DETAILED PROJECT REPORT (DPR) FOR MUNICIPAL SOLID WASTE DISPOSAL THROUGH INCINERATION PROCESS

PONDICHERY URBAN DEVELOPMENT AGENCY

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Foreword……..

On perusal of various Municipal Solid Waste processing technologies, Government of Pondicherry has indentified Incineration is one of the suitable method after taking in to consideration of prevailing condition of scarcity of Land and others factors.

Government of Pondicherry has submitted financial assistance to Japan International Co-operation Agency (JICA). As a part of this process, this Detailed Project Report (DPR) for Municipal Solid Waste Disposal through Incineration Process has been prepared in house.

Input and guidelines have been taken from the following:

(i) Municipal Solid Waste Management Manual – 2000 & 2014, Ministry of Urban Development, Government of India.

(ii) World Bank guideline for MSW Management - 2000

(iii) Report of the task force on Waste – Energy (Vol-I), - 2014. Planning Commission of India.

(iv) Draft Environment Impact Assessment Report for Integrated Municipal Solid Waste Processing and Land fill / Facility, 2011, PMSPL, Kivar Enviorn Pvt, Ltd., Bangalore .

(v) Guidelines for MSW Management, CPCB, 2010.

(vi) Comprehensive Waste Management, Technical guideline, 2010 Japan International Co-operation Agency.

I appreciate team of officer of DSTE Who have prepared this report.

(CHANDRAKER BHARTI)
SECRETARY(LAD)

Date: 12.08.2014

CONTENT

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

1.1 Background

As in other Cities of India, disposal of Municipal Solid Waste (MSW) poses greater challenges to the Government of Pondicherry. It is estimated that 600 TPD of MSW are generated in Pondicherry urban areas. Currently, it is being collected, transported and disposed at Kurumbapet dumping yard since 2010. These practices attract lot of public and academicians objection in view of open dumping of MSW, obnoxious odour and flies menace etc. It also poses great risk of ground water contamination due to percolation. Finding a scientific solution to the MSW disposal problem is prime consideration of the Government as it is connected with public health issues.

As per the Municipal Solid Waste (Management and Handling) Rules, 2000, waste disposal methods prescribed includes composting, vermin composting, anaerobic digestion and incineration. Puducherry Government explored the possibilities of adopting composting through Coimbatore and Vellore Model. Reportedly, two factors are attributing constraint to implement the same in Pondicherry viz. (i) Poor source segregation (ii) Mingling of plastic wastes with MSW.

A team under the Chairmanship of the Hon'ble Chief Minister of Puducherry Shri N. Rangaswamy consisting of Shri N.G. Pannir Selvam, The Hon'ble Minister for Local Administration, Shri Chetan B Sanghi, the Chief Secretary to Government, Shri Vaiyapuri Manikandan, The Chairman, Puducherry Tourism & Development Corporation, Shri I. Vasanthakumar Reddy, Officer on Special Duty to Chief Minister and Dr. N. Ramesh, Environmental Engineer, Department of Science, Technology & Environment have visited Malaysia and Singapore from 5.1.2014 to 7.1.2014 to understand the municipal solid waste disposal method being practiced there and explore the possibility of adopting the same model in Puducherry.

Collection and transportation system being practiced both in Malaysia and Singapore is similar but final disposal system is different from each other. In Malaysia, final disposal is

Sanitary Land Fill followed by power generation through methane gas formed in the land fill. In Singapore, final disposal method is incineration followed by power generation.

Fig.1 Expert Committee interacts with Malaysian counterpart about MSW disposal

Demerits of Malaysia Sanitary Land Fill Disposal

(i) It require larger land are (25 acre)

(ii) Huge investment (Rs.100 crores)

(iii) Generates 300 KLD of leachates, require treatment plant

(iv) Disposal of leachate is difficult

(v) Generates obnoxious odour

(vi) It generate Methane gas which is one of the potential Global Warming gas

(vii) Chances of ground water contamination exits due to percolation and fire hazards due to spontaneous firing

(viii) It require minimum 1 km buffer zone

Merits of Singapore Incineration Disposal

(i) It require smaller land area (2.5 acre)

(ii) Does not generate any leachate

(iii) Does not generate any obnoxious gas or methane gas

(iv) No chances of ground water contamination

(v) Generation of power, added value

(vi) Instance disposal

(vii) Proved to be successful method of MSW disposal in Japan and Korea

(viii) Possibility of adaptation of PPP mode

Considering land constraints, Population density and waste characteristics, Singapore method of incineration is suitable for disposal of Municipal Solid wastes in the U.T. Puducherry. Incineration is one of the method of MSW disposal in many countries. In Asian countries like Japan and Korea, this is prime method of MSW disposal.

With a view to evolving Scientific and Sustainable method for disposal of MSW for Pondicherry, a Detailed Project Report (DPR) has been prepared. This report envisage setting up of Incineration Plant for the disposal of MSW generated in the Pondicherry Urban area.

1.2 Need of the Project

As per the Municipal Solid Waste (Management and Handling) Rules, 2000, every Urban Local Body (ULB) shall finalize the MSW processing method before the year 2003. Pondicherry has been rated as second city in India having highest per capita income next to New Delhi. Thus per capita waste generation is also proportionally higher than the national average. It has been estimated that per capita waste generation in Pondicherry is 500gm. and nearly 500 Tons of MSW is being generated currently. With the projected population as 800,186 in the year 2020, it is estimated that 16000 tons of MSW would be generated in the year 2020.

Currently, it is being collected, transported and disposed at Kurumbapet a dumping yard without any scientific processing. These practices attract lot of public and academicians objection in view of open dumping of MSW and obnoxious odour and flies formation. These practices also poses great risk of ground water contamination due to percolation. It is assessed that nearly 21 diseases occur from improper disposal of MSW in our country.

Being tourism is one of the major income generation for Pondicherry, haphazard disposal of MSW gives ugly face to the coastal city. In order to protect the public health and environment, it is need of the hour to find a suitable method for MSW disposal. After evaluating various option available for MSW disposal and assessing factors like land availability, topography, climatic condition, geography, calorific value of MSW, paucity of

land for Secured Land Fill and cost benefit analysis etc., disposal of MSW through incineration is ideal method for Pondicherry

2 OBJECTIVES

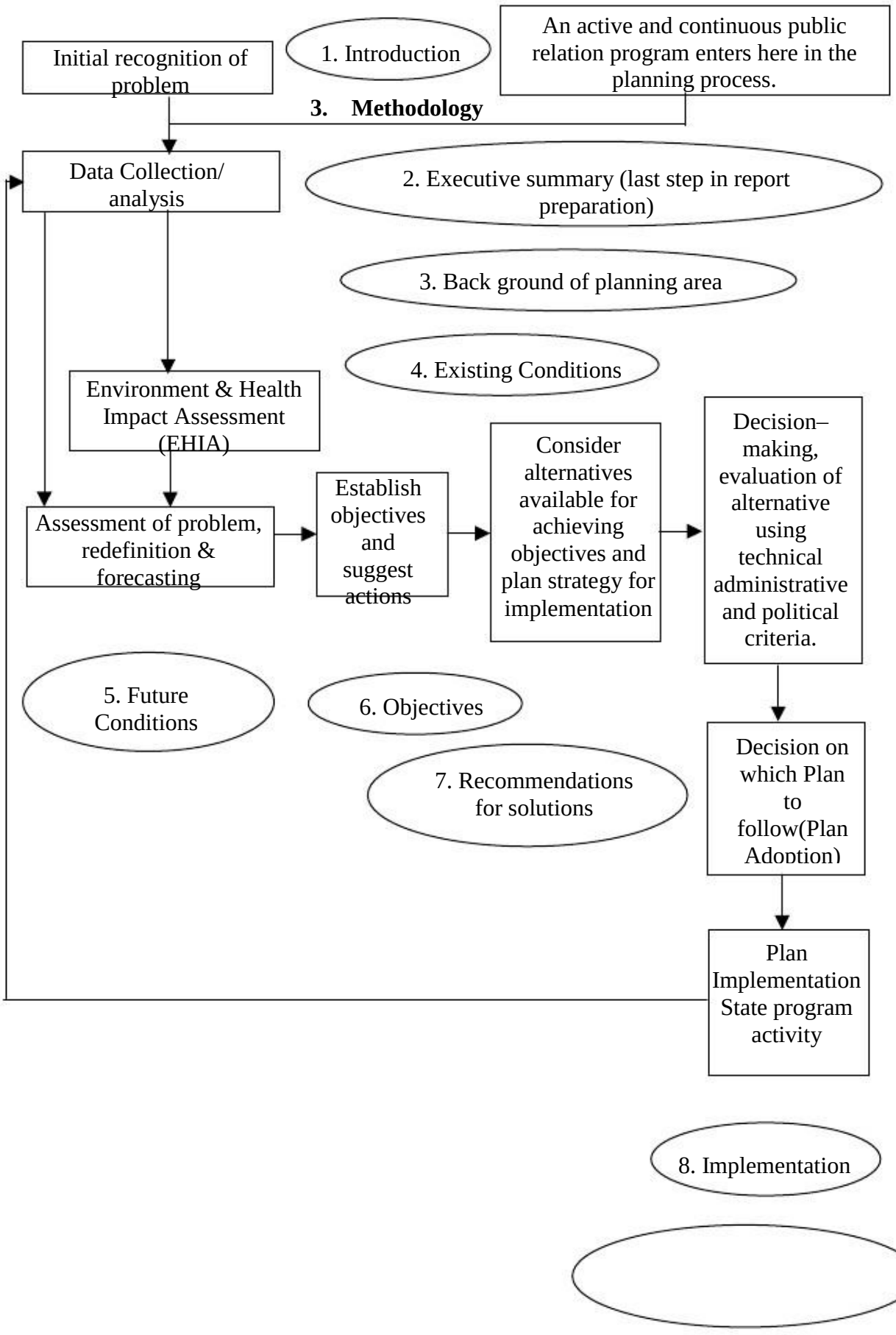
The broad objectives of the Detail Project Report (DPR) are to determine a technically and economically viable sold waste management project for the Urban area of Pondicherry. Following are the specific objectives:

(i) To devise a system for effective and efficient method of MSW disposal.

(ii) To assess Project feasibility
(iii) To assess Environment Impact Assessment of the Project
(iv) Cost Estimate
(v) To prepare operational plan
(vi) Organisational and Financial Studies
(vii) Training and Capacity Building

Scope & Limitations of the study

1. The study is limited to Pondicherry Urban area only
2. The study is limited to end of the disposal only


Initial recognition of problem
1. Introduction
An active and continuous public relation program enters here in the planning process.
3. Methodology
Data Collection/ analysis
2. Executive summary (last step in report preparation)
3. Back ground of planning area
4. Existing Conditions
Environment & Health Impact Assessment (EHIA)
Assessment of problem, redefinition & forecasting
Establish objectives and suggest actions
Consider alternatives available for achieving objectives and plan strategy for implementation
Decision–making, evaluation of alternative using technical administrative and political criteria.
5. Future Conditions
6. Objectives
7. Recommendations for solutions
Decision on which Plan to follow(Plan Adoption)
Plan Implementation State program activity
8. Implementation

4. Back Ground of the Study

4.1 Preamble

Solid waste management usually refers to the collection, transportations, recycling, resource recovery (composting, waste to energy, etc.,) and disposal of municipal solid waste, "Municipal solid waste is defined to include refuse from households, non-hazardous solid waste from industrial and commercial establishments, refuse from institutions, market waste, yard waste and street sweeping, etc. (World Bank, 1994).

Management of municipal solid waste involves (a) development of an insight into the impact of waste generation, collection, transportation and disposal methods adopted by a society on the environment and adoption of new methods to reduce this impact. (CPHEEO Manual, Jan-2000).

Accordingly, waste management should be an integrated affair, which shall include:

- Minimizing waste,
- Maximizing environmentally sound waste re - use and recycling
- Promoting environmentally sound waste disposal and treatment and
- Extending the coverage of waste management services

The stages involved in SWM are primarily as follows:

- Primary collection of solid waste from household levels
- Primary transportation to municipal waste bins and collection points,
- Secondary transportation of garbage from municipal bins to disposal sites, and
- Actual disposal of the waste

It is estimated that about 80,000 metric tons of solid waste are generated everyday in the urban centres of India at present. About 60% of generated are disposed off safely. The uncollected solid waste remains present in and around the locality or find its way into the open drains. Proper solid waste disposal is also hampered by the non – availability of suitable land fill site, partly due to the high

9. Monitoring & performance evaluation of the programme

land costs and partly due to rapid growth.

According to the survey, carried out by CPCB in 1998, it has been observed that the total quantity of solid waste generated by 23 metro cities of India is about 30,058 tons per day of solid waste. The per capita waste generation in small, medium and large cities/towns about 0.1kg, 0.3kg to 0.4 kg and 0.5 kg respectively. Because of this fact, management of solid waste is primarily an urban issue in country like India. In urban areas the responsibility of solid waste management lays exclusively with the urban local bodies, that is, municipal governments. However, the municipalities in most states in India are not statutorily responsible for collecting garbage from the households. They usually perform the third and fourth stages of the SWM function. But the households perform the first two and different arrangements are followed to accomplish the task. In many cases where residents are economically better off and environmentally conscious, community organizations are coming forward to handle at least the door to door collection of household waste and its transportation to municipal collection points. Even though such initiatives are still at nascent stage they are slowly gaining momentum and may assume a major role in future.

There is a stage between the collection and disposal of solid waste, that is, resource recovery or segregation of degradable and recyclable materials in the garbage and actual recycling. In no Indian city is the separation of garbage between degradable and non – degradable items and recycling taken up at the municipal level. This is so not only because it is uneconomical since only 13 to 20 % of municipal waste is recyclable the remaining 80-85% is compost able, but is also extremely laboured intensive. In most cases however, secondary waste collection is not being done adequately. On an average, 20 to 30 per cent of the total waste generated remains uncollected, creating Environmental hazards in urban settlements. Now a days due to increase in the environmental concern, emphasis is laid on recycling and reuse of domestic garbage is gaining momentum. The municipalities and municipal corporations themselves are unable to take up such projects of collection, segregation, and recycling or composting in an integrated manner because of the high costs involved. But NGO’s and many private agencies are now providing these services to the Municipalities or are independently running some projects for waste collection, segregation, recycling and composting or even bio-gas generation.

4.2 Policy Initiative for SWM

In India, in the last few years, there has been lots of pressure due to international events concerning better environment and human settlements. As a result, several initiatives were taken at the National, State and Local Government level to go deep into the flaws in the existing situation and suggest remedies. The Central and State Governments initiated efforts to develop policies and programmes in this regard. The Strategy Paper on Solid Waste Management in India by the National Environmental Engineering Research Institute (NEERI) in August 1995 is one of the most exhaustive evaluations of the problem at the national level. The J.L. Bajaj Committee constituted by the Planning Commission in 1994 immediately after the plague outbreak, also reviewed the prevalent conditions and made specific recommendations to deal with the situation. The Interim Report of the Committee on Solid Waste Management in Class I Cities in India constituted by the Central Government by the Supreme court in June 1998 is a valuable document which contains detailed recommendations for the removal of solid waste.

4.3 The Report of the Expert (J .L Bajaj) Committee of Planning Commission May 1995.

The main conclusion of the report was a situational analysis of the existing state of waste management in the Indian Cities and towns. The inevitable conclusion was that better sanitation standards could have been achieved in most of our cities and towns by prudent and planned allocation of available resources. Develop and support the application of appropriate low cost, eco-friendly technologies. The committee suggested large-scale Public Private Partnership(PPP) mode in garbage management .

4.4 Interim Report of the Committee on Solid Waste Management in the Class I cities in India, Constituted by the Supreme Court of India June 1998.

It contains deliberations on the present scenario in garbage management and detailed recommendations on number of technical, institutional and social aspects of storage, collection, transportation and disposal of garbage in class I cities. Its recommendations

include steps for strengthening the institutional set-up, management information system and financial and legal provisions. The committee also recommended certain specific responsibilities not only for the local, state and central governments, but also for the citizens and the community. The Committee, findings do not really reveal anything startling but they bring into focus the pitiable situation prevailing in this country and how the local governments are failing miserably in their responsibilities for providing a cleaner environment to the urban population. The Interim Report of the Committee includes crucial recommendations meticulously categorized mandatory and discretionary with delineated work responsibilities for three categories of stakeholders i.e. the citizens, local bodies, state and central government. Several norms have also been specified for each function. Besides setting goals with a specific time frame to achieve the same, the Committee has also emphasized the role of community participation which are being followed in some of the cities can ensure long term sustainability of the system and structure of municipal solid waste disposal developed by the local bodies.

4.5 Notification on Municipal Solid Waste Management (Management & Handling), Rules, 2000

The Government of India, in exercise of the powers conferred by sections 3, 6 and 25 of Environment Protection Act, 1986 (Act 29 of 1986) issued a Notification on the Management of Municipal Solid Waste (Management and Handling) Rules,2000. The Rule direct the State Governments and UTs to authorize an appropriate agency, preferably, The State Pollution Control Boards/Committees for regular monitoring of their implementation and compliance and submit an Annual review report by 15 May each year to the Secretary, Ministry of Environment and Forests in a specified format. It is responsibility of every ULB to finalise a suitable processing technology by December, 2003. Since, the deadlines have been crossed, the Government of India is in the process of amending the Municipal Solid Waste (Management and Handling) Rules, 2000.

4.6 Manual on Municipal Solid Waste Management by Central Public Health & Environmental Engineering Organization (CPHEEO),

With a view to assist and guide the Urban Local Bodies for managing the solid waste in an efficient manner, the Ministry of Urban Development , Government of India constituted an expert committee in February , 1998 by drawing experts from various field departments,

academics and research institutions and Central Ministries / Departments. The Committee after a series of deliberation framed a Manual on Municipal Solid Waste Management in the country. It includes all aspects such as Composition and Quantity of Solid Waste, Storage of waste at source, primary collection of waste, transportation of waste, composting, energy recovery from Municipal Solid Waste, emerging technologies, sanitary land fill site, bio-medical waste, economic & financial consideration, environmental & health impact assessment, institutional aspects and capacity building, prospects of private sector participation community participation and legal aspect etc. Subsequently the Manual has been revised in the year 2014 after convened a National Stakeholders Workshop for Finalization of the Revised Draft Manual on Municipal Solid Waste Management held on 24th-25th July, 2014. **In the revised Manual, process of Incineration has been accepted as one of the processing method**. For the preparation of this Detail Project Report, the CPHEEO manuals, 2000 and 2014 have been largely adopted.

4.7 Sectoral Policies

The first impression that the city creates in mind of a visitor is how clean the city is. The urbanization is done without a remarkable change in the attitude which is still rural, rustic and down to earth. The habit of throwing garbage on road and waiting for sweeper to sweep once in 24 hours needs to change.

Solid waste management is a part of health and sanitation, and according to the Indian Constitution, falls within the purview of the State list. Since this activity is non – exclusive, non – rivaled, and essential, the responsibility for providing the service lies within the public domain. The activity being of a local nature is entrusted to the Urban Local Bodies. Puducherry Urban Development Agency (PUDA), one of the wing of Local Administrative Department is responsible for the solid waste management.

4.8 Linkage of the projects to the Existing System

A well organized collection and transportation of MSW exists for Pondicherry Urban area. The collected wastes from various places will be transported and transferred to the waste processing unit.

5 THE PLANNING AREA

5.1 City Profile

The Union Territory of Puducherry comprises of four regions namely Puducherry, Karaikal, Mahe and Yanam, which are not geographically contiguous. Puducherry is located in the East Coast, about 162 kms south of Chennai. This is the largest among the four regions and consists of 12 scattered areas interspersed with enclaves of Villupuram and Cuddalore Districts of Tamil Nadu. Karaikal is about 160 km south of Puducherry and it is bounded by Nagapattinam and Thiruvarur Districts of Tamil Nadu State. Mahe lies almost parallel to Puducherry 653 km away on the west coast near Kannur District of Kerala State. Yanam is located about 840 km Northeast of Puducherry and it is located in the East Godhavari District of Andhra Pradesh State,

The Union Territory has a total area of 492 sq Km. In that, the total area of Puducherry region and its eleven enclaves is 290 Sq. km, with the total population at 735,332 according to the 2001 census. The bulk of Puducherry region is an irregular stretch of land consisting, the Municipalities of Puducherry & Oulgaret and Commune panchayats of Ariankuppam, Villianur, Nettapakkam, Mannadipet and Bahour. This project is applicable to Pondicherry Urban agglomeration consists of 37 wards of Oulgaret Municipality, 42 wards of Puducherry Municipality and two Commune Panchayats of Ariankuppam and Villiyanur.. The project area comprises of Puducherry urban area spread over an extent of 71.9 Sq.Km. The split up area details of Puducherry Urban Area is given in detail in Table.1.

