*Achras sapota(10m)*
4.	*Aegle marmelos (12 m)*
5.	*Annona squamosa (10 m)*
6.	*Albizia lebbeck(20 m)*
7.	*Azdirachta indica (20 m)*
8.	*Cassia siamea (10-12m)*
9.	*Casuarina equisetifolia (10 m)*
10.	*Dalbergia sisoo (10 m)*
11.	*Derris indica (10 m)*
12.	*Ficus bengalensis (20 m)*
13.	*Ficus religiosa (20 m)*
14.	*Peltophorum pterocarpum (10m)*
15.	*Pithecellobium dulce (8 m)*
16.	*Psidium guayava (15 m)*
17.	*Syzygium cumini (20 m)*
18.	*Tamarindus indica (20 m)*
19.	*Zizyphus mauritiana (10 m)*
Shrubs	
1.	*Bougainvillea spectabillis (8 m)*
2.	*Citrus lemon (3 m)*
3.	*Lawsonia inermis (5 m)*
4.	*Nerium indicum (5 m)*
5.	*Thevetia peruviana (6 m)*

Source: CPCB Guideline for Development of Green Belt, edition 2002

7.4 EMP for landfill site

7.4.1 Pollution Prevention During Operation

Measures are needed to ensure that the landfill operation does not adversely affect local environment within and outside the landfill. Operators may appoint community liaison officers to be available to visit complainants and establish the

nature and source of the problem. This is reported to the site manager so that corrective measures can be taken.

Traffic: Heavy lorry traffic can give rise to nuisance, damage to road surface and verges and routing problems. The following guidelines are helpful:

a. Routing to avoid residential areas
b. Using one-way routes to avoid traffic conflict in narrow roads
c. Carrying out road improvements, for example, strengthening or widening of roads, improved provision of footpaths, improvement of sight lines, provision of passing places, provision of new roads.
d. Limiting the number of vehicle movements
e. Restrictions on traffic movement hours which are staggered with respect to peak traffic hours.

Noise: Adverse impacts on the local community from noise may arise from a number of sources including - throughput of vehicles and fixed and mobile plant, for example compactors, generators at the site. Peripheral noise abatement site measures should be adopted.

Odour: Offensive odours at landfill sites may emanate from a number of sources, including waste materials, which have decomposed significantly prior to landfilling, leachates and leachate treatment system, and landfill gas.

Good landfill practices will greatly reduce general site smell and reduce impact from odours which could lead to complaints from the local community, site users and site staff. Good practice includes: (a) adequate compaction; (b) speedy disposal and burial of malodorous wastes; (c) effective use of appropriate types of daily cover; (d) progressive capping and restoration; (e) effective landfill gas management; (f) effective leachate management and (g) consideration of prevailing wind direction when planning leachate treatment plants, gas flares, and direction of tipping.

Litter: Poor litter control both on and off site is particularly offensive to neighbours. Good operational practice should be adhered to in terms of waste discharge, placement, compaction and covering to minimize the occurrence of windblown litter. Measures for controlling litter include:

a. Consideration of prevailing wind direction and strength when planning the filling direction and sequence.
b. Strategically placed mobile screen close to the tipping area or on the nearest downwind crest.
c. Temporary banks and bunds immediately adjacent to the tipping area.
d. Permanent catch fences and netting to trap windblown litter
e. Restricting incoming vehicles to only those which are sheeted and secured will reduce litter problems on the highways.

Litter pickers should be employed to collect litter which escapes the preventative measures. Litter screens, fences, nets and perimeter ditches should be maintained free of litter.

Bird Control: Birds are attracted to landfill sites in large numbers, particularly where sites receive appreciable amounts of food wastes. Usually only large birds such as eagles, gulls are regarded as a nuisance. Bird control techniques should be carefully planned taking into account the species likely to be affected. Measures which can be used to mitigate bird nuisance include the employment of good landfill practice, working in small active areas and progressive prompt covering of waste, together with the use of bird scaring techniques. Measures involving explosions or distress calls have inherently adverse environmental impacts in terms of noise.

Vermin and Other Pests: Landfills have potential to harbor flies and vermin, particularly where the waste contains food materials. Modern landfilling techniques including prompt emplacement, consolidation and covering of wastes in well-defined cells· are effective in the prevention of infestation by rodents and insects. Rats and flies are the main pests which require control. Sites with extensive non-operational land can become infested with rabbits.

Effective measures to deal with rodent infestation include regular visits by pest control contractors or fully trained operatives. The use of insecticides on exposed faces and flanks of the tipping area, by spraying and fogging, is an effective means of exterminating insects.

Dust: Dust from landfill operations is mainly a problem during periods of dry weather but can also arise from dusty waste as it is tipped. Dust is generally associated with (a) site preparation and restoration activities; (b) the disposal of waste comprising of fine particles, for example powders; and (c) traffic dust. Dust suppression can be effected by (a) limiting vehicle speed; (b) spraying. Roads with water; and (c) spraying site and powder type waste with water.

Mud on the Road: Mud on the public highway is one of the most common causes of public complaint. It is, therefore, in the interests of the landfill operator to provide adequate wheel cleaning facilities to ensure that mud is not carried off site by vehicles.

7.4.2 Landfill Fire Management

Fires in waste and landfill sites are not uncommon and it is important for site operators to be aware of the dangers, how to treat fires and to address the problems associated with them. All fires on-site should be treated as a potential emergency and dealt with accordingly.

All sites should have an emergency tipping area set aside from the immediate working area where incoming loads of material known to be on fire or suspected of being so can be deposited, inspected and dealt with.

Waste that is burning on delivery should be doused with water or more preferably covered progressively with adequate supplies of damp soil I cover followed by cooling and finally removal to its disposal point. It should not normally be allowed to burn itself out as this will give rise to nuisance from smoke and odour and may constitute a health risk. Fire fighting techniques should be appropriate for the waste type.

Fires within the operational area are either surface fires or deep-seated fires: The former usually occur in recently deposited and as yet un-compacted materials adjacent to the current working area, whilst the latter are found at depth in material deposited weeks or months earlier. Site operators should have a plan to deal with each type of fire and have a code of practice for their operators stating exactly how to tackle any outbreak. Regardless of the circumstances, no individual should ever tackle a landfill fire alone. Deep-seated fires require expensive remediation techniques including vertical cut-offs.

7.4.3 Landfill Safety Aspects

Training of employees should include site safety, first aid and the handling of dangerous materials where appropriate. Since landfill sites can pose dangers to both site operator and users, emergency plans should be laid down. Landfill sites should be regarded as potentially hazardous locations and the operator should have a written safety plan for the site.

Safety hazards present at landfill sites may include: (a) moving plant and vehicle; (b) steep slopes; (c) bodies of standing water; (d) contaminated, putrescible, toxic, flammable or infective material and (e) noxious, flammable, toxic or hazardous gas.

All employees and visitors to the site should be made aware of the potential hazards and the safety procedures to be implemented including fire safety.

7.4.4 Phase Closure

After the last set of cells of a phase are placed on the highest lift, an intermediate or final cover is constructed. If another phase is to be placed over the just completed phase, an intermediate cover is provided. However if the just completed phase has reached the final height of the landfill, the final cover system and surface water drainage system is provided.

An intermediate cover is made of locally available soil (preferably low-permeability) and is 45 to 60cm thick. It is compacted with smooth steel drum rollers and provided a suitable gradient (3 to 5%) to encourage surface water to run-off from the cover and thus minimize infiltration. The side slopes of the intermediate cover are compacted by the crawler tracked dozer moving up and down the slope.

Final cover construction and quality control issues are similar to those for liner construction. The layer below the low-permeability layer, referred to as the grading layer or gas venting layer, should be constructed using poorly graded sand. A grain size analysis for every 400 Cu.m of material used is recommended for quality control purposes. The layer should be compacted to above 75% relative density to provide a firm sub-base for the low-permeability layer above. The density should be tested at 30m grid points.

Lying of the topsoil layer should be done as soon as the protective layer construction is finished. Heavy construction equipment should not be allowed on the finished surface. The nutrient and liming requirements for the topsoil should be assessed from a competent agricultural laboratory. In the absence of a regulatory recommendation I requirement regarding seed mix, a horticulturist or soil scientist

should be consulted. A combination of grass and bush type vegetation capable of surviving

without irrigation water should be planted. At least five samples of topsoil per hectare (2.4 acres) should be tested for nutrient and liming requirements. Nutrient and seed mix application rates should be supervised on site for quality control purpose.

The final cover is provided a gradient of 3 to 5 percent to assist surface run-off. Lined ditches or channels are constructed on the final cover to intercept and carry surface water off the cover to the storm water basin.

On the cover of each phase, settlement devices are installed for monthly measurement of settlement of the landfill cover. This helps in identifying the quantity of soil required periodically for repair of the landfill cover.

7.4.5 Landfill Closure

As each phase is completed and as the final cover level is reached in successive phases, the following interconnectivities are established:

a. The leachate collection system of each phase is sequentially connected (if so designed)
b. The surface water drainage system at the cover of each phase is sequentially connected (if so designed)
c. The temporary surface water drainage system constructed at the base of each completed phase is dismantled.
d. The gas collection system (if provided) of each phase is sequentially connected.
e. Upon completion of all phases a final check is made of the proper functioning of all inter connected systems.

An access road is provided on the landfill cover to enable easy approach for routine inspection of the landfill cover.

7.4.6 Post Closure Care

Post closure care involves the routine inspection of the completed landfill site, maintenance of infrastructure and environmental monitoring. A well defined closure plan shall be formulated for effective implementation. Post closure shall be implemented as a separate contract, and is not included in the current scope of work.

Chapter 8

Summary and Conclusions

Chapter 8
Summary and Conclusion

Environmentally sound management of MSW has emerged as a growing challenge for various States and Municipal authorities in the Country. As per the Municipal Solid Waste (Management & Handling) Rules, 2000 enacted by Govt. of India, all the States and Municipal Authorities were required to improve/remediate existing dump sites and establish proper waste processing and disposal facilities.

Government of Goa has constituted Goa Waste Management Corporation (GWMC) to deal with all garbage related issues including dump sites in the Goa State. In their constant endeavor to the above, GWMC has proposed to set-up another integrated Common Municipal Solid Waste Management Facility (CMSWMF) at Bainguinim, Tiswadi, North Goa, in compliance with the Solid Waste Management Rules, 2016 prescribed by Ministry of Environment, Forests and Climate Change, Government of India. The proposed facility will treat the municipal solid waste, after recovering all possible recyclables and segregating the same into the Wet (Organic) and Dry (Inorganic) fractions. Biogas will be generated from the Wet (Organic) fraction, which will be converted into electricity whereas the stabilized organic sludge shall be further processed to generate high quality Soil Conditioner and Compost. The Dry (Inorganic) fraction shall be cleaned and used to generate high quality Refused Derived Fuel (RDF). Only residual / inert fraction shall be landfilled in the Sanitary Landfill Facility.

The baseline environmental quality is assessed through field studies within the impact zone for various components of environment, viz. air, noise, water, land, biological and socio-economic. The baseline environmental quality of Post-monsoon season has been assessed based on primary data generated during field survey and secondary data available for the proposed project site.

The 24 hourly total PM_{10} concentrations were recorded in the range of 27.2-53.6 $\mu g/m^3$ in the study area during monitoring. The 24 hourly total $PM_{2.5}$ concentrations were recorded in the range of 7.6-20.5 $\mu g/m^3$ in the study area during monitoring. The average concentrations of SO_2 and NO_x in the study area during post-monsoon season were in the range of 6.2-9.4 $\mu g/m^3$ and 5.9-13.7 $\mu g/m^3$ respectively. The concentrations of metals (Pb, AS & Ni) have found either BDL or in trace in the study area. The average noise levels in the study area was found 32.8-47.3 dB.

