ENVIRONMENTAL IMPACT ASSESSMENT REPORT

FOR

EXPANSION OF LPG BOTTLING PLANT TIRUCHIRAPALLI, TN

SUBMITTED TO

M/s INDIAN OIL CORPORATION LIMITED

PREPARED BY

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CHAPTER 1. INTRODUCTION

1.1 INTRODUCTION

M/s Indian Oil Corporation Ltd. proposes expansion and successful operation of Tiruchirapalli Bottling Plant, from 1000 MT to 1900 MT by introducing 3 mounded bullets of 300 MT capacities each.

As per EIA Notification, published in Gazette of India, Extraordinary Part-II, Section-3, sub-section (ii) of Ministry of Environment & Forest dated 14.09.2006 & subsequent amendments, the proposed project falls in Activity 6(b), Category-B of "List of Projects or Activities Requiring Prior Environmental Clearance". As per the above notification, proposed project will have to obtain Environmental Clearance

1.2 Identification of Project and Project Proponent

1.2.1 Project Proponent

Indian Oil Corporation Limited (IOCL) is a government of India enterprise with a Maharatna status, and a Fortune 500 and Forbes 2000 company. Incorporated as Indian Oil Corporation Ltd. on 1st September, 1964 Indian Oil and its subsidiaries account for approximately 48% petroleum products market share, 34% national refining capacity and 71% downstream sector pipelines capacity in India. It is India's flagship national oil company and downstream petroleum major thus being India's largest commercial enterprise.

As the flagship national oil company in the downstream sector, Indian Oil reaches precious petroleum products to millions of people every day through a countrywide network of about 35,000 sales points. They are backed for supplies by 167 bulk storage terminals and depots, 101 aviation fuel stations and 90 Indane (LPG) bottling plants.

Indian Oil Corporation Ltd. (IOCL) is a premier public sector company in the Oil & Gas Sector and is engaged in the business of refining and retailing of petroleum products including LPG in the country. It is the leading Indian corporate in the Fortune 'Global 500' listing, ranked at the 83rd position in the year 2012. IOCL is having about 90 LPG bottling plants, which serve every corner of the country. Indane (the trade name of LPG of IOCL) is supplied to the consumers through a network of about 5,456 distributors (51.8% of the industry).The growth in demand of LPG for domestic purpose is increasing at a rapid pace.

1.2.2 Identification of Project

IOCL is having about 90 LPG bottling plants which serve every corner of the country. Indane (the trade name of LPG of IOCL) is supplied to the consumers through a network of about 5,456 distributors (51.8% of the industry).The growth in demand of LPG for domestic purpose is increasing at a rapid pace.

The capacity of the Bottling Plant at Tiruchirapalli is currently 192 TMTPA. Operation carried out will be receipt of LPG (Liquid Petroleum Gas) by road tankers from IPPL,

Chennai; after receiving of bulk LPG in isolated storage vessels and filling of LPG into domestic and non-domestic cylinders using electronic carousel 1&2 and associated systems. The additional mounded storage will be in 3 bullets of 300 MT each with a total capacity of 900 MT.

Land ownership dpcument and Air & water consents are enclosed as **Annexure-I & II** respectively.

The gas leak detection, fire prevention and control system at Tiruchirapalli LPG Bottling Plant are the latest and comply with the OISD norms. The same shall be extended to the new LPG vessels. All LPG storage vessels, cylinder storage/ filling/ repair sheds, LPG Pump House and TLD are fully covered by medium velocity water spray system. This Bottling Plant will also cater to the non-domestic LPG demand, Bulk LPG and Auto LPG demand of Tiruchirapalli. The proposed additional facilities in Plant are estimated to cost of Rs.22.14 Crores.

1.1.3 Justification of Project

Currently, BP utilizes two electronic carousals (2 x 24 points) with total rated bottling of 192 TMTPA in 2 shift operations. With total 4 no of LPG storage vessels, maximum bulk LPG storage is 1000 MT in the plant. This translates to 1.6 days cover.
Hence, as an operational necessity, to ensure sustainable days cover, and maintain continuity in supply status, there is no other alternative but to go for augmentation of existing storage capacity of Tiruchirapalli Bottling Plant.

1.2 Schedule and Cost of the Project

The proposed project will be completed in approximately 24 months from the date of approval environmental & other statutory clearances. The total cost of the proposed project is around Rs 22.14 Crores.

1.3 Brief Description of the Project

1.3.1 Nature of the Project

The LPG is received in bulk from M/s IndianOil Petronas Pvt Ltd (M/s IPPL), a Joint Venture Company of IOCL through bullet trucks of 18 MT capacity each. From Bullet Trucks it is transferred to storage vessels. LPG is then filled into cylinders by operating LPG Pump.

LPG from bullets is transferred through a pipeline to filling manifolds of carousel with the help of centrifugal pumps. The empty LPG cylinders brought into premises by Lorries are received and stored in the empty shed. They are fed to carousels / filling gun after due inspection through conveyor system in the filling shed. The filling is cut off as soon as the weight of LPG in the cylinder reaches 14.2/19 kg. After filling, these cylinders are counter checked for correct weight, tested for leaks from valves and body, capped and sealed before

sending them to the filled cylinder shed. Any defective cylinder is emptied at evacuation unit and sent for cold repair in the "Cold Repair" shed.

1.3.2 Size of the Project

In the LPG Bottling Plant the additional storage will be pressurized form in mounded storage. The mounded storage will be in 3 bullets of 300 MT each with a total capacity of 900 MT. The system of mounded storage has been recognized as one of the safest form of storage of LPG. The details of existing and proposed LPG storage capacities are provided in **Table 1.1**.

Table 1.1: Existing And Proposed - LPG Storage

Type of Vessel	Existing/Proposed	Nos.	Capacity	Total Capacity
Bullets (A/G)	Existing	2	150 MT	300 MT
Bullets (A/G)	Existing	1	100 MT	100 MT
Horton sphere(A/G)	Existing	1	600 MT	600 MT
Mounded Bullets	Proposed	3	300 MT	900 MT
			Total	**1900 MT**

Source: IOCL

1.3.3 Location of the Project

The project site is located at distance of about 23 Km from Tiruchirapalli. The site is well connected to Chennai by NH – 45. The nearest Airport is Tiruchirapalli Airport located at 28 km

The details of environmental setting are given in **Table 1.2**. The index map of the project site is shown in **Figure 1.1**.

Table 1.2: Environmental Setting

Sr. No.	Particulars	Details
1	Plant location	Located in Inamkulathur Village, Tiruchirapalli District, Tamil Nadu State
2	Site Coordinates	Latitude : $10^0$42'27.1 N Longitude : $78^0$32'10.57 E
3	Climatic conditions at Tiruchirapalli, IMD Station	
4	Maximum temperature	48 ^{0}C
5	Minimum temperature	28 ^{0}C
6	Annual rainfall (total)	174 mm
7	Relative humidity	Maximum- 92 % (August) Minimum- 35 % (May)
8	Predominant wind directions	From West to East
9	Present land use at the site	Land use pattern is notified for industrial use

Sr. No.	Particulars	Details
10	Nearest highway	NH-45
11	Nearest railway station	Tiruchirapalli, 23 km
12	Nearest Airport	Tiruchirapalli, 28 km
13	Nearest major water bodies	--
14	Nearest town/City	Tiruchirapalli, 23 km
15	Archaeologically important places	--
16	Protected areas as per Wildlife Protection Act, 1972 (Tiger reserve, Elephant reserve, Biospheres, National parks, Wildlife sanctuaries, community reserves and conservation reserves)	--
17	Reserved / Protected Forests	--
18	Defence Installations	--
19	List of major Industries in 10 km radius	• Tamilnadu Newsprint & Papers Limited ,Unit –II, Poongudipatti (A Govt of Tamilnadu Enterprise)
20	Seismicity	Seismic Zone-II as per IS 1893 (Part I): 2002

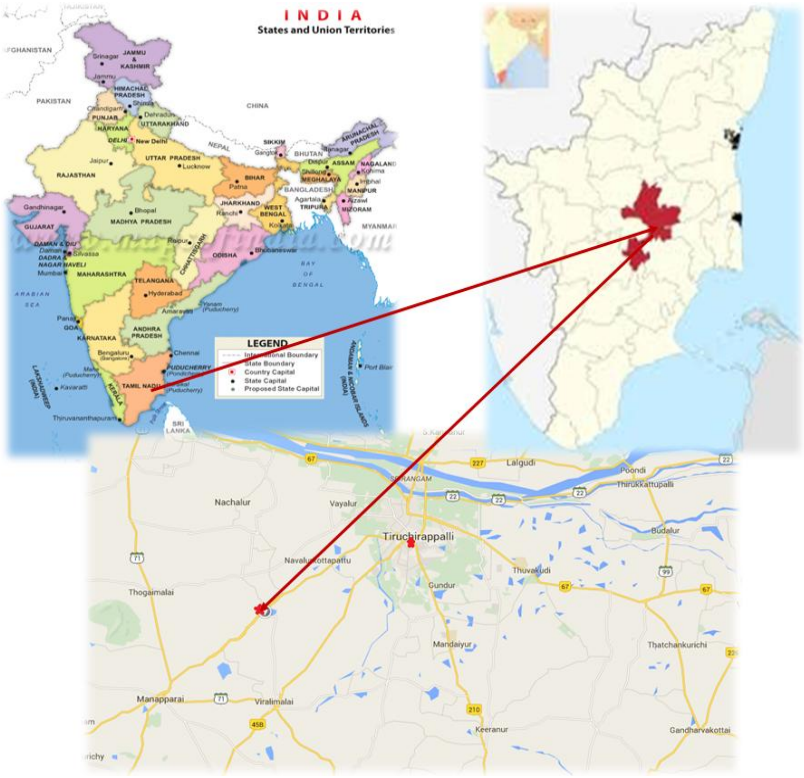


Figure 1.1: Index Map Showing the Project Site

1.3 Market Demand & Supply

India consumes about 16 MMTPA of LPG while domestic production is only 10 MMTPA. Net import of LPG is about 6 MMTPA. The consumption, import and export from last 5 years are presented in **Table 1.3**. During last 4 years, LPG consumption has grown at GAGR of 5.6% while production is almost static hence import has increased at CAGR of 25%.

Table 1.3: LPG Demand

LPG	2009-10	2010-11	2011-12	2012-13	2013-14
Consumption	13.13	14.33	15.35	15.60	16.34
Production	10.34	9.62	9.55	9.83	10.11
Export	0.13	0.15	0.17	0.20	0.23
Import	2.72	4.48	5.79	6.29	6.60

1.4 Scope of the Study

With a view to assess the environmental impacts arising due to the proposed expansion of LPG storage facility, IOCL has availed the services of M/s Ultra-Tech Environmental Consultancy and Laboratory, to prepare the EIA Report and suggest an Environmental Management Plan (EMP) for mitigating adverse impacts from the proposed expansion project.

Environmental baseline monitoring has been carried out by M/s. Eco Services Labs Pvt. Ltd. Chennai during 1st January to 31st March 2016. The scope of the present study is in-line with the Standard Terms of References as published by MoEF&CC on April, 2015.

1.4.1 Study Area Details

The study area for the EIA considered is within the 10 Km radius from the boundary of the facility. The topographical features of the study area (10km) are shown in **Figure 1.2**. Google image of the study area is shown in **Figure 1.3**. The environmental setting within the study area is given in **Table 1.2**.

1.4.2 Details of the Study

The scope of study broadly includes:

- To conduct literature review and to collect data relevant to the study area;
- To undertake environmental monitoring so as to establish the baseline environmental status of the study area;
- To predict incremental levels of pollutants in the terrestrial study area due to the proposed project activities;
- To evaluate the predicted impacts on the various environmental attributes in the study area by using scientifically developed and widely accepted environmental impact assessment methodologies;
- Risk Assessment study;

- To prepare an EMP outlining the measures for improving the environmental quality and scope for future expansions for environmentally sustainable development; and
- To identify critical environmental attributes required to be monitored suggesting a post-project monitoring programme.

  The literature review includes identification of relevant articles from various publications, collection of data from various government agencies and other sources.

1.4.3 Methodology of the Study

Reconnaissance survey was conducted by the consultants and concerned officials and sampling locations were identified on the basis of:

- Predominant wind directions in the study area as recorded by India Meteorological Department (IMD) at Chennai
- Existing topography, drainage pattern and location of surface water bodies like ponds, canals, and rivers;
- Location of villages/towns/sensitive areas;
- Areas which represent baseline conditions; and
- Collection, collation and analysis of baseline data for various environmental attributes.

The field observations are used to:

- To observe the baseline environmental status of study area;
- Identify extent of negative impacts on community/natural resources; and
- Identify mitigation measures and monitoring requirements.

The study also provides framework and institutional strengthening for implementing the mitigation measures. Field studies have been conducted to determine existing conditions of various environmental attributes as outlined in **Table 1.4**.

Table 1.4: Environmental Attributes and Frequency of Monitoring Adopted

Sr. No.	Environmental Component	Sampling Locations	Sampling Parameters	Sampling Period	Sampling Frequency	Methodology
1	Meteorology	One central location	Temperature, Wind Speed, Wind Direction	3 months	Hourly	The parameters were recorded by automatic micro-meteorological machine having anemometer, wind vane and thermometer. IMD data of Gannavaram also reviewed.
			Rainfall	3 months	Daily	Rainfall was recorded every morning at 0830 hours
			Relative Humidity, Cloud Cover	3 months	Hourly	Humidity measured using wet & dry bulb thermometer and psychometric charts on hourly basis.
2	Ambient Air Quality	8 locations	As per NAAQS 2009- PM_{10}, $PM_{2.5}$, SO_2, NO_X, CO, O_3, As, Ni, Pb, C_6H_6, BaP, NH_3	Two days per week for 13 weeks	24 hourly	Gravimetric method for $PM_{2.5}$ and PM_{10}. Modified West & Geake method for SO_2 (IS-5182 part-II 1969) using Tetrachloromercurate 0.01 N absorbing solution. Jacob-Hochheiser method (IS-5182 part-IV 1975) for NOX using Sodium Arsenate absorbing solution of 0.01 N absorbing solutions. CO was measured by GC method.
3	Water Quality	10 locations (2-Surface water 8-Ground water)	As per IS:10500-2012	Grab sampling	Once in study period	As per APHA methods. The conductivity, temperature were analyzed at site laboratory and rest of the parameters were analyzed at M/s. Eco Services Labs Pvt. Ltd. Chennai
			Heavy metals (As, Hg, Pb, Cd, Cr^{-6}, Total Cr, Cu, Zn, Se, Fe)	Grab sampling	Once during study period	

4	Noise	8 locations	L_{eq}, L_{day}, L_{night}, $L_{D/N}$	Hourly readings for 24 hours	Once during study period	Integrated on hourly basis
5	Soil	8 locations	Soil profile, Chemical constituents, Suitability for agricultural growth	Composite sample up to 90-cm depth	Once during study period	Analysis was carried out as per Soil Chemical analysis by ML Jackson
6	Terrestrial Ecology	Total study area	Flora and faTriuchirapalli	Field observations	Once during study period	Through field visits and collected secondary data. Count and quadrate method
7	Demography and Socio-economic aspects	Total study area	Demographic profile	-	-	Through field visits and secondary information sources like National Informatics Centre, Delhi, Census, etc.

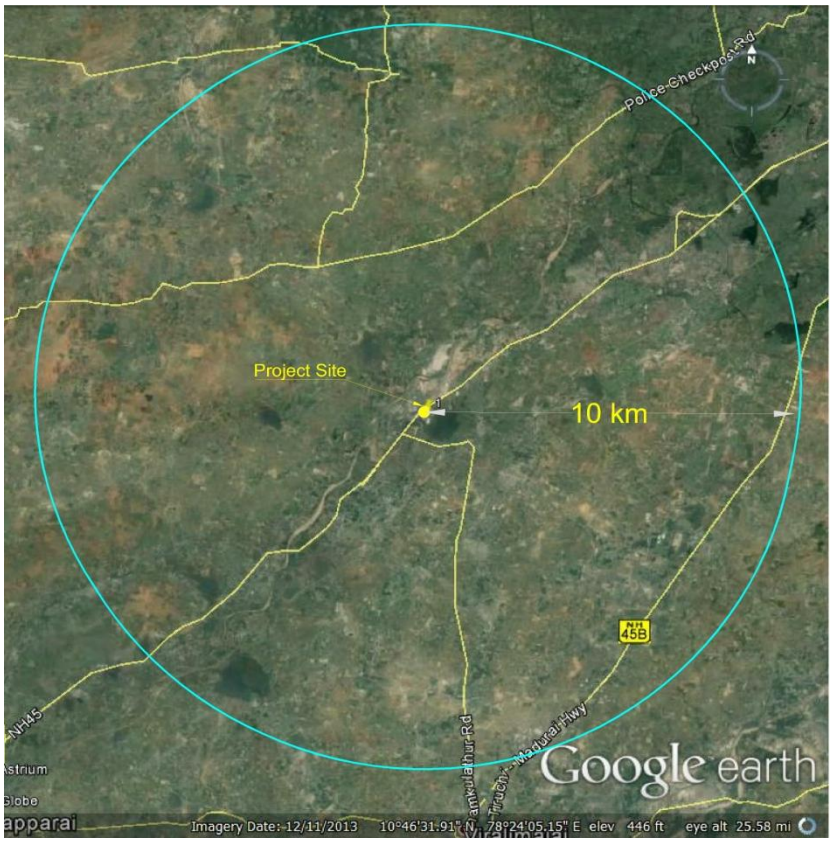


Figure 1.2: Study Area Map of the Project (10 Km Radius)

Figure 1.3: Google Image

CHAPTER 2. PROJECT DESCRIPTION

2.1 Type of the Project

IOCL Bottling Plant at Tiruchirapalli was commissioned during the year 1996 with 8 Unit Filling machines and LPG tankages of 2 x 150MT + 1 x 100 MT in above ground bullets were installed. Subsequently, both bottling capacity and LPG tankage was Augmented by replacing the Unit filling with 2 x 24 point Carousel and additional Horton Sphere 600 MT's capacity. Propose augmentation includes additional 3 x 300 MT mounded bullet system**.**

2.2 Need for Project Activity

The existing Trichy BP currently has 1.6 days cover against a bottling capacity of 600 MTD. This poses the following inconveniences:

- With small size vessels and dead stocks (unpumpable), the effective transfer/receipt quantity is even less which calls for frequent, switch-over between vessel under receipt and vessel engaged for cylinder bottling.
- Residual lives of 3 nos. existing old A/G bullets are limited. Any further reduction in storage would lead to severe constraint in day-to-day operation and a crisis situation.
- In view of the foregoing, the Div has proposed for provision of additional 3 nos of mounded bullets with 300 MT capacities each in the plant will ensure 3-4 days cover on a stand-alone basis against total bulk LPG storage capacity of 1900 MT. The Bottling Plant is estimated to cost of Rs.22.14 Crores.