Table 1. Puducherry Urban Area

Town	Area (Km^2)
Puducherry Municipality	19.54
Oulgaret Municipality	36.70
Ariankuppam Urban	4.77
Villianur Urban	10.89
Total	71.9

Source: Town and Country Planning Department, Puducherry

5.2 Population Projection

The total waste generation of the Puducherry is estimated based on projected urban population of Puducherry. Population is estimated by Arithmetic Mean Method and Incremental method. However incremental method is taken into consideration since this method projects higher value than the other. The population projection for Puducherry Urban area is presented in **Table 2.**

Table 2. Population Projection

Year	Population projection (persons)	
	Arithmetic Method	Incremental Method
2001	505,959	505,959
2006	556,952	568,234
2011	607,945	638,030
2016	658,939	715,347
2021	709,932	800,186
2026	811,918	992,427
2030	836,394	1,043,257
2031	842,514	1,055,965

Source: Department of Economics and Statistics, Puducherry

5.3 Estimated Waste Generation

The quantity of MSW generated depends on a number of factors such as population, food habits, standard of living, degree of commercial activities and seasons. Data on quantity variation and generation are useful in planning for collection and disposal systems. The increasing urbanization and changing lifestyles have increased the waste generation rate of Indian cities. In India, the amount of waste generated per capita is estimated to increase at a rate of 1-1.4 % annually. (Source: CPHEEO SWM MANUAL)

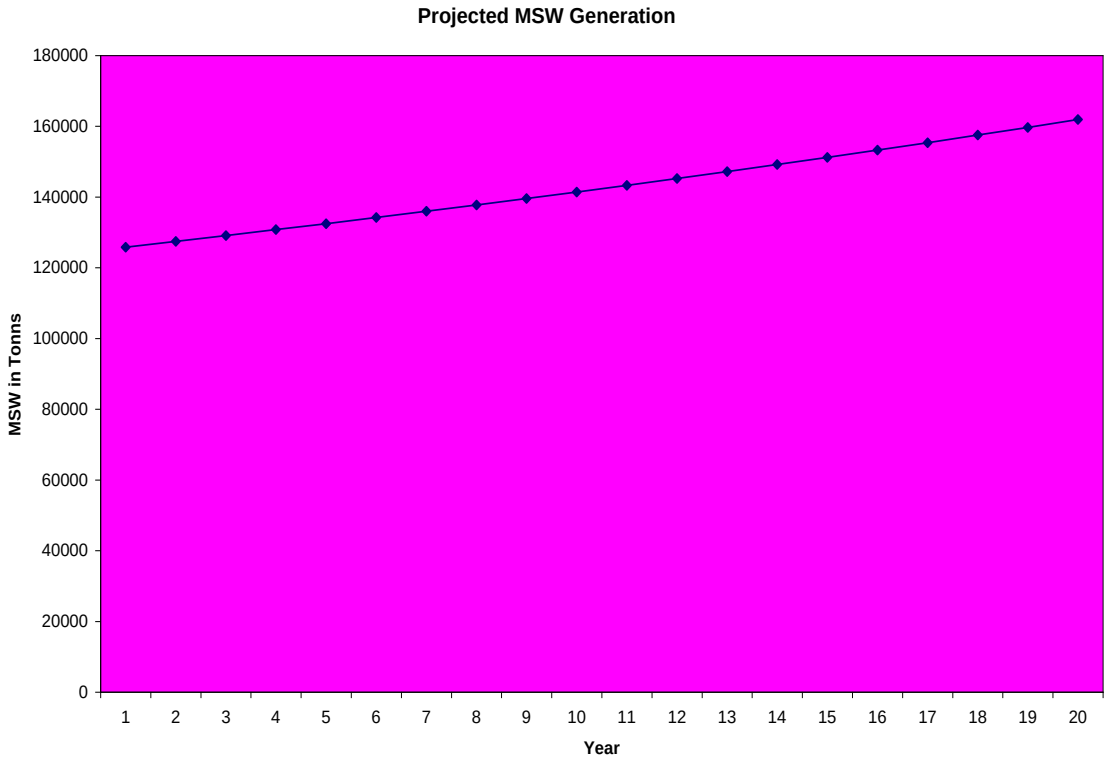
Criteria for assessing waste generation

- Past population estimates based on Census surveys
- Projected populations for the design period
- Density of Population
- Existing MSW quantities
- Existing per-capita waste

- Characterization of the existing waste quantities

The estimated waste generation for the upcoming years is calculated based on the annual increase in per capita waste generation and is presented in Fig.2. It is estimated that by the year 2020, 160000 Mt of MSW would be generated.

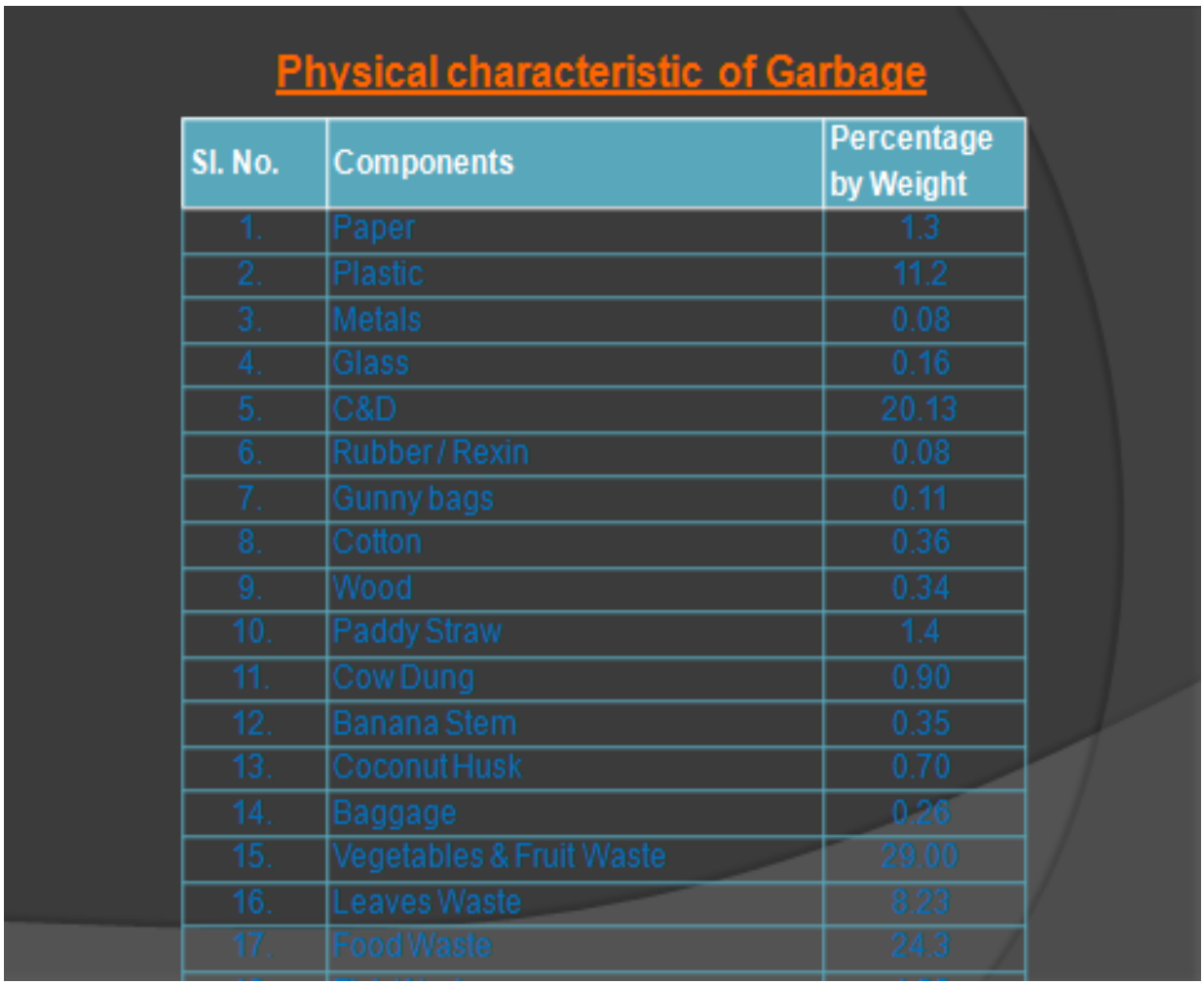
Fig.2. Projected MSW generation



5.4 Waste Characterization

Composite waste sampling was carried out to assess the waste composition and the same is presented in Table 3. It showed that C&D forms the major composition of 15 % followed by vegetable and fruit wastes and food wastes. Plastic wastes consist of 11 %. Barring metals and glass wastes and C&D wastes, the remaining all other types of wastes are incinerable wastes.

Table. 3 Physical Characteristic of MSW

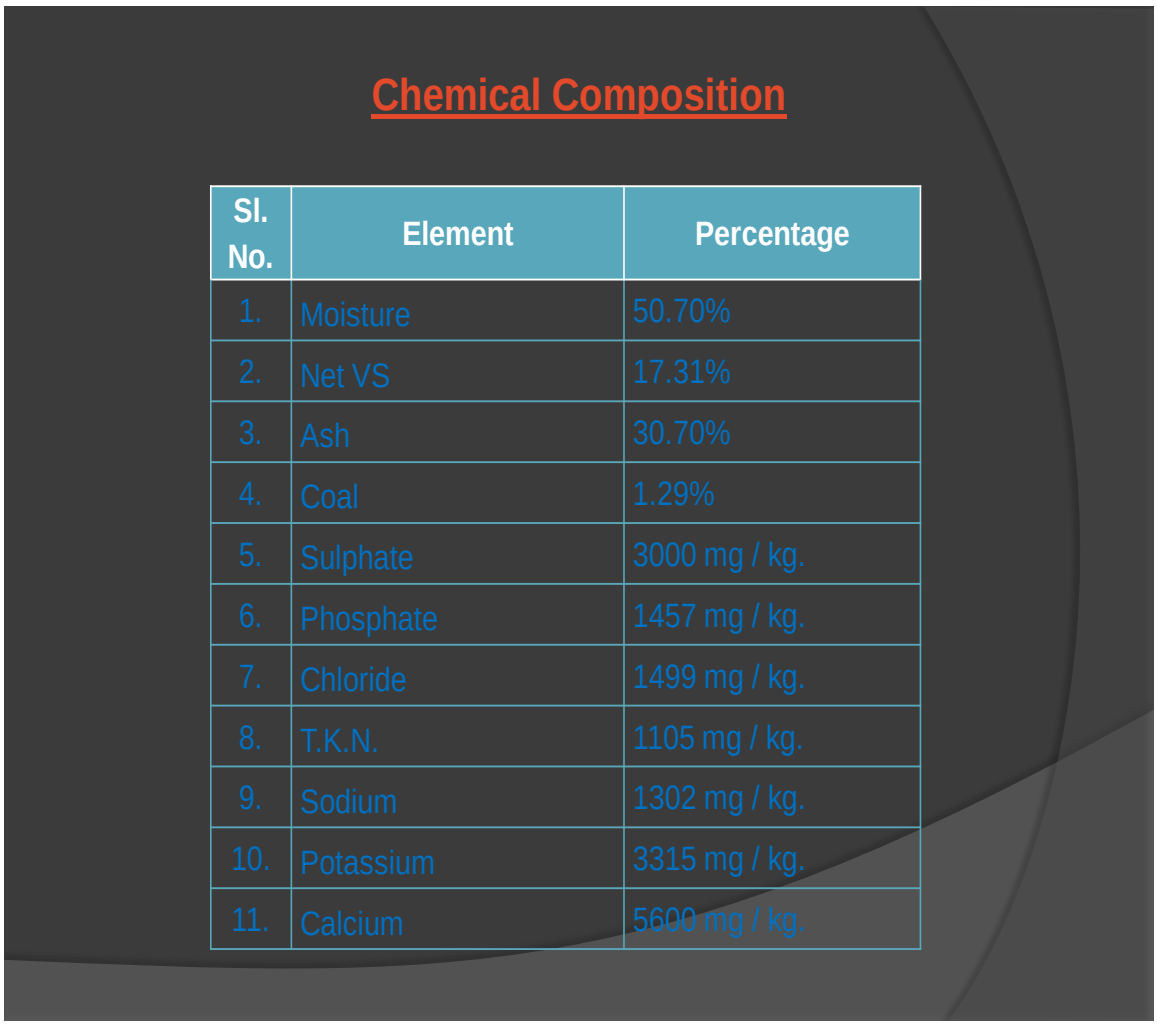


Physical characteristic of Garbage

Sl. No.	Components	Percentage by Weight
1.	Paper	1.3
2.	Plastic	11.2
3.	Metals	0.08
4.	Glass	0.16
5.	C&D	20.13
6.	Rubber / Rexin	0.08
7.	Gunny bags	0.11
8.	Cotton	0.36
9.	Wood	0.34
10.	Paddy Straw	1.4
11.	Cow Dung	0.90
12.	Banana Stem	0.35
13.	Coconut Husk	0.70
14.	Baggage	0.26
15.	Vegetables & Fruit Waste	29.00
16.	Leaves Waste	8.23
17.	Food Waste	24.3

The Chemical composition analysis of the MSW is presented in Table 4. It revealed that moisture forms major composition of 50.7 % followed by ash and volatile substances. The energy content has been estimated in the range of 1200 kcal/kg to 1800 kcal.kg.However, it is recommended that detiled waste characterization need to be done before the project actually commissioned.

Table 4. Chemical composition of MSW



Chemical Composition

Sl. No.	Element	Percentage
1.	Moisture	50.70%
2.	Net VS	17.31%
3.	Ash	30.70%
4.	Coal	1.29%
5.	Sulphate	3000 mg / kg.
6.	Phosphate	1457 mg / kg.
7.	Chloride	1499 mg / kg.
8.	T.K.N.	1105 mg / kg.
9.	Sodium	1302 mg / kg.
10.	Potassium	3315 mg / kg.
11.	Calcium	5600 mg / kg.

Methodology for Sampling:

Physical characteristic of Garbage:

In order to collect representative sample of garbage collected from different parts of Pondicherry urban area, composite sample was followed. Five garbage transporting trucks were randomly selected at different time interval. Approximately 20 kgs of garbage was collected after it unloaded from each truck. All the collected garbage are mixed manually and allowed for one day sun drying. 17 items have been identified and segregated from the pooled garbage. Using 10 kgs weighing pan, 17 items weight have been measured and recorded.

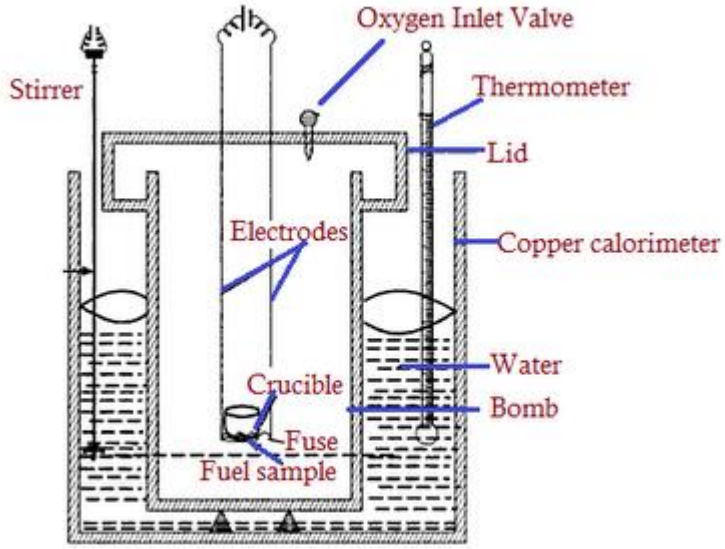
Chemical Characteristics of Garbage:

Compost pH was measured in distilled water (free of CO_2) using 10 g of compost sample and 25 ml distilled water (ration 1 : 2.5). The suspension was agitated for 3-5 min and placed for half an hour before measuring the pH value with a glass membrane electrode. Organic matter content was determined by the method of $K_2Cr_2O_7$-H_2SO_4 oxidation. Then, 0.1 g compost sample was mixed with H_2SO_4- $K_2Cr_2O_7$ solution and heated at 170-180°C. the solution was kept boiling for 5 min. After cooling, the residual $K_2Cr_2O_7$ was titrated by $FeSO_4$ standard solution with O-phenanthroline hydrate as an indicator. Organic matter content was calculated based on the amount of $K_2Cr_2O_7$ consumed. Total N content of the compost sample was analyzed using Kjeldahl digestion. For the dtermination of total P, total K, Ca, Mg, Fe, Mn and heavy metals, each sample (0.5 g) was digested with H_2SO_4 – Hcl/HNO_3 (aquaregia) – $HclO_4$. Digests were cooled, filtered, and diluted to 25 ml with deionized water. The contents of total P (TP), total K (TK), Ca, Fe, Mg, Mn, and heavy metals (Cu, Zn, Pb, Cd, Cr, and Ni) were determined by individuvely coupled plasma atomic emission spectrometry (ICP-AES).

Assssment of Calorfic Values:

Bomb Calorimeter for determination of Calorific Value of solid and liquid fuel :

- It is used to measure the calorific value (CV) of solid as well as liquid fuel. But to determine the CV of gas, one need to choose Junker's calorimeter.
- Calorimeter contain thick walled cylindrical vessel and it consists of lid which supports two electrodes which are in contact with fuse and fuel sample of known weight.
- Lid also contain oxygen inlet valve through which high pressure oxygen gas (at about 25 to 30 atm) is supplied.
- Entire lid with fuel sample is now held in a copper calorimeter containing known weight of water. Mechanical stirrer is provided to stirred well for uniform heating of water.
- A thermometer is also provided to measure the change in temperature of water due to combustion of fuel in Lid.



Bomb Calorimeter

Procedure of bomb calorimeter experiment

- A known quantity of fuel sample is added in crucible.
- Start the stirrer and not the initial temperature of water.
- Start current through crucible and let fuel sample to burn in presence of oxygen.
- Heat release during combustion of fuel is taken by water and temperature of it rises.
- Note final steady state temperature of water.

Higher Calorific Value of fuel = $(m_1+m_2) \times (Tc + T_1 - T_2) \times C_w / mf$

Where,

m1 and m2 are mass of water in copper calorimeter and water equivalent of bomb calorimeter respectively.

mf is mass of fuel sample whose calorific value is to be determined.

T1 and T2 are final and initial temperature of water sample.

Tc is temperature correction for radiation losses.

Cw is specific heat of water

6 EXISTING SOLID WASTE DISPOSAL SYSTEM

Currently 500 TPD of mixed MSW are collected from Pondicherry Urban area. The source of solid waste generation is given in Table 5. Among the various sources, solid waste generation is expected to be high in residential areas.

Table 5. Sectoral Source of MSW

Sl.No	Waste Source	% of Total
1	Residential	68
2	Commercial	14
3	Restaurants/Hotel/Marriage Hall	11
4	Market	4
5	Hospital	3
	Total	100

The collected mixed waste is transported to Kurumbapet dumping area by truck and dumped on open land without any processing. It causes obnoxious odour and fly formation. The Rag picker collects usable materials. They also involves in burning of waste to collect the valuable materials. The ambient air quality analysis carried out in the area showed higher values of PM, SO2 and NOx (Fig5-7). This problem results in public agitation against dumping of MSW in this site. Ground water contamination in the area also has been reported due to leaching from the dumping site.(Fig.4 & 8). In a nut shell, the existing practice poses greater challenges to the public health, environment and aesthetic value of the city.