A total of 14 water samples were collected from 10 km radius to the proposed project site. The pH was observed as 4.65-6.91; whereas Total alkalinity as CaCO3 was 12.85-170.78 mg/l. The total dissolved solids and chlorides were observed as 76-47328 and 15.53-28341 mg/l respectively and sulphate was found to be 18.36-270.94 mg/l. Nutrients in terms of nitrates as NO_3 and total phosphate were found to be 0.78-42.21 mg/l and 0.04-1.46 mg/l respectively. Heavy metals

concentrations were found as Cadmium: ND-0.001 mg/l, Chromium: 0.01-0.033 mg/l, Copper: 0.008-0.04 mg/l, Iron: 0.567-1.866 mg/l, Manganese: 0.005-0.052 mg/l, Nickel: 0.002-0.017 mg/l, Lead: ND-0.017 mg/l and Zinc: 0.033-0.482 mg/l; whereas, Cobalt was found to be not detectable.

A total of 36 tree species, 15 shrub species, 8 species of herbs, 1 species of climbers and 2 species of mangroves were recorded in the study area. Some medicinal plants such as *Ricinus cummunis*, *Mimosa pudica*, *Vitex negundo* were found, amongst which *Azadirachta indica*, *Cassia fistula and Syzygium cumini* etc. are important one. Mangrove flora in vicinity of the study area comprised of 2 species i.e. *Avicennia alba* and *Avicennia marina*, with *A. marina* as the dominant species. Among avifauna, Blue Rock Pigeon, Cattle Egret, Common Crow, Common Myna, House Sparrow, Indian Cuckoo, Pond Heron are commonly observed. Whereas, Bonnet Macaque, Common Mongoose, Squirrels, Indian Field Mouse, and Common House Rat are commonly observed in the study area.

The quantitative prediction of impacts is also essential to delineate pragmatic environmental management plan (pollution control measures) for implementation during and after the commissioning of proposed activities for minimizing the adverse impacts on environmental quality. During the construction phase, PM_{10} & $PM_{2.5}$ is expected to be the main pollutant associated with on-site roads (paved and unpaved), stockpiles and material handling. The proposed activities during construction phase would primarily involve development of site and construction of new plant. The 24 hourly maximum GLCs of NO_x due to Biogas Genset power plant computed from the model is 1364.92µg/m^3 at 1.26 km in the NE direction. Sources of noise emissions are expected from various construction machineries/equipments. However, since the construction phase is expected to be minor in nature and would be for a limited period, the possibility of all the equipments working together is ruled out, rather it will be used intermittently. Construction activities for the proposed development can have minor impact on hydrology and water quality of the area as the construction waste will not be leached into ground or any surface water body. No change in the land use of the site due to the proposed project is anticipated. Impact on soil owing to the project construction activity includes soil erosion, compaction, physical and chemical desegregations and pollution of soil in case of waste discharge on land. Due to commonness of the species recorded and small area of habitats for herbs and shrubs to be lost, potential impacts to flora are considered minor. During the construction stage; removal of understory (shrubs and herbs) will reduce the habitat for a few faunal species. It will be temporary and suitable alternatives are available in nearby areas.

EMP outlines the mitigation, monitoring and institutional measures to be taken during project implementation and operation to avoid or mitigate adverse environmental impacts, and the actions needed to implement these measures. The construction phase impacts are of temporary nature and localized phenomena, except the permanent change in local landscape and landuse pattern at the project site and are expected to reduce gradually on completion of the construction activities. At the time of civil works for proposed project units, it is necessary to control SPM levels through dust suppression methods. Hazardous materials such as petrol, diesel, lubricating oil, compressed gases, paint and varnishes as also explosives for blasting operations, if required at the construction site shall be stored and handled strictly in accordance with

the prevailing safety regulations. Though the gaseous emissions are not expected to contribute significantly to the prevailing ambient air quality, some generic measures to reduce fugitive and gaseous emissions during construction phase from point, area and line sources shall be taken.

At present the Sanitary landfill cells are designed to store 10% of the inert fraction over a period of 10 years in the existing land fill cells. The inerts generated from the processing of existing dump waste shall be disposed along with the inerts generated from the plant. During project implementation period, special emphasis will be made on measures to minimize leachate / effluent generation and dust control at source. The specific control measures related to air emissions, liquid effluent discharges, noise generation, solid waste disposal etc. due to proposed CMSWMF.

Chapter 9

Disclosure of Consultants Engaged

Chapter 9
Disclosure of Consultants Engaged

9.1 CSIR-NEERI Profile

CSIR-NEERI (National Environmental Engineering Research Institute) is a Constituent Laboratory of CSIR (Council of Scientific & Industrial Research), India (Website: www.neeri.res.in) was established in 1958.

9.1.1 CSIR-NEERI Mission and Vision

CSIR-NEERI Mission:

The Institute dedicates itself in the service of mankind by providing innovative and effective solutions to environmental and natural resource problems. It strives to enable individuals and organizations to achieve productive and sustainable use of natural resources on which all life and human activity depend. Highly skilled and motivated, the Institute strives for excellence in environmental science, technology and management by working hand in hand with its partners.

CSIR-NEERI Vision:

CSIR-NEERI envisions a world in which;

- All individuals and Institutions have capacity to act in a manner that ensures achievement of sustainable environmental and economic goals.
- The natural balance is no longer threatened and all share the benefit of a healthy environment.

CSIR-NEERI would continue to strive for;

- Leadership in environmental science, technology and management domestically and worldwide.
- Strong and effective working relationship with its partners in ensuring ecological health of all regions in India.

9.1.2 Mandate of CSIR-NEERI

- To conduct R&D studies in environmental science and engineering.
- To render assistance to the industries of the region, local bodies etc. in solving the problems of environmental pollution.
- To interact and collaborate with academic and research institutions on environmental science and engineering for mutual benefit.
- To participate in CSIR thrust area and mission projects.

9.1.3 CSIR-NEERI Activities

R&D Thrust Areas:

- Environmental Monitoring
- Environmental Modeling
- Environmental Impact & Risk Assessment
- Environmental System Design
- Environmental Biotechnology
- Environmental Genomics
- Environmental Policy Analysis

Advisory:

- Central Govt. Ministries
- State Govt. Ministries
- Industries
- Judiciary

9.1.4 CSIR-NEERI Services and Goods

Research Intensive Areas:

- Air, Water, Wastewater, Soil (Land), Solid & Hazardous Waste
- Environmental Biotechnology & Genomics
- Environmental Materials

Public and Strategic Areas:

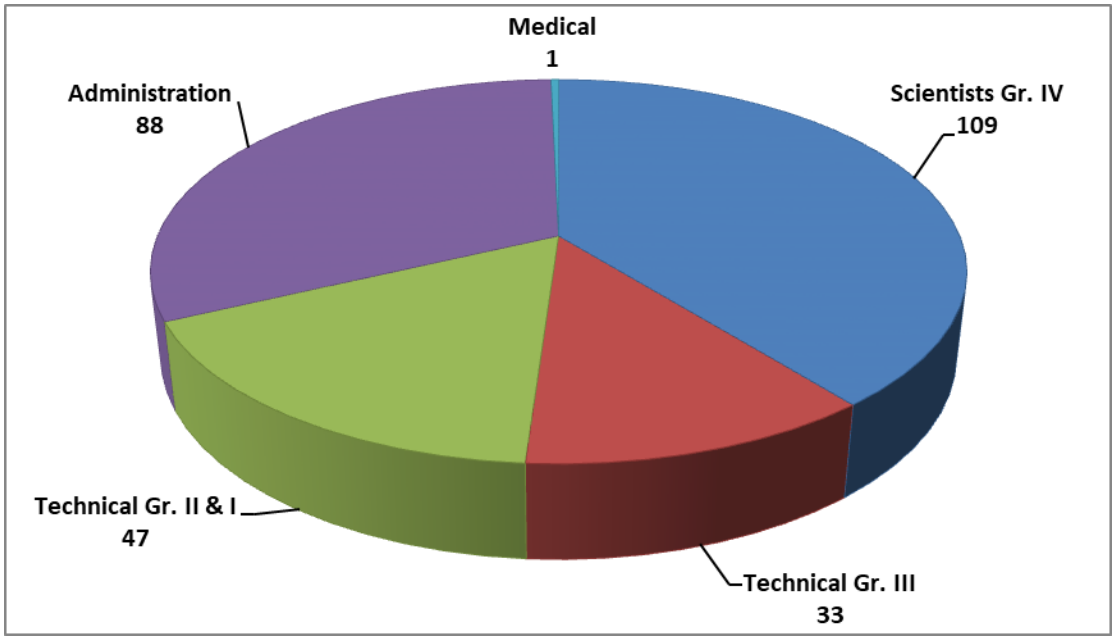
- Environmental Monitoring
- Environmental Policy Analysis

Socio-economic Areas (Urban & Rural):

- Drinking water
- Clean Air
- Environment & Health
- Advice to Central & State Government Agencies
- Judiciary

Industry Focus:

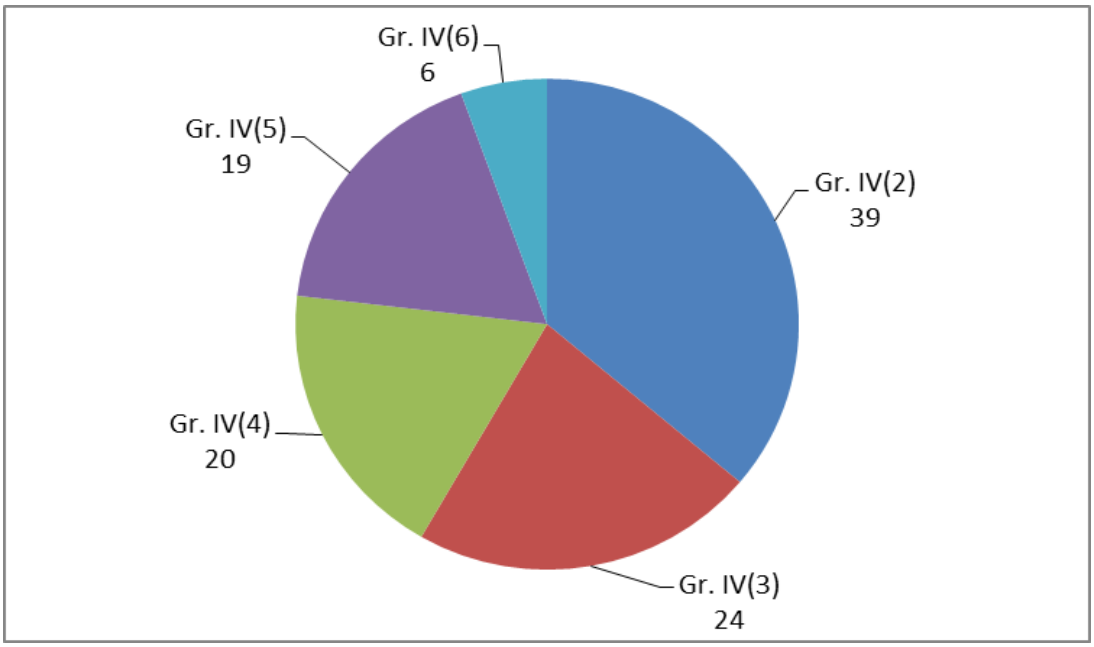
- Environmental Monitoring, Management and Audit
- Environmental Technology Assessment
- Environmental Impact & Risk Assessment



CSIR-NEERI: Human Resources (Total Manpower)