2.3 Location and Layout

The layout of the bottling plant has been prepared as per prescribed OISD – 144 & 150. The safety distances are maintained as per the OISD standards. The road network is designed to ensure smooth movement of bulk/filled cylinder trucks. Layout plan of the bottling plan including proposed facilities have been given in **Figure 2.1**.

- Design Parameters: Temperature, Pressure, Internal Corrosion, Hydro Test Pressure
- Design Procedure: As per the Design Code: ASME SEC. VIII or BS- 5500 or equivalent duly approved by PESO
- Piping layout is as per OISD-150. One liquid line, one vapour line, 2no's SRVs, ROVs on liquid and vapour lines

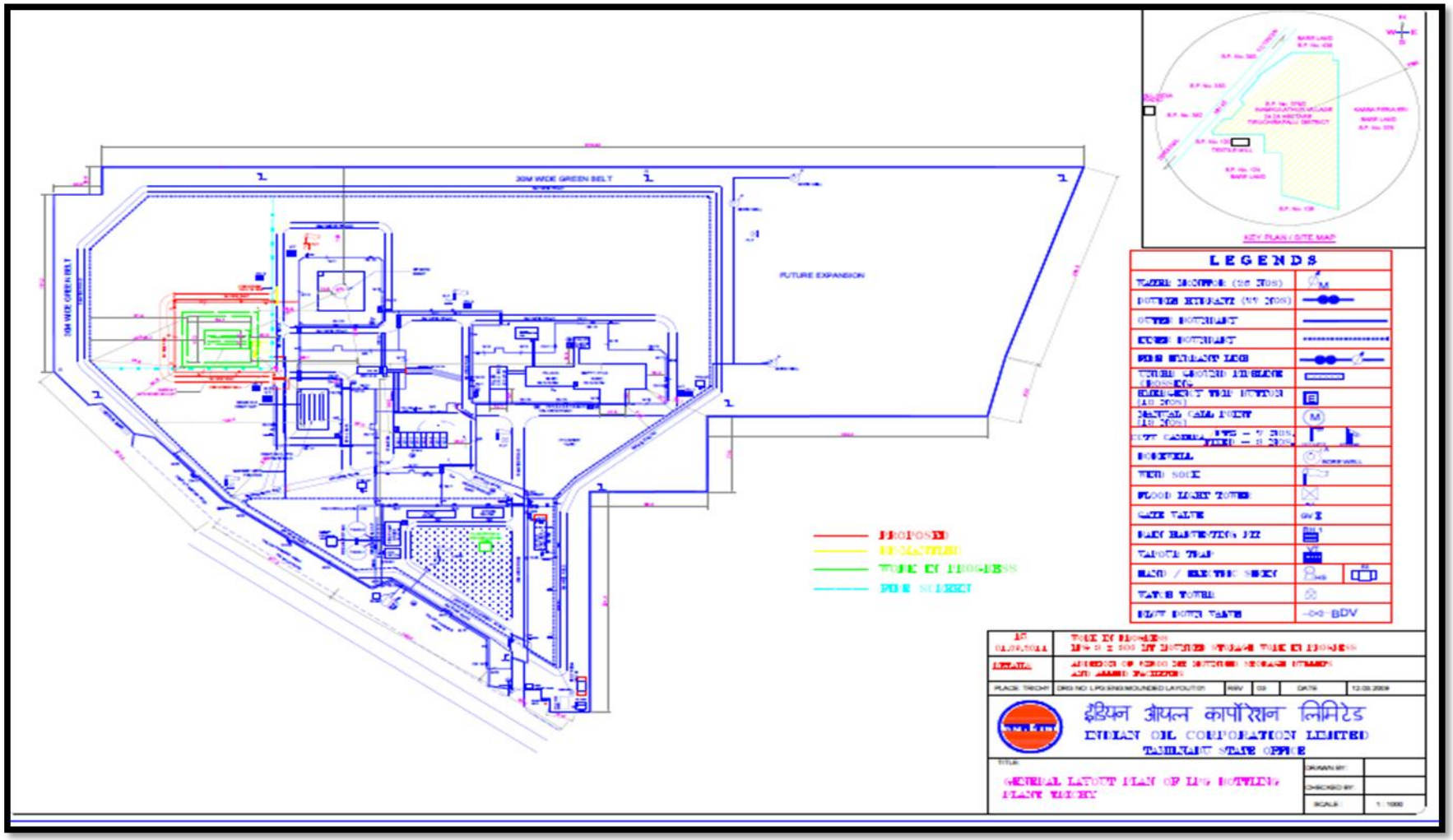


Figure 2.1: Layout of the Plant

2.4 Salient Features of the Project

The salient features of the proposed augmentation of Tiruchirapalli LPG BP are presented in **Table 2.1.**

Table 2.1: Salient Features of Existing and Proposed Plant

<table>
<tr><th>Sr. No.</th><th>Description</th><th>Details</th></tr>
<tr><td>1</td><td>Total Land</td><td>24.28 ha</td></tr>
<tr><td>2</td><td>Location</td><td>IOCL, Tiruchirapalli, Inamkulathur, Trichy – 620 009.</td></tr>
<tr><td>3</td><td>Present land use</td><td>Proposed expansion will be carried out within existing premises</td></tr>
<tr><td>4</td><td>Status of land acquisition</td><td>Entire land is in the name and possession of IOCL</td></tr>
<tr><td>5</td><td>Type of storage tanks</td><td>1. Mounded Bullet
2. Above ground bullets</td></tr>
<tr><td>6</td><td>Capacity of storage tank proposed</td><td>
<table>
<tr><th>Type of Vessel</th><th>Existing/Proposed</th><th>Nos.</th><th>Capacity</th><th>Total Capacity</th></tr>
<tr><td>Bullets (A/G)</td><td>Existing</td><td>2</td><td>150 MT</td><td>300 MT</td></tr>
<tr><td>Bullets (A/G)</td><td>Existing</td><td>1</td><td>100 MT</td><td>100 MT</td></tr>
<tr><td>Horton sphere(A/G)</td><td>Existing</td><td>1</td><td>600 MT</td><td>600 MT</td></tr>
<tr><td>Mounded Bullets</td><td>Proposed</td><td>3</td><td>300 MT</td><td>900 MT</td></tr>
<tr><td colspan="4">Total</td><td>1900 MT</td></tr>
</table>
</td></tr>
<tr><td>7</td><td colspan="2">Resource Requirement</td></tr>
<tr><td>8</td><td>Power requirement</td><td>Met through existing 400 kVA contract demand from TN Power grid</td></tr>
<tr><td>9</td><td>Water requirement</td><td>17 m^3/day met through Municipal water supply and existing bore wells</td></tr>
<tr><td>10</td><td>Man power</td><td></td></tr>
<tr><td>11</td><td>Project Cost</td><td>Rs 22.14 Crores</td></tr>
<tr><td>12</td><td>Cost towards environment protection</td><td>Rs 0.26 Crores (STP, Oil water separator, impervious dykes, plantation/lawns, etc.)</td></tr>
<tr><td>13</td><td colspan="2">Fire Fighting Facilities</td></tr>
<tr><td>A</td><td>Fire water storage</td><td>7400 KL</td></tr>
<tr><td>B</td><td>Fire water pumps</td><td>5 fire water pumps of 410 cum/ hr</td></tr>
</table>

Sr. No.	Description	Details
C	Jockey pumps	2 jockey pumps of 10 m^3/hr@7kg/cm^2
C	Water sprinkler / Deluge system	At all relevant places (will be covered by auto sprinkler system in line with OISD 144)
D	Fire Hydrant/monitor piping network	As per OISD
E	DCP & CO_2 extinguishers	As per OISD
F	Gas Monitoring System	As per OISD-150
G	ILSD	As per OISD-144

Source: Project Report, IOCL

2.4.1 Proposed Schedule and Approval for Implementation

The construction of LPG storage activities will commence on receipt of Environmental Clearance (EC) from SEIAA.

2.4.2 Land Use

The proposed expansion will be carried out within the existing premises, the site earmarked for expansion is a vacant land and hence the no change in land use. Land schedule is given in **Table 2.2.**

Table 2.2: Land Schedule of the Project Site

Sr. No	Land Schedule	Area in ha
1	Plant facilities	8.0
2	Administrative building	0.3
3	Greenbelt	14.78
4	Truck parking	1.2
	Total	**24.28 ha**

Source: Project Report, IOCL

2.5 Tiruchirapalli Bottling Plant Facilities

The mounded storage will be in 3 bullets of 300 MT each with a total capacity of 900 MT. The mounded storage has been recognized as one of the safest form of storage of LPG. The facilities at the LPG bottling plant, Tiruchirapalli are shown in **Table-2.3 (A&B).**

Photographs of the existing and proposed Tiruchirapalli Bottling Plant are shown in Figure-**2.1**. The plant layout showing existing and proposed plant facilities is shown in **Figure-2.3**.

Approval from Petroleum and Explosive Safety Organisation (PESO), is enclosed as Annexure-III

Table 2.3(A): Facilities at The LPG Bottling Plant, Tiruchirapalli

S No	Facility	Capacity	
		Existing	**Proposed**
1.	Storage	1000 MT	3X300 MT
2.	Unloading Bay	8 bays	
3.	No. of Carousel	Two	
4.	LPG Pumps	Two	
5.	LPG Vapour Compressor	Three	

Table 2.3(B): Storage Details of LPG

Scenario	Bulk Storage (MT)	Filing MT/day	Days' Cover
Existing capacity and storage	1000	615	1.6
Future BP capacity & existing storage	1000	615	1.6
Existing storage without 2x150 MT & 1x100 MT A/G bullets	600	615	0.97
With proposed BP storage	1900	615	3.08
With proposed BP storage & without 2x150 MT & 1x100 MT A/G bullets	1500	615	2.44

From the above, it can be observed that the days' cover for Tiruchirapalli BP would be in the range of 3-4 days' after proposed tankage addition.

Figure 2.1: Photographs of Existing Tiruchirapalli Bottling Plant

2.6 Description of Proposed Storage Facility

Proposed expansion of LPG storage facility is from 1000 MT to 1900 MT by installing 3x300 MT mounded storage unit.The tanks will be installed above the highest known water table level and the soil cover, therefore, usually protrudes above ground level as an earth mound, thereby practically eliminating the possibility of boiling liquid expanding vapour explosion' (BLEVE) happening. The mounded structure is shown in **Figure-2.2**

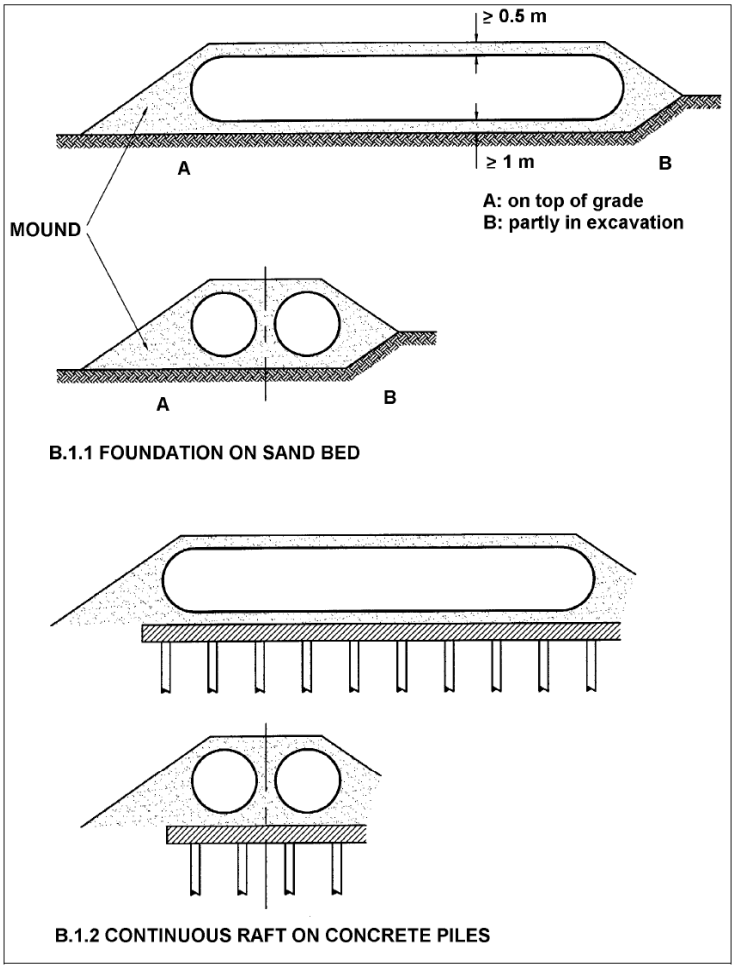


Figure 2.2: Mounded Storage Structure

Material safety data sheet of LPG is enclosed as **Annexure-IV**

Tank Accessories

The following accessories **Table-2.4**, will be installed on storage tank.

Table 2.4: Accessories on Mounded Tank

Parameter	Accessories on mounded tanks
Equipment for mounded tanks	Vents
	Instrumentation
	Access hatches
	Drains
	Sealing elements
	Valves

Description of accessories is given below:

Vents: Pressure relief valves (PVRVs)

Pressure relief valves prevent excessive pressure build-up in the tank. The tanks are fitted with two no's of Multiport SRV's set to operate at pressure less than the MAWP for the vessel.

Instrumentation

Local or remote instrumentation shall be in accordance with appropriate standards; the Institute of Petroleum (IP) Petroleum Measurement Manual and IP Electrical Safety Code will provide specific advice, as well as other codes, standards and guidelines in this field.

Level control and overfill protection

During filling procedures, usually it is insufficient to control and record only the filling level. Because there is a danger of overfilling and consequent soil and water pollution, storage tanks are equipped with overfill protection to interrupt automatically filling before the maximum authorised liquid level is reached. In case the filling is not carried out automatically, the tank is equipped with an alarm to indicate the maximum authorised liquid level is reached. And filling is stopped manually.

Flame arrester

LPG storage tanks will have flammable atmosphere above the liquid. To prevent vapours from being ignited, by an external source (e.g. lightening), vents are fitted with flame arresters. These will be regularly inspected to avoid blockage.

Leak and gas detection

Hydrocarbon detectors shall be installed to detect LPG liquid and/or gaseous leaks. The following is a non-exhaustive list of some typical techniques used:

- ✓ gas leaks can be detected by explosimeters, general purpose organic vapours analysers (OVA) or specific gas analysers; and
- ✓ Liquid leaks can be detected in the spillage collection systems. Level or interface level sensors can be used for insoluble organics, while pH meters and conductivity meters can be used.

Access Hatches

Access hatches at the top of the tank allow access during a shut-down of the tank and to fulfil gas freeing of the tank. This is also the access route where any solids left in the tank are removed during cleaning operations. An access hatch is also usually provided for horizontal tanks (both atmospheric and pressurised) on the top of the tank.

Drains

The two drain valves will be provided to enable simultaneous operation of both valves by a single operator. The downstream valve is normally a quick-acting spring loaded type (spring to close) valve that will operate as a dead man's handle. The drain outlet point can be lined up to a vapour treatment.

2.7 Process Description

The flow diagram of the LPG operations is shown in **Figure-2.5** and P&ID is shown in **Figure-2.6.**

The process involved the following steps:

Unloading

LPG from road tankers is unloaded in TLF shed comprising of unloading bays. The road tankers are connected to liquid and vapour lines from AG Bullet by unloading arm provided with excess flow check valve and isolation valve. Road tankers are provided with Roto gauges. Flow indicators are provided in the liquid line leading to Bullets. Vapour line is connected to the compressor through a four way valve. LPG is unloaded from the road tanker by differential pressure method. During LPG unloading, vapour from one storage bullet is sucked and is compressed in LPG compressor. The compressed LPG vapour is fed to bulk tanker to pressurize it and LPG (Liquid) is transferred from the road tanker to the Bullet.

After LPG unloading, the compressor suction is reversed by changing the four way valve position and LPG vapour is recovered from road tanker through the same compressor and discharged to AG Bullets till the suction pressure of compressor falls from an initial value of 11.6 Kg/cm^2 to 2 Kg/cm^2.