Fig. 3 Present MSW Dumping Yard, Kurumbapet

Fig.4 Ground water contamination through percolation

Fig. 5 Higher concentration of SPM near to the dumping yard

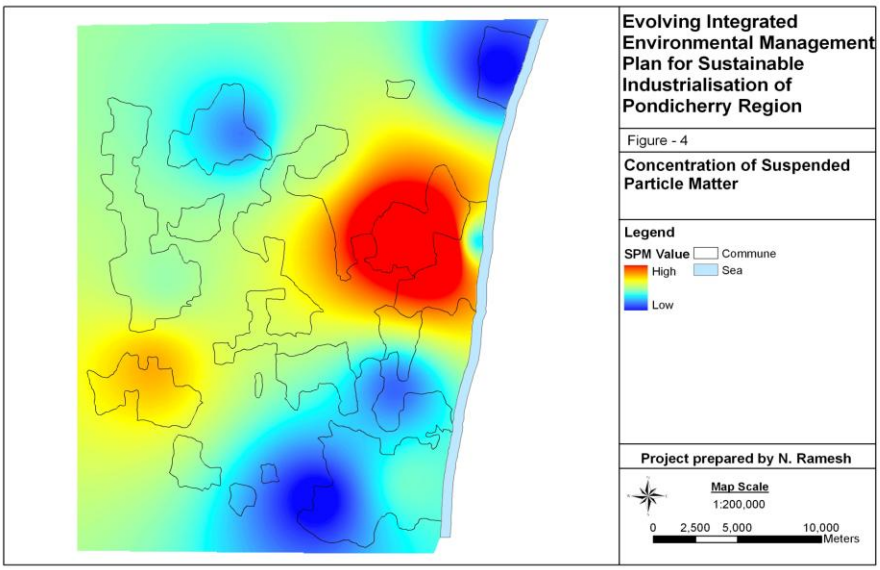


Fig.6. Higher concentration of SO2 near the dumping yard

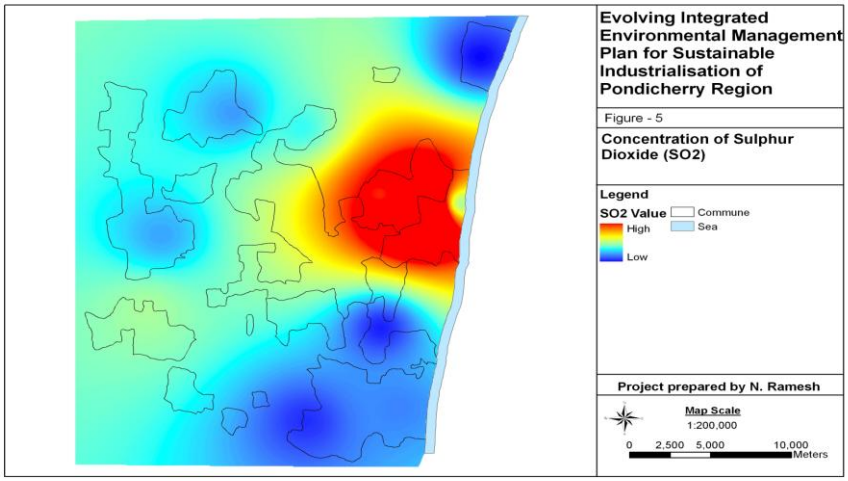


Fig.7 Higher concentration of NOx near to the dumping yard

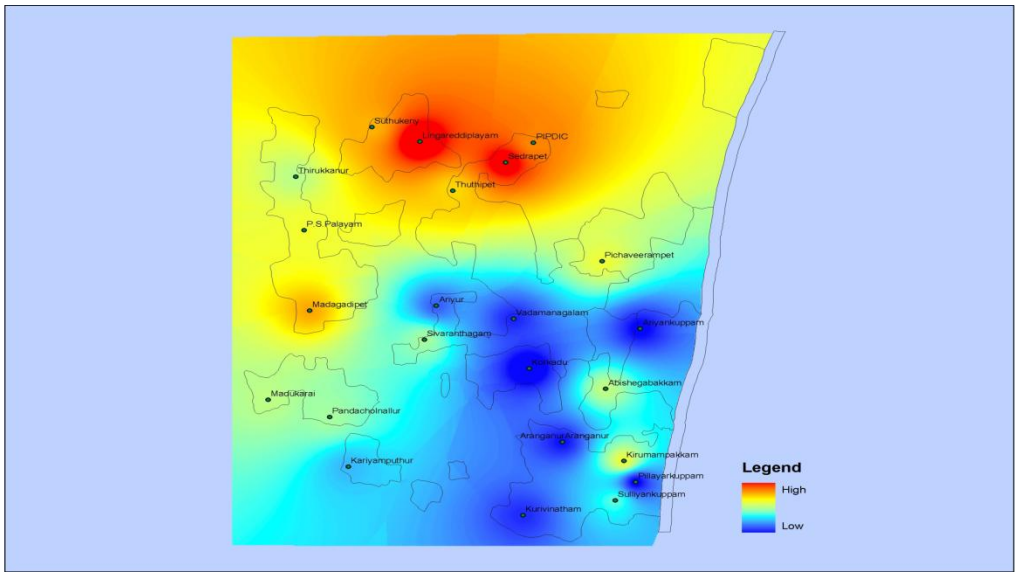
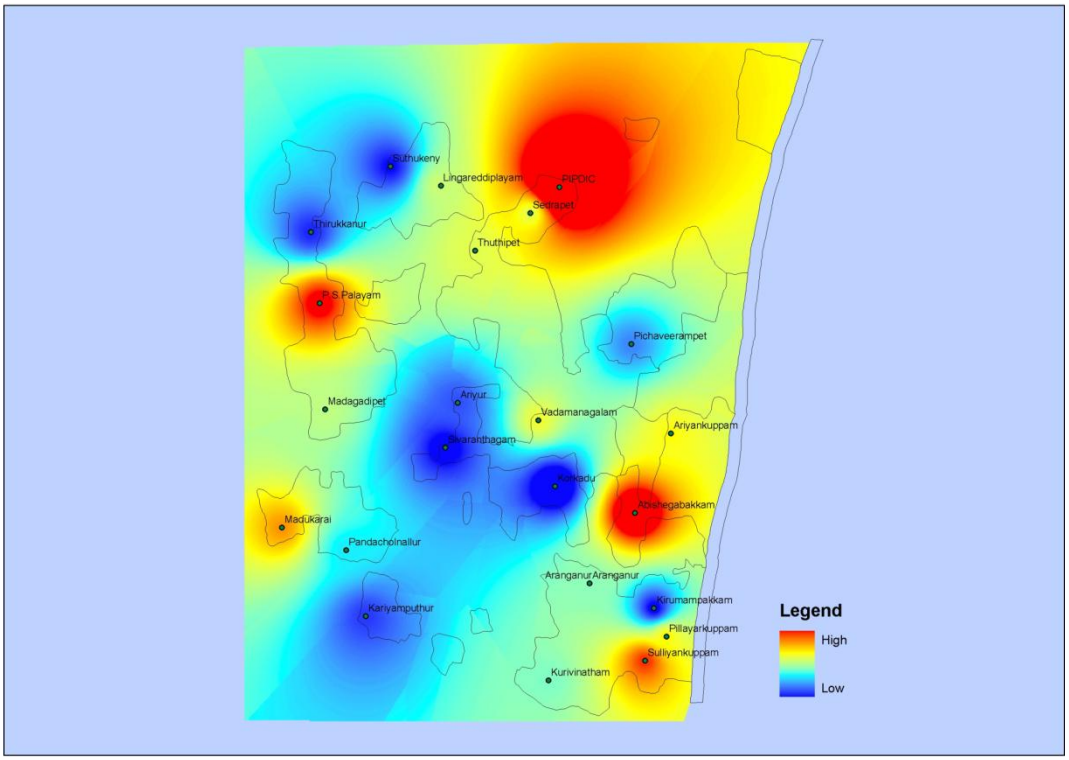


Fig.8 Higher Concentration of Zinc near to the dumping yard



6.1 Merits and Demerits of the Existing MSW disposal system

Open dumping, composting and Sanitary land filling are three methods being adopted for MSW disposal. The merits and demerits are summorised below:

Open Dumping

Merits	Demerits
❖ Inexpensive ❖ Instant disposal	❖ Health-hazard, insects, rodents, odour, etc. ❖ Air pollution ❖ Release of Methane ❖ Ugly look ❖ Ground water contamination and run off

	pollution

Composting

Merits	Demerits
Wealth from waste	Takes longer duration
Concentration of Nutrients	Release green house gases
Easier to transport	Require larger land
Composting kills parasites	Need to control rainfall runoff from the composting area
Usable in organic systems	Generate odour

Sanitary Landilling

Merits	Demerits
Accommodate huge quantity	Larger land area is required
Instant disposal	Cost intensive
Leachate can be collected	Odour
Longer duration	Methane formation
	ETP is required
Caped land can be reused for other community purposes	Chances of ground water contamination if lechate is not collected properly

Rehabilitation of Rag pickers :

Around 15 rag pickers are involving in segregating valuable articles from the Kurumbapet dumping site. The dumping yard is acting as major livelihood for these rag pickers. Once this project commence its operation, rag pickers would loss their revenue. In order to protect, their livelihood, it is proposed to get involve all the rag picker in waste segregation conveyor system. It would support their life sustainability.

7 INCINERATION –A BOON FOR MSW DISPOSAL

7.1 What is Incineration

Incineration is a thermo-decomposition process where in various components present in the wastes are ionized into harmless elements at a higher temperature in the presence of oxygen.

7.2 Why Incineration for disposal of MSW

After plastic articles are entered into human day today life, the composition of plastic wastes in MSW increased from 3 % to 13 %. Being plastic wastes are non-degradable and mingles with other biodegradable wastes, it defeated the composting process of waste disposal. The micro plastic particles formed after pulvarising of composted waste is blocked the micropore of soil while applying the compost on the land and thereby prevents exchange of atmospheric air and infiltration of water.

Presence of plastic wastes in MSW increased its total calorific values and made viable for incineration. The calorific value of the MSW waste assessed by the Civil Engineering Department of Pondicherry Engineering College showed that the values are ranging from 1100 kcal/kg to 1,800 kcal/kg. Detailed analysis of the waste seasonally to assess the calorific value is recommended. Further incineration is envisaged only as an option for disposal of waste not as a energy recovery/power generation project. As per the decision Makers Guide to Municipal Solid Waste Incineration, The World Bank, 1999 , the energy content of the waste is suitable for incineration. To ensure financial viability of incineration plants, the supply of waste feed should be at least 500 TPD of segregated waste with a LCV not less than 1500 kcal/kg of waste (Manual on Municipal Solid Waste Management, 2014, Ministry of Urban Development). As the generation of MSW in Pondicherry is 600 TPD and energy content is ranges from 1100 kcal to 1800 kcal, Incineration of MSW is technically, economically and environmentally viable method.

Non-availability of suitable land is another major constraint for not adopting Secured Land Fill and Composting process or any other option.

7.3 Success story of Incineration

Incineration is one of the prime method of MSW around the globe. In Tokyo, 12 Incineration Facility are successfully operating within the urban limit for more than two decades without causing any public health and environmental problem. In Korea and Singapore, MSW is being disposed through incineration. Okhla Incineration plant has been operating successfully since its commencement in 2011 .

Fig.9. Jindal Incineration Plant, Okhla, New Delhi

8 PROJECT SITE DETAILS

8.1 Project Site Alternatives Considered

The project area for MSW management is intended for Puducherry municipality, Oulgaret municipality, Ariyankuppam and Villianur commune panchayats. Government of Puducherry has taken keen initiative and acquired 23.88 acres of land from Oulgaret Municipality for setting up Municipal Solid Waste Processing and Landfill facility. The Puducherry urban area is spread over to an extent of 71.9 Sq.km. Since the Puducherry

region is small, there is no other alternate land available for establishment of the solid waste processing facility.

8.2 Description of Proposed Site

The site selected for setting up of Municipal Solid Waste Processing is located at Kurumbapet Village, Villianur Taluk, Puducherry, in 23.88 Acres, of R.S. Nos: 58/1B/2, 60/1, 61/2, 61/3, 62/1, 62/2A, 62/2B, 62/2C, 62/4, 62/5 & 62/6. **Figure 10** shows the location of the project site and **Figure 11** shows the view of the site. Table 6 gives the salient features of the site.

Table 6 Salient Features of the Project Site

Features	**Details**	
Geographical location	11°56'02" N & 79°45'43" E	
Elevation	10-15 m	
Climatic Conditions	Summer	Max. Temp. 40° C Min. Temp. 29° C
	Winter	Max. Temp. 30° C Min. Temp. 24° C
	Annual Rainfall : 1234 mm/yr Average Humidity: 70%	
Land availability	23.88 Acres	
Nearest Highway	NH 45A -1.4 Km NH 66 - 4.5 Km	
Nearest Railway station	Puducherry	
Nearest airport	Puducherry Airport – 6.5 Km	
Nearest village	Kurumbapet – 250 m	
Topography	Nearly Plain	
Archaeologically important places	Nil in 15 Km radius	
National parks/ Wildlife Sanctuaries	Oussudu lake (declared as Wildlife protected area) is located at 1.3 Km away from the project site	
River	Gingee river – 2.9 Km	
Reserved/ Protected Forests	No forest blocks in 10 Km radius	
Seismicity	The study area falls under Seismic Zone II	
Defense Installations	Nil in 10 Km radius	

Fig.10. Location of the project Site

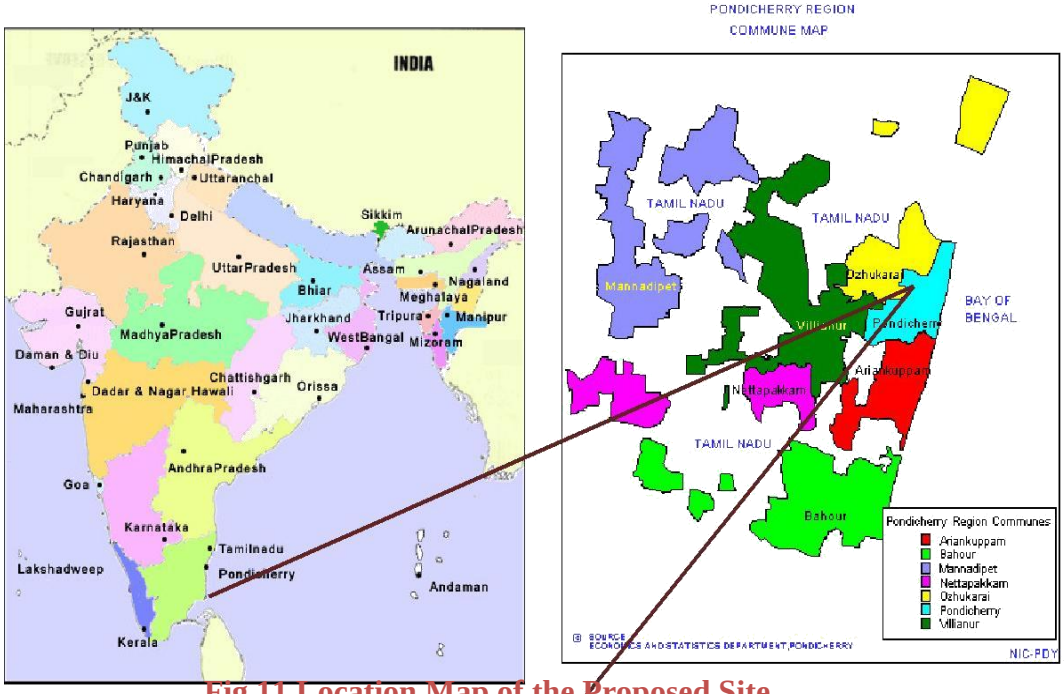
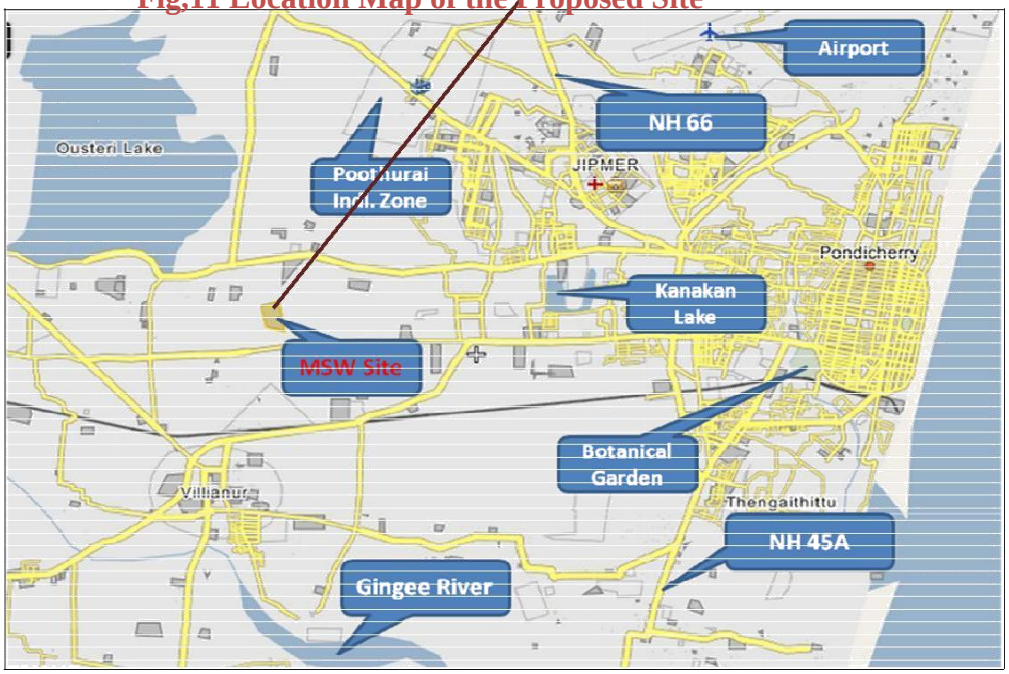


Fig.11 Location Map of the Proposed Site

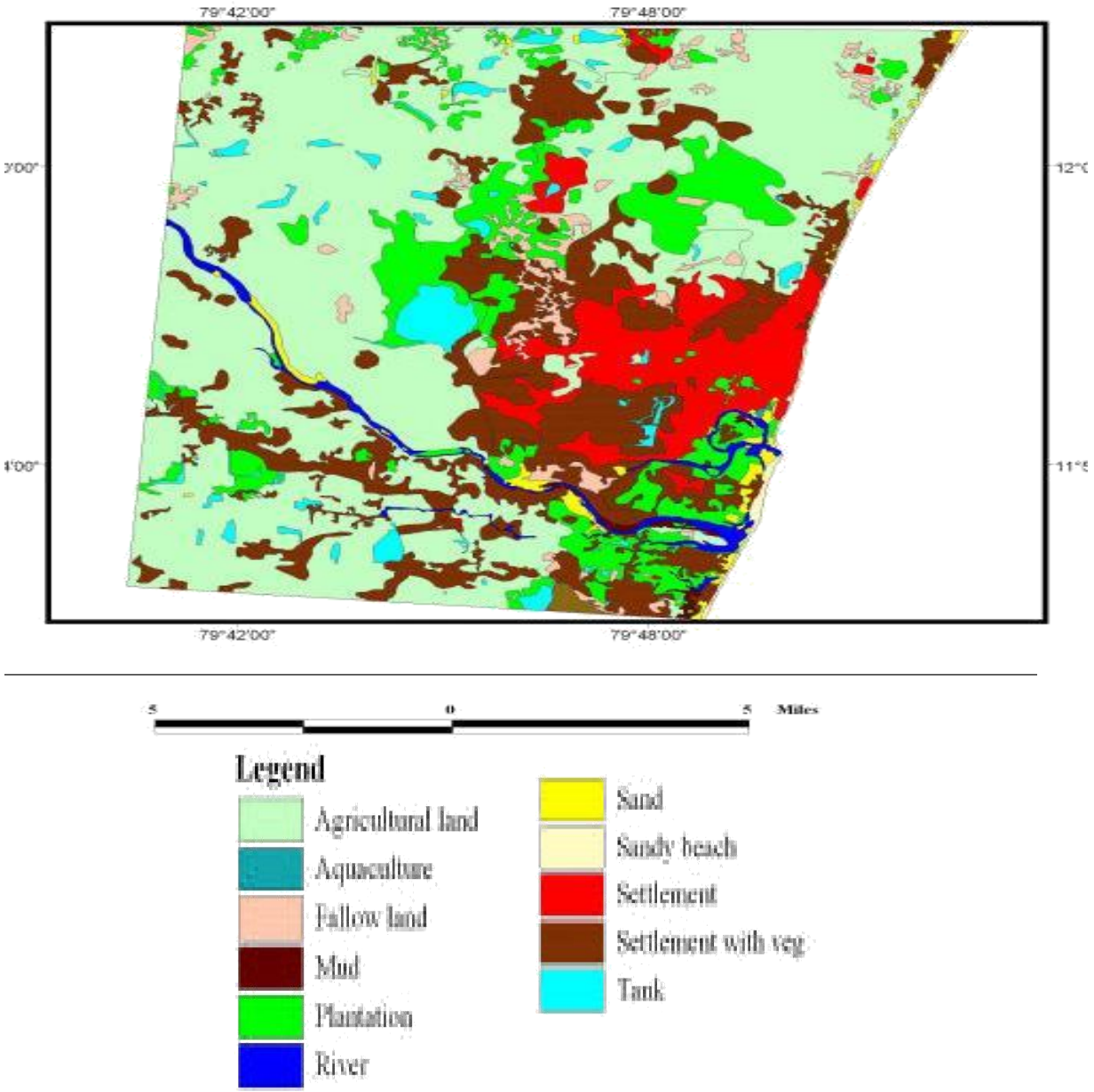


8.3. Land Use Profile

Land cover mapping serves as a basic inventory of land resources for all levels of government, environmental agencies and private industry throughout the world. In the study, 37920Ha area in and around Pondicherry was selected to delineate the present overlay of land

use/land cover changes. The study revealed that nearly 20057.56Ha of the area was covered by agriculture, 6958Ha of the area covered with settlement with vegetation and 4454.51Ha was under plantation whereas settlements alone hold 2939.81Ha of the study area. Tank (1127.75Ha), Fallow land (1107.02Ha), River (593.12Ha) and sandy area (460.20Ha) constitute fare area coverage in the study area, whereas Muddy area (109.64Ha), Sandy beach (102.98Ha) and aquaculture area (9.41Ha) were observed in a smaller area. Land use/ land cover map of the study area was shown in **Figure 12.**

Fig.12. Land Use pattern



Source: *'Land Use and Land Cover Assessment along Pondicherry and its Surroundings*

Using Indian Remote Sensing Satellite and GIS', American-Eurasian Journal of Scientific Research 4 (2): 54-58, 2009.