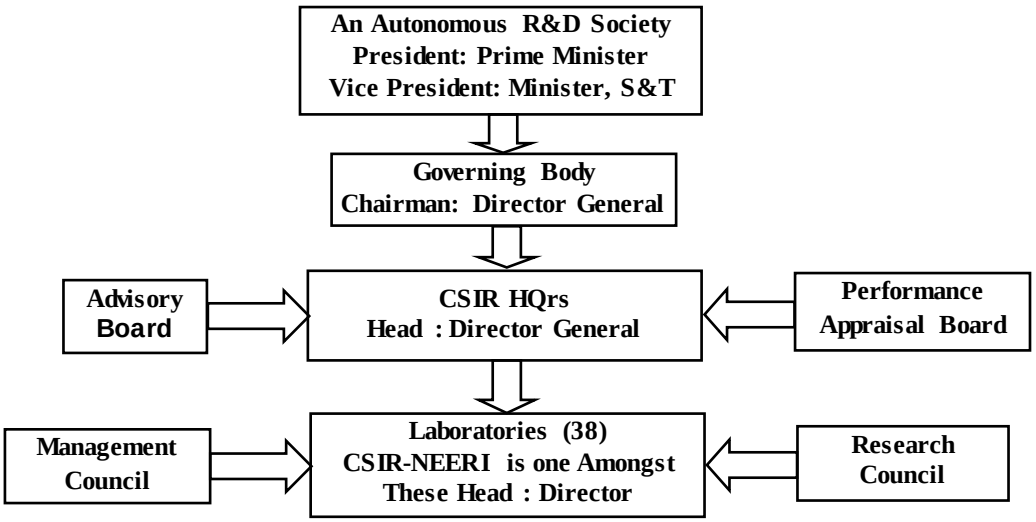
Total : 278 (As on December 31, 2018)

9.1.5 CSIR-NEERI Human Resources

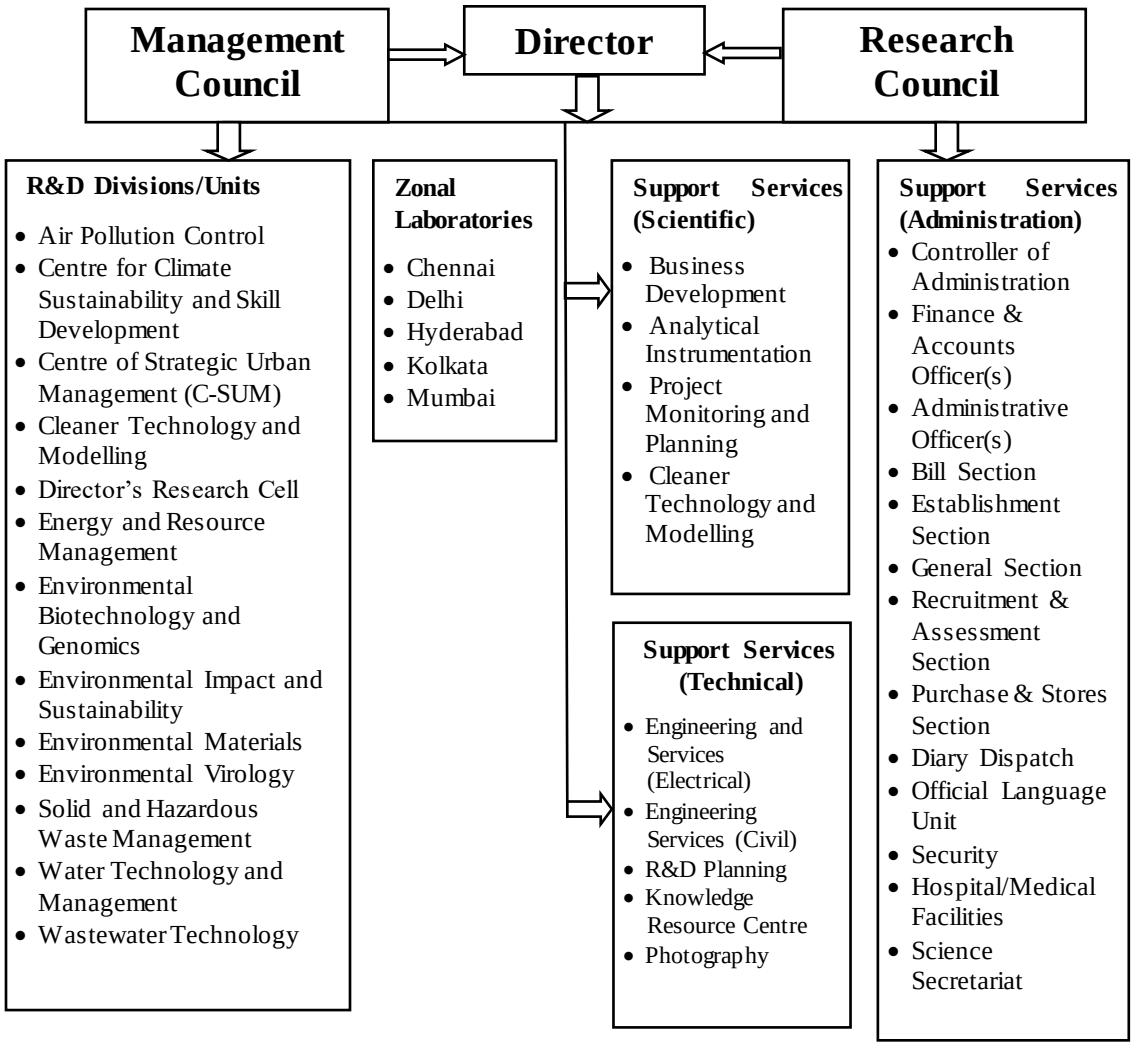


CSIR-NEERI: Human Resource – Scientific Staff
Total: 108 (As on December 31, 2018)

9.1.6 Organizational Chart of CSIR and CSIR-NEERI

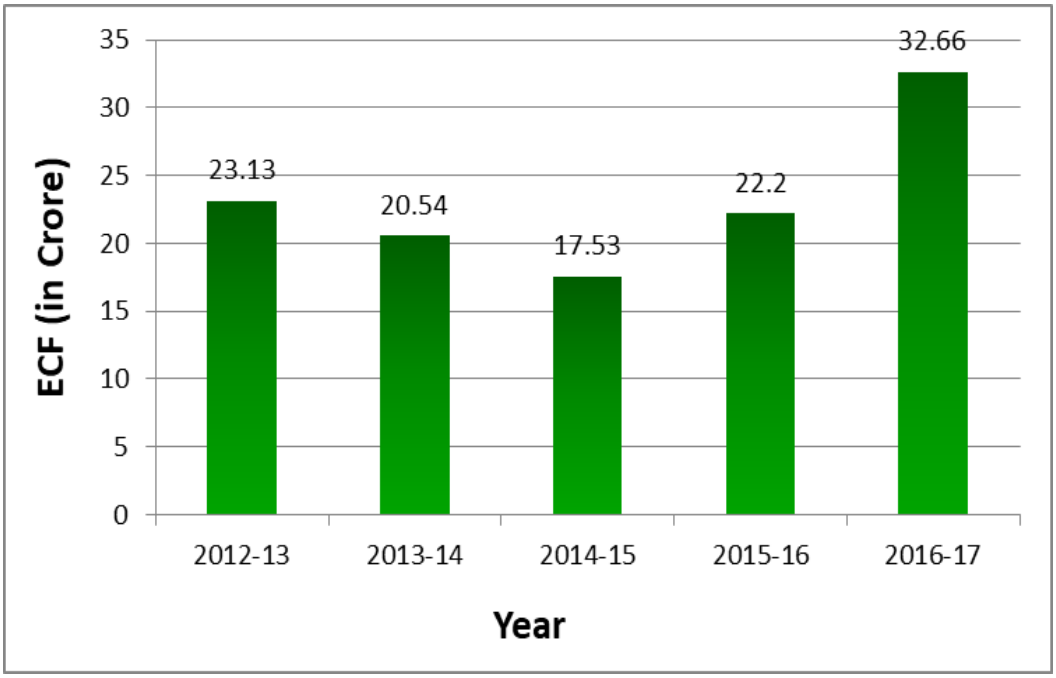


CSIR, India (Organizational Chart)



CSIR-NEERI: Organization Chart

9.1.7 Financial Resources of CSIR-NEERI



Financial Resources (2012- 2017) (in Crore) (ECF- External Cash Flow)

9.1.8 Analytical Instruments, Computer Systems and Software at CSIR-NEERI

9.1.8.1 Analytical Instrumentation Resource

- UV-VIS-NIR Spectrophotometer: Hitachi 330
- Atomic Absorption Spectrophotometer: GBC 904 A
- Fluorescence Spectrophotometers: Hitachi F-4000 & Hitachi F-4500
- Mercury Analyzers: Perkin Elmer MAS-50 A and MAS-50 B
- Gas Chromatographs: Perkin Elmer Autosystem – 5 nos.
- High Performance Liquid Chromatographs: Waters 204 and 501; Shimadzu-LC10
- Gas Chromatograph-Mass Spectrometer: Varian Saturn III
- Liquid Chromatograph-Mass Spectrometer-Mas Spectrometer: Quattro Ultima
- Ocean related studies: ADCP, CODAR, GPS, Ekmen Dredge, Reversible sampler, (Nishkin type) DRDF, Reversible thermometer, Tide Gauges
- Doppler SODAR
- Mini Sonde
- Microscopes
- Biolistic particle delivery system with accessories
- Gene Pulser II System with accessories & consumables
- Membrane Bioreactor Assembly

- Wet air Oxidation High pressure reactor
- Ground Penetrating Radar
- Multi Electrode resistivity Imaging system
- Ambient Ozone Analysers
- Eight Stage Cascade Impactor
- Microwave Furnace
- CHNS Analyser Vario ELIII
- Porosimeter Quanta Chrome PM33-7
- Mercury Analyser – Milestoen DMA80
- FTIR Spectrometer – Bruker Vertex 70

9.1.8.2 Computer Hardwares & Peripherals

Computer Hardware

- High performance computer systems configures around RISC workstations
- Sun Ultra Sparc Computer Station: Sun Ultra 1 Model 170
- Silicon Graphics 02 Workstations
- Silicon Graphics 2000 Workstations
- HP APOLLO 90001730 Workstations
- Personal Computers
- Laptop Computers
- Local Area Network

9.1.8.3 Supporting Software

- Geographic Information Systems – ARC INFO, MAP INFO
- Knowledge Based System – Prokappa
- Digital Image Processing – ERDAS, EASIPACE, PCI WORKS
- INGRES
- CADCORE
- SPSS
- IMSL
- COMPLIERS
- GRAPHICS
- MATLAB
- DIVAST

9.1.8.4 Software for Mathematical Modeling (Available at CSIR-NEERI)

Air Environment:

Model	Used for Predicting Impacts due to
PAL-DS	Point (stacks), area (quarry) and line (vehicular) sources in short range
ISCST-3	Point and area sources in short range
CALINE 4	Vehicular sources close to road
RTDM3.2	Point and area sources existing at rough terrain in short range
VALLEY	Point and area sources existing in valley in short range
MESOPUFF	Point and area sources in long range
CDM	Point and area sources in short range
RAM	Point and area sources in short range
BLP	Point and line sources in short range
SDM	Point and area sources existing in coastal region in short range
CAL3QHC	Vehicular sources close to road for Hydrocarbon Levels
ADAM	Point and area sources in long range
ADMS-3	Point and area sources in long range
PANACHE	Meteorological data and point, area & line sources in any range
MTDDIS	Point and area sources in long range
TAPM	Meteorological data and impacts due to point, area and line sources in short and long range

Noise Environment:

Model	Used for Predicting Impacts due to
FHWA	Vehicular sources
Wave Divergence	Stationary sources

Aquatic Environment – Ground Water:

Model	Used for Predicting Impacts due to
GMS	Flow, direction, contaminant transport in saturated and unsaturated zones, subsurface solute transport with aerobic and sequential anaerobic bio-degeneration, remediation
FEMWATER/ LEWASTE	Stable contaminant transport & pollution, groundwater pollution and remediation
PATRIOT	Hydrology, stable contaminant transport & pollution and landuse management
PRZM3	Stable contaminant transport & pollution and landuse management, consequence of surface water pollution on groundwater
WhAEM2000	Risk of groundwater contamination, hydrology, stable contaminant transport & pollution

Aquatic Environment – Surface Water:

Model	Used for Predicting Impacts due to
MIKE 11	One dimensional model for dam break analysis, sediment transport, ecological and water quality assessments in rivers and wetlands
MIKE 21	Two dimensional model for Environmental Impact Assessment of marine infrastructure, sediment and mud transport, spill analysis
MIKE 3	Three dimensional model for various applications in different water bodies for water pollutions studies
MIKE SHE	Integrated surface and groundwater modeling
ECO LAB	For ecological modeling in rivers wetlands, lakes, reservoirs, estuaries, coastal waters and sea
CORMIX	Software for simulation for fluid-flow mixing in different water bodies
EXAMS	Aquatic Chemistry & Biology in streams and sea
GCSOLAR	Photolysis, half life
HSCTM2D	Hydrology, sediment & contaminant transport in river and estuary
HSPF	Aquatic chemistry and biology sediment transport and deposition in rivers
OXYREF	Dissolved oxygen, respiration, ventilation
PLUMES	Available dilution, design of marine outfall
PRZM3	Hydrology, metals and pesticides prediction in surface water
QUAL2EU	Water quality in stream, planning, non-point sources
SED3D	Hydrodynamics, sediment transport, 3-D, lakes, estuary, harbour, coastal
SMPTOX3	Toxic-chemicals in streams, aquatic biology, combined sewers
SWMM	Aquatic biology, combine sewers, community discharge, rivers, streams
TMDL USLE	Soil and sediment loss, watershed management
Visual Plumes	Surface water, contaminant transport
WASP	Hydrodynamics, aquatic biology, toxicant dispersal, hydrology

Surface Water Runoff:

Model	Used for Predicting Impacts due to
HEC-5	Flood hydrography, runoff estimation, catchment area treatment
HSPF	Hydrologic simulation in reservoir, nutrient growth
STORM	Urban watershed, storage/reservoir routing, sedimentation, erosion, reservoir chemistry

Ecology:

Model	Used for Predicting Impacts due to
ECOMOD	Estuary linked reservoirs, tidal action, saltwater intrusion, in-stream and in-reservoir dissolved oxygen primary and secondary productivity estimation
LAKE-I	Thermal stratification primary and secondary productivity

Food Chain:

Model	Used for Predicting Impacts due to
EGETS	Exposure levels and effects of contaminants on organisms which make food chain
LC50	Lethal concentration, LC50 toxicity levels

Multimedia:

Model	Useful for Predicting Impacts due to
3MRA	Multimedia pathway, receptor exposure, risk assessment
MINTEQA2	Aquatic biology, multimedia pathway
MMSOILS	Multimedia pathway, exposure assessment
MULTIMED (1.01)	Environmental effects of waste disposal in one media to another surface & ground water

Dam Break Analysis:

Model	Useful for Predicting Impacts due to
DAMBRK	Downstream flow simulation consequent to dam break

Risk Assessment:

Model	Useful for Predicting Impacts due to
SAFETI 6.21 & 6.42V	Complete package for consequence analysis and risk analysis in onshore process engineering
PHAST 6.21 V & 6.42V	Complete package for consequence analysis in onshore process engineering

9.1.9 Clients of CSIR-NEERI

9.1.9.1 Clients: International




- The World Bank
- Asian Development Bank
- United Nations Development Programme
- United Nations Environment Programme
- World Health Organization
- International Union of Conservation for Nature
- Danish International Development Agency
- Global Scan Technologies, Dubai
- Global Tech Safety & Environmental Consultancy, Dubai
- Dept. of Public Works and Highways (DPWH) / Environment and Social Services Office (ESSO), Philippines

9.1.9.2 Clients: Central Government

- Atomic Energy Regulatory Board
- Bharat Oman Refineries Limited
- Bharat Petroleum Corporation Limited
- Department of Science and Technology
- Gas Authority of India Limited
- Hindustan Organic Chemicals Limited
- Hindustan Petroleum Corporation Limited
- Indian Navy, Ministry of Defence
- Indian Oil Corporation Limited

- Indian Petrochemicals Corporation Limited
- Jawaharlal Nehru Port Trust
- Madras Refineries Limited
- Mangalore Refinery and Petrochemicals Limited
- Mumbai Port Trust
- National Aluminium Corporation Limited
- National Hydroelectric Power Corporation
- National Thermal Power Corporation Limited
- Nuclear Power Corporation India Limited
- Numaligarh Refineries Limited
- Oil India Limited
- Oil and Natural Gas Corporation Limited
- Rashtriya Chemicals & Fertilizers Limited
- Tuticorin Port Trust
- Western Coal Field

9.1.9.3 Clients: State Government

- Gujarat Industrial Development Corporation Limited
- Gujarat Narmada Valley Fertilizers Company Limited
- Gujarat State Petroleum Corporation Limited
- Gujarat State Petronet Limited
- Kudremukh Iron Ore Company Limited
- Maharashtra State Electricity Board
- Maharashtra Pollution Control Board
- Tamilnadu Industrial Development Corporation
- Chattisgarh State Electricity Board
- Narmada Water Resources, Water Supply & Kalpasar Deptt.
- Karnataka State Industrial Infrastructure Development Corporation Ltd.
- Steel Authority of India

9.1.9.4 Clients: Private Industries (National)

- ABG Cement
- Adani Ports and SEZ Limited
- Alembic Pharmaceuticals Ltd.
- Amanora Park Town
- Asian Paints India Ltd.

- Andhra Sugars
- Ballarpur Industries Ltd.
- Chhindwara Plus Developers Ltd.
- Cochin Port Trust
- Dighi Port Pvt. Ltd.
- Dony Polo Petrochemicals Ltd.
- Electrosteel Castings Ltd.
- ESSAR Oil Ltd.
- Grasim Industries Ltd.
- Green Environment Services Co-op. Soc. Ltd.
- Gujarat Pipavav Port Ltd.
- Gujarat Positra Port Infrastructure Ltd.
- Hazira Port Pvt. Ltd.
- Hindustan Oil Exploration Company Ltd.
- Hindustan Waste Treatment Pvt. Ltd., Goa
- Jindal Vijaynagar Steel Pvt. Ltd.
- Khemani Distilleries Pvt. Ltd.
- Lavasa Corporation Ltd.
- Nagarjuna Fertilizer and Chemicals
- NCTL Pvt. Ltd.
- Paradeep Phosphates Ltd.
- Paradip Port Trust
- Pipavav Ship Dismantling & Engineering Ltd.
- Reliance Petrochemical Ltd.
- Reliance Industries Ltd.
- Sahara India Pvt. Ltd.
- Saint-Gobain India Pvt. Ltd.
- Saurashtra Chemicals Ltd.
- Saurashtra Cement Limited, Gujarat
- Search Chem Industries Ltd.
- Tata Petrodyne
- United Phosphorus Ltd.
- Zuari Industries Ltd.

9.1.9.5 Clients: Private Industries (Multi-National)

- British Gas International (India)
- Cairn Energy India Pty. Limited
- Command Petroleum, Australia
- Enron Oil & Gas India Limited

- Hindustan Oil Exploration Company Limited
- Hindustan Oman Petroleum Company Limited
- Niko Resources Limited
- Petro Energy Products Company India Limited
- Rio Tinto Orissa Mining Limited
- Shell India Private Limited
- South Asia LPG Company Ltd., (a JV of M/s Total Gas & Power India)
- Mitsui & Company, Japan
- OAO Gazprom, Russia
- Mosbacher India L.L.C

9.1.10 Studies with International Funding

- Construction of Middle Vaitarna Dam for Augmentation of Water Resources and Irrigation near Mumbai (WB) (1990-1993)
- Augmentation of Chennai Water Supply – a Project at New Veeranam, Tamilnadu (WB) (1994-1995)
- Construction of Aerated Lagoons and Selection of Marine Outfall Location (Worli) off Mumbai Coast (WB) (1994-1995)
- Water Quality Studies for Hyderabad Water Supply and Sanitation Project (WB) (1995-1990)
- Oceanographic Modeling Studies for Sewage Outfall Location (Bandra) off Mumbai Coast (WB) (1995-1998)
- Strengthening EIA capacity and environmental legislation in India (ADP) (1998-2000)
- Implementation off Master Tourism Plan in Andaman Islands (UNDP) (1999-2000)
- Design & Implementation of Information Network for Indian Centre for Cleaner Technologies (WB) (1999-2002)
- Planning for Coastal and Marine Environment under Gujarat State Environmental Action Programme (WB) (1999-2000)
- Development of National Guidance Manual & Support Manual on EIA Practices for Enhancing the Quality & Effectiveness of Indian EIA's (WB) (2002-2004)
- Water needs of Brahmani & Sabrmati river basins (ICID) (2002-2004)
- Technical Assistance to ESSO to Enhance the Management of Social and Environmental Safeguards for DPWH Projects, Manila, Philippines (WB) (2005-2007)

9.1.11 US-AEP AWARD TO CSIR-NEERI

W13

UNITED STATES - ASIA ENVIRONMENTAL PARTNERSHIP

ENVIRONMENTAL LEADERSHIP AWARD

This award recognizes outstanding contributions made through working in partnership to improve the environment and quality of life for the people of Asia.

PRESENTED TO:

NATIONAL ENVIRONMENTAL ENGINEERING RESEARCH INSTITUTE

Winston Bowman
Regional Environmental Director
USAID Regional Development Mission/Asia

USAID | ASIA

Kris Easter
India Country Manager
US-Asia Environmental Partnership

US-AEP

Suneel Parasnis
India, Western Region Director
US-Asia Environmental Partnership

US-AEP

9.1.12 Conformity to ISO 9001:2008

DNV·GL

MANAGEMENT SYSTEM CERTIFICATE

Certificate No: 30987-2008-AQ-IND-RvA | Initial certification date: 11, January, 2005 | Valid: 11, January, 2017 - 15, September, 2018

This is to certify that the management system of

CSIR-National Environmental Engineering Research Institute (NEERI)
Nehru Marg, Nagpur - 440 020, Maharashtra, India
and the sites as mentioned in the appendix accompanying this certificate

has been found to conform to the Quality Management System standard:
ISO 9001:2008

This certificate is valid for the following scope:
Design, develop and undertake R&D programmes for improvement in quality of environment through various activities leading to scientific and technological innovations, technical solutions, sharing knowledge & expertise for enabling government, industry and society

Place and date:
Chennai, 19, January, 2017

MGMT. SYS. RvA C 024

The RvA is a signatory to the IAF MLA

For the issuing office:
DNV GL – Business Assurance
ROMA, No. 10, GST Road, Alandur,
Chennai - 600 016, India

Sivadasan Madiyath
Management Representative

Lack of fulfilment of conditions as set out in the Certification Agreement may render this Certificate invalid.
ACCREDITED UNIT: DNV GL Business Assurance B.V., ZWOLSEWEG 1, 2994 LB, BARENDRECHT, NETHERLANDS. TEL: +31102922689.
assurance.dnvgl.com

9.1.13 NABET Accreditation

Quality Council of India

National Accreditation Board for Education & Training

CERTIFICATE OF ACCREDITATION

National Environmental Engineering Research Institute

CSIR-NEERI, Nehru Marg, Nagpur 440020

Accredited as **Category - A** organization under the QCI-NABET Scheme for Accreditation of EIA Consultant Organizations: Version 3 for preparing EIA-EMP reports in the following Sectors:

Sl. No.	Sector Description	Sector (as per)		Cat.
		NABET	MoEFCC	
1	Offshore and onshore oil and gas exploration, development & production	2	1 (b)	A
2	River Valley projects	3	1 (c)	A
3	Thermal power plants	4	1 (d)	A
4	Petroleum refining industry	10	4 (a)	A
5	Chlor-alkali industry	13	4 (d)	B
6	Chemical fertilizers	16	5 (a)	B
7	Petro-chemical complexes (industries based on processing of petroleum fractions & natural gas and/or reforming to aromatics)	18	5 (c)	A
8	Manmade fibers manufacturing	19	5 (d)	B
9	Oil & gas transportation pipeline (crude and refinery/ petrochemical products), passing through national parks/ sanctuaries/coral reefs / ecologically sensitive areas including LNG terminal	27	6 (a)	A
10	Industrial estates/ parks/ complexes/areas, export processing Zones(EPZs), Special Economic Zones(SEZs), Biotech Parks, Leather Complexes	31	7 (c)	A
11	Common hazardous waste treatment, storage and disposal facilities (TSDFs)	32	7 (d)	A
12	Ports, harbours, break waters and dredging	33	7 (e)	A
13	Common Effluent Treatment Plants (CETPs)	36	7 (h)	B
14	Common Municipal Solid Waste Management Facility (CMSWMF)	37	7 (i)	B

Note: Names of approved EIA Coordinators and Functional Area Experts are mentioned in RA AC minutes dated Feb. 02, 2018 posted on QCI-NABET website.