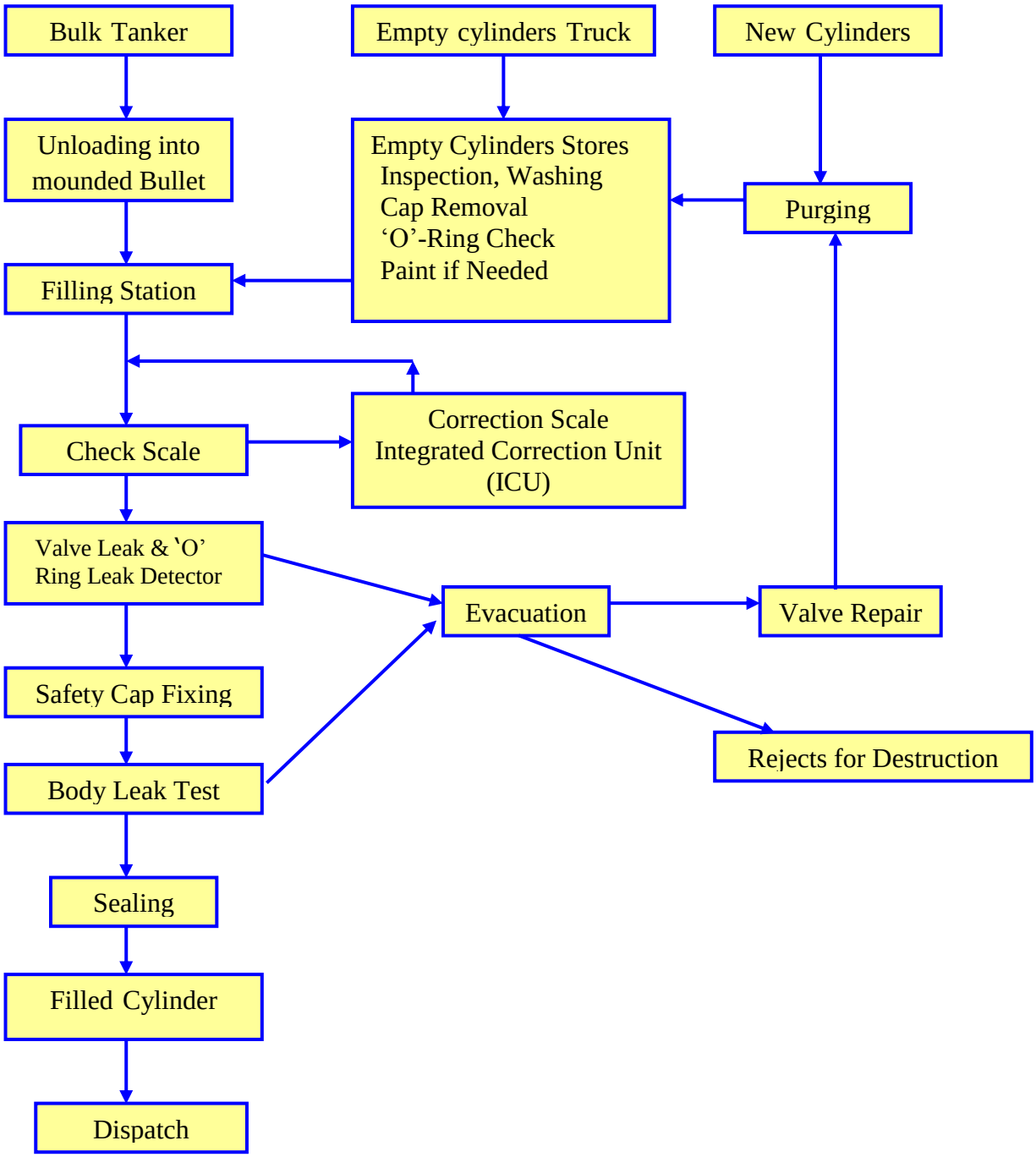


Figure 2.4: Process Flow Chart

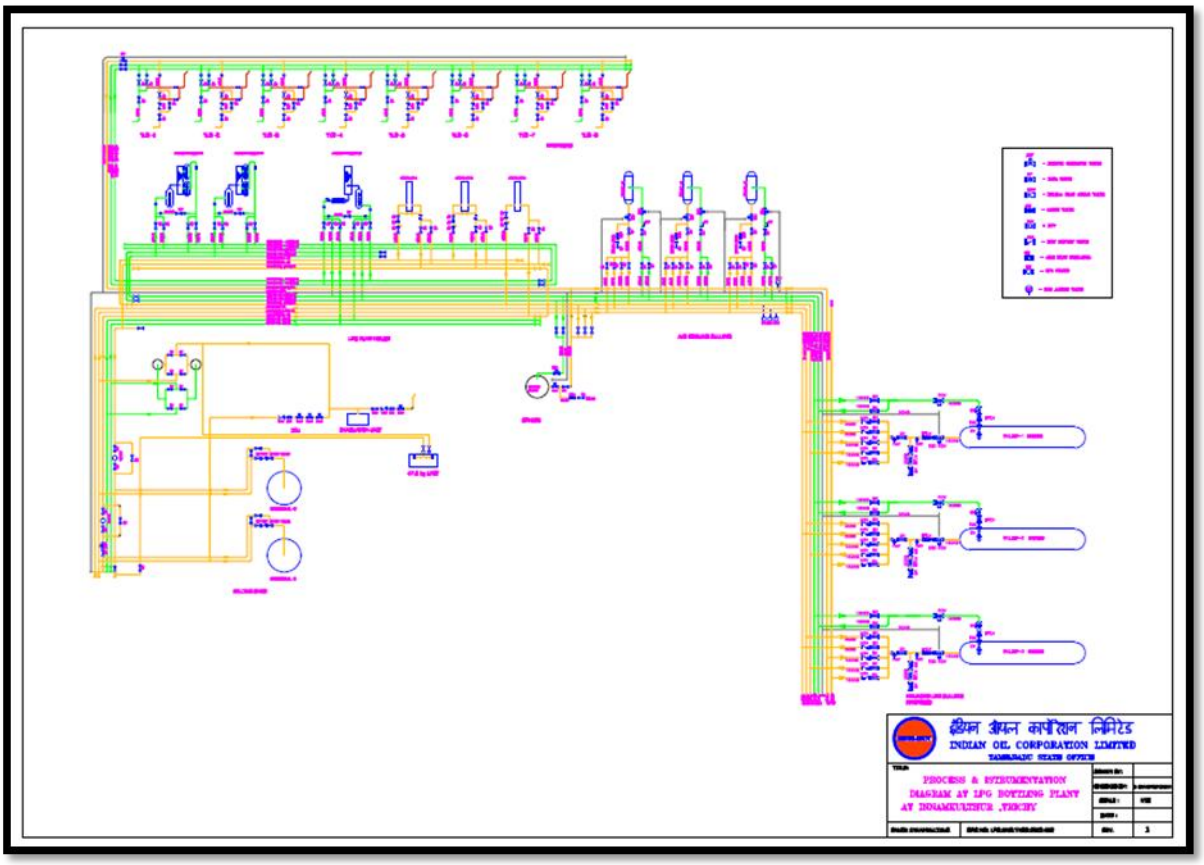


Figure 2.5: Piping System and Instrumentation

Receipt of LPG :

LPG is received from Indian Oil Petronas Pvt. Ltd (IPPL), Chennai through Road tankers. The LPG from tankers is transferred to storage vessels. About 615 MT of LPG is received daily.

LPG Pumps and Compressor House

LPG pumps will take suction from bottom of above ground Bullets and deliver liquid to carousal for filling in empty cylinders. Two vertical can-type pumps and one centrifugal pump has been installed to pump liquid LPG from storage vessels to carousel. These pumps have been provided with pop-up action valves on discharge lines and are coupled to flame proof motors.

Three LPG vapour compressors each coupled to a flame-proof motor have been installed for loading/unloading of LPG based differential pressure mechanism. The maximum discharge pressure of these compressors is 16.9 kg/cm^{2}g. Details of LPG pumps and Compressor house are given in **Table-2.5**.

Table 2.5: Pumps at the LPG BP, Tiruchirapalli

Item	Capacity (m^3/hr)	Type	Motor Rating, KW	Purpose (Bottling/TT UnLoading)	Line Size, inches	
					Suction	Discharge
Pump no.1	40	Horizontal centrifugal	30	**Bottling**	4	4
Pump no.2	85	Vertical can type centrifugal	45	**Bottling**	6	4
Pump no.3	85	Vertical can type centrifugal	45	**Bottling**	6	4
Vapour comp .1	170	Reciprocating Type	30	**TT Un Loading**	3	3
Vapour comp .2	230	Reciprocating Type	45	**TT Un Loading**	4	4
Vapour comp .3	230	Reciprocating Type	45	**TT Un Loading**	4	4

LPG Vapour Compressors

3 nos. of LPG vapour compressors have been provided for unloading of LPG from road tankers by pressurization and thereafter for recovery of LPG vapour from the road tankers when unloading is complete

Air Compressor & Air Drying Unit

2 nos. of non-lubricated screw type Air compressor are provided for supply of compressed air for plant requirement as well as for instrument air at a pressure of 7 Kg/Cm2a. The air compressor and air drying unit are located away from LPG handling facilities.

LPG Cylinder filling and associated facilities

Types of cylinders used are 14.2, 19, 47.5, and 5kg. Empty cylinders from storage shed are sent to filling shed by chain conveyer. LPG is filled by means of rotary machines (Carousel). The speed of the driving unit is variable so that the rotation of the carousel can be adapted to various filling capacities. The machine is preset for the net filling required in the cylinders. The filling machine is adjusted for the respective tare weight of the cylinders and is automatically cut off when the total gross weight reaches.

Two (each with 24 point) electronic filling machines and cylinder conveyor have been installed for filling of 14.2 kg and 19 kg cylinders. Besides the above this shed also have electronic check scales for weight checking of filled cylinders, weight correction unit machines, Automatic valve testing machines, Test bath for checking any leakage from cylinder bung and body. Hot air sealing machine for sealing of cylinders prior to dispatch and

SQC machine for quality checks of cylinders facilities are there in the filling shed. Processed cylinders directly go to loading bays and failed cylinders during testing go to repair/servicing.

Checking of weight and Leak testing

After filling, each cylinder is checked for the weight and the cylinders having less or more weight are segregated. The cylinders are checked for valve leakage and O Ring defect by Electronic leak detectors and then checking for body and bung leaks by totally submerging cylinders under water. Finally the cylinders are sent to filled cylinder shed via chain conveyers for loading in the trucks.

Air removal from cylinders and LPG vapour filling - Purging Unit

This unit is required to fill LPG vapour in cylinders (new and repaired) after sucking the air from cylinders by vacuum pumps. This operation is essential to eliminate the possibility of forming explosive mixture with air. Vacuum is created up to 300 mm of Hg inside the cylinder and then LPG vapour is injected into the cylinder up to a pressure of 1.5 to 2 kg/cm^2g before using them for filling.

Evacuation of leaky cylinders

LPG is taken out from leaky cylinders and defective valve is replaced in the repairing shed. This unit consists of one LPG vapour compressor, two evacuation vessels and cylinder stand to keep the leaky cylinders in inverted position. Transfer of LPG from leaky cylinders is done by differential pressure method. The liquid collected in a vessel is transferred to AG Bullets by pressurization. Leaky cylinders are further evacuated and thereafter depressurized through cold flare unit before sending for cold repair.

Storage of filled cylinders & transportation

Filled cylinders are stacked in the filled cylinder shed near the delivery end as per rules laid down by OISD/Gas Cylinder Rules, 1981. Filled cylinders are delivered only to the authorized LPG distributors. Drivers of the trucks carrying LPG are having valid license and are having training in safety & fire fighting procedures.

Receipt of Empty LPG Cylinders

Four Telescopic type unloading bays are provided for unloading of empty cylinders received in trucks at plant. All necessary inspections are carried out after unloading at telescopic conveyor before going for filling. The segregated cylinders are stacked separately and the same undergoes testing/repair.

Dispatch of Filled Cylinders

After passing of all tests, the filled cylinders are loaded in Cylinder trucks by using four Telescopic type loading bays. Packed cylinders are sent to distributors in a truck having capacity of 306/100 cylinders.

Tank Lorry Filling Shed

Bulk LPG is supplied thru Tankers. A eight bay Tank Lorry Decantation Shed (TLD) has been provided to un load LPG from Tank Trucks to Storage Vessels.

2.8 Resources requirement for the Proposed Project

2.8.1 Land use and Land Ownership

The proposed expansion will be carried out in the vacant land of existing plant. Hence, no alternate sites were considered for the project, no change in land use.

The total land in possession of IOCL is about 60 acres, out of which proposed project needs .3782 ha for proposed 3 mounded bullets, stone pitching around the bullets and 1480 m^2 motor-able road around the mounded bullets and for laying the fire fighting hydrant network around the mound.

2.8.2 Water requirement

Water will be sourced for the expansion project additional 17 KL of water is required for the proposed expansion by the 3 existing borewells and municipal water supply. The water balance chart is given in **Figure-2.7**. Breakup of existing and proposed water requirement is given in below **Table-2.6**.Water allocation letter enclosed as **Annexure-V**

Table 2.6: Water Consumption

Particulars	Quantity (m^3/d)	
	Existing	Proposed
Hydraulic testing and washing of cylinders	3.0	3.0
Gardening	1.0	1.0
Plant Utilities	4.0	6.0
Domestic	7	15.0
construction	8.0	15.0
Total	23	40

2.8.3 Power requirement

Plant receives power from Power Grid, with contract load of 400 kVA. Actual requirement of plant is 400 kVA. In addition, IOC has stand by DG sets of 625 kVA.

2.9 Proposed Schedule and Approval for Implementation.

The plant activities will be completed in a period of 24 months from the date of receipt of all the approvals from statutory authorities.

2.10 Utilities and Services

2.10.1 Machinery Stores

Adequate storage facilities for machinery spares and other consumables, including an open yard, have been established to meet the requirement of plant.

2.10.2 Workshop

Based on the location of the plant, reasonably good workshop facilities have been established, both for mechanical and electrical equipment repairs and maintenance.

2.10.3 Time Office and Security Office

The time office and security office complex is well established.

2.10.4 Fire Fighting System

For protection system has following:

- Hydrant system.
- High pressure water sprinkler system.
- Portable fire extinguishers (10 & 75 kg DCP)

2.10.5 Infrastructure Facilities for Labour Force

Presently no infrastructure, except an all weather good motor-able public road, is available in the area. Thus, the infrastructure like offices, workshop, electricity etc. will be added.

The following amenities will be provided to the workers:

- Drinking water facility;
- Sanitation facilities will be constructed which will include the adequate number of separate toilets for men and women. The make shift treatment plant will be installed and treated wastewater will be utilized in greenbelt development;
- Bins will be installed to collect municipal waste

2.10.6 First Aid Room

Occupational Health center provided in the main factory will be used for the construction workers also .First Aid Trained Personnel of IOC available in both shifts.

2.11 Sources of Pollution and Built-in Control Measures

2.11.1 General

In the operations, as well as in the auxiliary units, different waste materials will be generated. These waste materials mainly include gaseous emissions, wastewater and solid wastes from the utilities:

- The emissions include the dust due to vehicular movement;
- The main atmospheric pollutant is fugitive emissions;
- The water in the plant is mainly used for domestic purpose and no process wastewater is generated
- The solid waste in the form of sludge is mainly generated will be used as manure

The various types of pollution from the proposed expansion project are categorized under the following types:

- Air pollution;
- Water pollution;
- Pollution emanating due to solid waste; and
- Noise pollution

2.11.2 Air Pollution

The following are the potential emission sources while handling the liquid and liquefied gas storage and handling area:

- Filling;
- Cleaning;
- Pigging;
- Purging;
- Sampling
- Disconnecting;
- Opening;
- Pressure relief;
- Fugitive; and
- Emptying/draining.

Fugitive emissions of VOCs are the major sources of air pollution in storage facilities and from static and dynamic joints and seals used in flanges, pumps, mixers, valve packing and connection joints. In order to minimize the fugitive emissions of VOCs, the following measures are incorporated at design stage:

- Minimum number of flanges, valves etc;
- Provision of leak proof valves like ROV/Gate Valves/Quick Shut-Off valves;
- High grade gasket materials
- Usage of pumps with (single/double) mechanical seals

2.11.3 Wastewater Generation

Sewage generation is envisaged during operation phase and existing soak pit will be adequate to cater the sewage load. Sewage from the administration building will be routed to the septic tanks followed by soak pits and the sludge generated from the septic tank will be dried and used as manure for green belt area.

Storm water drains are provided at plant. These drains carry storm water from dykes/other areas outside the plant premises in a controlled manner (i.e. through vapour trap).

2.11.4 Solid Waste / Sub-Grade Material

No process / manufacturing involved. Hence no solid waste generated.

2.11.5 Noise Levels and Vibration

The DG sets shall be acoustically insulated resulting in reduction of noise as per limits prescribed by Central Pollution Control Board. The exhaust pipe from DG sets shall be taken above the building as per Central Pollution Control norms.

2.11.6 Source of potential Air and Water Emission sources

The details of possible emission sources are given in **Table 2.7**.

Table 2.7: Potential Emission Sources from Bottling Plant

Sr. No	Type of Storage	Potential Emissions to Air	Potential Emissions to Water
1	Above ground horizontal storage tanks	Filling, breathing, emptying, cleaning, blanketing, manual gauging, sampling, fugitive, draining	Draining, cleaning, sampling
2	Mounded storage (pressurised)		
Apart from operational losses, infrequent emissions also occur from incidents and (major) accidents such as leakages may occur			

CHAPTER 3. DESCRIPTION OF THE ENVIRONMENT

3.1 General

This chapter provides the description of the existing environmental status of the study area with reference to the environmental attributes like air, water, noise, soil, land use, ecology, socio economics, etc. The study area covers 10 km radius around the project site.

The existing environmental setting is considered to adjudge the baseline conditions which are described with respect to climate, atmospheric conditions, water quality, soil quality, ecology, socioeconomic profile, land use and places of archaeological importance.

3.2 Methodology

The methodology for conducting the baseline environmental survey obtained from the guidelines given in the EIA Manual of the MoEF& CC. Baseline information with respect to air, noise, water and land quality in the study has been collected by primary sampling/field studies during the period of **January 2016 to March 2016.**

The meteorological parameters play a vital role in transport and dispersion of pollutants in the atmosphere. The collection and analyses of meteorological data, therefore, is an essential component of environmental impact assessment studies. The long term and short term impact assessment could be made through utilization and interpretation of meteorological data collected over long and short periods. Since the meteorological parameters exhibit significant variation in time and space, meaningful interpretation can only be done through a careful analysis of reliable data collected very close to the site.

3.3 Study Area included in Environmental Setting

The study area is considered to be area within a radius of 10 km of the IOCL terminal boundary. The EIA guidelines of the MoEF mandate the study area in this manner for EIA's.

3.3.1 Land Use/Land Cover of the Study Area

The proposed Augmentation of LPG Bottling Capacity and LPG Bulk Storage Capacity from 1000 MT to 1900 MT by Installing 3 x 300 MT Mounded Storage Unit at LPG Indane Bottling Plant at Trichy is the project for which LULC study is carried out. The project site is located around centre coordinate points; Latitude- 10°42'26.97"N and Longitude- 78°32'15.45"E.

Software and Hardware

Satellite Data: Landsat 8 cloud free data has been used for Landuse / landcover analysis.
Satellite Sensor – OLI_TIRS
Path and Row – Path 143, Row 53
Resolutions –Panchromatic 15 m Reflective 30 m
Date of Pass: 1st July 2015
GIS and image-processing software are used for the purpose of image classification and for delineating drainage and other features in the study area.The LULC classes are identified and presented in **Table 3.1 and Figure 3.1**.