The classified image map of the study area (In and around Puducherry) showed that most of the lands were used for agricultural purposes. The proposed site comes under agricultural fallow land.

The landuse pattern categories and area covered under Puducherry and adjoining areas are presented in **Table. 7**

Table 7 Land use and Land cover of Puducherry along with surroundings

Name of the Feature	Total area (Ha)	% of Occupation
Agricultural land	20057.56	52.89
Aquaculture	9.41	0.03
Fallow land	1107.02	2.92
Mud	109.64	0.29
Plantation	4454.51	11.75
River	593.12	1.56
Sand	460.20	1.21
Sandy beach	102.98	0.27
Settlement	2939.81	7.76
Settlement with Vegetation	6958.00	18.35
Tank	1127.75	2.97
Total area	**37920.00**	**100.00**

Source: *'Land Use and Land Cover Assessment along Pondicherry and its Surroundings Using Indian Remote Sensing Satellite and GIS', American-Eurasian Journal of Scientific Research 4 (2): 54-58, 2009.*

8.4 Site Suitability Analysis

The problem of municipal solid waste management (MSWM) has acquired an alarming dimension in the developing countries during the last few decades. The quantity of solid waste generated has increased significantly and its characteristics have changed as a result of the change in the peoples' lifestyles due to swift industrialization and urbanization. Hence in

India, establishing solid waste management facility has become mandatory according to MSW Rules, 2000.

Since Puducherry is a small urban area, land availability is a great challenge to the proposed project. However Puducherry government has acquired 23.88 acres of land for establishment of processing facility. The site selected for setting up of solid waste management located at Kurumbapet has the following advantages:

(i) The site selected is an undeveloped site comes under agricultural fallow land. Hence the site can be developed for processing of waste without any major impact.

(ii) National Highway NH 45 A is located at a distance of 1.4 Km from the site and thus provides accessibility to the site for transporting municipal solid waste to the site for processing.

(iii) From geotechnical investigation of the site, it has been observed that the ground water has not encountered till 10 m. Hence the possibility of ground water contamination is very less.

(iv) The surface water bodies are located at a distance greater than 1.5 Km from the site and thus comply with the standards.

(v) Also, the contour map of the site shows that the elevation of the site is at a lower elevation when compared with the nearby surrounding area. This will be a great advantage of the site.

Thus from the above points, it has been concluded that the site selected is suitable for the proposed project. But the location of Ossudu lake and Puducherry airport near the site are the main disadvantages. However adequate mitigation measures will be taken up for the proposed site .

8.5 Site Evaluation Methodology

Since Puducherry Urban Area covers only 71.9 Km^2, there is no other better land available within its limits for setting up of solid waste processing and treatment facility. Therefore only the present site is considered for assessment. Manual on Solid Waste Management has prescribed some of the criteria for selecting the site for Incineration facility. The site was

evaluated based on the location criteria as per CPHEEO Manual and discussed in **Table 8.**

Table 8 Location Criteria as Per CPHEEO Manual

Criteria	CPHEEO Manual Requirements	Status of the Site	Compliance
Lake/Pond	200 m away from the Lake/Pond	Ossudu Lake - 1.3 km from site	Complies
River	100 m away from the rivers	Gingee River - 2.9 km from site	Complies
Flood plain	No land fill within a 100 year flood plain	No flood plain	Complies
Highway	Away from 200 m NHAI/State	NH 45A - 1.4 km from site NH 66 - 4.5 km from site SH 136 - 4.4 km from site	Complies
Public parks	300 m away from public parks	Botanical Garden 6.8 km from site	Complies
Wet lands	No landfill within wet lands	No wetland No wetland	Complies
Habitation	500 m away from the notified habitation area	Kurumbapet village– 250 m	Do not comply
Ground water table	Ground water table >2m.	Borehole was done till 10 m and no water was found	Complies
Critical habitat area	No landfill within the Critical habitat area. It is defined as the area in which 1 or more endangered species live.	Not a critical habitat area	Complies
Air ports	No landfill within 20 km	Pondicherry Airport - 7 km from site	Do not comply. NOC has to be Obtained from Airport Authority.
Water supply Schemes/ wells.	Minimum 500 m away	Thillai Nagar Water Supply - 2 km from project site	Complies
Coastal regulatory zone	Should not be sited	Bay of Bengal - 8.5 km from site.	Not applicable
Unstable zone	No landfill	Site is not susceptible to landslide.	Complies
Buffer zone	As prescribed by regulatory	Few habitations are found at a distance of 250 m from the site	Do not comply

8.6 Site Development

The site will be developed suitably for setting up of processing and treatment facility. The land is leveled after clearing the bushes in the site. Boundary wall around the site will be constructed to prevent the entry of public inside the site. Then the total area will be split according to the requirements. For installing incineration plant , an area of 45450 sq.m is allocated , 6000 Sq.mt. for sorting and segregation plant and 7000 Sq.mt. is designed for secured landfill for inert materials. The remaining areas will be used for other activities viz. Vehicle Parking , Green belt development and Administration Block.

Al the roads inside the site will be designed and well developed. The main roads inside the site will be 7 m wide and the internal roads in the site will be 5 m wide. The roads will be given suitable camber to drain rain water.

The storm water drains will be provided all along roads, green belt and open space to collect the rainwater. The water from the open area will be drained into storm water drains, which in turn drain to a common municipal drain. The rainwater from roof of the buildings will be collected through PVC down take pipes and taken to RWH sump.

8.7 Waste Sorting and Segregation Plant

Since only mixed wastes will reach the processing facility, Semi Automatic Sorting and Segregation Plant Will be installed. All the C&D waste, glass and ceramics wastes would be removed by gravitational forces and metals will be removed by magnetic separator. Worker also will be employed in this section. Incinerable waste only allowed to the plant.

9 INSTALATION OF INCINERATION PLANT

9.1 Introduction

This Chapter describes, in outline, the overall approach that will be adopted to achieve completion of the engineering, procurement and construction phases of the Project. Incineration Plant, on schedule and in accordance with the specification, optional, safety

environmental and requirements up to and including the design, construction, testing and commissioning of the Project on the basis of Turn-Key.

The purpose of this project is to install the plant for incinerating the municipal waste. The designed plant shall provide a pleasant surrounding environment and smooth operation of incineration plant by controlling the exhausted air pollutant materials in compliance with the prevailing environmental law. The given specification is indicative only, and may be modified the Specification of Incineration plant system or may improve its design condition.

9.2 Incinerator Chamber & Boiler

Combustion takes place above the grate in the incineration chamber. The incineration chamber typically consists of a grate situated at the bottom, cooled walls on the furnace sides, and a ceiling or boiler surface heater at the top. As municipal waste generally has a high volatile content, the volatile gases are driven off and only a small part of the actual incineration takes place on or near the grate

The following requirements influence the design of the incineration chamber:

- form and size of the incineration grate - the size of the grate determines the size of the cross-section of the incineration chamber
- vortexing and homogeneity of flue-gas flow - complete mixing of the flue-gases is ensured for good flue-gas incineration
- sufficient residence time for the flue-gases in the hot furnace - sufficient reaction time at high temperatures will be assured for complete incineration
- partial cooling of flue-gases - in order to avoid fusion of hot fly ash at the boiler, the flue gas temperature will not exceed an upper limit at the incineration chamber exit.

9.3 Incinerator Air Feeding

Injection of air into the incinerator is required for:

- provision of oxidant
- cooling
- avoidance of slag formation in the furnace
- mixing of flue-gas

Air is added at various places in the combustion chamber, depending on the location it is described as primary and secondary air. Tertiary air and re-circulated flue-gases may also be used. Primary air is generally taken from the waste bunker. This lowers the air pressure in the bunker hall and eliminates most odour emissions from the bunker area. Primary air is blown by fans into the areas below the grate, where its distribution can be closely controlled using multiple wind boxes, and distribution valves. Primary air is forced through the grate layer into the MSW bed. It cools the grate bar and carries oxygen into the incineration bed.

9.4 Flue Gas Recirculation

Flue gas recirculation is an integral part of the furnace design. After passing through the dust filter, part of the flue gas (20 to 30%) is retained and recirculated through an insulated duct to the furnace. The recirculated flue gas is injected through separate nozzles in the furnace. Among its primary advantages, flue gas recirculation:

- leads to a higher thermal efficiency, as the excess air and the oxygen content can be significantly reduced (efficiency can increase about 1to 3 percent)
- reduces NOx content by 20 to 40 percent
- reduces dioxin and furan generation
- stabilizes and improves the flow and turbulence conditions- particularly at partial load

9.5 Residual Haulage and Disposal System

During the incineration process, most of the waste is combusted and converted to gases such as carbon dioxide, water vapour and toxic gases which are cleaned through a complex flue gas treatment system. However, part of the waste is incombustible and is removed from the incineration furnace as slag, a solid residue. The amount of slag generated depends on the composition of the waste and amounts to 20 to 25 percent by weight of the waste combusted. The slag from a well-operated waste incinerator will be well burnt out, with only a minor content of organic material. Besides, the heavy metals in the slag which are normally leachable will to some extent become vitrified and thus insoluble The slag would be sent to secured land fill designed adjacent to the plant.

The flue gas cleaning process also produce residues, either directly (fly ash) or by the subsequent treatment of the spent scrubbing liquids. Fly ash from filter systems is highly

contaminated and hence, care will be taken to separately collect bottom ash and fly ash separately. Bottom ash can be treated for further use. Bottom ash will be treated on-site by a dry system suitably combined with ageing. Dry bottom ash treatment installations combine the techniques of ferrous metals separation, size reduction and screening, non-ferrous metals separation and ageing of the treated bottom ash, usually for a period of 6 to 20 weeks. The product is a dry aggregate which can be used as a secondary construction material. Wet bottom ash treatment system in the ash quench tank allows the production of a material for recycling with minimal leachability of metals. The economy of the bottom ash treatment depends on the market price of the produced fractions. Revenue can be generated by the sale of non-ferrous and ferrous metals fractions.

The fly ash generated in the boilers and air pollution control equipment is highly contaminated and would be disposed off appropriately. Since, the salt and heavy metal content is very high in the ash, it cannot be used for construction purposes. Fly ash may be stabilized in concrete and then disposed in the secured landfill.

Secured land fill:

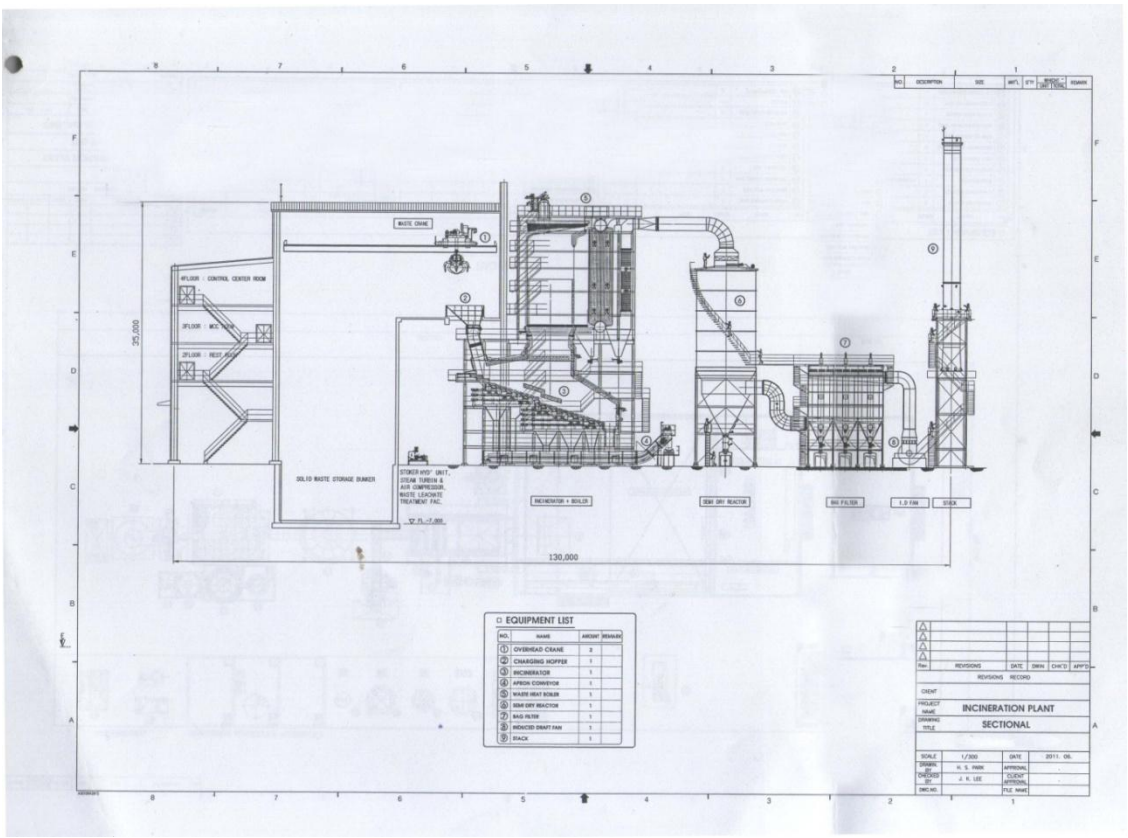
7000 Sq.mt is earmarked for secured land fill of inert materials and incinerated ash. It is estimated that around 0.5 TPD of inert and incinerated ash would be disposed in secured land fill.

9.6 Consumption of Raw Materials and Energy By Incineration Plants

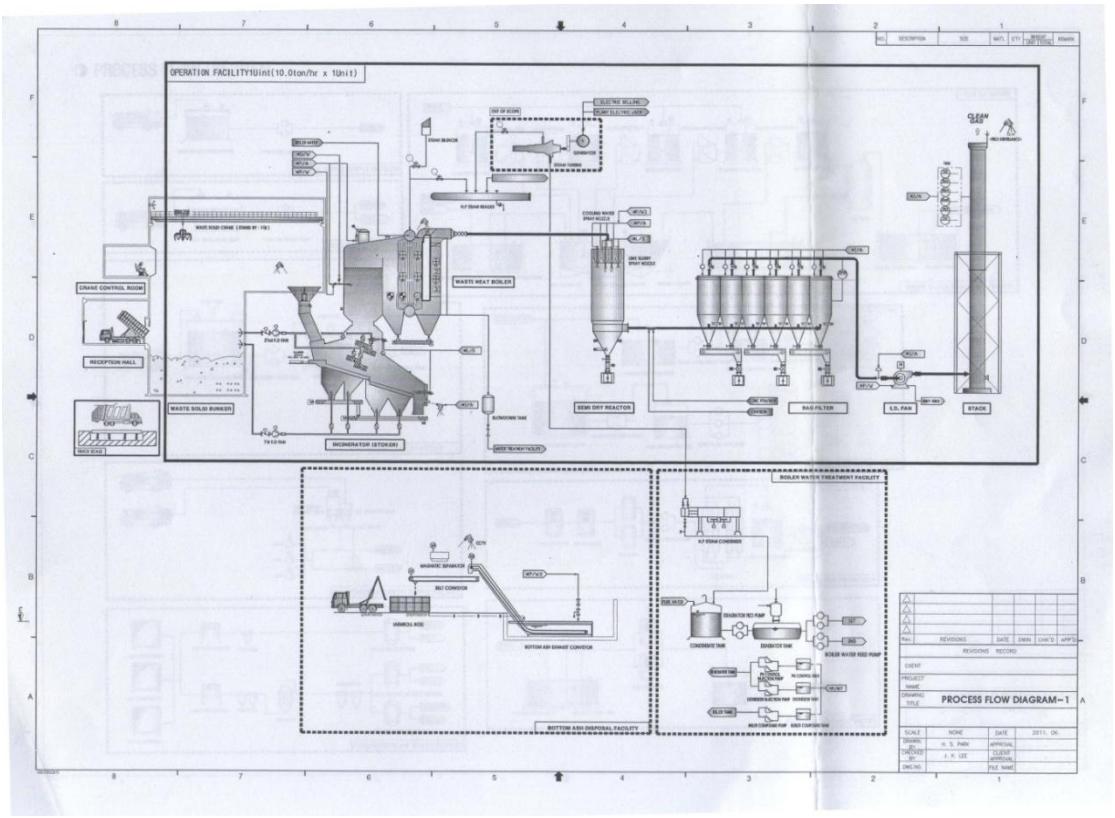
Waste incineration plants (process dependent) may consume:

- electricity, for process plant operation (500 KVA)
- heat, for specific process needs
- fuels, support fuels (, light oils) (Required fir initial ignition -2000 L)
- water, for flue-gas treatment, cooling and boiler operation (Initially 500 KL, make up water-100 KLD)
- flue-gas treatment reagents, e.g. caustic soda, lime, sodium bicarbonate, sodium sulphite, hydrogen peroxide, activated carbon, ammonia, and urea
- water treatment reagents, e.g. acids, alkalis, tri-mercapto tri-azine, sodium sulphite,
- high pressure air, for compressors.

9.7 Plant Details (Fig.13)



9.8 Supply of Main Facility (Fig.14)



Incinerator Plant Capacity	: 25ton/hr(600ton/day).
Incineration Type	: Stoker type.
Steam production facility	: 2-Drum water pipe type waste heat boiler, 62.9 ton/hrX 18Kg/cm^{2}G)
Environment Pollution Prevention Facility	: SNCR + Semi Dry Reactor + Lime powder/Activated Carbon Supply Facility + Bag Filter.
Ventilation Facility:	Combustion air forced draft fan (Stocker) + Induced draft fan + Stack.
Combustion Ask Facility	: Bottom ash disposal conveyor, Belt conveyor, Fly ash conveyor, Magnetic

separator.