The Accreditation shall remain in force subject to continued compliance to the terms and conditions mentioned in QCI-NABET's letter of accreditation bearing no. QCI/NABET/ENV/ACO/18/0592 dated March 15, 2018.The accreditation needs to be renewed before the expiry date by National Environmental Engineering Research Institute, Nagpur following due process of assessment

Sr. Director, NABET
Dated: Mar. 15, 2018

Certificate No.
NABET/ EIA/1720/ RA 0088

Valid till
17-02-2020

For the updated List of Accredited EIA Consultant Organizations with approved Sectors please refer to QCI-NABET website.

9.1.14 Contact Persons

DIRECTOR	**:**	Dr. Rakesh Kumar
Phone	**:**	+91 712 2249999
Fax	**:**	+91 712 2249900
Email	**:**	director@neeri.res.in
NABET Coordinator	:	Dr. M. Suresh Kumar
Phone	**:**	+91 712 2247844
Fax	**:**	+91 712 2249896
Email	**:**	ms_kumar@neeri.res.in

Annexures

Annexure – I

Inward No 17113
Date : 24/3/14
GSIDC LIMITED

Government of Goa
Department of Science, Technology & Environment
Opp. Saligao Seminary, Saligao, Bardez – Goa. 403 511
Phone Nos.: 0832-2407189 / 2407187 / 2407580 Fax No.: 0832-2407176
e-mail: dir-ste.goa@nic.in

No.3-209-2013 /DIR-STE/ 1820 Date: 21/03/2014

To,
The Managing Director,
Goa State Infrastructure Development Corporation,
EDC Bldg,
Panaji Goa.

Sub: - Terms of Reference to conduct EIA study for proposed Solid Waste Management Facility at Calangute/Saligao in North Goa and Cacora in South Goa issued by Goa State Expert Appraisal Committee.

Sir,

Please find enclosed herewith the terms of reference issued by Goa State Expert Appraisal Committee for conducting EIA study for proposed Solid Waste Management facility at Calangute/Saligao in North Goa and Cacora in South Goa for further necessary action at your end.

Yours faithfully,

(Sanjeev Joglekar)
OSD (DST&E)

Encl:- as above

Copy for favour of information to:
1) The Under Secretary to Chief Secretary and Principal Secretary, Science and Technology, Secretariat, Porvorim Goa.

Annexure - II

National Ambient Air Quality Standards (NAAQS) (1994, 1998)

Pollutant	Time weighted average	Concentration in ambient air			Method of measurement
		Industrial area	Residential, Rural & other areas	Sensitive area	
1	2	3	4	5	6
Sulphur dioxide (SO_2)	Annual average* 24 hours**	80 μg/m^3 120 μg/m^3	60 μg/m^3 80 μg/m^3	15 μg/m^3 30 μg/m^3	- Improved West & Geake method - Ultraviolet fluorescence
Oxides of Nitrogen (as NO_2)	Annual average* 24 hours**	80 μg/m^3 120 μg/m^3	60 μg/m^3 80 μg/m^3	15 μg/m^3 30 μg/m^3	- Jacob & Hochheiser (Na-Arsenite) method - Gas phase chemiluminescence
Suspended Particulate Matter (SPM)	Annual average* 24 hours**	360 μg/m^3 500 μg/m^3	140 μg/m^3 200 μg/m^3	70 μg/m^3 100 μg/m^3	- High volume sampling (average flow rate not less than 1.1 m^3/min)
Respirable Particulate Matter (size less than 10 μm) (RPM)	Annual average* 24 hours**	120 μg/m^3 150 μg/m^3	60 μg/m^3 100 μg/m^3	50 μg/m^3 75 μg/m^3	- Respirable particulate matter sampler
Lead (Pb)	Annual average* 24 hours**	1.0 μg/m^3 1.5 μg/m^3	0.75 μg/m^3 1.00 μg/m^3	0.50 μg/m^3 0.75 μg/m^3	- AAS method after sampling using EPM 2000 or equivalent filter paper
Carbon Monoxide (CO)	8 hours** 1 hour	5.0 mg/m^3 10.0 mg/m^3	2.0 mg/m^3 4.0 mg/m^3	1.00 mg/m^3 2.00 mg/m^3	- Non-dispersive infrared spectroscopy
Ammonia (NH_3)	Annual average* 24 hours**	-- --	100 μg/m^3 400 μg/m^3	-- --	- --

* Annual arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval.

** 24 hourly/8 hourly values should be met 98% of the time in a year. However, 2% of the time it may exceed but not on two consecutive days

NOTE

1. National Ambient Air Quality Standard : The levels of air quality necessary with an adequate margin of safety, to protect the public health, vegetation and property.
2. Whenever and wherever two consecutive values exceeds the limit specified above for the respective category, it would be considered adequate reason to institute regular/continuous monitoring and further investigations.
3. The State Government/State Board shall notify the sensitive and other areas in the respective states within a period of six months from the date of Notification of National Ambient Air Quality Standards.

Annexure - III

Ambient Air Quality Standards in Respect of Noise

Area Code	Category of Area/Zone	Limits in dB(A) Leq*	
		Day Time	Night Time
(A)	Industrial Area	75	70
(B)	Commercial Area	65	55
(C)	Residential Area	55	45
(D)	Silence Zone	50	40

Notes :

1. Day time shall mean from 6.00 a.m. to 10.00 p.m.
2. Night time shall mean from 10.00 p.m. to 6.00 a.m.
3. Silence zone is defined as an area comprising not less than 100 meters around Hospitals, Educational Institutions and courts. The silence zones are zones which are declared as such by the competent authority.
4. Mixed categories of areas may be declared as one of the four abovementioned categories by the Component Authority.

* dB(A) Leq denotes the time weighted average of the level of sound in decibels on scale A which is related to human hearing

"A", in dB(A) Leq, denotes the frequency weighting in the measurement of noise and corresponds to frequency response characteristics of human ear

Leq : It is an energy mean of the noise level over a specified period

Annexure -IV

Damage Risk Criteria for Hearing Loss
Occupational Safety & Health Administration (OSHA)

Maximum Allowable Duration Per Day, h	Noise Level dB(A) (Slow Response)
8	90
6	92
4	95
3	97
2	100
1.5	102
1	105
0.5	110
0.25 or less	115

S. No.	Substances or Characteristic Max.	Requirement (Desirable limit)	Undesirable effects outside the desirable limit	Permissible limit in absence of alternate source	Method of Test Cl Ref of IS : 3025	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Essential Characteristics						
1.	Colour, Hazen unit	5	Above, consumer acceptance decreases	25	4 of 3025, 1983	Extended upto 25 only if toxic substances are not suspected in absence of alternate source
2.	Odour		Unobjectionable	-	5 of 3025, 1983	a. Test cold and when heated b. Test at several dilutions
3.	Taste		Agreeable	-	- been established	Test to be conducted only after safety has

S. No.	Substances or Characteristic Max.	Requirement (Desirable limit)	Undesirable effects outside the desirable limit	Permissible limit in absence of alternate source	Method of Test Cl Ref of IS : 3025	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
4.	Turbidity, NTU	5	Above, consumer acceptance decreases	10	8	-
5.	pH value	6.5-8.5	Beyond this range the water will affect the mucous membrane and/or water supply system	No relaxation	8	-
6.	Total hardness, mg/L as $CaCO_3$	300	Encrustation on water supply structure and adverse effects on domestic use	600	-	-
7.	Iron (as Fe), mg/L	0.3	Beyond this limit, taste/appearance are affected, has adverse effect on domestic uses and water supply structures, & promotes iron bacteria	1.0	32 of 3025, 1964	-

S. No.	Substances or Characteristic Max.	Requirement (Desirable limit)	Undesirable effects outside the desirable limit	Permissible limit in absence of alternate source	Method of Test Cl Ref of IS : 3025	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
				8. XX-2		
Chlorides (as Cl)m	mg/l	250	Beyond this limit, taste, corrosion and palatability are affected	1000	32 of 3025, 1988	-
9.	Residual free chlorine, mg/L	0.2	-	-	26 of 3025, 1986	To be applicable only when water is chlorinated Tested at consumer end, When protection against viral infection is required, it should be min 0.5 mg/L
Desirable Characteristics						
10.	Dissolved solids, mg/L	500	Beyond this palatability decrease and may cause gastrointestinal irritation	2000	16 of 3025, 1984	
11.	Calcium (as Ca), mg/L	75	-	200	40 of 3025, 1984	

Annexure V(Contd...)

S. No.	Substances or Characteristic Max.	Requirement (Desirable limit)	Undesirable effects out-side the desi-rable limit	Permissible limit in absence of alternate source	Method of Test Cl Ref of IS : 3025	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
12.	Copper (as Cu), mg/L	0.05	Astringent, taste discoloration of pipes, fitting and utensils will be caused beyond this	1.5	36 of 3025, 1964	
13.	Manganese (as Mn), mg/L	0.1	Astringent taste, discoloration of pipes, fitting and utensils will be caused beyond this	0.3	35 of 3025, 1964	
14.	Sulphates, (as SO_4), mg/L	200	Beyond this causes gastro intestinal irritation when magnesium or sodium are present	400	24 of 3025, 1986	May be extended upto 400 provided (as Mg) does not exceed 30 mg/L
15.	Nitrates (as NO_3), mg/L	45	Beyond this methaemoglobinemia takes place	100	-	-

S. No.	Substances or Characteristic Max.	Requirement (Desirable limit)	Undesirable effects outside the desirable limit	Permissible limit in absence of alternate source	Method of Test Cl Ref of IS : 3025	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
16.	Fluoride (as F), mg/L	1.0	Fluoride may be kept as low as possible. High fluoride may cause fluorosis	1.5	23 of 3025, 1964	-
17.	Phenolic substances, mg/L (as C_6H_5OH)	0.001	Beyond this, it may cause objectionable taste and odour	0.002	54 of 3025, 1964	
18.	Mercury (as Hg), mg/L	0.001	Beyond this, the water becomes toxic	No relaxation	see note mercury ion analyser	To be tested when pollution is suspected
19.	Cadmium (as Cd), mg/L	0.01	Beyond this, the water becomes toxic	No relaxation	see note mercury ion analyser	To be tested when pollution is suspected
20.	Selenium (as Se) mg/L	0.01	Beyond this, the water becomes toxic	No relaxation	28 of 3025, 1964	To be tested when pollution is suspected
21.	Arsenic (As), mg/L	0.05	Beyond this, the water becomes toxic	No relaxation	37 of 3025, 1988	To be tested when pollution is suspected

S. No.	Substances or Characteristic Max.	Requirement (Desirable limit)	Undesirable effects out-side the desi-rable limit	Permissible limit in absence of alternate source	Method of Test Cl Ref of IS : 3025	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
22.	Cyanide (CN), mg/L	0.05	Beyond this, the water becomes toxic	No relaxation	27 of 3025, 1986 pollution is suspected	To be tested when
23.	Lead (Pb), mg/L	0.05	Beyond this, the water becomes toxic	No relaxation	See note 86	To be tested when pollution plumbosolvency is suspected
24.	Zinc (as Zn), mg/L	5	Beyond this limit it can cause astringent taste and an opalescence in water	15	39 of 3025, 1964	To be tested when pollution is suspected
25.	Anionic detergents, mg/L (as MBAS)	0.2	Beyond this limit, it can cause a light froth in water	1.0	Methylene blue extraction method	To be tested when pollution is suspected
26.	Chromium (as Cr^{+6}), mg/L	0.01	May be carconogenic above this limit	0.05	28 of 3025, 1964	To be tested when pollution is suspected
27.	Polynuclear aromatic hydrocarbons (as PAH), mg/L	-	May be carcinogenic	-	-	-

Annexure V(Contd...)