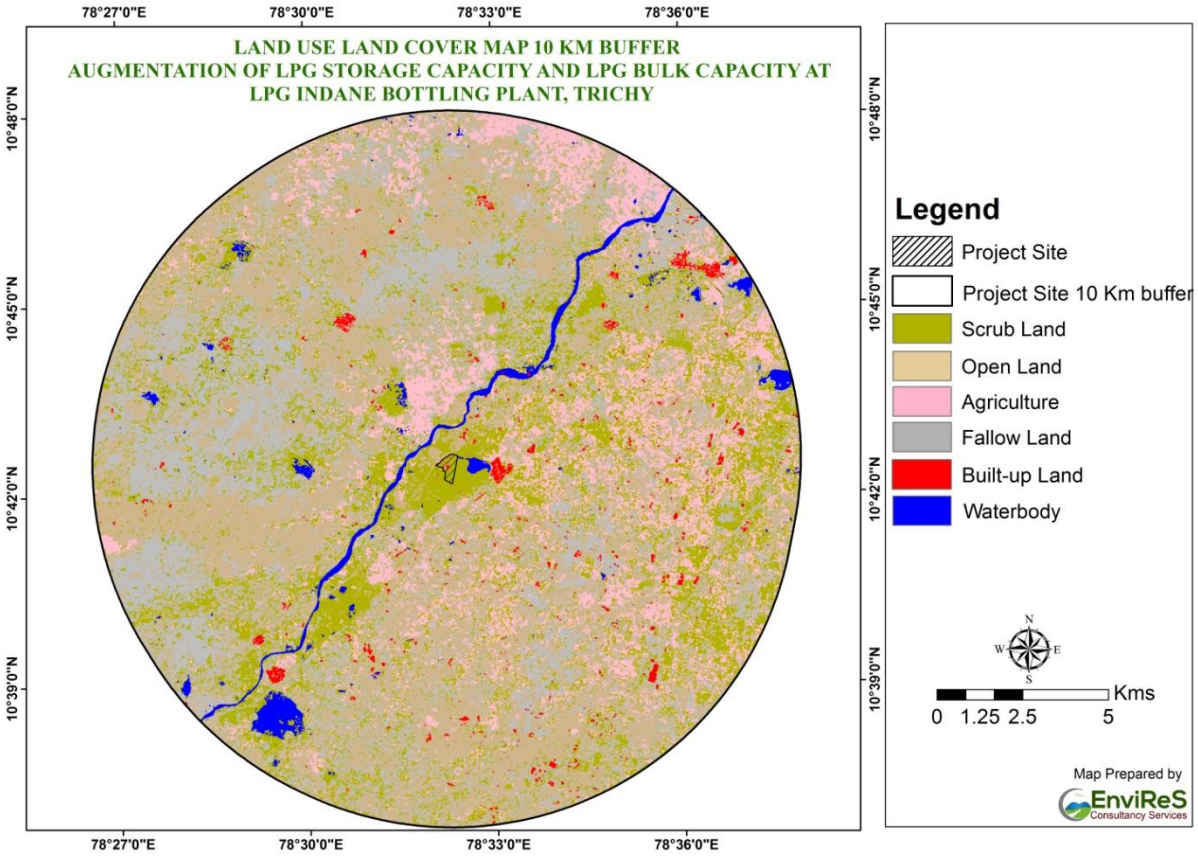


Figure 3.1: Landuse/Landcover of 10 Km Study Area

The study area of 10km radius from the centre of project site shows six different land use classes. Open land (35.05%) along with scrub land (21.27%) dominates the land use pattern covering 10km radius around project site. Agriculture land (15.44%) and Fallow land (25.56%) together contribute to more than 41% of land use indicating agriculture as one of the major source of income for nearby villagers. Built-up land (0.99%) and water body (1.69%) are some of the minor LULC classes observed within stud area.

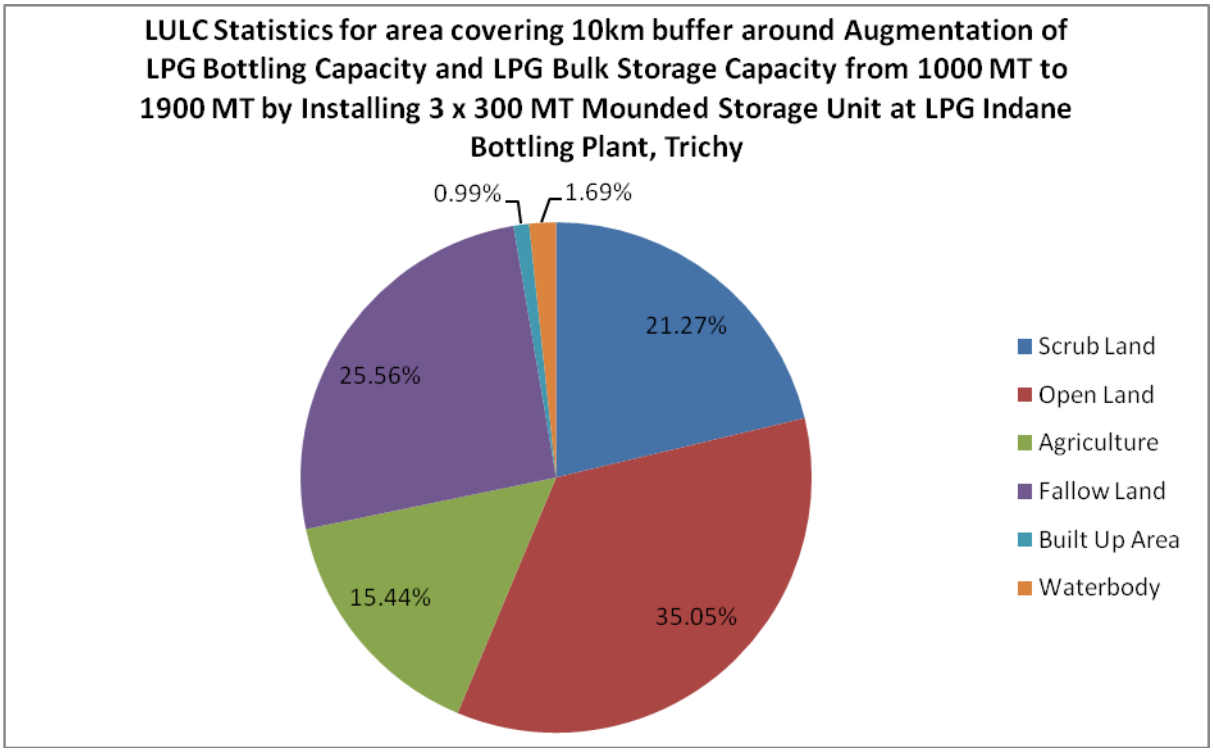


Table 3.1: Landuse / Landcover Statistics of Area within 10 km Radius

LULC Class	Area(Sq. Km)	%
Scrub Land	71.99	21.27
Open Land	118.67	35.05
Agriculture	52.29	15.44
Fallow Land	86.52	25.56
Built Up Area	3.34	0.99
Water body	5.73	1.69
Total	**338.54**	**100.00**

Four (4) different landuse/ landcover (LULC) classes are identified for the area covering 500m radial distance around proposed project site. The LULC classes are identified and presented in **Table 3.2 and Figure 3.2**.

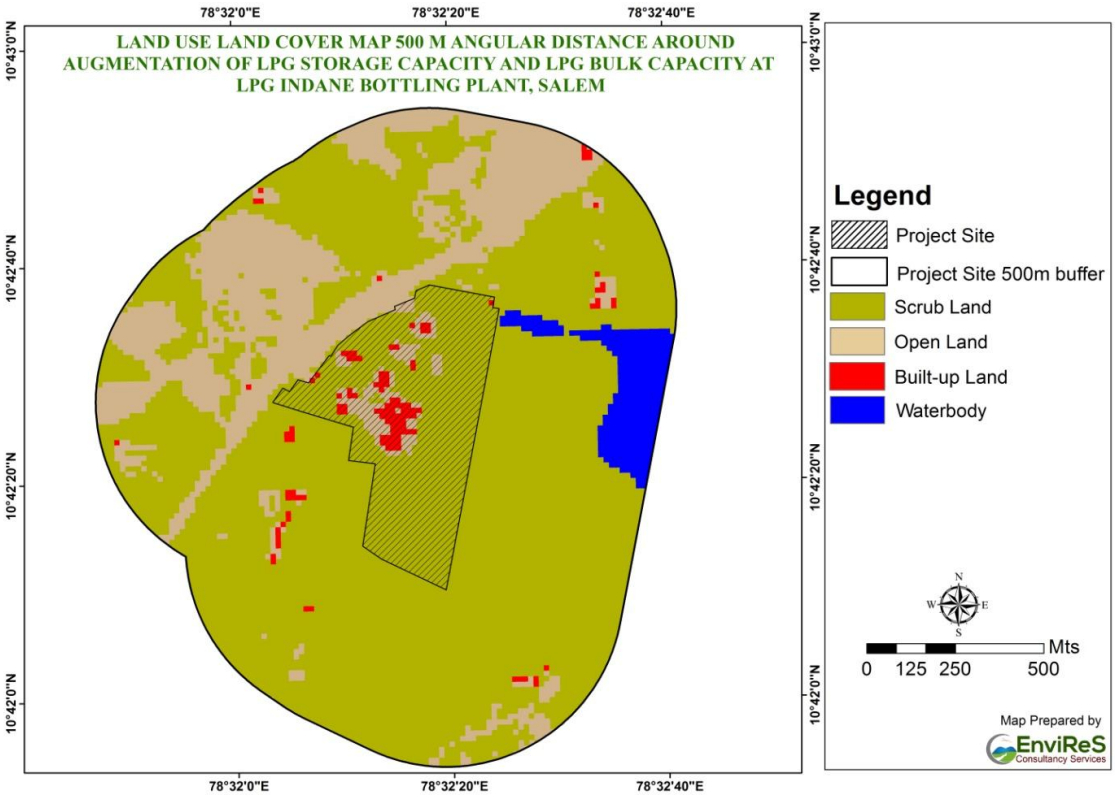


Figure 3.2: Landuse/Landcover of 500 m Buffer Area

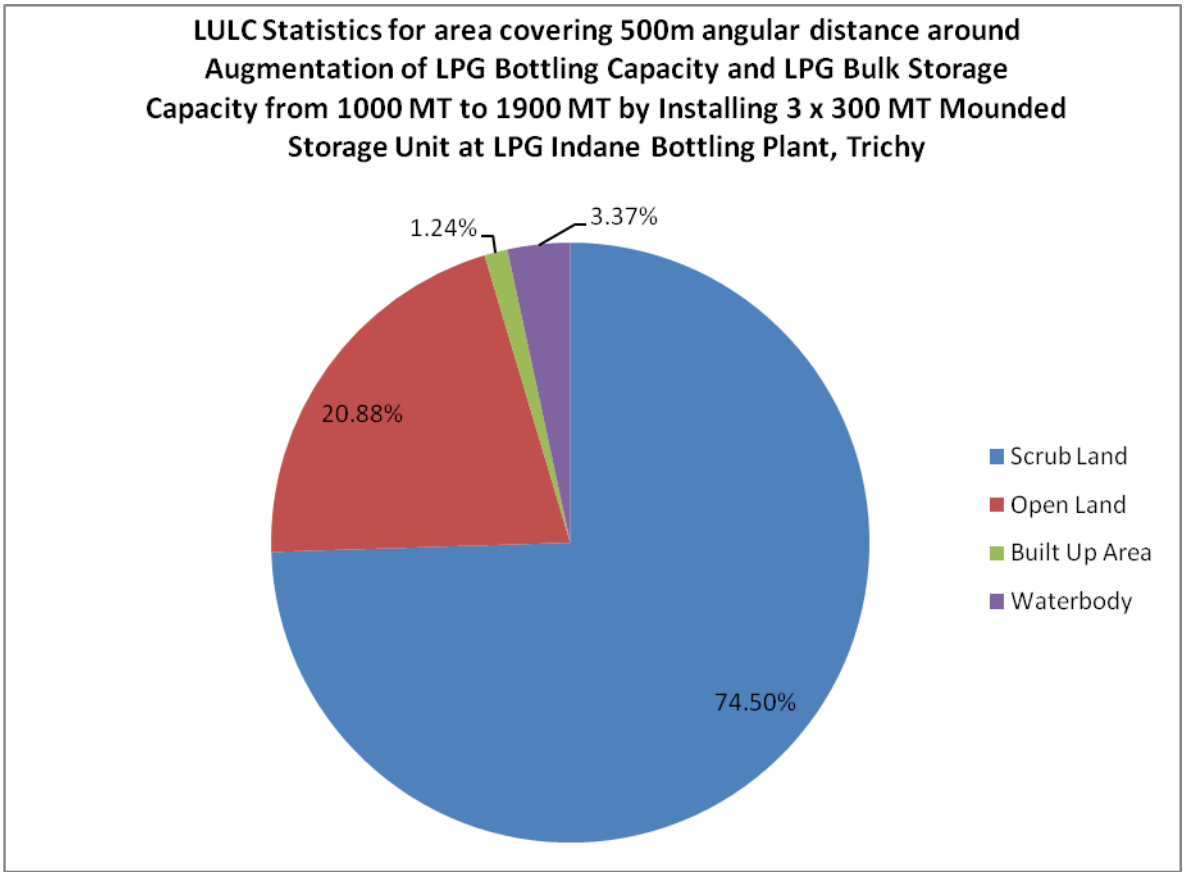


Table 3.2: Landuse / Landcover Statistics of Area within 500m Buffer Area

LULC Class	Area(Sq. km)	%
Scrub Land	1.72	74.50
Open Land	0.48	20.88
Built Up Area	0.03	1.24
Water body	0.08	3.37
Total Area	**2.31**	**100.00**

Open land (20.88%) and Scrub land (74.50%) dominate the landuse pattern covering 500 m angular distance around project site. Built-up Area (1.24%) and Water body (3.37%) indicate availability of irrigation in the surround area. Water body is not dominating the land use pattern in the study area covering 500 m angular distance around the project site. It covers only 3.37% of the total study area. Built-up land constitutes 0.03 m^2 of the total area of 2.31 m^2 landuse.

3.3.2 Drainage Map of the Study Area

Drainage layer, which was generated after scanning the thematic manuscripts, was edited for line the errors. Two different layers were made separately for line drainage. Drainage order was given to all the drain lines in the layers. Strahler method of ordering was used for giving order to drainage. Whenever two drains of any order joined the order of next drain was increase by one.

The study area exhibits majority of third order of drainage of drainage pattern.One of the tributaries of Korai River Kalimangalam passes along the western boundary of project site.Drainage pattern within 10 km radius around project site shows the dendritic type of drainage pattern of fourth order and majority of streams flow towards North east side and merge into Korai River Kalimangalam.Mayanur barrage canal is also seen in the north east side of the study area covering 10km radius around project site. The 10 km area around project site exhibits a number of lakessuch as InamKulathurlake and alake near Samudram.

The area shows not much of undulating topography. The area covering 500 m angular distance around project site shows drainage lines passing towards east and some of them merge into one of the tributaries of Korai RiverKalimangalam. No natural drainage lines pass through the project site and however those passing along the project site further confluence into River.

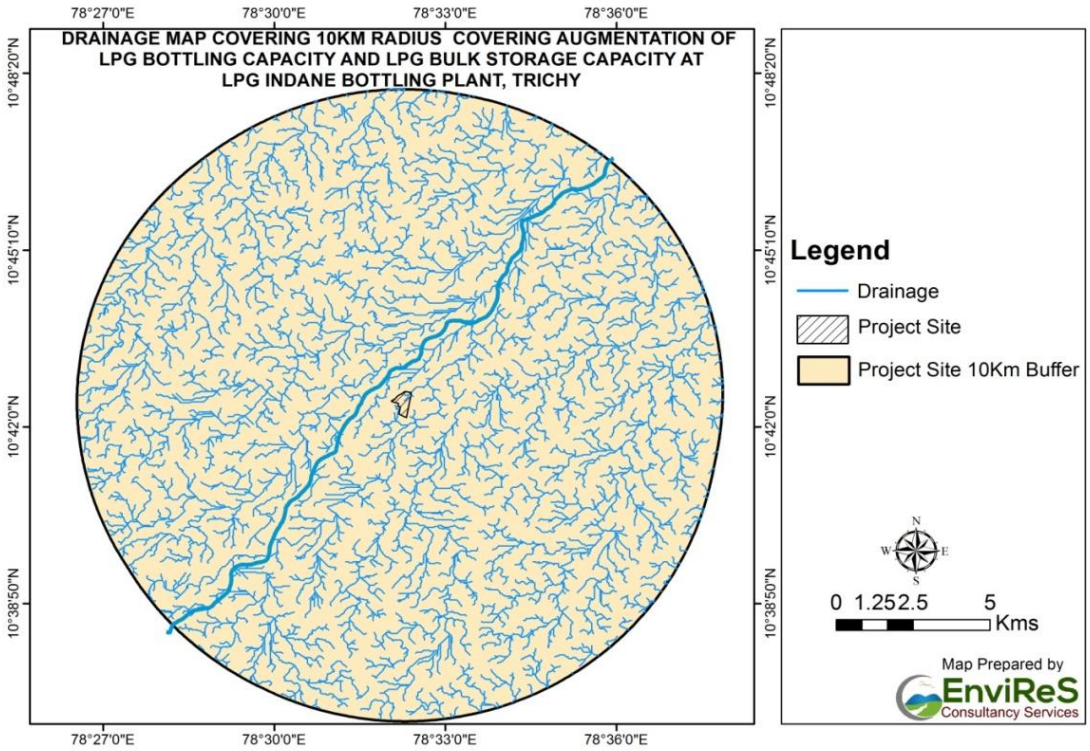


Figure 3.3: Drainage Pattern of 10 Km Study Area

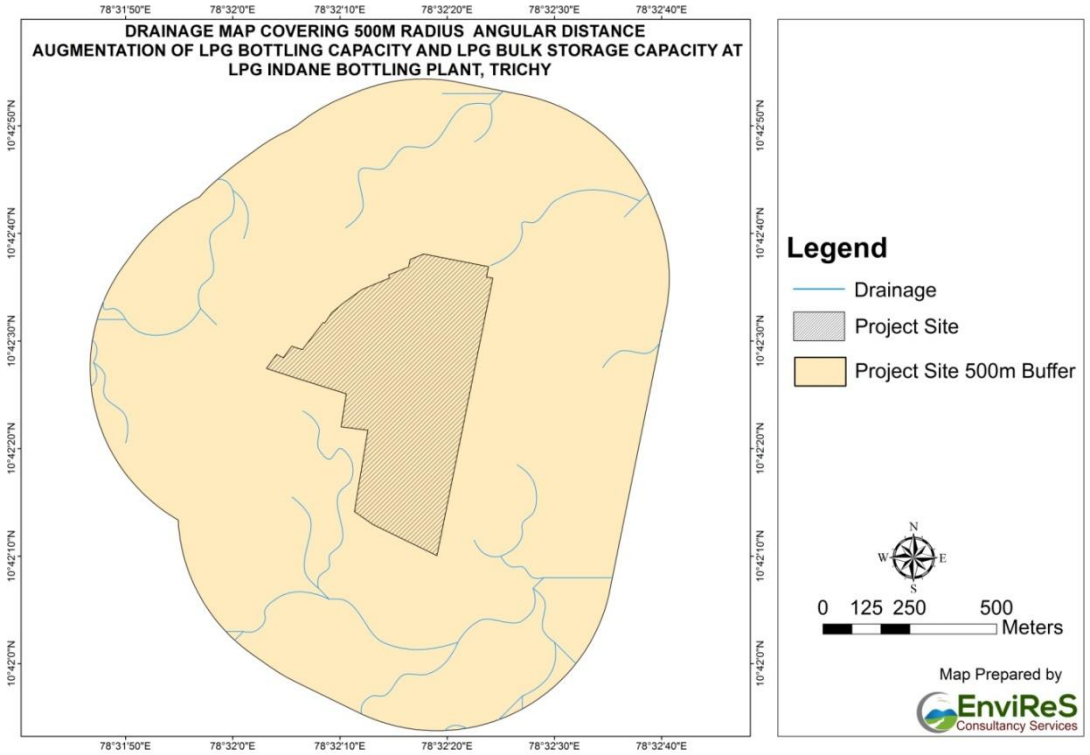


Figure 3.4: Drainage Pattern of 500 m Buffer Area

3.3.3 Contour Pattern of the Study Area

Thematic manuscript for contour layer was generated from Digital Elevation Model (DEM). After scanning, coverage was generated. Coverage was edited to remove all errors of dangle. Attribute value was given to each contour in the coverage.