Other Facility : Compressed Air Supplying Facility, Fuel supplying Facility, Waste water Treatment Facility, Leachate Treatment Facility

Electric Process Control Facility : 380V, 50Hz, 3 phase, 4 line, Auto Control Facility

- Input/Supply Facility
  - Measuring facility
  - Waste solid Crane
- Combustion Facility
  - Kiln + Stocker combined Incinerator
  - Burner and Oil Pressure Facility
- Steam Production Facility
  - Waste Heat Boiler Facility
  - Boiler Water Supply
  - Chemical Injection Facility
  - Steam Condeser Facility
- Combustion Gas Treatment Facility

  -SNCR& Semi Dry Reactor Facility

  1. Liquid Lime slurry Injection Facility
  2. Lime Powder Injection Facility
  3. Activated Carbon Injection Facility
  4. Bag Filter Facility
- Ventilation Facility
  - Kiln & Stocker Forced Draft Fan
  - Induced Draft Fan

- Stack
- Duct for combustion Gas and Air

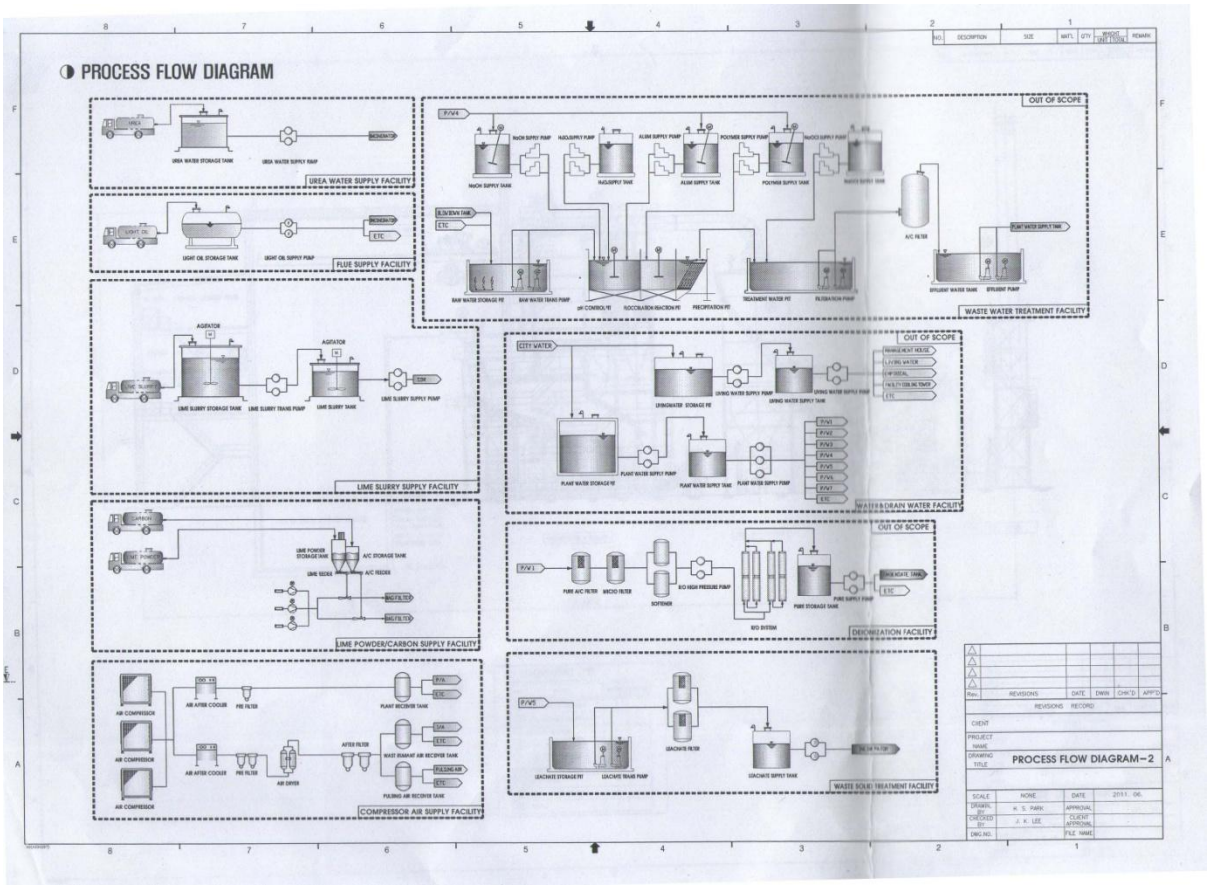
- Ash Treatment Facility
  - Bottom Ash Disposal Facility
  - Fly Ash Disposal Facility
  - Magnetic Separator

- Other Facility
  - Compressed Air Supply Facility
  - Process water Supply Facility
  - Fuel Supply Facility
  - Waste Water Treatment Facility
  - Leachate Treatment Facility

- Electric Facility
  - MCC

- Process Control/Stack Auto Measuring Instrument
  - MMI
  - TMS System

9.9 Design Standard (Fig.15)


PROCESS FLOW DIAGRAM
UREA WATER SUPPLY FACILITY
FLUE SUPPLY FACILITY
LIME SLURRY SUPPLY FACILITY
LIME POWDER/CARBON SUPPLY FACILITY
COMPRESSOR AIR SUPPLY FACILITY
WASTE WATER TREATMENT FACILITY
WATER&DRAIN WATER FACILITY
DEIONIZATION FACILITY
WASTE SOLID TREATMENT FACILITY
OUT OF SCOPE
PROCESS FLOW DIAGRAM-2

Combustion Waste

Classification / Subject Waste	Incinerating amount (kg/hr)	Composition Ratio(%)	Based on generated heat amount (kcal/kg)
Composition Waste	600 ton/day	100.0	1400 Kcl
Design Condition	600 ton/day	100.0	1200~2000

9.10 Waste Composition

Composition / Waste	Combustible Material						Non-Comb	H_2O	Composition Ratio
	C	H	O	N	S	Cl			
Higher Calorific Value	**26.13**	**3.2**	**17.95**	**0.33**	**0.03**	**0.26**	**7.1**	**45**	**100**

8.5.3Waste Heating Value

1) High Heating Value (Hh): 2,442 kcal/kg

2) Lowe Heating Value (Hl):1200 kcal/kg

9.11. Main Facility Specification

8.6.1 Computation of Incineration Furnace (Stoker)

1) Discharging gas quantity of incineration furnce:52,570Nm^3/hr

2) Outlet temperature of incineration furnace:970-$^{+}$ 50^0C

3) 1^{St} combustion chamber volume: $130m^3$

4) 2^{nd} combustion chamber volume: 145m3 (detention time: 10 seconds)

8.6..2 Combustion Gas Cooling Facility

1) Waste heat boiler inducing gas amount: 52, 890 Nm^3/hr.

2) Waste heat boiler outlet temperature:210 $\pm$ 20^0C

3) Steam capacity (operation): 27.9 ton/hr

4) Steam pressure (operation):18kg/cm^2g x 208^0C

8.6.3 Semi Dry Reactor Facility

1) SDR inducing gas quantity: 52,890Nm^3/hr
2) SDR outlet gas temperature: 160^0C
3) SRD casing size: 5,830 x 12,300H (hopper excluded)
4) SRD inducing gas velocity: 1.0m/sec(detention time 12 sec)

9.12 Bag Filter Facility

1) Bag filter inducing gas quantity: 54,790Nm^3/hr
2) Bag filter outlet gas temperature: 152^0c
3) Number of bag filter: 5 row x 12 column x 6 chambers
4) Bag of gas velocity: off-line (0.76m/min)

9.13.Induced Draft Fan

1) Inducing gas quantity : 56, 050Nm^3/hr
2) Inlet gas inlet temperature: 152^0C
3) Induced fan dosage: 1,770 Am^3/min
4) Induced fan total pressure: 580mmAq
5) Induced fan power: 375 Kw, Inverter Control (VVVF)

9.14 . Stack

1) Stack inducing gas quantity :56,050Nm^3/hr
2) Stack size:2,200mm x 50, 000H

9.15 Design Standard of the Incineration Plant [600ton/day, operation basis]

Table 9 Design Standard

Item	Unit	Legal Standard	Warrantee Design	Remarks
Outlet temperature of 2nd combustion chamber	°C	More than 850	More than 850	Decomposition of Dioxin
Detention time of combustion gas	Sec	More than 2	More than 2	Minimization of pollutant generation
Volatile solids of bottom ash	%	Less than 10	Less than 7	Minimization of bottom ash generation
Possible increasing temperature of auxiliary combustion apparatus	°C	More than 600	More than 600	In case of normal transmission to stack auto measuring control center
Surface temperature of combustion apparatus	°C	Less than 80	Less than 75	After reflection of refractory
Induction temperature of first dust collector	°C	Less than 200	Less than 180	

9.16 Design Standard of Air Pollution [240 ton/day, operation basis]

Table.10 Design Standard of Air Pollution

Air Pollutant	Unit	Generation amount of incinerator outlet	Emission allowance standard	Guaranteed performance
Dust	Mg/sm^2	3,000	Less than 120 (12)	Less than 30(12)
SO_2	ppm	150	Less than 30(12)	Less than 25(12)
HCl	ppm	700	Less than 25 (12)	Less than 20 (12)
No_2	ppm	150	Less than 180(12)	Less than 70 (12)
Dioxin	Ng-TEQ/sm^2	5	Less than 30	Less than 0.1

( ) standard oxygen Density (Vol. % of O_2)

9.17 Construction Schedule

Table 11 Construction Schedule

ITEM	PERIOD (month)
Executive Design, Procurement	3
Fabrication	6
Transportation (Ocean & Inland)	1
Installation	8
Commissioning, Training	2
Total completion period	20

Time schedule for completion of the project is given in Fig.16

9.16.1 Summary of Costs

Table-12 Summary of Costs

		Item	Price (In Rs)	
A.		Engineering Fee		58,944,000
B.		Supply of Equipment		1,787,968,000
	a.	Incineration facility	392,960,000	
		Stoker unit (240 ton/day) others (Burner, Ash Disposal, Grate, Hydraulic unit, Refractory, Combustion Fan & Duct)		
	b.	Flue Gas Cooling Facility	343,840,000	
		Waste heat boiler, Steam supply, Fly ash Treatment, Deaerator, Chemical supply, Deionization, Insulation		
	c.	Flue Gas Treatment facility	245,600,000	
		Semi Dry Reactor, Lime Slurry Supply, Bag Filter, others(Lime Powder Injection, A/C Silo Injection SNCR system, Ventilation including Stack)		
	d.	Common Facility	343,840,000	
		Waste feeding, chemical supply, Utility supply (water supply & Drainage, cooling, deionization Leachate treatment, Light oil supply, Air compressor, etc)		
	e.	Electrical works & TMS	245,600,000	
	g.	Others (Piping & Insulation)	216,128,000	
C		Sea Freight Charge		85,960,000

D		Site Installation including supervision fee		196,480,000
		Grand total		**2,129,352,000**

9.17 Scheme of Training

Table 13 Scheme of Training

ITEM	CONTENTS
Progress Technology	Outline of Progress - character of progress, factor of design, & management skill - management instruction of machine, electronics & equipment
Management Technology	Detail of operation technology Operation together - how to operate normally or emergency - the way of installment & Changing program - the way of manual & auto operation
Equipment control Technology	Common & Uncommon operation Way of taking measures when something happens to program Memorize control condition & interface Development background & function of operation soft ware Variation of operation mode & amendment theory
Maintenance Technology	Character of materials & operation Maintenance of materials & actual training

9.20 Fund Source

The total estimated cost of installation of Incinerator is **2,129,352,000.** A loan proposal for Rs.2,02,60,00,000 has been submitted to Japan International Cooperation Agency (JICA). The balance amount Rs.10.33 crores would be meet out from State Govt. grant.

9.21 Period of Completion

The project is expected to be commissioned within 20 months period.

9.22. Operation and Maintenance

The commissioned firm is responsible for one year period of operation and maintenance

10 ENVIRONMENTAL IMPACT ASSESSMENT

10.1 Environmental Concerns

There are two major rivers draining this region 1) the Gingee river, which traverses the region diagonally from north-west to south-east (2 Kms from project site) and 2) the Ponnaiyar (Penniyar) river, which forms the southern border of the region (7 Kms from project site). There is no impact for these rivers due to this project activity.

Oussudu lake which has been declared as wild life sanctuary is located 1.3 Km away from the project site in North West direction. Oussudu is located at higher elevation. The elevation of the Oussudu Lake (20m MSL) is higher than the project site (12 mMSL). The slope of the terrain is towards South East direction. So, there is no chance of water movement towards the Oussudu lake.

Location of habitations within 500 m of the site is also of environmental concern. But the density of population is very less and also appropriate measures will be taken to minimise the impact on habitations. The location of airport at a distance of 6.5 Km poses another hindrance. However NOC will be obtained from the authority and adequate measures will be taken to prevent bird nuisance and bird hit.

10.2 Assessment of Base line Environmental Status

Baseline Environmental Studies have been conducted to determine the existing status of various Environmental attributes viz., Climatic and Atmospheric Conditions, Air, Water, Noise, Soil, Land use pattern prior to setting up of the proposed project. This study would help to undertake corrective mitigation measures for protection of the environment on account of any change deviation of attributes due to activities of the proposed project.

10.3 Methodology of Conducting Baseline Study

As part of Rapid Environmental and Social Impact Assessment, this study was undertaken for a period of three months viz November'10 to January'11. An area, covering a 10 km radial distance from the project site is considered as study area for the purpose of the baseline studies. Primary data on Air, Water, Noise and Soil were collected by a team of Engineers and Scientists. Secondary data was collected from various Departments of State/Central

Government Organizations, Semi-Government and Public Sector Organizations. The **Table 14** gives various environmental attributes considered for baseline study.

Table 14 Various Primary Environmental Parameters and its Attributes

S.No	Parameter	Attributes	Sampling		Measurement Method
			Network	Frequency	
1	Ambient Air Quality	Particulate Matter (PM10)	Requisite locations in the project influence area	24 Hourly	Gravimetric (High- volume
		Particulate matter (PM2.5)			Gravimetric (High Volume with cyclone)
		Sulphur Di-Oxide (SO2)	Requisite locations in the project influence area	24 Hourly	EPA Modified West & Gaeke method
		Oxides of Nitrogen(NOx)			Arsenite Modified Jacob & Hochheiser
2	Water Quality	Parameters for water quality: pH, temp, turbidity, Total hardness, total alkalinity, chloride, sulphate, nitrate, fluoride, sodium, potassium, Electrical Conductivity, Ammonical nitrogen, Nitrate-Nitrogen total phosphorus, BOD,COD Calcium, Magnesium, Total Dissolved Solids, Total Suspended Solids	Set of grab samples at requisite locations for ground and surface water	Once	Samples for water quality collected and analyzed 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.

S.No	Parameter	Attributes	Sampling		Measurement Method
			Network	Frequency	
3	Noise levels	Hourly equivalent noise levels	Requisite locations in the project Influence area	Once	Instrument : Noise level meter
4	Soil	Parameter for soil quality: pH, texture, electrical conductivity, organic matter, nitrogen, phosphate, sodium, calcium, potassium and Magnesium.	Requisite soil samples be collected as per BIS specifications within project influence area	Once	Collected and analyzed as per soil analysis reference book, M.L.Jackson
5	Ecology	Existing terrestrial flora and fauna within the 10 km radius of project influence area	Secondary sources and Field survey	once	Either by direct observations and discussion with people
6	Socio-economic aspects	Socio-economic characteristics of the affected area	Based on field survey and data collected from secondary sources	Once	

10.4 Meteorology

The meteorological data recorded during study period is very useful for proper interpretation of the baseline information as well as input data, to predict models for air quality dispersion.

The year may broadly be divided into four seasons.

- Winter season : December to February
- Summer season : March to May
- Monsoon season (South West Monsoon) : June to September
- Post monsoon (North East Monsoon) : October to November

The climate in the region is greatly influenced and governed by the northeast and southwest monsoons. The southwest monsoon, starts by June 1st and lasts up to mid-September. This is followed by the northeast monsoon, the period of heavy rainfall occurring normally during October – November. Occasional showers also hit the region in remaining months.

10.4.1 Temperature

Pondicherry experiences hot and humid climate for the maximum part of the year, with temperatures varying between 26° C and 38° C. The summer season is mostly dry with a clear and blue sky. The summer season extends from March till July, and the temperature varies between 24.50° C to 41° C.

10.4.2 Rainfall

The average annual rainfall of Puducherry region is 1200 mm, of which around 63% occurs in north east monsoon, while the remaining is scattered sporadically throughout the year. The monsoon season in Pondicherry is very small compared to other parts of India. The region receives good rainfall during the months from November to January and from July to September. The annual average rainfall in Puducherry for the past 12 years is presented in

Table 15 Annual Average Rainfall in Puducherry

Month Year		Jan	Feb	March	April	May	June	July	August	Sep	Oct	Nov	Dec	Total
1999	Day	-	-	-	2	1	5	3	6	4	15	10	6	52
	Rain	-	-	-	53	7.40	57	84	133.6	23.5	462.9	306.2	304.0	1432
2000	Day	3	4	-	2	2	3	1	6	9	7	10	4	51
	Rain	60.1	191	-	29.1	23.1	25.5	8.0	124.6	168.6	142.4	1709	178.3	1122
2001	Day	1	-	-	2	3	4	6	4	4	9	10	7	50
	Rain	6	-	-	22	18.2	37.6	109.4	110	121.2	229.4	169.4	112	935
2002	Day	2	3	-	-	3	1	4	4	4	8	5	2	36
	Rain	31	154.4	-	-	19.6	35.4	36.5	37.6	77	247.7	305.5	141	1086
2003	Day	-	-	-	-	2	1	5	10	3	9	15	1	46
	Rain	-	-	-	-	40	20	7108	204.1	52	156.3	510.4	12	1067
2004	Day	1	-	-	-	6	2	2	4	8	11	11	1	46
	Rain	43	-	-	-	212.2	50	45	67	202	411.6	253	12	1296
2005	Day	-	1	-	4	2	-	2	7	6	12	12	9	55
	Rain	2	26	-	89	26	2	21.5	90.6	139	151.5	758.5	258	1564

2006	Day	0	0	2	1	2	4	3	4	3	11	13	3	46
	Rain	2	-	29	11	89	85	33	39	38	432	256	253	1247
2007	Day	0	1	-	2	0	1	11	8	4	14	5	9	55
	Rain	-	6	-	9	2	6	103	110	31.5	435	93	295	1091
2008	Day	2	0	10	0	1	4	4	4	2	14	11	3	55
	Rain	74	0	240	0	29	38	21	41	40	317	837	84	1721
2009	Day	2	-	2	1	3	-	2	4	12	5	15	10	56
	Rain	18	-	159	23	42	-	37	75	200.8	231	539	264	1589
2010	Day	2	-	-	1	2	7	2	10	9	10	20	12	75
	Rain	22	-	-	62	49	298	18	194	117	182	579	284	1805

10.4.3 Relative Humidity

In view of the coastal location the relative humidity is generally high. It ranges from 50% to 80%. Annual profile for Temperature and Relative Humidity at Puducherry is represented in

Table 16 Annual Profile for Temperature and Relative Humidity at Puducherry

Year	Mean Temperature		Relative Humidity	
	Max (°C)	Min (°C)	8.30 hrs	17.30 hrs
1995	33.2	24.6	77	76
1996	32.3	23.6	85	81
1997	32.8	24.0	84	80
1998	33.4	24.5	83	79
1999	33.1	23.8	84	78
2000	33.2	24.0	83	77
2001	33.4	24.2	83	77
2002	33.7	24.1	79	74
2003	33.6	24.2	79	72
2004	33.1	23.9	78	70
2005	33.3	24.4	79	72
2006	33.4	24.1	79	71
2007	33.1	24.1	79	72

Source: India Meteorological Department, Chennai

10.4.4 Wind

The predominant wind direction in Puducherry is presented in **Table 17**

Table 17 Predominant Wind Direction

S.No.	Season	Predominant Wind Direction
1	Winter Season	NNE or ENE
2	Summer Season	SW
3	South West Monsoon	W or SW
4	North East Monsoon	N or NE

10.4.5 Micro Meteorology

The site specific meteorological data for the study period (November to January) are presented in **Table 18**

Table 18 Meteorological data during baseline study

Months	Temperature			Precipitation (mm)		Wind Speed (km/h)		Predominant Wind Direction
	Max	Avg	Min	Max	Avg	Max	Avg	
Nov	29	26	23	160	12.4	28	1	NE
Dec	28	25	22	48	5.5	44	2	NNE
Jan	29	25	26	170	4	97	4	NE

10.4.6 Wind Rose Diagram

The wind rose denotes a class of diagrams designed to display the distribution of wind direction experienced at a given location over a period of time. The **Figures 13-15** shows the Wind Rose diagram for the months of November, December and January **r**espectively in Puducherry.