S. No.	Substances or Characteristic Max.	Requirement (Desirable limit)	Undesirable effects out-side the desi-rable limit	Permissible limit in absence of alternate source	Method of Test Cl Ref of IS : 3025	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
28.	Mineral oil, mg/L	0.01	Beyond this limit undesirable taste and odour after chlo-rination takes place	0.03	Gas chromatographic method	To be tested when pollution is suspected
29.	Pesticides, mg/L	Absent	Toxic	0.001	58 of 3025, 1964	-
30.	Radioactive materials					
	a. Alpha emitters Bq/L	-	-	0.1	-	-
	b. Beta emitters pci/L	-	-	1.0	-	-
31.	Alkalinity (as $CaCO_3$), mg/L	200	Beyond this limit taste becomes unpleasant	600	13 of 3025, 1964	-
32.	Aluminimum (as Al), mg/L	0.03	Cumulative effect is reported to cause dementia	0.2	31 of 3025, 1964	-
33.	Boron (as B), mg/L	1	-	5	29 of 3025, 1964	-

Note : Atomic absorption spectrophotometric method may be used

Annexure - VI

Classification of Inland Surface Water
(CPCB Standards)

	Characteristics	A[@]	B[@]	C[@]	D[@]	E[@]
1.	Dissolved oxygen, mg/l,Min	6	5	4	4	-
2.	Biochemical oxygen demand, mg/l. Max	2	3	3	-	-
3.	Total Coliform organisms,* MPN/100 ml, max	50	500	5000	-	-
4.	Total Dissolved Solids,mg/l, Max.	500	-	1500	-	2100
5.	Chlorides(as Cl), mg/l, Max.	250	-	600	-	600
6.	Colour, Hazen units, Max.	10	300	300	-	-
7.	Sodium absorption ratio, Max.	-	-	-	-	26
8.	Boron (as B) \, mg/l, Max.	-	-	-	-	2
9.	Sulphates (as SO_4),mg/l, Max	400	-	400	-	1000
10.	Nitrates (as NO_3),mg/l, Max.	20	-	50	-	-
11.	Free Ammonia (as N), mg/l, Max.	-	-	-	1.2	-
12.	Conductivity at 25^oC, micromhos/cm, Max.	-	-	-	1.0	2.25
13.	pH value	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.0-8.0
14.	Arsenic (as As),mg/l, Max.	0.05	0.2	0.2	-	-
15.	Iron (as Fe) mg/l, Max.	0.3	-	50.0	-	-
16.	Fluorides (as F), Mg/l, Max.	1.5	1.5	1.5	-	-
17.	Lead (as Pb),mg/l, Max.	0.1	-	0.1	-	-
18.	Copper (as Cu), mg/l, Max.	1.5	-	1.5	-	-
19.	Zinc (as Zn), mg/l, Max.	15.0	-	15.0	-	-

✸ If the coliform count is found to be more than the prescribed tolerance limits, the criteria for coliforms shall be satisfied if not more than 20 percent of samples show more than the tolerance limits specified, and not more than 5 percent of samples show values more than 4 times the tolerance limits. Further, the fecal coliform should not be more than 20 percent of the coliform. Source: Indian Standard (IS:229 - 1982).

@ A - Drinking water source without conventional treatment but after disinfection
B - Outdoor bathing (organised)
C - Drinking water source with conventional treatment followed by disinfection
D - Propagation of Wildlife, Fisheries
E - Irrigation, Industrial cooling, Controlled waste disposal

Annexure VII

Standards for Treated Wastewater for Irrigation Purpose

	Tolerance limit for inland surface water for irrigation	
	MEF, 1993	IS 2296, 1982
pH	5.5-9.0	6.0-8.5
Dissolved solids mg/l	--	2100
Electrical Conductivity *(EC) μS/cm	--	Class-C_3
Sodium mg/l	--	--
Percent sodium	--	60
Sodium adsorption ration (*SAR)	--	Class-S_1
Sulphates mg/l	--	1000
Chlorides mg/l	--	600
Oil and grease mg/l	10	--
Biochemical oxygen demand (BOD) mg/l	100	--
Suspended solids mg/l	200	--
Bioassay	90% survival for 96 hrs in 100% effluent	--

*	**EC**	**Class**	**SAR**	**Class**
	100-200	C_1	<10	S_1
	250-750	C_2	10-18	S_2
	750-2250	C_3	18-26	S_3
	2250-5000	C_4	>26	S_4

Annexure VIII

Land use, land cover (LU/LC) Classification Scheme (NRSC/ISRO)

DESCRIPTIONS OF LAND USE AND LAND COVER CLASSES

LULC classification scheme and brief description of classes are as given hereunder:

Sl.	Description-1	Description-2	Classes from NRC LULC50K Mapping Project
1	Builtup	Urban	Residential, Mixed builtup, Public / Semi Public, Communication, Public utilities / facility, Commercial, Transportation, Reclaimed land, Vegetated Area, Recreational, Industrial, Industrial / Mine dump, Ash / Cooling pond
		Rural	Rural
		Mining	Mine / Quarry, Abandoned Mine Pit, Land fill area
2	Agriculture	Crop land	Kharif, Rabi, Zaid, Two cropped, More than two cropped
		Plantation	Plantation - Agricultural, Horticultural, Agro Horticultural
		Fallow	Current and Long Fallow
		Current Shifting cultivation	Current Shifting cultivation
3	Forest	Evergreen / Semi evergreen	Dense / Closed and Open category of Evergreen / Semi evergreen
		Deciduous	Dense / Closed and Open category of Deciduous and Tree Clad Area
		Forest Plantation	Forest Plantation
		Scrub Forest	Scrub Forest, Forest Blank, Current & Abandoned Shifting Cultivation
		Swamp / Mangroves	Dense / Closed & Open Mangrove
4	Grass/ Grazing	Grass/ Grazing	Grassland: Alpine / Sub-Alpine, Temperate / Sub Tropical, Tropical / Desertic
5	Barren/unculturable/Watelands	Salt Affected Land	Slight, Moderate & Strong Salt Affected Land
		Gullied / Ravinous Land	Gullied, Shallow ravine & Deep ravine area
		Scrub land	Dense / Closed and Open category of scrub land
		Sandy area	Desertic, Coastal, Riverine sandy area
		Barren rocky	Barren rocky
		Rann	Rann
6	Wetlands / Water Bodies	Inland Wetland	Inland Natural and Inland Manmade wetland
		Coastal Wetland	Coastal Natural and Coastal Manmade wetland
		River / Stream / canals	Perennial & Dry River/stream and line & unlined canal/drain
		Water bodies	Perennial, Dry, Kharif, Rabi &Zaid extent of lake/pond and reservoir and tanks
7	Snow and Glacier		Seasonal and Permanent snow

Annexure IX

Methods of Monitoring and Analysis

Guidance for Assessment of Representativeness and Reliability of Baseline Environmental Attributes

(Also Please Refer CPCB Guidelines on Methods of Monitoring and Analysis)

Attributes	Sampling		Measurement Method	Remarks
A. Air Environment	Network	Frequency		
Meteorological · Wind speed · Wind direction · Dry bulb temperature · Wet bulb temperature · Relative humidity · Rainfall · Solar radiation · Cloud cover · Environmental Lapse Rate	Minimum 1 site in the project impact area	1 hourly continuous	Mechanical/automatic weather station Rain gauge As per IMD specifications As per IMD specifications Mini Sonde/SODAR	IS 5182 Part 1-20 Site specific primary data is essential Secondary data from IMD, New Delhi CPCB guidelines
Pollutants PM_{10}	10 to 15 locations in the project impact area	24 hourly twice a week (Please refer	Gravimetric (High-Volume)	Monitoring Network · Minimum 2 locations in upwind side, more sites in downwind side / impact zone
$PM_{2.5}$		National Ambient Air Quality Standards, CPCB	Gravimetric (High-Volume with Cyclone)	· All the sensitive receptors need to be covered
· SO_2		Notification dated 11th April, 1994)	EPA Modified West & Gaeke method	Measurement Methods
· NO_x			Arsenite modified Jacob & Hochheiser	As per CPCB standards for NAQM, 1994
· CO		8 hourly twice a week	NDIR technique	
· H_2S*		24 hourly twice a week	Methylene-blue	
· NH^*_3			Nessler's method	
· HC*			Infra Red analyser	
· Fluoride*			Specific Ion meter	
· Pb*				

*Project Specific

Note: For Rapid Environmental Impact Assessment one complete season data except monsoon is adequate while the comprehensive Environmental Impact Assessment Resources coverage of three seasons.

Guidance for Assessment of Representativeness and Reliability of Baseline Environmental Attributes

Attributes	Sampling		Measurement Method	Remarks
B. Noise	Network	Frequency		
· Hourly equivalent noise levels	Identified study area	Once in each season	Instrument : Noise level meter	IS:4954-1968 as adopted by CPCB
· Hourly equivalent noise levels	Inplant (1.5 metre from machinery)	Once	Instrument : Noise level meter	CPCB/OSHA
· Hourly equivalent noise levels	Highways	Once in each season	Instrument : Noise level meter	CPCB/IS:4954-1968
· Peak particle velocity	150-200m from blast site	Once	PPV meter	
C. Water				
Parameters for water quality · pH, temp, turbidity, magnesium hardness, total alkalinity, chloride, sulphate, nitrate, fluoride, sodium, potassium, salinity · Total nitrogen, total phosphorus, DO, BOD, COD, Phenol · Heavy metals · Total coliforms, faecal coliforms · Phyto plankton · Zoo plankton	· Set of grab samples during pre and post-monsoon for ground and surface water for 10 km distance	Diurnal and Season wise	Samples for water quality should be collected and analysed as per : · IS : 2488 (Part 1-5) methods for sampling and testing of Industrial effluents · Standard methods for examination of water and wastewater analysis published by American Public Health Association.	

Guidance for Assessment of Representativeness and Reliability of Baseline Environmental Attributes

Attributes	Sampling		Measurement Method	Remarks
	Network	Frequency		
For River Bodies · Total Carbon · pH · Dissolved Oxygen · Biological Oxygen Demand · Free NH_4 · Boron · Sodium Absorption Ratio · Electrical Conductivity	· Standard methodology for collection of surface water (BIS standards) · At least one grab sample per location per season	· Yield of water sources to be measured during critical season · River Stretch within project area be divided in grids (say 1 km length and 1/3 width) and samples should be from each grid at a time when the wastewater	Samples for water quality should be collected and analysed as per : · IS : 2488 (Part 1-5) methods for sampling and testing of Industrial effluents · Standard methods for examination of water and	Data should be collected from relevant offices such as central water commission, state and central ground water board, Irrigation dept.

Attributes	Sampling		Measurement Method	Remarks
	Network	Frequency		
		discharged by other sources of pollution is expected to be maximum	wastewater analysis published by American Public Health Association.	