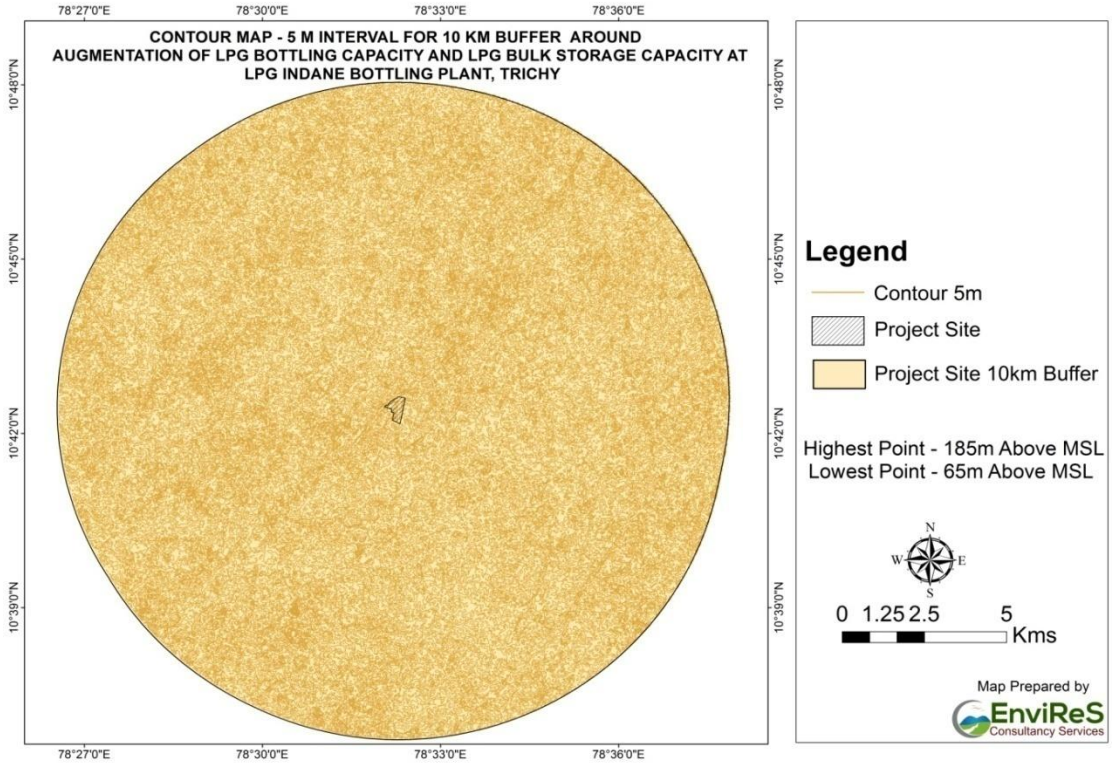


Figure 3.5: Contour Pattern of 10 Km Study Area

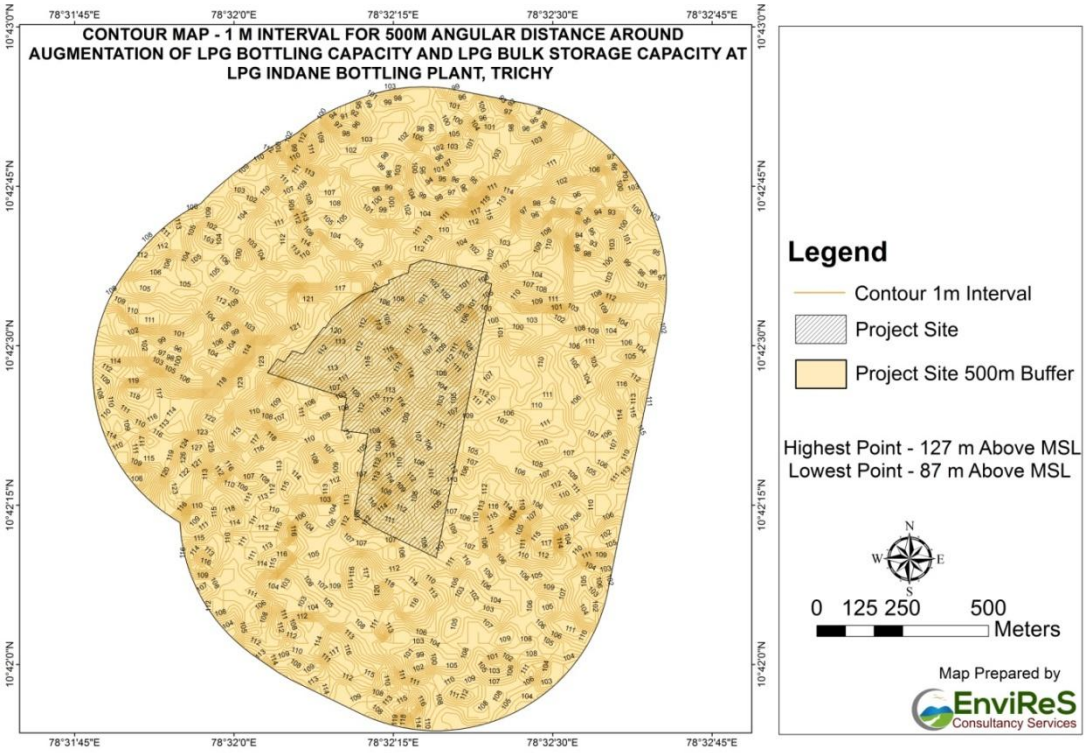


Figure 3.6: Contour Pattern of 500 m Buffer Area

Contour map of 10 km radius around project site does not show any predominant mountain range. The overall topography within the 10 km radius around project site is not very undulating and has overall slope towards north east. Highest point of the area covering 10 km radius around project site is 185 m whereas the lowest point is less than65m above mean sea level.

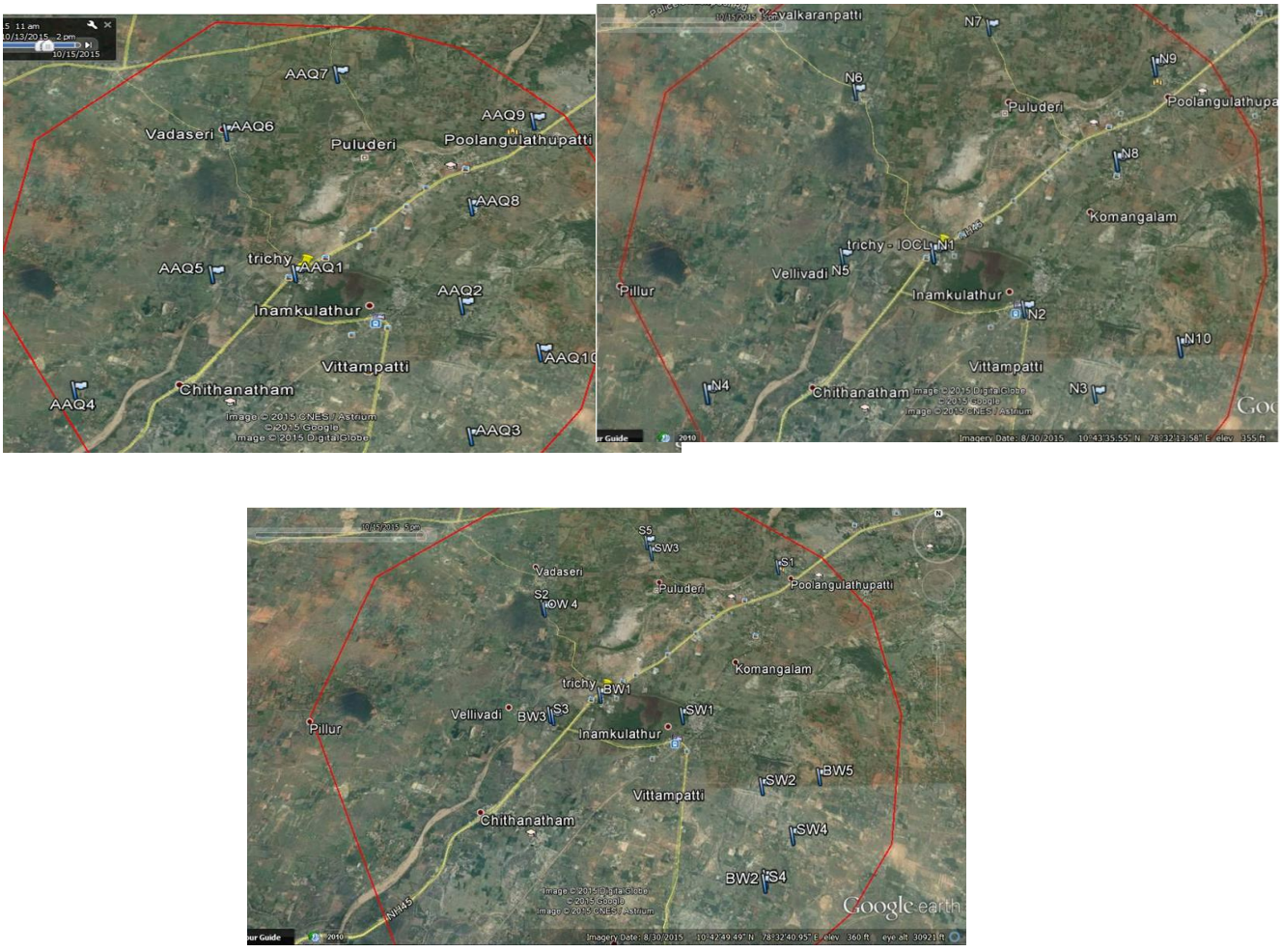
500 m angular distance around project site shows comparatively flat terrain. Overall expanse of the contours is gradual and do not show steep slopes.The project site shows slope towards north whereas highest point is seen towards southwest side of project site. Highest point of the area covering 500 m angular distance around project site is 127 m located at the south west side whereas the lowest point is located towards north east of the project site at 87 m.

3.4 Meteorological Data

During study, a continuous automatic weather monitoring station was established at site to record wind speed, wind direction, relative humidity and temperature. Atmospheric pressure was recorded twice a day at **08.30 and 17.30 hrs**. Cumulative rainfall was monitored by rain gauge on daily basis. This station was in operation in study period.

The methodology adopted for monitoring meteorological observations is as per the standard norms laid down by Bureau of Indian Standards and the India Meteorological Department (IMD). Hourly maximum, minimum and average values of wind speed, direction and temperature are recorded continuously at site.

.The 10 km study area inclusive of all the monitoring locations has been as shown in **Figure 3.7**.



Air, Water and Soil Sampling locations

Figure 3.7: Baseline Sampling Monitoring Locations

A fully instrumented continuous recording meteorological observatory is established and operated at project site during study period The parameters are being monitored at site is given in **Table 3.3**.

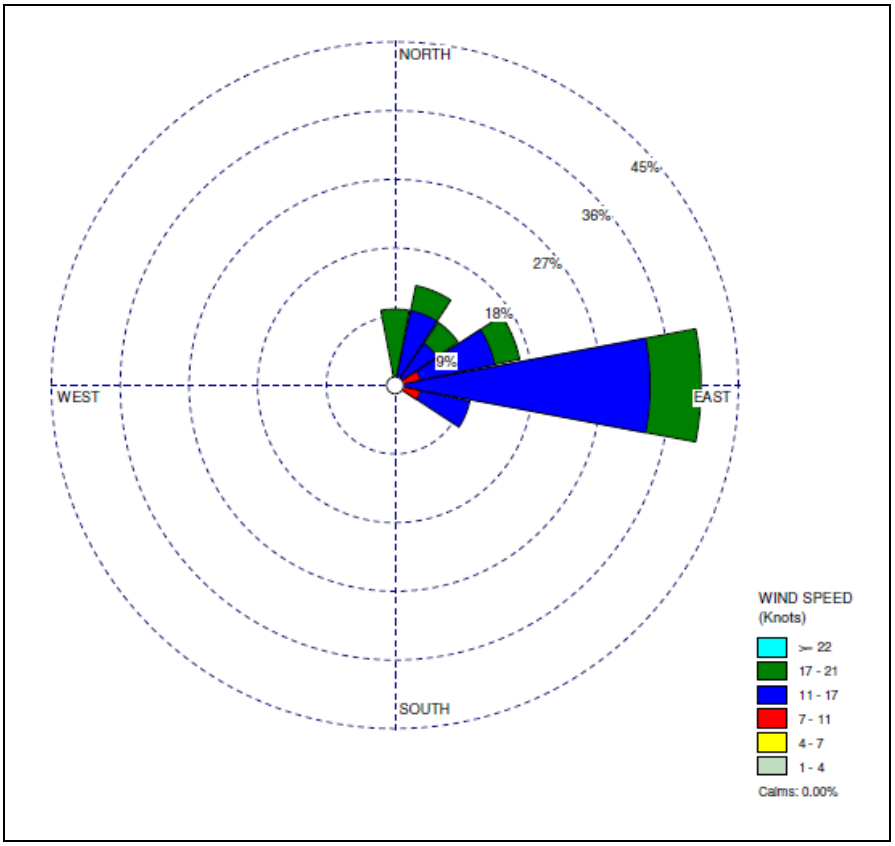
Table 3.3: Meteorological Monitoring At Site

S.N.	Parameter	Instrument	Frequency
1	Wind Speed	Automatic Weather station (Envirotech WM 251)	Continuous Automatic 1 hourly Average
2	Wind Direction		
3	Ambient Temperature		
4	Max. & Min Temperature	Wet & Dry Bulb Thermometer	Daily at 08:30 and 17:30 IST
5	Relative Humidity	Hygrometer	Daily at 08:30 and 17:30 IST
6	Rainfall	Rain Gauge	Daily

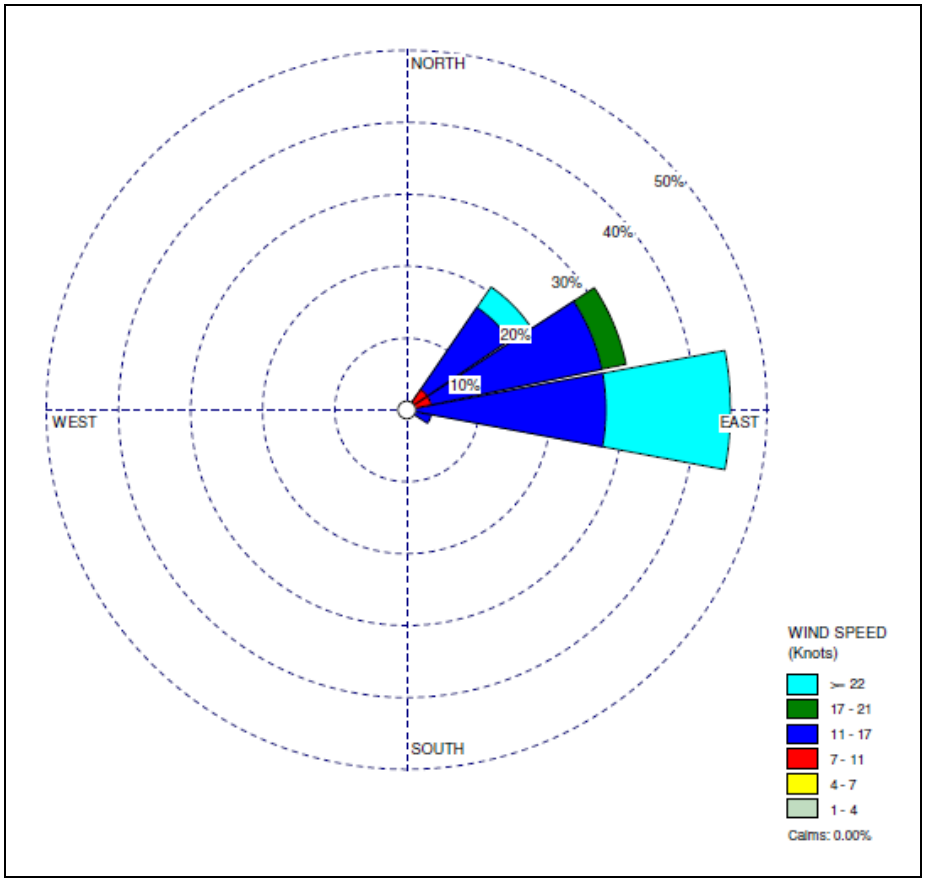
The aforesaid meteorological parameters were being observed in the field during monitoring period. The analysis of the field observations is given in **Table 3.4**. The wind rose during the study period is presented in **Figure 3.8.**