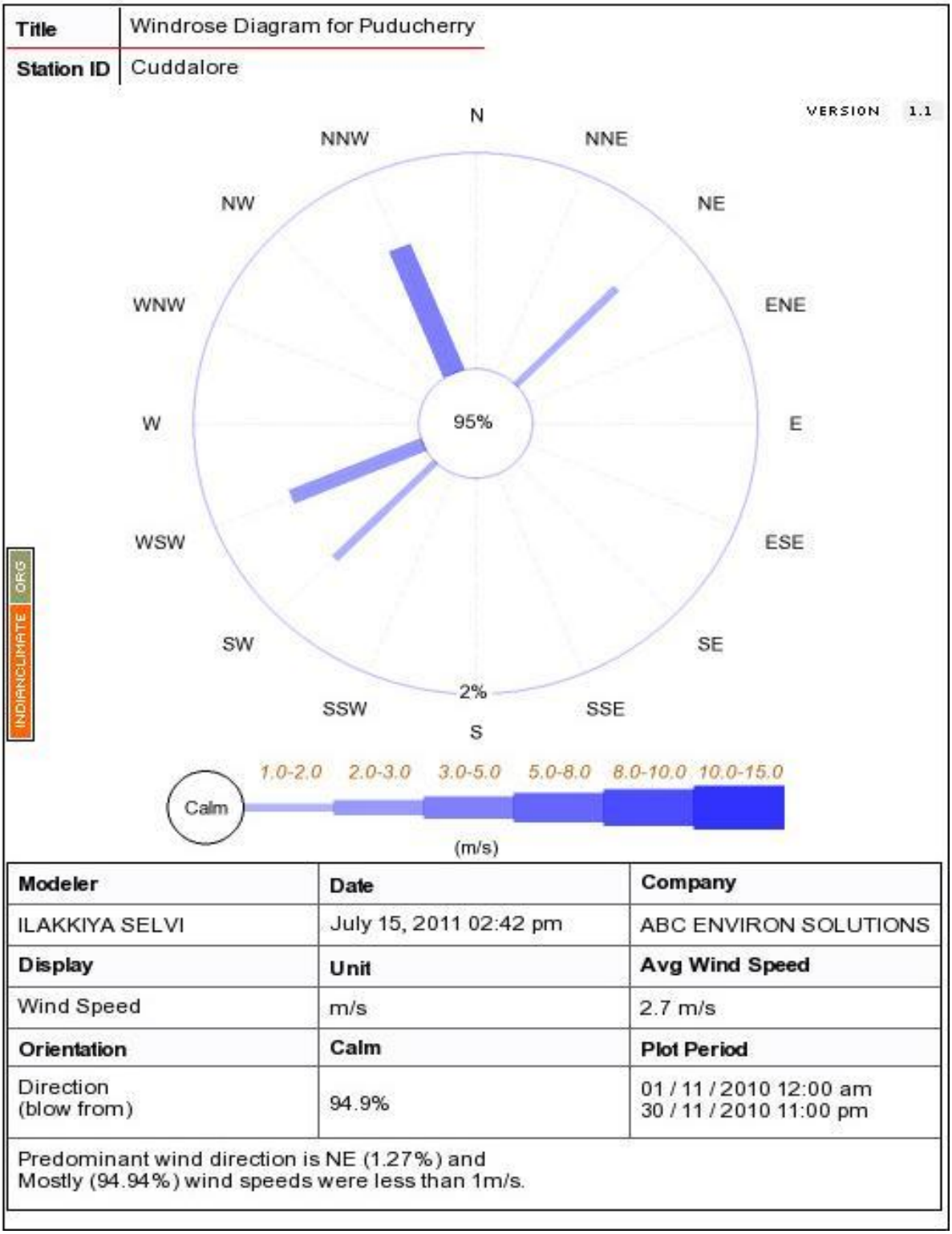
In the month of November 2010, the North East direction was found to be the predominant wind direction and 94.94 % of the wind speed was less than 1 m/s.

The wind rose diagram of the month December 2010 reveals that wind was blowing

predominantly from the North North East direction and 94.85 % of the wind speed was less than 1 m/s.

The wind rose diagram of the month January 2011 reveals that wind was blowing predominantly from the North East direction and 91.94 % of the wind speed was less than 1 m/s.

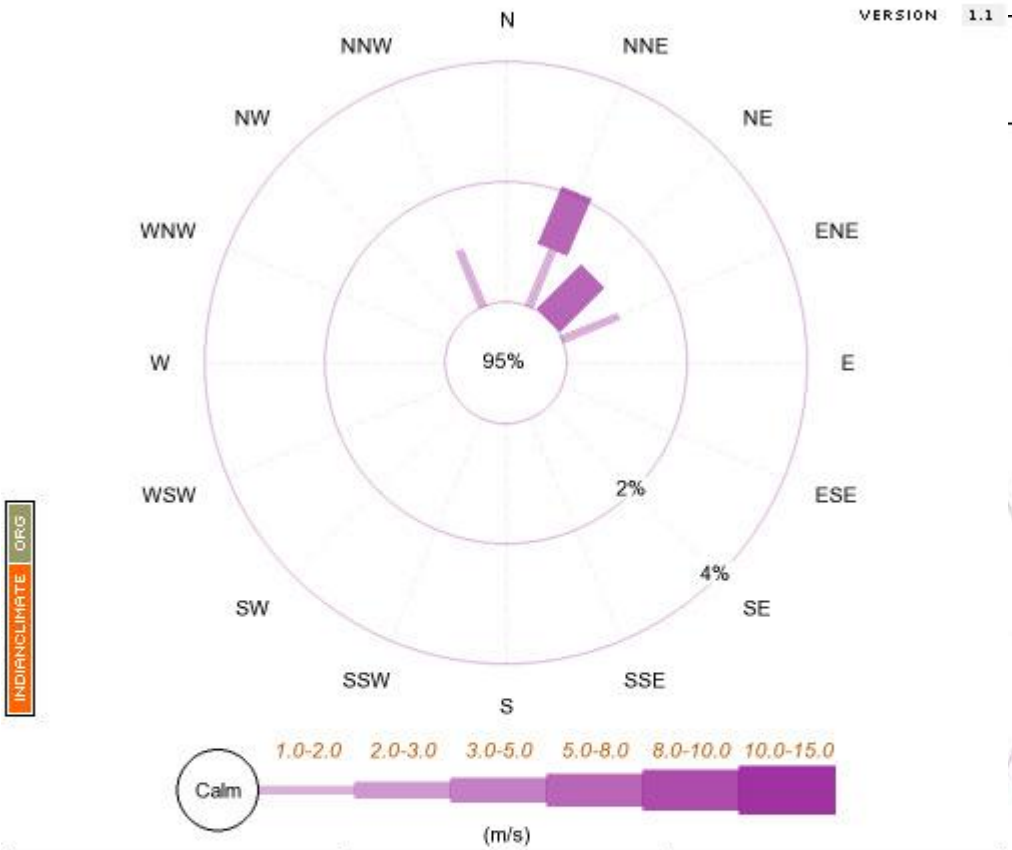
Fig.17. Windrose Diagram – For the Month of November



Modeler	Date	Company
ILAKKIYA SELVI	July 15, 2011 02:42 pm	ABC ENVIRON SOLUTIONS
Display	**Unit**	**Avg Wind Speed**
Wind Speed	m/s	2.7 m/s
Orientation	**Calm**	**Plot Period**
Direction (blow from)	94.9%	01 / 11 / 2010 12:00 am 30 / 11 / 2010 11:00 pm
Predominant wind direction is NE (1.27%) and Mostly (94.94%) wind speeds were less than 1m/s.		

Fig.18 Windrose Diagram – For the Month of December

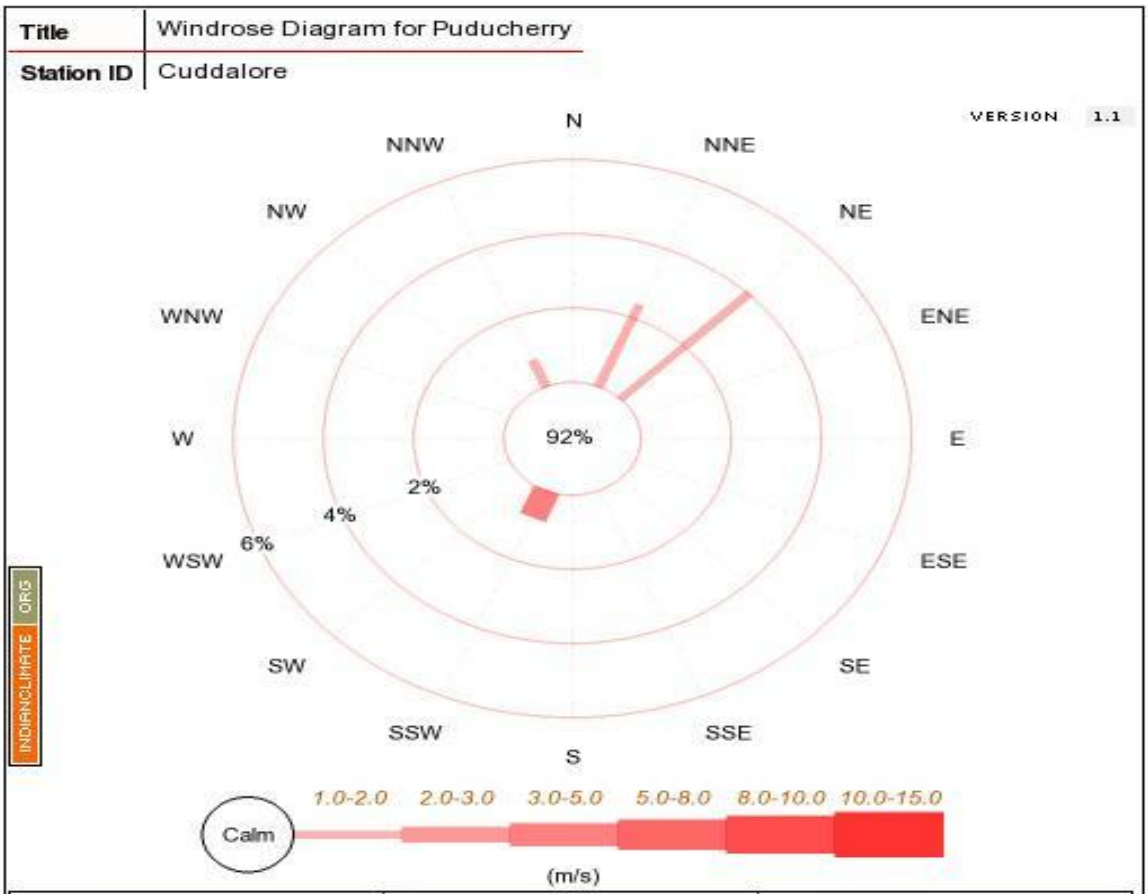
Title	Windrose Diagram for Puducherry
Station ID	Cuddalore



Modeler	**Date**	**Company**
ILAKKIYA SELVI	July 15, 2011 02:46 pm	ABC ENVIRON SOLUTIONS
Display	**Unit**	**Avg Wind Speed**
Wind Speed	m/s	2.9 m/s
Orientation	**Calm**	**Plot Period**
Direction (blow from)	94.8%	01 / 12 / 2010 12:00 am 31 / 12 / 2010 11:00 pm
Predominant wind direction is NNE (2.06%) and Mostly (94.85%) wind speeds were less than 1m/s.		

Display	**Unit**	**Avg Wind Speed**
Wind Speed	m/s	2.9 m/s
Orientation	**Calm**	**Plot Period**
Direction (blow from)	94.8%	01 / 12 / 2010 12:00 am 31 / 12 / 2010 11:00 pm
Predominant wind direction is NNE (2.06%) and Mostly (94.85%) wind speeds were less than 1m/s.		

Fig.19 Windrose Diagram – For the Month of January



Modeler	Date	Company
ILAKKIYA SELVI	July 15, 2011 03:07 pm	ABC ENVIRON SOLUTIONS
Display	**Unit**	**Avg Wind Speed**
Wind Speed	m/s	2.7 m/s
Orientation	**Calm**	**Plot Period**
Direction (blow from)	91.9%	01 / 01 / 2011 12:00 am 31 / 01 / 2011 11:00 pm
Predominant wind direction is NE (4.03%) and Mostly (91.94%) wind speeds were less than 1m/s.		

10.5 Air Environment

The prime objective of the baseline air monitoring is to evaluate the existing air quality of the area. This will also be useful for assessing the conformity to standards of the ambient air quality during the Construction and Operation of the proposed project. This section describes the selection of sampling locations, methodology adopted for sampling, analytical techniques and frequency of sampling.

10.5.1 Methodology Adopted for Ambient Air Quality Survey

a) Selection of Sampling Locations

The baseline status of the air quality in the study area has been assessed through a scientifically designed ambient air quality monitoring network. The design of monitoring network in the air quality surveillance has been based on the following considerations;

- Meteorological conditions
- Topography of the study area
- Locations where air quality is likely to be impacted as a result of localized activities or disturbances & Site Specific Conditions

Ambient Air Quality Monitoring (AAQM) stations were set up at six locations with due consideration to the above mentioned points. The locations of the selected stations are given in **Table 19** The layout showing Air Quality Monitoring Locations is enclosed.

Table 19 Details of Ambient Air Quality Monitoring Locations

Location Code	Location	Geographical location	Distance w.r.t. Project site (kms)
AAQ1	Project Site (Kurumbapet)	11°55'57.4"N,79°45'49.8"E	-----
AAQ2	Gorimedu	11°55'51.6"N,79°47'47.5" E	4.42
AAQ3	Villianur	11°55'00.3"N,79°45'24,7" E	2.84
AAQ4	Arumparthapuram	11°55'22.0"N,79°46'31.6" E	1.75
AAQ5	Ellaipillaichavadi	11°56’06” N, 79°48’37” E	5.13
AAQ6	Koodapakkam	11°56’08” N, 79°43’50” E	3.47

** With respect to Site*

b) Frequency and Parameters for Sampling

Ambient Air Quality monitoring has been carried out simultaneously at six locations. The baseline data of air environment has been generated for the following parameters;

- Particulate Matter (PM10)
- Particulate Matter (PM2.5)
- Sulphur dioxide (SO2)
- Oxides of Nitrogen (NOX)

c) Instruments for Sampling

Respirable Dust Samplers were used for monitoring Particulate Matter (PM10), Particulate Matter (PM2.5) and gaseous pollutants like SO2 and NOx.

d) Sampling and Analytical Techniques PM10, PM2.5, SO2 and NOx

The air inlet has a circular symmetry so that air entry is unaffected by wind direction and is designed to keep out rain, insects and very large particles. The inlet section immediately leads to an impactor stage designed to trap particles with an aerodynamic diameter larger than 10 microns. Thus the air stream in the down tube consists of only medium and fine particulates. The streamlined air flow of the down tube is accelerated through the nozzle of the well shaped impactor designed to trap medium size particulates with an aerodynamic diameter between 2.5 and 10 microns. To avoid sampling errors due to the tendency of small particles to bounce off the impaction surface a 37mm diameter GF/A paper immersed in silicone oil is used as an impaction surface. The air stream leaving the WINS impactor consists of microns. These fine particles are collected on a special Teflon membrane filter of 47 mm diameter. Modified West and Gaeke method (IS – 5182 part – II, 1969) has been adopted for estimation of SO2 and Arsenates Modified Jacob & Hochheiser has been adopted for estimation of NOx. The techniques used for the monitoring of Ambient Air quality is given in **Table 20**

e) Calibration

Calibration charts have been prepared for all gaseous pollutants. The calibration is carried out whenever new absorbing solutions are prepared and used.

Table 20 Techniques Used for Ambient Air Quality Monitoring

S.No	Parameter	Technique	Minimum Detectable Limit (µg / m^3)
1	Particulate Matter10	Respirable Dust Sampler (Gravimetric method)	1.0
2	Particulate Matter2.5	Respirable Dust Sampler (Gravimetric method)	1.0
3	Sulphur Dioxide	West and Gaeke	5.0
4	Nitrogen Oxide	Jacob & Hochheiser	5.0

10.5.2 Presentation of data

Pollutant specific monitoring results indicating of PM10, PM2.5, SO2 and NOX with respect to applicable standards are presented in **Table** 21 and the results are shown in the bar graph in **Figures** and **Figure**

Table 22 Ambient Air Quality Results

Code	Location	PM 10				PM 2.5				SO2				NOx			
		Min	Max	Avg	98%	Min	Max	Avg	98%	Min	Max	Avg	98%	Min	Max	Avg	98%
AAQ1	Project site (Kurumbapet)	32	43	37	40.2	13	17	15	16.2	5.1	5.6	5.4	5.5	9.8	11.9	10.6	11.6
AAQ2	Gorimedu	38	46	43	45.2	15	23	18	22.1	5.4	5.9	5.6	5.7	11.8	14.2	13.1	13.9
AAQ3	Villianur	41	54	48	52.8	21	27	24	26.5	5.2	6.0	5.7	5.9	12.4	15.4	14.6	15.2
AAQ4	Arumparthapuram	44	58	52	56.8	17	24	22	23.8	5.4	6.3	5.8	6.2	10.8	13.9	12.3	13.7
AAQ5	Ellaipillai chavadi	58	66	59	64.8	23	31	27	30.3	6.1	6.9	6.5	6.7	14.9	19.6	17.4	19.3
AAQ6	Koodapakkam	34	46	39	44.8	14	19	16	17.9	5.0	5.5	5.3	5.4	9.3	12.2	11.4	12.0
CPCB STANDARDS																	
Industrial /Residential / Rural and Other Area		**100**				**60**				**80**				**80**			

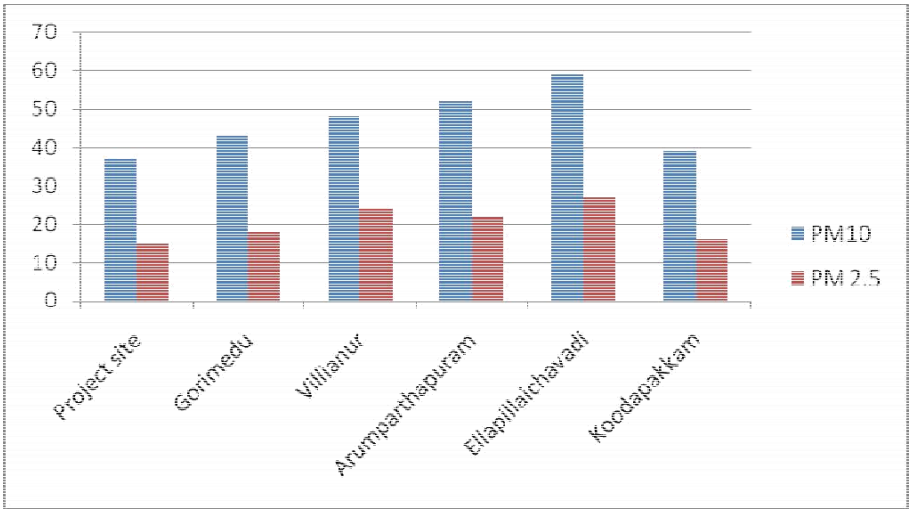
** all the Units are in µg/m^3*

a) Observations

Particulate Matter10

In the study area, PM10 level observations are found to be within the specified standards of CPCB at all locations. The maximum value of 66 µg/m^3 of PM10 was observed at Ellaipillaichavadi (AAQ5). Next higher value of 58µg/m^3 was observed at Arumparthapuram (AAQ4). The lower value of 43µg/m^3 was observed at Project Site (AAQ1). The 24 hours applicable limit is 100µg/m^3.

Figure 20. Ambient Air Quality Result for PM10 & PM2.5

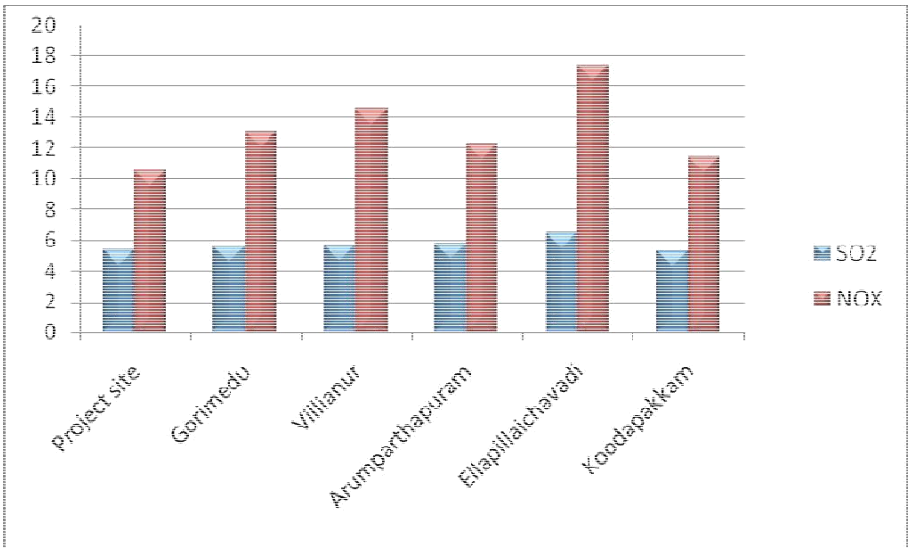


In the study area, PM2.5 level observations are found to be within the specified standards of CPCB at all locations. The maximum value of 31 µg / m^3 was observed at Ellaipillaichavadi (AAQ5). The next higher value of 27µg/m^3 was observed at Villianur (AAQ3). The lower value of 17µg/m^3 was observed at Project Site (AAQ1).The 24 hours applicable limit is 60µg/$m^{3.}$

c) Sulphur-Di-Oxide

In the study area, SO2 level observations are well within the specified standards at all the 6 monitored locations. The maximum values of SO2 was observed to be 6.5 µg/ m^3 at Ellaipillaichavadi (AAQ4).The 24 hours applicable limit is 80 µg/ m^3.