Guidance for Assessment of Representativeness and Reliability of Baseline Environmental Attributes

Attributes	Sampling		Measurement Method	Remarks
	Network	Frequency		
Parameters for wastewater characterisation · Temp, colour, odour, turbidity, TSS, TDS · pH, alkalinity as $CaCO_3$, p value, M value, total hardness as $CaCO_3$, chloride as Cl sulphate as SO_4, Nitrate as N O_3, Fluoride as F, Phosphate as PO_4, Chromium as Cr. (Hexavalent, total) Ammonical Nitrogen as N, TKN, % sodium, BOD at 20°C, COD, DO, total residual chlorine as Cl_2, oil and grease, sulphide, phenolic compound	· In plant sources · Grab and composite sampling	· Diurnal and season wise variation	Samples for water quality should be collected and analysed as per : · IS : 2488 (Part 1-5) methods for sampling and testing of Industrial effluents Standard methods for examination of water and wastewater analysis published by American Public Health Association.	All plant sources categorised as : · Process wastewater · ETP wastewater · Domestic/sanitary wastewater

Guidance for Assessment of Representativeness and Reliability of Baseline Environmental Attributes

Attributes	Sampling		Measurement Method	Remarks
	Network	Frequency		
D. Land Environment				
Soil · Particle size distribution · Texture · pH · Electrical conductivity · Cation exchange capacity · Alkali metals · Sodium Absorption Ratio (SAR) · Permeability · Water holding capacity · Porosity	One surface sample from each village, (soil samples be collected as per BIS specifications)	Seasonwise	Collected and analysed as per soil analysis reference book, M.I.Jackson and soil analysis reference book by C.A. Black	
Land use/Landscape · Location code · Total project area · Topography · Drainage (natural) · Cultivated, forest, plantations, water bodies, roads and settlements	At least 20 points along the boundary		Global positioning system Topo sheets Satellite Imageries* (1:25,000) Satellite Imageries* (1:25,000) *Project specific	

Guidance for Assessment of Representativeness and Reliability of Baseline Environmental Attributes

Attributes	Sampling		Measurement Method	Remarks
	Network	Frequency		
Solid Waste				
Domestic Waste · Per capita contribution · Collection, transport and disposal system · Process waste · Quality (oily, chemical, biological)	Grab and composite samples	Seasonwise	Guidelines IS 9569 : 1980 IS 10447 : 1983 IS 12625 : 1989 IS 12647 : 1989 IS 12662 (PTI) 1989	
Quality · Loss on heating · pH · EC · Calorific value, metals etc.	Grab and composite samples	Seasonwise	Analysis IS 9334 : 1979 IS 9235 : 1979 IS 10158 : 1982	
Hazardous Waste · Permeability and porosity	Grab and composite samples		Analysis IS 9334 : 1979 IS 9235 : 1979	

Attributes	Sampling		Measurement Method	Remarks
	Network	Frequency		
· Moisture pH · Electrical conductivity · Loss on ignition · Phosphorous · Total nitrogen · Cation exchange capacity · Particle size distribution · Heavy metal · Arsenic · Fluoride			IS 10158 : 1982	

Guidance for Assessment of Representativeness and Reliability of Baseline Environmental Attributes

Attributes	Sampling		Measurement Method	Remarks
	Network	Frequency		
E. Biological Environment Aquatic · Primary productivity · Aquatic weeds · Enumeration of phyto plankton, zoo plankton and benthos · Fisheries · Diversity indices · Trophic levels · Rare and endangered species · Marine Parks/ Sanctuaries/ closed areas /coastal regulation zone (CRZ) Terrestrial · Vegetation-species list, economic importance, forest produce, medicinal value · Importance value index (IVI) of trees · Fauna	· Considering probable impact, sampling points and number of samples to be decided on personal judgement within 10/25 km radius from the proposed site · Samples to collect from upstream and downstream of discharge point, nearby tributaries at down stream, and also from dug wells close to activity site	Season wise	Standard techniques (APHA et. al. 1995, Rau and Wooten 1980) to be followed for sampling and measurement	· Seasonal sampling for aquatic biota · One season for terrestrial biota, in addition to vegetation studies during monsoon season · Preliminary assessment · Microscopic analysis of plankton and me bents, studies of macro fauna, aquatic vegetation and application of indices, viz. Shannon, similarity, dominance IVI etc. · Point quarter plot less method for terrestrial vegetation survey

Guidance for Assessment of Representativeness and Reliability of Baseline Environmental Attributes

Attributes	Sampling		Measurement Method	Remarks
	Network	Frequency		
· Avi fauna · Rare and endangered species · Sanctuaries / National park / Biosphere reserve · Migratory routes	· For forest studies, direction of wind should be considered while selecting forests			· Secondary data to collect from Government offices, NGOs, published literature · Plankton net · Sediment dredge · Depth sampler · Microscope · Field binocular
F. socio-economic				
· Demographic structure · Infrastructure resource base · Economic resource base · Health status : Morbidity pattern · Cultural and aesthetic attributes · Education	Socio-economic survey is based on proportionate, stratified and random sampling method	Minimum for two phases of the project	Primary data collection through questionnaire	Secondary data from census records, statistical hard books, topo sheets, health records and relevant official records available with Govt. agencies

Annexure X

DIESEL GENERATOR SETS: STACK HEIGHT

The minimum height of stack to be provided with each generator set can be worked out using the following formula:

H = h+0.2x ÖKVA

H = Total height of stack in metre

h = Height of the building in metres where the generator set is installed

KVA = Total generator capacity of the set in KVA

Based on the above formula the minimum stack height to be provided with different range of generator sets may be categorised as follows:

For Generator Sets	Total Height of stack in metre
50 KVA	**Ht. of the building + 1.5 metre**
50-100 KVA	**Ht. of the building + 2.0 metre**
100-150 KVA	**Ht. of the building + 2.5 metre**
150-200 KVA	**Ht. of the building + 3.0 metre**
200-250 KVA	**Ht. of the building + 3.5 metre**
250-300 KVA	**Ht. of the building + 3.5 metre**

Similarly for higher KVA ratings a stack height can be worked out using the above formula.

Source: Evolved By CPCB
[Emission Regulations Part IV: COINDS/26/1986-87

EMISSION STANDARDS (G/KW HR) FOR NEW GENSETS (UP TO 19 KILOWATT, KEROSENE AND PETROL BASED) WITH IMPLEMENTATION SCHEDULE

A. From June 1, 2000

Class	Displacement (cc)	CO (g/kw-hr)		HC + NOx (g/kw-hr)	
		2-stroke engine	4-stroke engine	2-stroke engine	4-stroke engine
1	<65	603	623	166	65
2	>65<99	-	623	-	36
3	>99<225	-	623	-	19.3
4	>225	-	623	-	16.1

B. From June 1, 2001

Class	Displacement (cc)	CO (g/kw-hr)	HC + NOx (g/kw-hr)
1	<65	519	54
2	>65<99	519	30
3	>99<225	519	16.1
4	>225	519	13.4

C. Test method shall be as specified in SAE J 1088. Measurement mode shall be D1 cycle specified under ISO 8178 (weighting factor of 0.3 for 100% load, 0.5 for 75% load and 0.2 for 50% load)

D. Following organisations are recommended for testing and certifying the gensets:

i. Automotive Research Association of India, Pune
ii. Indian Institute of Petroleum, Dehradun
iii. Indian Oil Corporation (R & D Centre), Faridabad
iv. Vehicle Research Development Establishment, Ahmednagar

Source : EPA, 1986
GSR 682 (E), dated Oct. 5, 1999

Vehicular Exhaust

Emission norms for passenger cars

Norms	CO(g/km)	HC+ NOx(g/km)
1991Norms	14.3-27.1	2.0(Only HC)
1996 Norms	8.68-12.40	3.00-4.36
1998Norms	4.34-6.20	1.50-2.18
India stage 2000 norms	2.72	0.97
Bharat stage-II	2.2	0.5
Bharat Stage-III	2.3	0.35(combined)
Bharat Stage-IV	1.0	0.18(combined)

Emission norms for Heavy Diesel vehicles

Norms	CO(g/kmhr)	HC (g/kmhr)	NOx (g/kmhr)	PM(g/kwhr)
1991Norms	14	3.5	18	-
1996 Norms	11.2	2.4	14.4	-
India stage 2000 norms	4.5	1.1	8.0	0.36
Bharat stage-II	4.0	1.1	7.0	0.15
Bharat Stage-III	2.1	1.6	5.0	0.10
Bharat Stage-IV	1.5	0.96	3.5	0.02

Emission Norms for 2/3 wheeler

Norms	CO(g/km)	HC+ NOx)(g/km)
1991Norms	12-30	8-12 (only HC)
1996 Norms	4.5	3.6
India stage 2000 norms	2.0	2.0
Bharat stage-II	1.6	1.5
Bharat Stage-III	1.0	1.0

Revised Terms of Reference (ToRs') for conducting Environmental Impact Assessment study for establishing a Municipal Solid Waste Management Facility (MSWMF) at Bainguinnim, Goa for 250 + 20%TPD.

1.0. Background

This should include, profile of the Corporation of City of Panaji (CCP) as a Project Proponent (PP), contact address, implementing organization (*Concessioner*), Project Consultants for design of the plant as well as Environmental Consultants appointed, if any. (s*upporting documents may be annexed*).

1. The PP must furnish information on any / all similar projects handled / being handled by it in the State of Goa detailing the project stage and clearly spelling out the feasibility thresholds, feeding centres, probable commissioning dates.

2. A special mention must be made of judicial interventions / 'stop work orders', if any, in the ongoing projects of similar scope handled by it. Submissions made by the PP in this regard to the Appellate Authority must be shared with the Goa-SEAC (*hereinafter referred as 'Committee'*).

3. A statement on available / earmarked funding for the proposal must be shared with the Committee. Escalation costs, if any, envisioned through the project period must be accounted for.

4. A statement of justification and 'cost benefit analysis' of 'Saligao Solid Waste Management Facility (SSWMF)' *vis a vis* 'separate discrete facility proposed at Bainguinim' be prepared by the PP, defining the minimum threshold quantum and source of waste for operationlizing the facilities.

5. Chronologically provide sequence of the project from its initiation till date with reference to administrative approvals taken up by the PP. Describe the geographical location of the proposed facility and its surroundings, capacity, need, goal and objectives for proposed MSWMF, significance of the project both at local and regional level may be mentioned clearly.

6. Detailed demography / land-use / existing, proposed & approved residential colonies / archaeological sites / World Heritage Monuments / Hospitals (*existing and proposed*) /perennial lentic and lotic water-bodies surrounding the project-site as well as buffer area of 5 and10 km radius around the site should be superimposed on a Google imagery at a decipherable scale.

7. A separate plan be prepared delineating the existing / TCP-approved residential colonies / settlement around the boundaries of the proposed facility within a radius of 3 km. (*i.e. zone of likely impact*).

8. Adequate and rational sensitization of the local stakeholders by the PP on the proposal and sentiments of the local stakeholders towards the proposal, if any, be furnished.

9. PP must furnish primary database on biodiversity inventories based on ground-truthing, and not secondary data available. The biological data shall have to be collected for one cycle covering all seasons.

10. Considering the rich bird diversity of Kadamba plateau region, PP shall study the 'Habitat value' of the proposed site for biodiversity with special reference to the avifaunal diversity.

11. Discuss project location with reference ~~to~~ distance from major landmarks. policy, legal and administrative framework within which the project is set, major stakeholder(s) / Department(s) of the State and Central Government with their specific roles, applicable laws, clearance requirements at various levels of project execution and their current status.

12. Describe in detail if any litigation(s) are pending against the proposed project and / or any directives or 'orders' passed by any court of law / statutory authority. In addition, the PP should inform its area of jurisdiction *vis-a-vis* Appellate Authority to resolve legal disputes, if any.

2.0. Project Description

Background information for implementation of the project and baseline studies taken up, if any, and overall scenario of the proposed facility in the context of Panaji's solid waste management issues and challenges, procedures adopted for selection of technology, criteria for site-selection should be discussed.

Following information should be included:

- Primary waste characteristics, physical, chemical in Municipalities and Panchayats catchment areas and comparison with waste characteristic at the existing facility at Calangute. This characterization shall be done for one season and the sheets with the dates, area of sampling, time, duly signed by the GWMC officials shall be submitted as part of the report. The sample size shall be arrived at based on the calculations shall be placed as part of the report

- Population / area covered under MSWMF.

- Expected quality / quantity of solid waste (MSW) generated (*based on the resident plus floating population*).

- Quantity of MSW actually collected (*average figure*) – details of seasonal variation for actual collection (*from secondary sources*).

- Methodology for collection of MSW – doorstep collection, segregation at source, community bins, collection from commercial, hotels and office premises, etc.
- Transportation of MSW – type of vehicles (*fast or slow moving*), frequency of transportation and distance of transportation, Access to the solid waste mgt site (preferably alternate/multiple).

Details of the proposed MSWMF

The information will be sourced from engineering and design studies conducted for the project. This section should contain the following details:

- Land requirement for the facility, including its optimization, break up for various purposes and its availability, If any.

- Details of the following may be furnished –
  - each unit in the facility, with a brief description of its operations.

  - waste collection system – compliance with the statutory requirements and description of proposed operations.