Table 3.4: Meteorological Data Recorded at Site

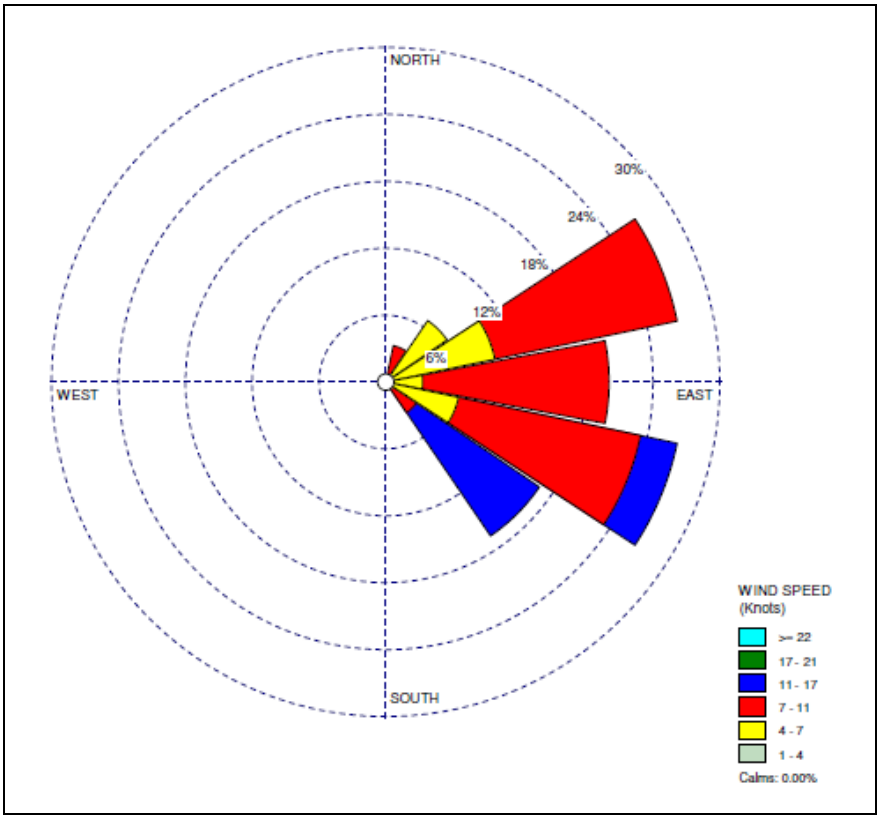
Month	Temperature, °C		Relative Humidity, %		Wind Speed, m/s	Predominant wind direction
	Min	Max	Min	Max	Mean	
January to March 2016	25.3	31.7	37.2	96	2.6	W



January 2016



February 2016



March 2016

Figure 3.8: Windrose for period of January 2016 to March 2016

3.5 Ambient Air Quality

The ambient air quality monitoring was carried out at ten locations within the 10 km radius around the site of project to know the existing background ambient air quality. The purpose of the estimation of background pollutant concentration was to assess the impact of the project on the ambient air quality within the region based on the activities of the project. The parameters chosen for assessment of air quality were PM_{10}, $PM_{2.5}$, Sulphur Dioxide (SO_2), Oxides of Nitrogen (NOx), Hydrocarbon (Methane and Non-methane HC) and VOCs.

3.5.1 Methodology Adopted for the Study

$PM_{10,}$ $PM_{2.5,}$ Sulphur dioxide (SO_2), Oxides of Nitrogen (NOx), Hydrocarbon (Methane and Non-methane HC) and VOCs were the major pollutants associated with project. The baseline status of the ambient air quality has been established through field monitoring data on PM_{10}, $PM_{2.5,}$ Sulphur dioxide (SO_2), oxides of nitrogen (NOx), Hydrocarbon (HC) Methane and Non-methane HC) and VOCs at 10 locations within the study area. The locations for air quality monitoring were scientifically selected based on the following considerations using climatological data.

- Meteorological conditions on synoptic scale;
- Topography of the study area;
- Representativeness of the region for establishing baseline status; and
- Representativeness with respect to likely impact areas.

Ambient air quality monitoring was carried out on 24 hour basis with a frequency of twice a week at a station during the study period for 10 locations.

The location of the monitoring stations with reference to the project site is given in **Table 3.5**.

Table 3.5: Ambient Air Monitoring Locations

SN	Location	Location Code
1	Main gate – IOCL Trichy	A1
2	Inamkulathur Village	A2
3	Vittampatti Village	A3
4	Chithanatham village	A4
5	Vellivadi Village	A5
6	Vadaseri Village	A6
7	Puluderi Village	A7
8	Komangalam village	A8
9	Poolangulathupatti Village	A9
10	Perumampatti Village	A10

3.5.2 Sampling and Analytical Techniques

Respirable Dust Samplers APM-451 of Envirotech instruments were used for monitoring Respirable fraction (<10 microns) and gaseous pollutants like SO_2, NOx, Methane and Non-methane (HC) and VOCs. **Table 3.6** shows the techniques for sampling and analysis for these parameters.

Table 3.6: Techniques Used For Ambient Air Quality Monitoring

Parameters	**Technique**	**Technical Protocol**	**Detectable Limit, ug/m^3**
PM_{10}	Respirable Dust Sampler (Gravimetric method)	CPCB Guidelines	10.0
Sulphur Dioxide	West and Gaeke	IS-5182 (Part-II)	5.0
Nitrogen Oxide	Jacob & Hochheiser	IS-5182 (Part-VI)	5.0
Hydrocarbon (Methane and Non-Methane)	Gas Chromatograph (FID Detector)	Is-5182 (Part-XXI)	0.1 ppb
VOCs	Activated Charcoal method (GC FID Detector)	EPA TO-17	1 mg/m^3

Ambient air at the monitoring location is sucked through a cyclone. Coarse and non-respirable dust is separated from the air stream by centrifugal forces acting on the solid particles and these particles fall through the cyclone's conical hopper and get collected in the sampling cap placed at the bottom. The fine dust (<10 microns) forming the PM_{10} passes the cyclone and is retained on the filter paper. A tapping is provided on the suction side of the blower to provide suction for sampling air through a set of impingers for containing

absorbing solutions for SO_2 and NOx. Samples of gases are drawn at a flow rate of 0.2 liters per minute.

PM_{10} has been estimated by gravimetric method. Modified West and Gaeke method (IS-5182 part-II, 1969) has been adopted for estimation of SO_2 and Jacobs-Hochheiser method (IS-5182 part-VI, 1975) has been adopted for the estimation of NOx. Calibration charts have been prepared for all gaseous pollutants.

The ambient air quality results are as summarised in **Table 3.7.**

Table 3.7: Ambient Air Quality Monitoring Results

PM_{10} (µg/m^3)										
	A1	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**	**A8**	**A9**	**A10**
Min	51.9	45.6	40.6	40.3	34.5	35.1	39.6	30.5	33.4	33.8
Max	66.8	54.3	48.5	45.7	46.1	41.6	46.1	43.8	45.9	40.6
Mean	59.35	49.95	44.55	43	40.3	38.35	42.85	37.15	39.65	37.2
Standard	100	100	100	100	100	100	100	100	100	100
$PM_{2.5}$ (µg/m^3)										
Min	20.2	19.8	15.2	15.3	15.2	15.4	15.2	15.4	15.7	15.6
Max	31.9	28.6	23.6	21.6	26.5	21.3	21.6	23.8	23.5	24.7
Mean	26.05	24.2	19.4	18.45	20.85	18.35	18.4	19.6	19.6	20.15
Standard	60	60	60	60	60	60	60	60	60	60
SO_2 (µg/m^3)										
Min	5.3	5.1	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Max	16.2	8.4	6.3	5.1	6.4	5.2	4.8	7.6	10.9	6.1
Mean	34.9	6.75	5.4	4.8	5.45	4.85	4.65	6.05	7.7	5.3
Standard	80	80	80	80	80	80	80	80	80	80
NO_x (µg/m^3)										
Min	15.3	13.7	18.3	14.1	15.3	15.3	16.5	11.1	10.2	13.2
Max	25.1	19.2	27.3	26.1	28.6	24.2	22.7	20.9	18.2	18.5
Mean	20.2	16.45	22.8	20.1	21.95	19.75	19.6	16	14.2	15.85
Standard	80	80	80	80	80	80	80	80	80	80

3.6 Noise

Noise in general is sound, which is composed of many frequency components of various loudness distributed over the audible frequency range. The most common and universally accepted scale is the A weighted scale which is measured as dB (A). This is more suitable for audible range of 20 to 20,000 Hz and has been designed to weigh various components of noise according to the response of a human ear.The environmental assessment of noise from the industrial activity, construction activity and vehicular traffic can be undertaken by taking into consideration various factors like potential damage to hearing, physiological responses, and annoyance and general community responses.

3.6.1 Objective

The main objective of monitoring of ambient noise levels was to establish the baseline noise

levels in different zones. i.e. Residential, Industrial, Commercial and Silence zones, in the surrounding areas and to assess the total noise level in the environment of the study area.

3.6.2 Methodology

- **Identification of Sampling Locations**

A preliminary reconnaissance survey was undertaken to identify the major noise sources in the area. The sampling location in the area was identified considering location of industry, commercial shopping complex activities, residential areas with various traffic activity and sensitive areas like hospital, court, temple and schools also near the railway track for railway noise.

The noise monitoring was conducted at eight locations in the study area during monitoring period. 10 sampling locations were selected for the sampling of noise.

- **Equivalent sound pressure level (Leq)**

The sound from noise source often fluctuates widely during a given period of time. Leq is the equivalent continuous sound level, which is equivalent to the same sound energy as the actual fluctuating sound measured in the same time period.

- **Instrument used for Monitoring**

Noise levels were measured using an Integrating sound level meter manufactured by Cygnet (Model No. 2031). It had an indicating mode of Lp and Leq. Keeping the mode in Lp for few minutes and setting the corresponding range and the weighting network in "A" weighing set the sound level meter was run for one hour time and Leq was measured at all locations.

There are different types of fields for measuring the ambient noise level, e categorized as free field, near field and far field.

- **Free Field**

The free field is defined as a region where sound wave propagates without obstruction from source to the receiver. In such case, the inverse square law can be applied so that the sound pressure level decreases by 6 dB (A) as the distance is doubled.

- **Near Field**

The near field is defined as that region close to the source where the inverse square law does not apply. Usually this region is located within a few wavelengths from the source.

- **Far Field**

The far field is defined as that region which is at a distance of more than 1-meter from the source.

Table 3.8: Noise Level Monitoring Stations in the Study Area

Sl. No	Location	Location Code
1	Main gate – IOCL Trichy	N1
2	Near Govt. Higher.Secon. School - Inamkulathur Village	N2
3	Near Govt. School - Thoopupatti Village	N3

4	Near Govt. Primary school - Chithanatham village	N4
5	Near Govt. Primary School - Vellivadi Village	N5
6	Near Govt. High. Secon. school - Vadaseri Village	N6
7	Near Govt. Middle School – Puluderi Village	N7
8	Near Govt. Primary School – Komangalam Village	N8
9	Near Govt. Primary School– Poolangulathupatti Village	N9
10	Near Govt. Primary School - Perumampatti Village	N10

3.6.3 Method of Monitoring and Parameters Measured

Noise monitoring was carried out continuously for 24-hours with one hour interval. During each hour parameters like L_{10}, L_{50}, L_{90} and Leq were directly computed by the instrument based on the sound pressure levels. Monitoring was carried out at 'A' weighting and in fast response mode.

The important parameters to be measured are L_{eq}, L_{day}, and $L_{night.}$

L_{eq}: Latest noise monitoring equipments have the facility for measurement of L_{eq} directly. However, L_{eq} can also be calculated using the following equation:

$L_{eq\ (hrly)} = L_{50} + (L_{10} - L_{90})^2 / 60$

Where,

L_{10} (Ten Percentile Exceeding Level) is the level of sound exceeding 10% of the total time of measurement.

L_{50} (Fifty Percentile Exceeding Level) is the level of sound exceeding 50% of the total time of measurement.

L_{90} (Ninety Percentile Exceeding Level) is the level of sound exceeding 90% of the total time of measurement.

L_{day}: This represents L_{eq} of daytime. L_{day} is calculated as Logarithmic average using the hourly L_{eq}'s for day time hours from 6.00a.m to 10.00p.m

L_{night}: This represents L_{eq} of night time. L_{night} is calculated as Logarithmic average using the hourly L_{eq}'s for night time hours from 10.00p.m to 6.00a.m.

3.6.4 Noise Results

The values of noise level parameters like Leq (day), and Leq (night), were monitored during study period and are presented in **Table 3.9.**

Table 3.9: Ambient Noise Monitoring Results

SN	Villages	Code	Leq (day)	Leq (night)	Remarks
1	Main gate – IOCL Trichy	N1	63.2	54.4	Within Limits
2	Near Govt. Higher. Secondary. School -	N2	51.8	41.2	Within Limits

	Inamkulathur Village				
3	Near Govt. School - Thoopupatti Village	N3	50.5	40.6	Within Limits
4	Near Govt. Primary school - Chithanatham village	N4	51.1	40.2	Within Limits
5	Near Govt. Primary School - Vellivadi Village	N5	48.7	39.7	Within Limits
6	Near Govt. High. Secondary school - Vadaseri Village	N6	54.2	40.5	Within Limits
7	Near Govt. Middle School – Puluderi Village	N7	50.0	38.6	Within Limits
8	Near Govt. Primary School – Komangalam Village	N8	52.3	39.7	Within Limits
9	Near Govt. Primary School– Poolangulathupatti Village	N9	51.8	39.5	Within Limits
10	Near Govt. Primary School - Perumampatti Village	N10	53.3	40.0	Within Limits

- **Noise Standards**

Ambient air quality standard in respect of noise have been stipulated by Govt. of India vide Gazette notification dated. 14.2.2000. **Table 3.10** describes ambient noise standards.

In Respect of Noise*

Table 3.10: Ambient Noise Standards

Area Code	Category of Area	Limits in dB(A), L_{eq}	
		** Day time	#Night time
A	Industrial Area	75	70
B	Commercial Area	65	55
C	Residential Area	55	45
D	Silence Zone @	50	40

* As per Environment protection act.

** Day Time: 6.00a.m to 10.00p.m.

Night Time: 10.00p.m to 6.00a.m.

@ Silence zone is defined as an area upto 100 meters around such premises as hospitals, educational institutions and courts. The silence zones are to be declared by the competent authority; Use of horns, loudspeakers and bursting of crackers shall be banned in these zones.

The noise data compiled on noise levels is given in **Table 3.9.** Noise level of the study area varied from 48.7 to 63.2 dB (A) in day time and from 38.6 to 54.4 dB (A) in the night time

3.7 Water Environment

3.7.1 Ground Water Hydrology

Hydro-geologically the weathered and fractured zones of crystalline constitute the

predominant hydro-geological units. Groundwater occurs under phreatic condition in the weathered horizons. Highly weathered and jointed granitic gneisses occurring the undulating plains form the potential aquifers in the hard rock terrain. Micaschists and shale having very thick weathered residuum also sometimes form good shallow aquifers to be tapped through dug wells.

In the study area, ground water occurs under semi-confined and confined aquifer conditions. The quality of ground water at project site is saline.

The depth of water table in the study area range varies from 2.2 to 9.49 m below ground level during pre-monsoon period and less than 2.6 to 11.15 m during post-monsoon period. (Source: Central Ground Water Board).

3.7.2 Selection of Sampling Locations

The assessment of present status of water quality within the study area was conducted by collecting water from ground water sources and surface water sources during Monitoring Period. The sampling locations were identified on the basis of their importance. Five (5) surface water samples and four (4) ground water samples were collected during monitoring period.

Table 3.11: Water Quality Sampling Locations

Station Code	Location
GW1	Open well water – IOCL Trichy
GW2	Open well water – Vittampatti Village
GW3	Hand pump water - Vellivadi Village
GW4	Open well water-Puluderi village
GW5	Hand pump water - Perumampatti Village
SW1	Lake Water– Inamkulathur
SW2	Pond water – Vittampatti Village
SW3	Lake water-Puluderi village
SW4	Pond water - Perumampatti Village

3.7.3 Methodology

Water samples were collected from above sampling locations and analyzed for relevant physical, chemical and bacteriological parameters. Collection and analysis of the samples was carried out as per established standard methods and procedures, prescribed by CPCB, relevant IS Codes and Standard Methods of Examination of Water (IS 3025 and APHA 22nd ed).

Analyses of the parameters like temperature; pH, dissolved oxygen and alkalinity were carried out at the sampling stations immediately after collection of samples with the help of Field Analysis Kits. For analysis of other parameters, the samples were preserved and brought to laboratory. The metallic constituents like arsenic, mercury, lead, cadmium, chromium, copper, zinc, selenium, iron and manganese were analyzed with Atomic Absorption Spectroscope.

3.7.4 Ground and Surface Water Quality

The analysis data for the monitoring period is presented in **Table 3.12**. The physico-chemical characteristics of Ground water are confirming to permissible limits of drinking water standards, prescribed in IS: 10500 (Test Characteristics for Drinking Water) and suitable for consumption.