Figure 21 Ambient Air Quality Result for SO2 and NOx



d) Oxides of Nitrogen

The NOx concentration is well below the prescribed NAAQS limits at all locations. The maximum value of 19.6µg/m^3 was observed at Ellaipillaichavadi due to Vehicular Movement and the minimum value of 11.9µg/m^3 was observed in Project Site.

10.6 Noise Environment

Noise survey has been conducted in the study area to assess the background noise levels in different zones viz., Residential, Industrial, Commercial and Silence zones. The main objective of noise monitoring in the study area is to establish the baseline noise levels and assess the impact of the total noise expected to be generated in the surrounding areas by implementing the proposed project.

10.6.1 Methodology

a) Identification of Sampling Locations

A preliminary reconnaissance survey was undertaken to identify the major noise generating sources in the area. The noise monitoring has been conducted at five locations in the study area. The physical location of noise monitoring stations is given in **Table 23.**

Table 22 Details of Noise Monitoring Locations

Location code	Place Name	Geographical Location	Distance w.r.t project site (Km)
N1	Project Site (Kurumbapet)	11°55'57.4" N, 79°45'49.8" E	-----
N2	Gorimedu	11°55'51.6" N, 79°47'47.5" E	4.42
N3	Villianur	11°55'00.3" N, 79°45'24,7" E	2.84
N4	Reddiarpalayam	11°55'51.5" N, 79°47'47.6" E	3.96
N5	Arumparthapuram	11°55'22.0" N, 79°46'31.6" E	1.75

b) Instrument Used for Monitoring

Noise levels were measured using a sound level meter. The sound level meter measures the Sound Pressure Level (SPL), the Maximum Sound Pressure Level (max) and the equivalent continuous noise level (Leq) by switching on the corresponding functional modes.

c) Method of Monitoring

Sound Pressure Level (SPL) measurements were taken at the specified locations, with an interval of 1 minute over a period of one ho
ur for 24 hours. The noise levels during day time have been monitored between 6 am to 10 pm and night noise levels during 10 pm to 6 am at all the locations covered in the study area. Noise levels were recorded every one minute in the following manner. To obtain noise levels at 8 AM, noise readings, with setting at 'A' response – slow mode, were recorded continuously for 60 minutes. All the readings were obtained for 24 hours.

d) Parameters Measured During Monitoring

For noise levels measured over a given period of time interval, it is possible to derive important features of noise using statistical methods.

- Lday Average noise levels between 6.00 hours to 22.00 hours.
- Lnight Average noise levels between 22.00 hours to 6.00 hours.

10.6.2 Presentation of Results

The summary of computed ambient noise level parameters like Lday and Lnight for all the sampling locations are presented in **Table 23** and **Figure** and compared to the standards specified by CPCB as given below in **Table 24**

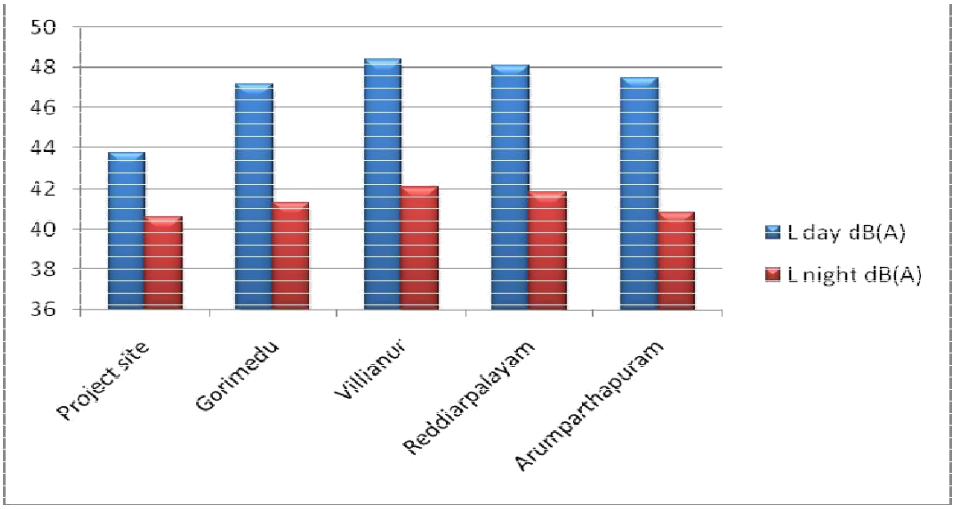
Table 23 Ambient Noise Levels Recorded in this Study Area [dB (A)]

Location Code	Location	LDAY DB(A)	LNIGHT DB(A)
N1	Project site (Kurumbapet)	43.8	40.6
N2	Gorimedu	47.2	41.3
N3	Villianur	48.4	42.1
N4	Reddiarpalayam	48.1	41.8
N5	Arumparthapuram	47.5	40.8

Table 24 Ambient Noise Standards

Ambient noise standards	L day	L night
Industrial Area	75	70
Commercial Area	65	55
Residential Area	55	45
Silence Zone	50	40

Figure 22 Ambient Noise Level Recorded in this Study Area



10.6.3 Observations

A. Day time Noise Levels

Noise levels during day time were found to be in the range 43 to 49 dB (A). The maximum noise level was observed to be 48.4 dB (A) at Villianur and a minimum of 43.8 dB (A) was observed at Project site (Kurumbapet).

B. Night time Noise Levels

Noise levels observed to fall in the range 40 to 43 dB (A) during the night time. A maximum of 42.1 dB (A) was observed at Villianur and a minimum of 40.6 dB (A) was observed at Project site (Kurumbapet).

10.7 Water Environment

Selected water quality parameters of surface and ground water resources within the study area have been considered for assessing the water environment. To assess the water quality, in the study area five ground water and one surface water sampling locations were selected.

10.7.1 Water Sampling Locations

Water samples were collected from six sampling locations. These samples were collected as grab samples and were analyzed for various parameters. The water sampling locations are listed below in **Table 25**

Table 25 Details of Water Sampling Locations

Location Code	Place	Geographical location	Source
W1	Project Site (Gobalankadai)	11°55'57.4" N,79°45'49.8"E	Ground Water
W2	Gorimedu	11°55'51.6" N,79°47'47.5"E	Ground Water
W3	Villianur	11°55'00.3" N,79°45'24,7"E	Ground Water
W4	Reddiarpalayam	11°55'51.5" N,79°47'47.6"E	Ground Water
W5	Arumparthapuram	11°55'22.0" N,79°46'31.6"E	Ground Water
W6	Oussudu lake	11°54'59.9" N,79°45'24.1"E	Surface water

10.7.2 Presentation of Results

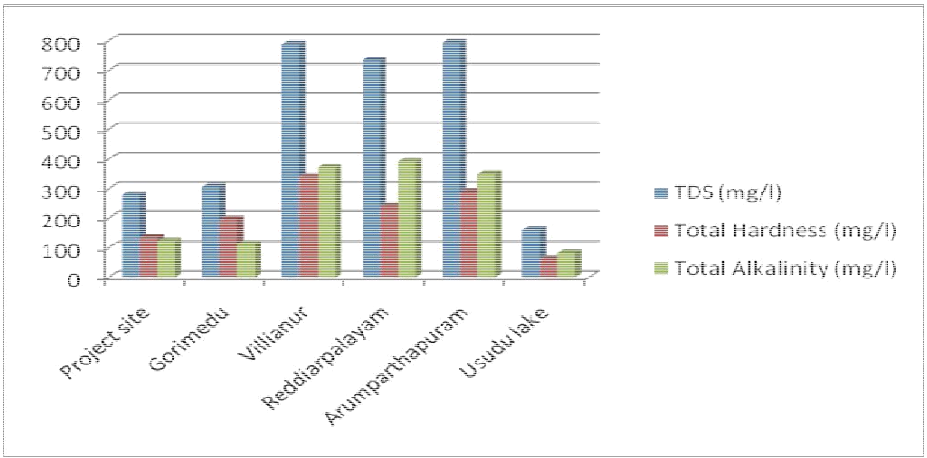
The water sampling results for surface and ground water samples are given in **Table 26** and also in **Figure** The ground water and surface water analysis results are compared with the standards. The ground water quality within 50 meters of the periphery of landfill site has been monitored and results are presented. Results of nitrate and Phosphate contents of the water samples are also given.

Table 26 Summary of Water Quality Result

S.No	Parameters	Unit	Limit as per IS:10500	W1	W2	W3	W4	W5	W6
1	pH at 25°c	-	6.5-8.5	7.11	7.40	7.44	7.61	7.34	8.78
2	Electrical Conductivity,	µS/cm	Not Specified	413	464	1215	1069	1196	246
3	Turbidity	NTU	5	BDL(0.5)	BDL(0.5)	0.9	BDL(0.5)	BDL(0.5)	18.5
4	Total Dissolved Solids,	mg/l	500	278	306	787	732	792	158
5	Total Hardness as CaCO3	mg/l	300	134	196	340	240	290	62
6	Total Alkalinity as CaCO3	mg/l	200	122	112	370	390	350	82
7	Chloride as Cl	mg/l	250	47	48	154	119	114	22.8
8	Sulphate as SO4	mg/l	200	22	4	68	63	64	2
9	Fluoride as F	mg/l	1	0.23	0.33	0.67	0.41	0.54	0.28
10	Nitrate as NO3	mg/l	45	8.5	72.5	13	9	48	BDL(<1)
11	Ammonia as NH3	mg/l	Not Specified	BDL (<0.05)	BDL (<0.05)	BDL	BDL (<0.05)	BDL (<0.05)	0.12

						(<0.05)			
12	Phosphate as PO4		Not Specified	0.4	0.10	0.36	3.6	2.0	0.16
13	Sodium as Na	mg/l	Not Specified	29	-	170	380	280	106
14	Pottasium as K	mg/l	Not Specified	5.7	1.0	7.7	32	44	3.2
15	Calcium as Ca	mg/l	75	37	63	92	68	76	15
16	Magnesium as Mg	mg/l	30	10.2	9.2	27	17	24.3	5.8
17	Iron as Fe	mg/l	0.3	0.1	-	0.22	0.20	0.60	0.28
18	Total Suspended Solids	mg/l	-	-	-	-	-	-	16
19	COD	mg/l	-	-	-	-	-	-	18

Figure 23 Results for TDS, Total Hardness and Total Alkalinity



10.7.3 Observations

The analysis results indicate that the average pH ranges in between 6.5 to 8.78. TDS ranges from 278 to 792mg/L. Total hardness ranges from 134 to 340 mg/L. The chlorides were observed to be ranging between 47 to 154 mg/L.

10.7.4 Land Environment

It is essential to determine the type & quality of soil in the study area and identify the current impacts of urbanization on soil quality and also predict probable impacts due to the proposed plant. Accordingly, a study of assessment of the baseline soil quality was carried out.

11 Geology

In Pondicherry region the entire area, except the northeastern corner is mostly covered by sedimentary formations ranging in age from cretaceous to recent. Information on the geology of a site is required for properly engineering a facility. Such information serves three important purposes:

1) Identification of geological hazards,
2) Provision of information for facility design, and
3) Assessment of vulnerability of the site to groundwater contamination due to the hydrogeology of the site.

The soil type of project site and nearby villages is given in **Table 27**

Table 27 Types of Soil

Location	Type of Soil
Kurumbapet (Project site)	Sandy Loam
Arumparthapuram	Sandy Clay Loam
Villianur	Sandy Clay Loam
Reddiarpalayam	Sandy Clay Loam
Kombakkam	Sandy Clay

11.1 Geo -Technical Investigation

For the construction of any structure a detailed soil investigation is essential for collecting the relevant data required for preparing the design. The sub surface investigation reveals the presence and the extent of soil and rock stratum in the region likely to be affected by the proposed work and determines the nature of each stratum and engineering properties of soil which may affect the design. The data collected provide reliable, specific and detailed information to facilitate a safe and economic design of the proposed structure.

11.2 Depth of Exploration

Exploration is carried to a depth at which the net increase in vertical stress is less than the allowable bearing pressure of the soil. Since proposed shallow foundation to be adopted to explore to a depth up to which advancement of bore hole manually and a bore well was done up to a depth of 10.00m.

11.3 Ground Water Level

Observation of location of water table and its fluctuation under different seasons is very important. The location of ground water level is also important for deep excavation and foundation works and also on sites susceptible to be water logged. Open wells at the site or in the vicinity of the site give a clear idea of water table and its fluctuation. Boreholes can also be used for recording water levels. Water table was not met with during the bore hole and the water table is reported to be 10.00m below ground level during rainy seasons.

11.4 Terrain and Land use

The processing area is located on flat terrain and the leveling of land at site will be managed with the local cutting and filling of the earth.

11.5 Habitations, Institutions and Water Bodies

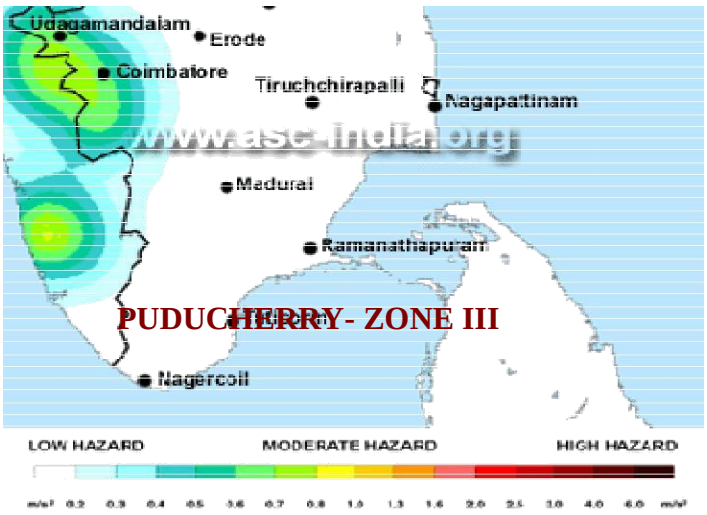
The site is located nearby NH 45 A and Villianur at a distance of 2 Km. On the Northern side of the proposed site, industries and Puducherry Veterinary College are located. On the North western side, Oussudu Lake is located. The habitations Gobalankadai and Kurumbapet are located at 250 m from the site on Southern & Eastern directions.

The drainage pattern in and around the project site is towards southeast. The stream is originated from the Oussudu lake situated on the northern side of the project site and flow towards eastern side. So, during the rainy season, runoff follows the natural slope and will not alter existing or natural drainage patterns.

11.6 Seismicity

According to GSHAP (Global Seismic Hazard Assessment Program), the whole of the Union Territory now figures in the moderate seismic risk zone III in the latest map of the Bureau of Indian Standards. The seismic Zoning map of India is given in **Figure 20**

Fig.24 The seismic Zoning map



11.7 Soil Sampling

a) Data Generation

For studying soil quality of the region, sampling locations were selected to assess the existing soil conditions in and around the project area based on various land use conditions. The physical and chemical concentrations were determined. The samples were collected from different specified depths viz., 30cm, 60cm and 100cm.

The present study of the soil quality establishes the baseline characteristics and this will help in future in identifying the incremental concentrations if any, due to the operation of the proposed plant. The sampling locations have been identified with the following objectives;

- To determine the baseline soil characteristics of the study area.
- To determine the impact of proposed project on soil characteristics and
- To determine the impact on soils more importantly loss of fertility from agricultural productivity point of view.

Various locations within 10-km radius of the plant site were selected for soil sampling. At each location, soil samples were collected from three different depths viz., 30cm, 60cm, and 100cm below the surface. The samples were analyzed for physical and chemical characteristics. The samples have been analyzed as per the established scientific methods for physio-chemical parameters.

b) Soil Sampling Locations

The details of the sampling locations selected for soil sampling are given in **Table 28**
The layout showing Soil Quality Monitoring Locations is enclosed.

Table 28 Details of Soil Sampling Locations

LOCATION CODE	LOCATION	LATTITUDE & LONGITUDE
S1	Project Site (Kurumbapet)	11°55'57.4" N,79°45'49.8"E
S2	Arumparthapuram	11°55'22.0" N,79°46'31.6"E
S3	Villianur	11°55'00.3" N,79°45'24,7"E
S4	Reddiarpalayam	11°55'51.5" N,79°47'47.6"E
S5	Kombakkam	11°54’15” N, 79°46’58” E

c) Presentation of Results

The Standard soil classification is given in **Table 30**. The results of the soil analysis are tabulated in **Table 31** & **Figure 5.9 and Figure 5.10.**

Table 29 Standard Soil Classification

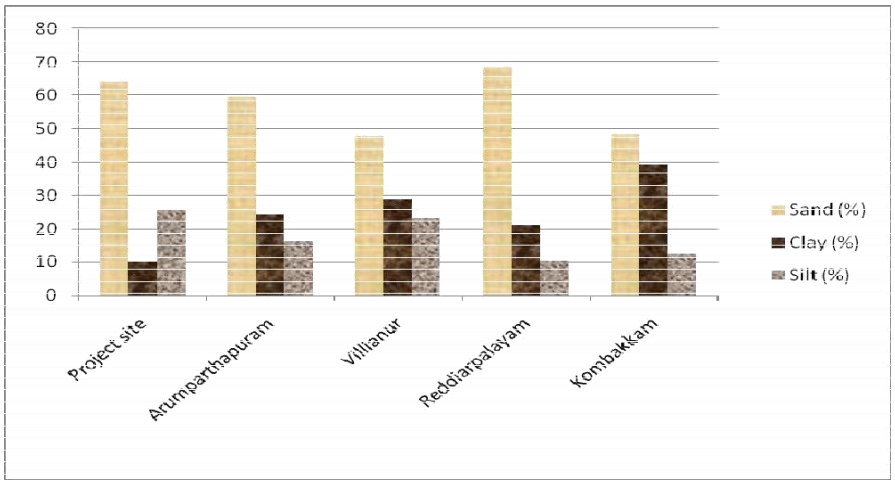
Chemical Parameters	Ranking				
	Very Low	Low	Moderate	High	Very High
pH	<4, very Strongly Acidic	4-5, Strongly Acidic	5-8, Ideal for Plant Growth	8-9 Strongly Basic	>9 Very Strongly Basic
Electrical conductivity (µS/cm)	<2000, Non saline	2000-4000 Saline	4000-8000 Moderately Saline	8000-16000 Highly Saline	>16000 Extremely Saline
Total Nitrogen (%)	<0.05 Very Low	0.05-0.15 Low	0.15-0.25 Moderate	0.25-0.5 High	>0.5 Very High
Total Phosphorous (mg/kg)	<5 Very Low	5-10 Low	10-30 Moderate	30-60 High	>60 Very High
Sodium (mg/kg)	-	<200 Non Sodic	200-500 Moderate	>500 Sodic	
Potassium (mg/kg)	-	<150 Low	150-250 Moderate	250-800 High	>800 Very High

Chemical Parameters	Ranking				
	Very Low	Low	Moderate	High	Very High
Calcium (mg/kg)	-	<1000 Low	1000-2000 Moderate	>2000 High	-
Magnesium (mg/kg)	<40 Very Low	40-100 Low	100-300 Moderate	>300 High	-
% Organic Matter	0.5-1.0 Very Low	1.0-2.0 Low	2.0-3.0 Moderate	3.0-5.0 High	>5 Very High

Table 30 Summary of Soil Sample Result

S.No	Test parameters	S1	S2	S3	S4	S5
1	pH	8.58	8.41	7.56	8.36	8.21
2	Electrical conductivity, mS/cm	0.127	0.456	0.754	0.239	0.956
3	Available nitrogen, mg/kg	33	21	9	49	31
4	Available Phosphorous, mg/kg	35.2	14.7	33.6	28.2	14.5
5	Available potassium, mg/kg	175	324	254	212	389
6	Exchangeable Calcium as Ca, m. eq/100g	1.85	2.54	5.2	1.22	4.4
7	Exchangeable Magnesium as Mg, m. eq/100g	1.38	1.81	4.10	1.54	3.81
8	Exchangeable Sodium as Na, m.eq/100g	1.14	1.58	2.1	1.31	1.6
9	Organic matter (%)	0.41	0.31	0.82	0.57	0.49
10	Texture classification	Sandy Loam	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay
11	Sand (%)	64.2	59.6	47.5	68.5	48.2
12	Clay (%)	10.0	24.2	29.1	21.1	39.3
13	Silt (%)	25.8	16.2	23.4	10.4	12.5

Figure 25 Results of Soil Sample Analysis for Ions



e) Observations:

The soil results were compared with soil standards. It has been observed that the pH of the soil was ranging from 7.56 – 8.58 indicating the soils are slightly basic in nature. Conductivity of the soil ranges from 0.127 to 0.956 mS/cm. Since the EC value is less than 2µS/cm, the soil is said to be non saline in nature.