  - proposed protocol for waste acceptance (*system for sampling, parameters, analysis methods, time lags, number of people, qualifications; manifest system, etc.*)

  - Ultimate disposal of the waste – details of the methodology of disposal including life span and design of the existing/proposed site.

  - existing solid waste dumping scenario on the proposed site.

  - Details of chosen waste treatment process / technology and whether it is in compliance with the applicable law (*at present "Municipal Solid Wastes (Management and Handling) Rules, 2000"*).

  - Details of safety measures for occupational health

- Mass and Energy Balance flow diagram (step-by-step) for the process technology proposed.

- Energy conversion technology should be clearly detailed out with specifications of the biogas engines and alternators used for this conversion process.

- List of plant(s) and equipment(s) to be set up and vehicles to be used.

- Details on expansion/up gradation of the existing processing facility, if any.

- Source of water and electrical power / details about captive utility of in-plant power generation.

- The quality of compost being generated from the existing facility.

- Details of the laboratory facilities available for testing, analysis, etc.,

- Specific details on leachate collection system around the plant and around the facility, generation rates, treatment and disposal.

- Details of the landfill operation – filling, layers, equipment, compaction levels, cross-checking mechanism, stability considerations, landfill gas monitoring, troubleshooting mechanism, etc and analysis and report o the landfill at a similar existing plant in Goa.

- Details pertaining to monitoring of test wells within and around the landfill site as per standard procedure, its locations, frequency of monitoring, parameters as prescribed by the CPCB norms, etc.

- Fire detection, suppression and safety & health protection measures during project design and operations.

- Feasibility study for utilization of segregated combustible fuel (SCF) or Preparation of Refuse Derived Fuel (RDF) to produce electricity and/or replace traditional sources of fuel in local industries. Its production and quality (*Calorific value and C/H ratio*) as well as list of promising buyers.

- Assessment of generation of horticulture waste, transportation plan and feasibility study for utilization of the same for manufacture of briquettes or other alternative treatment methodologies.

- Assessment of generation of slaughter house waste, transportation plan and treatment methodologies

Provide a Contour map on 1:1000 scale for the study area showing proposed breakup of the land. Detailed layout plan of proposed project development, communication facilities, access/approach roads, internal roads, landscape, sewage disposal facilities, and waste disposal etc; to be given. Layout plan of proposed development of built up areas with covered construction such as DG-Set rooms, Administrative buildings, Utilities such as Main and Stand-by Power, Water supply installations, location of STP, RWH structures & Green Belt area etc.

3.0. Description of the Environment in the delineated study area

As a primary requirement of EIA process, the proponent should collect baseline data in the project area as well as in the area within 10 km of the proposed project boundary (*buffer zone*). Map of the study area clearly delineating the location of various monitoring stations (air/ water / soil and noise) superimposed with location of habitats are to be shown. Primary data (*baseline data*), wherever feasible, should be collected for one season except rainy season. Secondary data should be collected for area within 10 km aerial distance from the project site-boundary, as specifically mentioned at column 9(iii) of Form-I of EIA Notification 2006.

The following components of the environment shall be studied:

3.1. Land Environment

a) Land use / land cover: Data on the land use (*conformity with existing development regulation*), habitation, and forest cover around the proposed CMSWMF ascertained from local authorities, revenue records, etc.

b) Topography: Baseline data needs to be given on existing situation of the land at the proposed project area, including description of plateau features, terrain analysis, slope and elevation, microclimatic factors.

c) Geology: Baseline data should be provided on rock types, regional tectonic setting and history of any seismicity and associated hazards. Information on distance of quarries/excavation, if any, from habitat, restrictions for cutting / filling, environmental controls, etc., should be provided.

d) Soil: Data including type, stratification (*soil profile*), characteristics, soil properties, porosity and permeability, inherent fertility etc. are important from engineering considerations for design of structures like landfills, green belt development, etc should be submitted. The current level of soil and water contamination, if any, due to existing dumps need to be ascertained.

3.2. Water Environment

a) Groundwater: Baseline data on groundwater sources (springs, open-dug wells, bore wells), including data on depth (groundwater table), physico-chemical parameters is to be collected at least for one season.

b) Surface water: Baseline data on location of surface lentic and lotic water sources details such as their present quality and utility, if any. Details of water bodies present within the project area and 5 kms. surrounding the site-boundary should be provided.

c) Prepare an existing drainage map on a toposheet of the site with 1.5 km surrounding with natural surface drainage flow points.

d) Estimate water intake requirements for the project and identify the source of water to be used (*provide water balance table*). Ground water budgeting, if being used, has to be provided. Rainwater harvesting (if proposed) to be detailed out.

e) Quantity of wastewater generated during construction and operational phase and details of its treatment and disposal is to be provided.

3.3. Biological Environment

a) Terrestrial ecology: Inventory of Flora and Fauna based on primary data in the study area as well as that within 10km of its boundary, shall be included in the list of flora and fauna along with classification as per the schedule given in the Wildlife Protection Act, 1972 (for fauna) and in the Red Book Data (flora). Also, a statement clearly specifying whether the study area forms a part of an ecologically sensitive area should be provided. In the event of occurrence of any scheduled-I species, as per IWPA, 1972, a conservation plan be prepared in consultation with and authenticated by the Chief Wildlife Warden (CWW), Govt. of Goa.

b) A particular emphasis be laid down on avifaunal diversity highlighting the raptors and scavenging birds at the existing site, besides the forest bird species of the general plateau around the area within a radius of 10km.

c) In the water bodies within 5 kms. of crow-fly distance surrounding the site-boundary, excluding the marine realm; an inventory of fresh-water biodiversity to be compiled with emphasis on icthyofauna and waders, if any.

d) Inventory of Agro-biodiversity within 5kms buffer zone highlighting local cultivars, if any.

e) Designated Wildlife protected areas / Natural habitat of any IWPA scheduled species, if any, within 10-km radius of project boundary be brought on record.

3.4. Air Environment:

Climatological data is to be obtained from nearest Indian Meteorological Department (IMD) station for one full year. Micro meteorological data consisting of wind speed, wind direction, temperature, cloud cover, (amount and height), humidity, inversions, rainfall (peak and average daily rainfall) and wind rose patterns, from primary and secondary sources in the study area.

Baseline data of air pollutant parameters extending an area of 10 Km from the project should be monitored at a number of locations. Description of base line data of ambient air parameters namely PM_{10} and PM2.5, oxides of Nitrogen (NOx), Sulphur dioxide, and carbon monoxide are to be collected. One season data is to be monitored other than monsoon as per the CPCB Norms. Sampling locations are to be located as per CPCB norms.

3.5. Noise: Baseline data on noise pollution at the project area and the neighbourhood residential areas is to be monitored as per the CPCB norms.

3.6. Socio-Economic and Occupational Health Environments: Baseline data at the project area shall include the demography of the village panchayat at the project site, existing residential projects around the proposed site, existing infrastructure facilities in the proposed area and anticipated area of impact due to the proposed activity. This should be clearly demarcated on a map denoting the existing and proposed project within 1.5 km around the project site.

4.0. Anticipated Environmental Impacts and Mitigation Measures

This section should describe the likely impact of the project on each of the environmental parameters of Land Environment (Topography, Geology and Soil), Water Environment (Groundwater and surface water), Biological Environment, and Air Environment. The methods adopted / proposed to be adopted for assessing the impact such as model studies, empirical methods, reference to existing similar situations, and reference to previous studies should be discussed in detail. Details of specific mitigation methods to reduce adverse effects of the project, best environmental practices and conservation of natural resources should be detailed out of each of the parameters. A separate dedicated technical section on 'Odor emanation, mitigation & management' shall be written by an accredited domain-expert, defining the budgetary outlay for the purpose.

This should include proposed measures for fire detection, suppression and occupational safety and health protection measures during project design and operations, scheme for storm water management within and around the proposed facility, details on impacts of landfill gases and its preventive measures, as per CPCB norms and action plan for green belt development, including the details of

species, width of plantation, height & density and planning schedule as per CPCB norms.

PP shall give special attention to the menace of insect and rodent vector breeding at the site and around it. In view of this apprehension; an inventory of arthropod and rodent species of pest/vector value shall be prepared by PP based on ground-truthing. Control measures shall be spelt out.

A detailed discussion should also be included for socio-Economic and health Environment for resident population anticipated living around the project site with detailing of specific details on odour, noise and transportation. Impact of the project on socio-cultural and tourism aspects should be assessed.

Environmental Monitoring Program

- Frequency, location, parameters of monitoring air, water, noise and soil during operation of SWMF.
- Compilation and analysis of data and reporting system in a discrete EMP document.

Institutional arrangement by PP to implement mitigation measures shall be identified and steps to strengthen or expand existing arrangements, if required, shall be proposed. A detailed responsibility chart to be included for mitigation measures for construction and operational phase of the project and for any disaster mitigation.

Project Benefits - This section should detail out the positive impacts of the CMSWMF including improvements in physical infrastructure, if any.

5.0 Public Hearing and Stakeholder Consultations shall be conducted, if applicable, including community consultations at the affected community levels. The objective of the consultation sessions shall be to improve project components with regard to proper environmental management.

Issues identified by the public and other stakeholders during public hearings along with the issues raised by the public and the appropriate responses of the project proponent should be included in the final EIA report.

6.0 Environmental Management Plans (EMPs)

Based on the impacts predicted, EMPs shall be prepared to fulfil all requirements of GoI, MoEF and GoG. The scope of EMPs shall include:

- Recommendation of feasible and cost-effective measures to prevent or reduce significant negative impacts to acceptable levels.
- Description of implementation arrangement needed for the project.
- Specification of environmental supervision, monitoring and auditing requirements, including the technical aspects of monitoring the effectiveness of mitigation measures (including measurement methodologies, data analysis, reporting schedules, emergency procedures, detailed budget & procurement schedules).
- Summary matrix of environmental monitoring, during construction and operation stages, along with the requirement of monitoring facilities, frequency, location, parameters of monitoring, compilation and analysis of data, comparison with base line data, compliance to accepted norms and reporting system, and plantation monitoring program.
- Post-closure plan for landfill site, if any.
- Listing of all the mandatory government clearance conditions, and the status of procuring clearances.

7.0. Executive Summary (Summary EIA)

This should be a summary of the EIA report condensed to 10 A-4 size pages. It should necessarily cover in brief the following chapters of the EIA report: Introduction, Project Description, and Description of the Environment, Anticipated Environmental Impacts & Mitigation Measures, Additional Studies, Environmental Monitoring Programme / Project benefits, and Environmental Management Plan (EMP).

Such an Executive Summary may be required during public hearing process, as applicable, for distribution to public on demand. If required, it has to be translated into a local language(s).

8.0 Disclosure of Consultant Engaged

This shall include the names of the consultants engaged with their brief resume and nature of consultancy rendered.

The following general points should be noted:

- All documents should be properly indexed, page numbered.
- Period/date of data collection should be clearly indicated.

- While preparing the EIA report, the instructions for the proponents and instructions for the consultants issued by MoEF vide O.M. No. J-11013/41/2006-IA.II (I) dated 4th August, 2009 and 5th October 2011, which are available on the website of the Ministry, should also be followed.

- The consultants involved in the preparation of EIA/EMP report after accreditation with Quality Council of India (QCI) / National Accreditation Board of Education and Training (NABET) would need to include a certificate in this regard in the EIA/EMP reports prepared by them and data provided by other organization / Laboratories including their status of approvals etc. In this regard circular no F. No.J -I1013/77/2004-IA-II(I) dated 2nd December, 2009,18th March 2010, 28th May 2010, 28th June 2010 and 30th September 2011 posted on the Ministry's website http://www.moef.nic.in may be referred.

- After the preparation of the draft (*as per the generic structure prescribed in Appendix –III of the EIA Notification, 2006*) covering the above mentioned TORs', the project proponent shall get the Public Hearing conducted, if applicable, and take further necessary action for obtaining prior environmental clearance (EC) in accordance with the procedure prescribed under the EIA Notification, 2006.

- The copy of the letter received from Goa-SEAC on the TORs' prescribed for the project should be attached as an annexure to the final EIA-EMP report. The compliance statement of TORs' prescribed should also be incorporated.