Table 3.12: Ground Water Quality Results

Sno.	Parametr (Characterstics)					
		GW 1	**GW 3**	**GW 4**	**GW 5**	**GW 2**
1	Turbidity in NTU	BDL(DL:1.0)	1.8	3.8	4.6	BDL(DL:1.0)
2	Temperature °C	25.8	25.8	25.9	25.7	25.8
3	pH @ 25°C	7.09	7.78	7.9	6.96	7.09
4	Salinity g/l	1.37	1.08	0.83	0.016	1.37
5	Total Dissolved Solids in mg/l	1730	1394	1084	287	1730
6	Alkalinity in mg/l	128	756	332	28	128
7	Total Hardness as $CaCO_3$ in mg/l	828	188	552	96	828
8	Calcium as Ca in mg/l	231	29	147	14.4	231
9	Magnesium as Mg in mg/l	61	28	45	14.6	61
10	Sodium as Na in mg/l	368	192	162	32	368
11	Potassium as K in mg/l	84	34	52	6	84
12	Chloride as Cl in mg/l	498	286	298	54	498
13	Sulphate as SO_4 in mg/l	224	177	187	110	224

14	Nitrate as NO_3 in mg/l	BDL(DL:0.5)	BDL(DL:0.5)	BDL(DL:0.5)	BDL(DL:0.5)	BDL(DL:0.5)
15	Total Nitrogen as N in mg/l	BDL(DL:0.5)	BDL(DL:0.5)	BDL(DL:0.5)	BDL(DL:0.5)	BDL(DL:0.5)
16	Total Phosphorous as P in mg/l	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)
17	Phenol as C_6H_5OH in mg/l	BDL(DL:1.0)	BDL(DL:1.0)	BDL(DL:1.0)	BDL(DL:1.0)	BDL(DL:1.0)
18	Dissolved Oxygen in mg/l	5.7	6	6.1	5.5	5.7
19	Chemical Oxygen Demand in mg/l	BDL(Dl:4.0)	BDL(Dl:4.0)	BDL(Dl:4.0)	BDL(Dl:4.0)	BDL(Dl:4.0)
20	Bio Chemical Oxygen Demand in mg/l	BDL(DL:2.0)	BDL(DL:2.0)	BDL(DL:2.0)	BDL(DL:2.0)	BDL(DL:2.0)
21	Fluoride as F in mg/l	1.4	1.4	1.4	1.4	1.4
22	Iron as Fe in mg/l	0.25	0.25	0.25	0.25	0.25
23	Chromium as Cr^{6+} in mg/l	BDL(DL:0.03)	BDL(DL:0.03)	BDL(DL:0.03)	BDL(DL:0.03)	BDL(DL:0.03)
24	Copper as Cu in mg/l	BDL(DL:0.03)	BDL(DL:0.03)	BDL(DL:0.03)	BDL(DL:0.03)	BDL(DL:0.03)
25	Manganese as Mn in mg/l	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)
26	Nickel as Ni in mg/l	BDL(DL:0.03)	BDL(DL:0.03)	BDL(DL:0.03)	BDL(DL:0.03)	BDL(DL:0.03)
27	Aluminium as Al in mg/l	BDL(DL:0.02)	BDL(DL:0.02)	BDL(DL:0.02)	BDL(DL:0.02)	BDL(DL:0.02)
28	Zinc as Zn	2.4	2.4	2.4	2.4	2.4
29	Mercury as Hg in mg/l	BDL(DL:0.0005)	BDL(DL:0.0005)	BDL(DL:0.0005)	BDL(DL:0.0005)	BDL(DL:0.0005)
30	Arsenic as As in mg/l	BDL (DL:0.005)	BDL (DL:0.005)	BDL (DL:0.005)	BDL (DL:0.005)	BDL (DL:0.005)

31	Lead as Pb in mg/l	BDL (DL:0.005)	BDL (DL:0.005)	BDL (DL:0.005)	BDL (DL:0.005)	BDL (DL:0.005)
32	Cadmium in mg/l	BDL (DL:0.005)	BDL (DL:0.005)	BDL (DL:0.005)	BDL (DL:0.005)	BDL (DL:0.005)

Surface Water Quality Results

Sno.	Parameter (Characterstics)	Test Results at following locations			
		SW 1	**SW 2**	**SW 3**	**SW 4**
1	pH @ 25^{o}C	6.92	7.81	7.05	7.55
2	Specific Conductance 25^{o}C	248	972	256	1010
3	Total Dissolved Solids in mg/l	154	609	162	640
4	Total Hardness as $CaCO_3$ in mg/l	132	224	138	256
5	Calcium as Ca in mg/l	21	45	28	40
6	Magnesium as Mg in mg/l	19.5	27	24	38
7	Sodium as Na in mg/l	12	74	16	88
8	Potassium as K in mg/l	2	12	4	14
9	Nitrate as NO_3 in mg/l	BDL(DL:0.5)	BDL(DL:0.5)	BDL(DL:0.5)	BDL(DL:0.5)
10	Dissolved Oxygen in mg/l	5.8	6.1	5.9	6.0
11	Bio Chemical Oxygen Demand in mg/l	BDL(DL:2.0)	BDL(DL:2.0)	BDL(DL:2.0)	BDL(DL:2.0)
12	Sodium Absorption Ratio in meq/l	0.45	2.14	0.54	2.39

3.8 Soil

Soil is generally differentiated into two horizons of minerals and organic constituents of variable depth, which differ from the parent material below in morphology, physical properties, constituents, chemical properties, and composition and biological characteristics.
The physico- chemical characteristics of soil have been determined at 5 locations during the monitoring period with respect to colour, texture, cation exchange capacity, pH, N, P, and K etc. The sampling locations have been selected to represent the study area.

3.8.1 Selection of sampling Locations

The soil sampling locations were identified primarily based on the local distribution of vegetation and the agricultural practices. The sampling locations were mainly selected from agricultural field and project site. The sampling locations are given in **Table 3.13** and presented in **Figure 3.7**.

Table 3.13: Soil Sampling Stations in the Study Area

Code	Locations
S1	Soil – Poolangulathupatti
S2	Soil -Vadaseri Village
S3	Soil - Vellivadi Village
S4	Soil -Vittampatti village
S5	Soil - Puluderi Village

3.8.2 Methodology

The soil samples were collected during monitoring period. The samples collected from the all locations are homogeneous representative of each location. At random 5 sub locations were identified at each location and soil was dug from 30 cm below the surface. It was uniformly mixed before homogenizing the soil samples. The samples were filled in polythene bags, labeled in the field with number and site name and sent to laboratory for analysis.

3.8.3 Soil Results

The detailed soil results of all the monitoring locations are as shown in **Table 3.14**.

Table 3.14: Chemical Characteristics of Soil in the Study Area

S.No.	Test Parameters	Method	Unit	Locations and Results				
				Vadaseri	**Velliyadi**	**Vittampatti**	**Puluderi**	**Poolansulathupatti**
1	pH @ 25°C	IS 2720 Part 26:(Reaff:2011)	--	7.86	8.41	8.19	8.05	8.32
2	Electrical Conductivity @ 25°C	IS 14767: 2000 (Reaff.2010)	µmhos/cm	384	680	586	935	1028
3	Particle Size Distribution							
	a) 10 mm	IS 2720 - Part 4	%	0.16	NIL	0.16	0.3	0.23
	b) 4.75 mm	IS 2720 - Part 4	%	1.34	1.14	1.32	1	1.26
	c) 2 mm	IS 2720 - Part 4	%	10.4	8.6	10.6	4.7	11.4
	d) 425 micron	IS 2720 - Part 4	%	71.7	68.5	75.4	68.9	71.3
	e) 75 micron	IS 2720 - Part 4	%	18.4	22.7	12.4	23.9	16.8
4	Texture							
	a. Percent Clay	FAO United Nations Rome,2007	%	24	24	18	18	34
	b. Percent Silt	FAO United Nations Rome,2007	%	72	69	77	74	60
	c. Percent Sand	FAO United Nations Rome,2007	%	4	7	5	8	8
5	Calcium as Ca	ESIPL/SOP/C-S/13	meq/L	2.6	1.58	5.2	3	3.28
6	Magnesium as Mg	ESIPL/SOP/C-S/13	meq/L	2.22	1.35	4.3	2.2	2.8
7	Sodium as Na (Soluble) in	FAO United Nations Rome,2007	meq/100g	4.6	2.8	9	3.57	5.8
8	Potassium as K (Soluble) in meq/100g	FAO United Nations Rome,2007	meq/100g	2.33	1.39	4.5	BDL(DL:0.05)	2.93
9	Cation Exchange Capacity in meq/l	FAO United Nations Rome,2007	meq/100g	3.91	2.38	7.6	4.2	4.93

10	Sodium Absorption Ratio	IS 11624 - 1986	meq/L	2.96	2.31	4.1	2.2	3.3

3.9 Ecological and Bilogical Environment

Objectives

1. To carry out a systematic baseline survey of Flora and Fauna around 10 km radius of the study area.
2. To list the plants and animals present in the study area as per the classifications of MOEF,
3. To identify the impacts of the proposed expansion activities on the plants and animals,
4. To evaluate the impacts of the proposed action, and to propose Environmental Management Plan.

Biological Environment Assessment - Flora & Fauna

A habitat or an area comprises of different kinds of plants and animals within its boundary. The distribution of flora and fauna in the given area represents the Biological portion of the environment that includes, what is present in the study area, its value, and its response to impacts, description of community uniqueness, the dominant species, and an evaluation of rare or endangered species.

The ecological status of the study area has been assessed based on the following methodology:

- Primary field surveys to establish primary baseline of the study area
- Compilation of information available in published literatures and as obtained from Forest survey of India, Botanical Survey of India and Zoological Survey of India.

Flora

The Study of flora involved intensive sample survey of vegetation in the project site and other locations applying standard methods. The species of vegetation found in each station were identified and listed according to their families, both in dicotyledons and monocotyledons of the plant kingdom. The plant species were classified as per the classifications of "Bentham and Hooker" and identified by using Gambles book on "Flora of Madras Presidency" and Mathew's book on "Flora of the Tamil Nadu Carnatic".

Fauna

Both direct and indirect observation methods were used to survey the fauna. Visual encounter (search) method was employed to record vertebrate species. Additionally survey of relevant literature was also done to consolidate the list of vertebrate fauna distributed in the area. Since birds may be considered as indicators for monitoring and understanding human impacts on ecological systems attempt was made to gather quantitative data on the group.

Based on the Wildlife Protection Act, 1972 (WPA 1972 species were short-listed under schedules.

Description about the Study sites

Core Zone: The study was carried out in the core zone (upto 3km surroundings) including the proposed site. The plain land with small streams flow from north to south. There is Notable River Korai River Kalimangalam of the study area (**Fig 1.1)**. A branch stream, originating from this river, flows towards south and confluences with Ponnaiyaru dam. There is the Inam Kulathur lake in the study area. Entire area is characterized by Scrubby elements and the type of forest is Tropical Scrub forest. It is chiefly characterized by Acacias and Prosopis community representing the Umbrella thorn forest.

Buffer Zone: The terrain of the area (3-10km periphery) is undulating with mixed scrub vegetation. The entire area is characterized by Scrubby elements and the type of forest is Tropical Scrub forest. It is chiefly characterized by Acacias and Prosopis community representing the Umbrella thorn forest.

Assessment of Flora in the study area

It was observed that the flora, which includes herbs, shrubs and trees, were sparsely distributed in Core Zone (**Table 3.15**). Around the core zone the natural vegetation showed moderate growth. The core zone has herbaceous and shrubby vegetation which are scarcely distributed.

Among natural vegetation the common herbs such as Croton, and common grasses like *Aristida hysterix, Cynodon dactylon*, etc.were available in the study areas. Less population of herbs were found in the core zone as compared to the buffer zone.

Table 3.15 Distribution of flora of different families within project site & up to 10 km of the buffer zone

Family	Scientific Name	Type
Acanthaceae	***Thunbergia fragrans*** Roxb. var. ***vestita*** Nees	Tree
Agavaceae	***Agave sisalana*** Perrine ex Engelm	Tree
Apocynaceae	***Parsonsia alboflavescens*** (Dennst.) Mabberley	Tree
Araliaceae	***Schefflera racemosa*** (Wight) Harms	Tree
Arecaceae	***Phoenix loureirii*** Kunth var. ***humilis*** (Becc.) S.C. Barrow	Tree
Arecaceae	***Phoenix rupicola*** L.	Tree
Bignoniaceae	***Dolichandrone atrovirens*** (Heyne ex Roth) Sprague	Tree
Burseraceae	***Commiphora caudata*** (Wight & Arn.) Engler var. ***caudata***	Tree
Caesalpiniaceae	***Senna occidentalis*** (L.) Link	Tree
Caesalpiniaceae	***Tamarindus indica*** L.	Tree
Cannabaceae	***Cannabis sativa*** L.	Tree
Caprifoliaceae	***Lonicera ligustrina*** Wall.	Tree
Celastraceae	***Cassine glauca*** (Rottb.) Kuntze	Tree
Combretaceae	***Anogeissus acuminata*** (Roxb. ex DC.) Guill. & Perr.	Tree
Compositae	***Vernonia fysonii*** Calder	Tree
Cornaceae	***Cornus capitata*** Wall.	Tree
Ebenaceae	***Diospyros ovalifolia*** Wight	Tree
Ericaceae	***Erica arborea*** L.	Tree

Euphorbiaceae	***Acalypha racemosa*** Heyne ex Baill.	Tree
Euphorbiaceae	***Trewia nudiflora*** L.	Tree
Fabaceae	***Butea monosperma*** (Lam.) Taub.	Tree
Gentianaceae	***Swertia minor*** (Griseb.) Knobl.	Tree
Hamamelidaceae	***Exbucklandia populnea*** (R.Br. Ex Griffith) R. W. Br.	Tree
Lauraceae	***Phoebe wightii*** Meisner	Tree
Lecythidaceae	***Couroupita guianensis*** Aubl.	Tree
Loganiaceae	***Spigelia anthelmia*** L.	Tree
Lythraceae	***Lagerstroemia parviflora*** Roxb.	Tree
Magnoliaceae	***Michelia champaca*** L.	Tree
Malvaceae	***Hibiscus tiliaceus*** L.	Tree
Melastomataceae	***Memecylon subramanii*** Henry	Tree
Meliaceae	***Aglaia elaeagnoidea*** (Juss.) Benth.	Tree
Mimosaceae	***Prosopis juliflora*** (Sw.) Dc.	Tree
Moraceae	***Antiaris toxicaria*** (Pers.) Lesch.	Tree
Moraceae	***Plecospermum spinosum*** Trec.	Tree
Myrsinaceae	***Aegiceras corniculatus*** (L.) Blanco	Tree
Myrtaceae	***Syzygium zeylanicum*** (L.) DC. var. ***megamalayanum*** K. Ravik. & Lakshmanan	Tree
Nyctaginaceae	***Pisonia aculeata*** L.	Tree
Pandanaceae	***Pandanus odoratissimus*** L.f.	Tree
Passifloraceae	***Passiflora suberosa*** L.	Tree
Piperaceae	***Piper hymenophyllum*** Miq.	Tree
Rhamnaceae	***Ziziphus mauritiana*** Lam. var. ***mauritiana***	Tree
Rhizophoraceae	***Bruguiera gymnorrhiza*** (L.) Savigny	Large tree
Rosaceae	***Prunus ceylanica*** (Wight) Miq.	Tree
Rubiaceae	***Byrsophyllum tetrandrum*** (Bedd.) Hook.f. ex Bedd.	Tree
Rubiaceae	***Tricalysia apiocarpa*** (Dalz.) Gamble	Tree
Rutaceae	***Citrus sinensis*** (L.) Osbeck.	Tree
Sapotaceae	***Xantolis tomentosa*** (Roxb.) Rafin. var. ***elengioides*** (A.DC.) Vajravelu	Tree
Simaroubaceae	***Ailanthus excelsa*** Roxb.	Tree
Solanaceae	***Cestrum nocturnum*** L.	Tree
Sterculiaceae	***Pterospermum canescens*** Roxb.	Tree
Sterculiaceae	***Sterculia urens*** Roxb.	Large Tree
Tiliaceae	***Berrya cordifolia*** (Willd.) Burret.	Large Tree
Ulmaceae	***Celtis timorensis*** Spanoghe	Tree
Ulmaceae	***Holoptelea integrifolia*** (Roxb.) Planch.	Tree
Urticaceae	***Pouzolzia wightii*** Benn. var. ***wallichiana*** Hook.f.	Tree
Verbenaceae	***Duranta erecta*** L.	Tree
Anacardiaceae	***Nothopegia beddomei*** Gamble	Small tree
Apiaceae	***Trachyspermum roxburghianum*** (DC.) Craib	Small tree
Apocynaceae	***Carissa salicina*** Lam.	Small tree
Averrhoaceae	***Averrhoa bilimbi*** L.	Small Tree
Barringtoniaceae	***Barringtonia racemosa*** (L.) Spreng.	Small or medium sized tree
Bixaceae	***Bixa orellana*** L.	Small Tree
Burseraceae	***Commiphora berryi*** (Arn.) Engler	Small Tree

Caesalpiniaceae	***Bauhinia purpurea*** L.	Moderate sized tree
Caesalpiniaceae	***Schizolobium parahybum*** (Vell.) S. F. Blake	Medium Sized Tree
Capparidaceae	***Crateva adansonii*** DC. subsp. ***odora*** (Buch. - Ham.) Jacobs	Small Tree
Celastraceae	***Euonymus dichotomous*** Heyne ex Roxb.	Small tree
Celastraceae	***Glyptopetalum lawsonii*** Gamble	Small tree
Convolvulaceae	***Rivea ornata*** (Roxb.) Choisy	Small tree
Elaeocarpaceae	***Elaeocarpus serratus*** L.	Small Tree
Erythroxylaceae	***Erythroxylum monogynum*** Roxb.	Small Tree
Euphorbiaceae	***Phyllanthus pinnatus*** (Wight) Webster	Small tree
Flacourtiaceae	***Casearia tomentosa*** Roxb.	Small Tree
Malvaceae	***Hibiscus canescens*** Heyne ex Wight & Arn.	Small Tree
Melastomataceae	***Memecylon tirunelvelicum*** Murugan, Manickam & Sundaresan	Small tree
Meliaceae	***Aphanamixis polystachya*** (Wall.) Parker	Moderate sized tree
Mimosaceae	***Albizia amara*** (Roxb.) Boivin	Moderate sized tree
Myrsinaceae	***Embelia basaal*** (Roem. & Schultes) A.DC.	Small tree
Myrsinaceae	***Embelia ribes*** Burm.f.	Small tree
Myrtaceae	***Eucalyptus camaldulensis*** Dehnh.	Medium Sized Tree
Myrtaceae	***Syzygium zeylanicum*** (L.) DC. var. ***lineare*** (Duthie) Alston	Small tree
Ochnaceae	***Ochna lanceolata*** Spreng.	Small tree
Ochnaceae	***Ochna gamblei*** King ex Brandis	Small Tree
Pandanaceae	***Pandanus amaryllifolius*** Roxb.	Small Tree
Rhamnaceae	***Sageretia parviflora*** (Klein) G. Don	Small Tree
Rhamnaceae	***Ziziphus xylopyrus*** (Retz.) Willd.	Small tree
Rhizophoraceae	***Bruguiera cylindrica*** (L.) Blume	Small tree
Rubiaceae	***Pavetta hispidula*** Wight & Arn.	Small tree
Rutaceae	***Aegle marmelos*** (L.) Correa	Small Thorny Tree
Solanaceae	***Solanum elaeagnifolium*** Cav.	Small Tree
Sterculiaceae	***Guazuma ulmifolia*** Lam.	Small Tree
Sterculiaceae	***Kleinhovia hospita*** L.	Small Tree
Symplocaceae	***Symplocos cochinchinensis*** (Lour.) Moore subsp. ***laurina*** (Retz.) Nooteb.	Small tree
Tiliaceae	***Grewia abutilifolia*** Juss.	Small Tree
Tiliaceae	***Muntingia calabura*** L.	Small Tree
Verbenaceae	***Clerodendrum aculeatum*** Griseb.	Small tree
Verbenaceae	***Vitex leucoxylon*** L.f.	Small tree
Zygophyllaceae	***Guaiacum officinale*** L.	Small Tree
Acanthaceae	***Stenosiphonium parviflorum*** T.And.	Shrub
Agavaceae	***Agave americana*** L.	Shrub
Amaranthaceae	***Pupalia lappacea*** (L.) Juss.	Shrub/Stragglin g Undershrub
Annonaceae	***Miliusa eriocarpa*** Dunn	Shrub