Texture of the soil sample is predominantly Sandy clay loam. Soil organic content varied from 0.31-82 % which indicates the low level of organic matter.

Nutrient Content

The available nitrogen content ranges between 9 to 49 mg/kg in the locality and the value of phosphorus content varies between 14.5 to 35.2 mg/kg. This indicates that the soil have smaller quantities of Nitrogen and Phosphorus.

The potassium content varies from 175 to 389 mg/kg which indicates that the soils have better quantities of potassium.

Exchangeable Cations

The Magnesium content in the soil ranges from 1.38 to 4.10 m.eq/100 g soil. This indicates that the soil contains moderate to high amount of magnesium in the soil.

From the above observations it was found that the soil in the Study area shows moderate

fertility.

12 Ecology

Study of biological environment is one of the important aspects in Environmental Impact Assessments. Biotic component comprises of both plant and animal communities which interact within the community and between themselves but also with abiotic i.e. physical and chemical components of the environment. Generally a biological community is being dependent on the environmental conditions and resources of its location it may change if there are many major changes in the environment.

The number of variables like temperature, humidity, atmospheric conditions, soil, and topography, etc. is responsible for maintaining the homeostasis of the environment and a change in any one or more of these variables may tend to destabilize the ecosystem. In such cases the change may be mostly irreversible. Therefore the need to assess the changes of the plant and animal resources is primary requisite as these living things determine the environmental healthiness of any given ecosystem or environment.

12.1. Assessment of Ecological Environment

Assessment of the existing vegetation types in the core and buffer zones has been done using standard procedures. The terrain of the impact zone is chiefly plain and in some places gentle undulations are observed.

The Biodiversity studies were already carried out in the entire study area of 10 km radius. The study of flora is conducted as per the guidelines of the Ministry of Environment and Forests, Government of India (Anonymous 1994), with respect to the scope and objectives. The study involved in collection of primary data by conducting survey in the field, examination of floral and faunal records in previously published reports and records, and analysis of the information in view of the possible alteration in environment of the proposed project site. For the survey of fauna both direct and indirect observation methods were used.

The flora of proposed region has an appreciable diversity, which may be attributed to the diversity in soil type and the physiography of the region. Some flora and fauna observed in the study area are furnished in **Table 31**& **Table 32** respectively.

a) Flora

The buffer zone of the proposed site consists of agricultural lands, waste lands, etc. The semi

arid conditions with high temperature and poor rainfall influence the nature of flora.
The buffer zone is within a radius of 10 km consisting of naturally occurring species as well as agricultural crops. The naturally occurring wild species grow in groups. The floral species present in the study area is given below:

Table 31 List of Floral Species Present in the Study Area

S.No	Botanical name	Common name	Family
	Trees		
1.	Polyalthia longifolia	Ashoka	Anonaceae
2.	Mangnifere indica	Mango	Anacardiaceae
3.	Saccopetalum tomentosum	Ashoka	Anonaceae
4.	Sparganium erectum	Hale Nelli	Sparganiaceae
5.	Tamarindus indica	Tamarind	Caesalpiniaceae
6.	Casuarina eguistifolia	Casuarina	Casuarinaceae
7.	Emblica officinalis	Nelli	Euphorbiaceae
8.	Bambusa bamboo	Bamboo	Gramenae
9.	Azadirachta indica	Neem	Meliaceae
10.	Cocus nucifera	Coconut	Palmaceae
11.	Citrus limonum	Lemon	Rutaceae
12.	Musa paradisiacal	Banana	Musaceae
13.	Eucalyptus terticornis	Eucalyptus	Myrtaceae
14.	Prunus dulcis	Almond	Rosaceae
15.	Pongamia pinnata	Pungai	Fabaceae
16.	Prosopis juniflora	Cimaikaruvel	Fabaceae
17.	Ficus benghalensis	Banyan	Moraceae
18.	Moringa oleifera	Murungai	Moringaceae
19.	Terminalia alata	Indian laurel.	Combretaceae

20.	Cyperus rotandus	muttakkacu	Cyperaceae
21.	Cassia auriculata	Avaram	Fabaceae
22.	Tectona grandis	Teak	Lamiaceae
23.	Ziziphus jujuba	Jujube	Rhamnaceae
24.	Bombax ceiba	Silk cotton tree	Bombacaceae
Shrubs			
1.	Ocimum grabissium	Tulasi	Labsiatae
2.	Hybiscus rosasinensis	Sembaruthi	Malvaceae
3.	Sida rhombifolia	Sembaruthi	Nakvaceae
4.	Solanum melangiana	Brinjal	Solanaceae
5.	Solanum anuvum	Mirch	Solanaceae
6.	Jasmium sessiliflorum	Sooman(Jasmin)	Oleaceae
7.	Calotropis gigantean	Erruku	Asclepiadacae
Herbs/Grasses			
1.	Buttea superba	Palasbel	Papilionaceae
2.	Cassia tora	Chakunda	Ceasalpinaceae
3.	Eragrostis tremula	Chirka	Graminae

b) Fauna

Field studies are conducted to assess fauna in the study area. On the basis of field studies and secondary sources, there are no endangered animal species present in the study area. List of animals present in the study area are given below.

Table 32 List of Fauna Present in the Study Area

Scientific Name	Common Name Aves
Quills contronix	Grey qauil
Corvus splendens	House crow
Pycnonotus jokokus	White browed bulbul

Scientific Name	Common Name
Pycnonotus cafer	Red vented bulbul
Tchitrea paradisi	Paradise flycatcher
Oriolus oriolus	Indian Oriole
Cinnyris asiatica	Purple Sunbird
Megalaima merulinus	Indian Cuckoo
Hierococys varius	Common Hawk Cuckoo
Centropus sinensis	Crow Pheasant
Halcyon smyrnensis	White breasted king fisher
Acridotheres tristis	Common myna
Saxicoloides fulicatus	Indian robin
Dicrurus macrocercus	Black drongo
Orthotomus sutorius	Tailor bird
Gallus sonneratii	Grey jungle fowl
Reptiles	
Ptyas mucosus	Rat Snake
Nerodia piscator	Fresh water snake
Naja naja	Cobra
Vipera russeli	Viper
Calotes Versicolor	Garden lizard
Sauria lacertidae	Lizard
Amphibian	
Rana hexadactyla	Frog
Rana tigrina	Bull frog
Mammals	
Lepus nigricollis	Hare
Canis auries	Jackel
Funambulus spp	Squirrel
Rattus norvegicus	Field mouse
Capra hircus	Goat
Felis catus	Cat
Cannis Familiaris	Dog

Rattus rattus	Rat

12.2 Socio- Economic Profile

Socio- Economic status of the population is an indicator for the development of the region. Any developmental project of any magnitude will have a bearing on the living conditions and on the economic base of population in particular and the region as a whole. Similarly, the proposed activities will have its share of socio-economic influence in the study area. The section delineates the overall appraisal of society relevant attributes. The data collection for evaluation of impact of proposed project on socioeconomic aspects in the study area has been done through primary field survey and through the analysis of secondary data available for study area.

12.3 Methodology

The methodology adopted in assessment of socio-economic conditions is given below;

- To assess socio-economic conditions of the Population.
- Analysis of the identified social attributes like population distribution, availability of public utilities, Literacy rates etc., through Census of India 2001.
- Survey to assess the present status of population of the study area.

a) Sources of Information

As per the scope of this study, the information on socio-economic aspects has been gathered and compiled from several secondary sources. These include Taluk Office, Collectorate, Agriculture Department, Irrigation Department and Central Ground Water Board. The demographic data has mainly been compiled from the Census of India 2001. The socio-economic details are briefly described in following sections.

b) Socio-Economic Profile

Sociological aspects include human settlement, demographic and socioeconomic aspects and infrastructure facilities available in the study area. The economic aspects include agriculture and occupational structure of workers.

c) Settlement Pattern

As explained earlier, the study area is covered in Puducherry. The study area is decided as an area within 10 km radius from the proposed units. Altogether, the village in the study area and their spatial distribution are furnished below. The socio economic status of the project area is presented in **Table 34**

Table 33 Socio – Economic Status

Parameter	Total	Rural	Urban
Population	735,332	229,373	505,959
Male	369,428	116,053	253,375
Female	365,904	113,320	252,584
Population (0-6)	88,209	30,182	58,027
Scheduled Castes	120,980	66,169	54,811
Scheduled Tribes	0	0	0
Literates	521,928	141,584	380,344
Illiterates	213,404	87,789	125,615
Workers	265,660	93,911	171,749
Main Workers	33.7	36.5	32.4
Main Cultivators (%)	3.3	8.1	0.8
Main Agricultural laborers (%)	18.0	46.2	3.6
Main Workers in Household industries (%)	1.7	1.7	1.8
Main other Workers (%)	77.0	44.0	93.9
Marginal Workers	2.4	4.4	1.5
Marginal Cultivators (%)	1.5	2.2	0.5
Marginal Agricultural laborers (%)	47.1	73.1	13.5
Marginal Workers in Household industries (%)	4.1	2.1	6.7
Marginal Other Workers (%)	47.3	22.6	79.3

d) Demography

The population of **Puducherry (census 2001) is 8.5 lakhs.** As a proportion of the country's total population, it is 0.09%. Women and men constitute exactly 50% of the population (4.87 lakhs). The average annual exponential growth rate (1991-2001) of population is 1.87% as against 1.93% for the whole of India. The UT has registered significant reduction in population growth rate compared to the previous decade (1981-1991) which was 2.90%. Population growth rate in Pondicherry is also impacted by migration from Tamil Nadu, Kerala and Andhra Pradesh.

Urbanization

Puducherry is highly urbanized. Urban population accounts for 67% as against the All India proportion of 28% (2001). The average annual growth rate of urbanization of the UT is 1.95% (1991-2001). Majority of the population of the UT resides in the districts of Pondicherry and Karaikal. In terms of the size of the population, ranking in the descending order is Puducherry, Karaikal, Mahe and Yanam. In Puducherry district, the proportion of rural population is 31%.

Density

The UT occupies the third rank in the country amongst States and Union Territories with a population density of 2,029 per Sq.km. This reflects an addition of 346 per Sq.km compared to 1991 when it was 1,683 per sq.km. Density in the UT is seven times that of India as a whole.

Scheduled Castes

Scheduled Caste population of the UT is 1.58 lakhs, constituting 16.2% as against 16.5% in the population of the country as a whole. Majority of the scheduled Caste population (77%) lives in Pondicherry district. There are no Scheduled Tribes in the UT.

Sex Ratio

Puducherry had quite a favorable sex ratio at the beginning of the 20th Century. But, it was steadily decreasing decade after decade until 1991 when it reached 979. However, there has been a remarkable improvement in sex ratio in the UT in 2001 (1001) compared to 1991.

Table 34 Sex Ratio

Indicator	Year	Puducherry	Comments
Sex ratio	1971	989	Puducherry is the only other State apart from Kerala which has a sex ratio above unity, in 2001
	1981	985	
	1991	979	
	2001	1001	
	2011	1037	

Literacy Levels

Literacy is an important indicator for understanding the level of socio-economic development of any area. The literacy levels in study area in year 2001 were as follows:

Table 35 Literacy Rate

Person	Population	Literates	Illiterates
Total	735332	521928	213404
Rural	229373	141584	87789
Urban	505959	380344	125615

13 Infrastructure

Availability of infrastructure and facilities denote the level of overall development in the study area. The availability of facilities with regard to education, health, transport & communication, water supply and availability of electricity are dealt with in the following:

a) Health Infrastructure

Puducherry has a health care infrastructure superior to that in existence in the rest of India. Despite the logistical problems that the UT has in facilitating access to medical services. The people live in habitations spread over 261 villages, many of them falling in the distant enclaves of Karaikal, Mahe and Yanam, located 130 kms, 650 kms and 950 kms respectively from Puducherry. It has also been estimated that more than 40% of the patients accessing medical care in Pondicherry are from the adjoining States of Tamil Nadu, Kerala

and Andhra Pradesh. Access to medical care is available for the people of the UT within an average distance of less than 1.18 Km.

Table 36 Health Centres in Puducherry

Institutions	Number
Hospitals*	5
Primary Health Centres	15
Community Health Centres	2
Sub Centres	35
Urban Health Centres (JIPMER)	1
Rural Health Centres (JIPMER)	1
Doctor : Population ratio*	1:705
Nurse : Population ratio*	1:678
Bed : Population ratio*	1:296

Source: Directorate of Economics and Statistics. Statistical Handbook, Annual Report 2002-03. including JIPMER*

b) Industrial Estates

The Govt. of Puducherry had initially started three industrial estates in the Territory in order to motivate the industrial development. Later a Corporation for industrial development has been established in the year 1974 viz. Pondicherry Industrial Promotion, Development and Investment Corporation (PIPDIC). Then the corporation has taken over the infrastructure development for industrial promotion. Industrial Estate were developed and allotted to the needy entrepreneurs. All the industrial estates are provided with all necessary basic infrastructure facilities.

Thattanchavady - Thattanchavady Industrial Estate was established in the year 1962 over an area of 51 acres of the land. There are 60 sheds of various sizes. 110 units are functioning in the estate. In order to encourage the industries the sheds/plots are sold under Hire-purchase Scheme and Conditional assignment scheme.

Kattukuppam - The Rural Industrial Estate, Kattukuppam, Manapet was established in the

year 1969 over an area of 15.58 acres of the land. There are 13 sheds and 38 plots of 11,200 Sq. Ft. There are 19 units functioning in this estate.

Mettupalayam - The Industrial Estate, at Metttupalayam was established in the year 1976 over an area of 167.00 acres by PIPDIC. There are 367 plots and 89 sheds of various sizes. 257 units are functioning in this Industrial Estate.

Sedarapet - The Industrial Estate, at Sedarapet was established in the year 1982 over an area of 62.19 acres by PIPDIC. There are 191 plots of various sizes. 83 units are functioning in this PIPDIC Industrial Estate.

Kirumampakkam - The Industrial Estate, at Kirumampakkam was established by PIPDIC over an area of 25.00 acres. 19 units are functioning in this PIPDIC Industrial Estate.

Thirubuvanai - An exclusive industrial for Electronic Industries was established by PIPDIC over an area of 50 acres.

Table 37 Industrial Estates

Name	Area in acres	No. of Units
Thattanchavady	51.22	110
Mettupalayam	167.00	257
Sedarapet	62.19	83
Kattukuppam	15.58	27
Kirumampakkam	25.00	19

14 ENVIRONMENTAL MANAGEMENT PLAN

Municipal solid waste incineration produces a range of volatile and gaseous emissions, which, if untreated released to the atmosphere, can compromise environment quality. Fly ash and dust carry toxic contaminants. Ash leachate might contaminate soil and water. The actual range of emissions depends upon the specific characteristics of the waste stream and engineering design of the plant such as combustion temperature, combustion chamber design and ancillary emission abatement technologies. Proper planning to minimize

environmental damage, as well as public education and involvement, are essential to successful incineration programs.

14.1 Emission Reduction In Incinerators

Incineration of MSW generates large volumes of flue gases which carry ash, heavy metals and wide range of organic and inorganic compounds. Major air emissions from MSW incinerators include HCl, HF, SO2 , NOx, CO, VOC and heavy metals etc. which are hazardous to human health and environment. Dioxins and Furans are especially potent and need to be controlled through appropriate operating conditions and flue gas treatment technology. Primary control measures include initiatives that actually retard the formation of pollutants, especially NOx and dioxins. It includes:

- Efficient combustion process
- With long flue gas retention duration at high temperature
- Appropriate oxygen content
- Intensive mixing
- Recirculation of flue gas
- Precipitation of ashes in the boiler
- Short flue gas retention time at intermediate temperature
- Continuous constant feeding (around the clock)

Secondary measures include installation of air pollution control equipment which comprise of bag house filters, dry, acid gas removal systems, catalytic reduction systems etc. Flue gas would be undergo quenching process which includes sudden decrease of flue gas temperature from 800C to 200 C. This process eliminate formation of Dioxin and Furan

Stack height of 50 mt will be installed for better dispersion of flue gas

14.2 Green Belt Development

Selection of the plant species will be based on their adaptability to the existing geographical conditions and the vegetation composition of the forest type of the region. During the development of the green belt within the project area, it has to be emphasized that those native plant species should be planted which are having good ornamental values and are fast

growing with excellent canopy cover. The proposed area for Green belt development and paved roads is 31890 sqm.

A green belt is provided to mitigate various emissions. Green belts are wide strip of trees and shrubs planted in rows to reduce air velocity there by facilitating settling of the particles on the leaf surfaces and allowing absorption of the pollutant gases. It also serves to cool the atmosphere by transpiration from the leaf surface and also provide habitat for birds, reptiles and insects.

Table 38. Plant Suggested for Green belt Development

S.No.	Vernacular Name	Botanical Name
1	Veppam	Azadirachta indica
2	Vagai	Albizia lebbeck
3	Poovarasu	Thespesia populnea
4	Thaila maram	Eucalyptus sp.
5	Ashoka maram	Polyalthia longifolia
6	Thoongumungi maram	Samanea Saman
7	Savukku	Casuarina equisetifolia
8	Pungam	Derris indica
9	Agathi	Sesbania grandifura
10	Amanakku	Ricinus communis

Source: Guidelines for Green belt development, CPCB

14.3 Environmental Surveillance

For the effective implementation of the EMP, an Environmental Management System (EMS) will be established at the proposed project. The EMS should include the following:

• Environmental management cell

• Environmental Monitoring

14.4 Environment Management Cell

It is proposed to set up a separate to keep a close watch on the performance of the pollution control equipments, emissions from the sources and the quality of surrounding environment in accordance with the monitoring programme. The department will include a safety cell for ensuring that safety measures are followed in the development of greenbelt and afforestation.

The team will consist of well qualified and experience personnel. To achieve the objectives of pollution control, it is essential not only to provide latest pollution control and monitoring systems but also provide trained manpower to operate and maintain such systems. So, the Environmental management department personnel will be provided with additional specialized training to operate and maintain the equipment to be deployed on the installation. All persons will be trained to deal with pollution emergencies also. General and preventive maintenance of pollution control system will be done by the General Maintenance Department. The manager will ordinate with the maintenance and production departments to achieve optimum efficiency of the control equipments and to maintain the quality of the environment.

Environmental cell is responsible for all the issues of environment. The cell will be responsible for following task:

- To implement the environmental management plan,
- To assure regulatory compliance with all relevant rules and regulations,
- To ensure regular operation and maintenance of pollution control devices,
- To minimize environmental impacts of operations as by strict adherence to the EMP,
- To initiate environmental monitoring as per approved schedule.
- Review and interpretation of monitored results and corrective measures in case.
- Maintain documentation of good environmental practices and applicable environmental laws as ready reference.
- Maintain environmental related records.
- Coordination with regulatory agencies, external consultants, monitoring laboratories.
- Maintain of log of public complaints and the action taken
- Maintenance of green belt;
- Environmental training & awareness.

It is also proposed to have committee at Street Level and Ward Level with member like Street Level In charge and Ward Level In charge to ensure the complete collection of garbage on daily basis and to develop awareness on source segregation at house hold level

14.5 Environmental Monitoring

The 'Environmental Management Plan' puts forward skeleton criteria for a construction and operational phase environmental management system. As mentioned, the MSW Management and Handling) rules, 2000 standards for environmental control have been used as a basis to monitor overall compliance. It must ensured that it adheres to the principles of Municipal Solid Waste (Management and Handling) rules, 2000. In general, it can be stated that compliance monitoring will be conducted through regular environmental inspections, audits, control feed-back mechanisms, document control and reviews to check if activities and operations are in compliance with proposed local standards or indicators proposed in this EIA.