Apiaceae	***Bupleurum distichophyllum*** Wight & Arn.	Shrub
Apocynaceae	***Beaumontia grandiflora*** Wall.	Climbing Shrub
Apocynaceae	***Carissa carandas*** L.	Shrub
Arecaceae	***Calamus rheedii*** Griff	Shrub
Arecaceae	***Phoenix loureirii*** Kunth var. ***humilis*** (Becc.) S.C. Barrow	Shrub
Asclepiadaceae	***Brachystelma rangacharii*** Gamble	Shrub
Begoniaceae	***Begonia integrifolia*** Dalz.	Shrub
Bignoniaceae	***Tecoma stans*** (L.) Kunth	Shrub
Boraginaceae	***Ehretia pubescens*** Benth.	Shrub
Burseraceae	***Commiphora berryi*** (Arn.) Engler	Shrub
Cactaceae	***Cereus pterogonus*** Lem.	Shrub
Cactaceae	***Cylindropuntia ramosissima*** (Engler) Knuth	Shrub
Cactaceae	***Opuntia vulgaris*** Mill.	Shrub
Caesalpiniaceae	***Bauhinia tomentosa*** L.	Shrub
Campanulaceae	***Campanula drabifolia*** Sibth. & Smith	Shrub
Capparidaceae	***Cadaba fruticosa*** (L.) Druce	Straggling Shrub
Celastraceae	***Salacia chinensis*** L.	Shrub
Chenopodiaceae	***Salicornia brachiata*** Roxb.	Shrub
Chenopodiaceae	***Suaeda vermiculata*** Forssk. ex J.F.Gmel.	Shrub
Combretaceae	***Calycopteris floribunda*** Lam.	Shrub
Compositae	***Vernonia fysonii*** Calder	Under shrub
Convolvulaceae	***Argyreia imbricata*** (Roth) Sant. & Patel	Shrub
Convolvulaceae	***Rivea ornata*** (Roxb.) Choisy	Climbing shrub
Datiscaceae	***Tetrameles nudiflora*** R. Br.	Shrub
Dracaenaceae	***Dracaena terniflora*** Roxb.	Shrub
Elaeagnaceae	***Elaeagnus kologa*** Schlecht.	Straggling/Climbing Shrub
Ericaceae	***Erica arborea*** L.	Shrub
Euphorbiaceae	***Acalypha fruticosa*** Forssk.	Undershrub
Fabaceae	***Tephrosia spinosa*** (L.f.) Pers.	Shrub
Flacourtiaceae	***Flacourtia indica*** (Burm.f.) Merr.	Shrub
Flacourtiaceae	***Oncoba spinosa*** Forsk.	Shrub
Icacinaceae	***Pyrenacantha volubilis*** Wight	Shrub
Labiatae	***Plectranthus deccanicus*** Briq.	Undershrub
Leeaceae	***Leea indica*** (Burm. F.) Merr.	Large shrub
Linaceae	***Hugonia mystax*** L.	Rambling or Climbing Shrub
Loranthaceae	***Taxillus courtallensis*** (Gamble) Danser	Shrub
Loranthaceae	***Taxillus cuneatus*** (Heyne ex Roth) Danser	Shrub
Lythraceae	***Cuphea hyssopifolia*** Kunth	Subshrub
Malpighiaceae	***Malpighia heternantha*** Wight	Shrub
Malvaceae	***Abelmoschus ficulneus*** (L.) Wight & Arn.	Erect Undershrub
Melastomataceae	***Tibouchina urvilleana*** (DC.) Cogn.	Shrub
Menispermaceae	***Cissampelos pareira*** L. var. ***hirsuta*** (Buch.-Ham. ex DC.) Forman	Shrub
Mimosaceae	***Mimosa hamata*** Willd.	Shrub

Mimosaceae	***Mimosa pudica*** L.	Undershrub
Moraceae	***Ficus heterophylla*** L.f.	Shrub
Moraceae	***Plecospermum spinosum*** Trec.	Shrub
Myrsinaceae	***Aegiceras corniculatus*** (L.) Blanco	Shrub
Myrtaceae	***Syzygium zeylanicum*** (L.) DC. var. ***lineare*** (Duthie) Alston	Shrub
Nyctaginaceae	***Bougainvillea glabra*** Choisy	Climbing shrub
Nyctaginaceae	***Bougainvillea spectabilis*** Willd.	Climbing shrub
Ochnaceae	***Ochna jabotapita*** L.	Shrub
Ochnaceae	***Ochna lanceolata*** Spreng.	Shrub
Olacaceae	***Olax scandens*** Roxb.	Climbing shrub
Oleaceae	***Jasminum arborescens*** Roxb.	Climbing Shrub
Onagraceae	***Ludwigia peruviana*** (L.) Hara	Shrub
Opiliaceae	***Cansjera rheedii*** Gmel.	Shrub
Pandanaceae	***Pandanus thwaitesii*** Martelli	Undershrub
Passifloraceae	***Passiflora laurifolia*** L.	Shrub
Poaceae	***Teinostachyum wightii*** Bedd.	Shrub
Polygalaceae	***Polygala javana*** DC.	Undershrub
Polygonaceae	***Antigonon leptopus*** Hook. & Arn.	Climbing shrub
Portulacaceae	***Talinum triangulare*** Willd.	Erect Shrub
Ranunculaceae	***Naravelia zeylanica*** (L.) DC.	Climbing Shrub
Rhamnaceae	***Colubrina asiatica*** (L.) Brongn.	Shrub
Rhamnaceae	***Ziziphus xylopyrus*** (Retz.) Willd.	Large shrub
Rhizophoraceae	***Rhizophora x annamalayana*** Kathir.	Shrub
Rosaceae	***Rosa x damascena*** Mill.	Shrub
Rubiaceae	***Agrostemma verticillatum*** Wall.	Shrub
Rubiaceae	***Benkara malabarica*** (Lam.) Tirvengadum	Shrub
Santalaceae	***Osyris quadripartita*** Salzm. ex Decne. var. ***puberula*** (Hook.f.) Kumari	Shrub
Sapindaceae	***Allophylus cobbe*** (L.) Raeusch.	Large shrub
Sapindaceae	***Dodonaea viscosa*** (L.) Jacq.	Shrub
Scrophulariaceae	***Russelia equisetiformis*** Schlecht. & Cham.	Shrub
Scrophulariaceae	***Scoparia dulcis*** L.	Undershrub
Solanaceae	***Browallia viscosa*** Kunth.	Shrub
Sterculiaceae	***Waltheria indica*** L.	Erect Herb or Undershrub
Symplocaceae	***Symplocos pulchra*** Wight subsp. ***coriacea*** Gopalan & Henry	Shrub
Tiliaceae	***Grewia abutilifolia*** Juss.	Shrub
Vacciniaceae	***Vaccinium leschenaultii*** Wight var. ***zeylanica*** Clarke	Shrub
Verbenaceae	***Clerodendrum aculeatum*** Griseb.	Shrub
Verbenaceae	***Vitex negundo*** L. var. ***purpurascens*** Sivar. & Moldenke	Shrub
Violaceae	***Hybanthus enneaspermus*** (L.) F. v. Muell.	Shrub
Vitaceae	***Ampelocissus tomentosa*** (Heyne ex Roth) Planch.	Shrub
Acanthaceae	***Ruellia colorata*** Blume	Herb
Acanthaceae	***Rungia pectinata*** (L.) Nees	Herb
Aizoaceae	***Lampranthus spectabilis*** (Haw.) N. E. Br.	Herb
Alliaceae	***Allium porrum*** L.	Herb

Alstroemeriaceae	***Bomarea oligantha*** Baker	Herb
Amaranthaceae	***Achyranthes bidentata*** Blume	Herb
Amaryllidaceae	***Zephyranthes tubispatha*** Herbert	Herb
Anthericaceae	***Chlorophytum nimmonii*** (Graham) Dalz.	Herb
Apiaceae	***Anethum graveolens*** L.	Herb
Apocynaceae	***Vallaris solanacea*** (Roth) Kuntze	Herb
Araceae	***Alocasia indica*** (Roxb.) Schott	Herb
Araceae	***Zantedeschia aethiopica*** (L.) Spreng.	Herb
Asclepiadaceae	***Caralluma adscendens*** (Roxb.) Haw. var. ***adscendens***	Herb
Asphodelaceae	***Asphodelus tenuifolius*** Cav.	Herb
Balanophoraceae	***Balanophora fungosa*** J.R. & G. Forst. subsp. ***indica*** (Arn.) Hansen var. ***tirunelveliensis*** Viswanathan, Prem Kumar & Ramesh	Herb
Begoniaceae	***Begonia albo-coccinea*** Hook.	Herb
Brassicaceae	***Raphanus sativus*** L.	Herb
Cactaceae	***Hylocereus undatus*** (Haw.) Britton & Rosc.	Herb
Caesalpiniaceae	***Peltophorum africanum*** Sond.	Herb
Callitrichaceae	***Callitriche stagnalis*** Scop.	Herb
Campanulaceae	***Campanula alphonsii*** Wall. ex A.DC.	Herb
Campanulaceae	***Wahlenbergia flexuosa*** (Hook.f. & Thoms.) Thulin	Herb
Cannabaceae	***Cannabis sativa*** L.	Herb
Cannaceae	***Canna indica*** L.	Herb
Capparidaceae	***Cleome aspera*** Koen ex. DC.	Herb
Caryophyllaceae	***Polycarpon prostratum*** (Forsk.) Asch. & Sehweinf.	Herb
Chenopodiaceae	***Beta vulgaris*** L.	Herb
Chenopodiaceae	***Chenopodium album*** L.	Herb
Colchicaceae	***Gloriosa rothschildiana*** O'Brien	Herb
Colchicaceae	***Gloriosa superba*** L.	Herb
Commelinaceae	***Belosynapsis vivipara*** (Dalz.) Fischer	Epiphytic Herb
Commelinaceae	***Setcreasea purpurea*** Boom	Herb
Compositae	***Acroclinium roseum*** Hook.	Herb
Convolvulaceae	***Ipomoea asarifolia*** (Desr.) Roem. & Schultes	Herb
Crassulaceae	***Kalanchoe pinnata*** (Lam.) Pers.	Herb
Cucurbitaceae	***Benincasa hispida*** (Thunb.) Cogn.	Herb
Cucurbitaceae	***Zehneria thwaitesii*** (Schweinf.) Jeffrey	Herb
Cyperaceae	***Ascopholis gamblei*** Fischer	Herb
Dipsacaceae	***Dipsacus leschenaultii*** Coult.	Herb
Dracaenaceae	***Sansevieria roxburghiana*** Schultes & Schultes	Herb
Elatinaceae	***Elatine ambigua*** Wight	Prostrate Herb
Eriocaulaceae	***Eriocaulon brownianum*** Martius ex Wall.	Herb
Euphorbiaceae	***Tragia bicolor*** Miq.	Herb
Fabaceae	***Aeschynomene indica*** L.	Herb
Fabaceae	***Smithia blanda*** Wall. ex Wight & Arn. var. ***racemosa*** (Heyne ex Wight & Arn.) Baker	Herb
Gentianaceae	***Exacum sessile*** L.	Herb
Haloragaceae	***Myriophyllum oliganthum*** (Wight & Arn.) F. v. Muell.	Herb
Hyacinthaceae	***Ornithogalum conicum*** Jacq.	Herb
Hyacinthaceae	***Urginea congesta*** Wight	Herb

Hydrocharitaceae	***Blyxa aubertii*** Rich. var. ***echinosperma*** (Clarke) Cook & Luond	Submerged Herb
Hypoxidaceae	***Molineria trichocarpa*** (Wight) Balakr.	Herb
Juncaceae	***Juncus inflexus*** L.	Herb
Labiatae	***Anisomeles heyneana*** Benth.	Herb
Lemnaceae	***Spirodela polyrhiza*** (L.) Schleiden	Floating Herb
Lentibulariaceae	***Utricularia bifida*** L**.**	Herb
Lentibulariaceae	***Utricularia stellaris*** L.f.	Herb
Linaceae	***Linum mysurense*** Heyne ex Benth.	Herb
Linaceae	***Linum usitatissimum*** L.	Herb
Lobeliaceae	***Lobelia leschenaultiana*** (Presl) Skottsb.	Herb
Lobeliaceae	***Lobelia nicotianifolia*** Roth ex Schultes var. ***trichandra*** (Wight) Clarke	Herb
Loganiaceae	***Mitrasacme indica*** Wight	Herb
Lythraceae	***Ammania baccifera*** L. subsp ***baccifera***	Herb
Malvaceae	***Malvastrum coromandelianum*** (L.) Garcke	Annual Herb
Martyniaceae	***Martynia annua*** L.	Herb
Molluginaceae	***Mollugo stricta*** L.	Herb
Musaceae	***Ensete ventricosum***(Welw.) Cheesman	Herb
Nelumbonaceae	***Nelumbo nucifera*** Gaertn.	Erect Herb
Nyctaginaceae	***Boerhavia crispa*** Heyne ex Hook.f.	Herb
Onagraceae	***Oenothera glazioviana*** Mich.	Herb
Orchidaceae	***Eulophia cullenii*** (Wight) Blume	Terrestrial Herb
Pedaliaceae	***Sesamum radiatum*** Schumach. & Thonn.	Herb
Phytolaccaceae	***Rivina humilis*** L.	Herb
Piperaceae	***Peperomia heyneana*** Miq.	Herb
Poaceae	***Agrostis zenkeri*** Trin.	Herb
Polygonaceae	***Rumex nepalensis*** Spreng.	Herb
Pontederiaceae	***Eichhornia crassipes*** (Mart.) Solms-Laub.	Floating Herb
Portulacaceae	***Portulacaria afra*** Jacq.	Herb
Primulaceae	***Anagallis arvensis*** L.	Herb
Primulaceae	***Anagallis pumila*** Sw.	Herb
Primulaceae	***Lysimachia leschenaultii*** Duby	Trailing Herb
Rubiaceae	***Acranthera anamallica*** Bedd.	Herb
Rubiaceae	***Wendlandia thyrsoidea*** (Schultes) Steud.	Herb
Sambucaceae	***Sambucus nigra*** L.	Herb
Sapindaceae	***Cardiospermum halicacabum*** L.	Herb
Saxifragaceae	***Vahlia digyna*** (Retz.) Bullock	Herb
Scrophulariaceae	***Adenosma indianum*** (Lour.) Merr.	Herb
Solanaceae	***Browallia americana*** L.	Herb
Sterculiaceae	***Melochia corchorifolia*** L.	Herb
Taccaceae	***Tacca leontopetaloides*** (L.) Kuntze	Herb
Tiliaceae	***Corchorus aestuans*** L.	Herb
Turneraceae	***Turnera subulata*** Smith	Herb
Urticaceae	***Pilea melastomoides*** (Poir.) Blume	Herb
Urticaceae	***Pilea wightii*** Wedd.	Herb
Urticaceae	***Pouzolzia wightii*** Benn. var. ***wallichiana*** Hook.f.	Herb
Valerianaceae	***Valeriana arnottiana*** Wight	Herb
Valerianaceae	***Valeriana leschenaultii*** DC.	Herb

Verbenaceae	***Priva cordifolia*** (L.f.) Druce	Herb
Violaceae	***Hybanthus enneaspermus*** (L.) F. v. Muell.	Herb or Undershrub
Vitaceae	***Cayratia trifolia*** (L.) Domin.	Herb
Vitaceae	***Cyphostemma setosum*** (Roxb.) Alston	Herb
Zingiberaceae	***Alpinia abundiflora*** Burtt & Smith	Herb
Zygophyllaceae	***Tribulus lanuginosis*** L.	Herb
Acanthaceae	***Thunbergia fragrans*** Roxb. var. ***vestita*** Nees	Climber
Alangiaceae	***Alangium salvifolium*** (L.f.) Wang. subsp. ***hexapetalum*** (Lam.) Wang	Climber
Amaranthaceae	***Psilotrichum elliotii*** Baker & Clarke	Climbing
Annonaceae	***Artabotrys hexapetalus*** (L. f.) Bhandari	Climbing
Apocynaceae	***Beaumontia grandiflora*** Wall.	Climbing
Apocynaceae	***Kopsia fruticosa*** (Ker-Gawl.) A.DC.	Climber
Apocynaceae	***Rauvolfia verticillata*** (Lour.) Baill	Climbing
Arecaceae	***Calamus travancoricus*** L.	Climber
Aristolochiaceae	***Aristolochia grandiflora*** Sw.	Climber
Aristolochiaceae	***Aristolochia indica*** L.	Climber
Aristolochiaceae	***Aristolochia ringens*** Vahl	Climber
Asclepiadaceae	***Ceropegia bulbosa*** Roxb. var**.** ***lushii*** (Graham) Hook.f.	Climber
Asparagaceae	***Asparagus setaceus*** (Kunth) Jessop	Climber
Bignoniaceae	***Clytostoma purpureum*** (Lodd. ex Sweet) Rehder	Climber
Bignoniaceae	***Macfadynea unguis-cati*** (L.) A. Gentry	Climber
Cactaceae	***Epiphyllum oxypetalum*** (DC.) Haw.	Climber
Capparidaceae	***Capparis zeylanica*** L**.**	Twiner Climber
Compositae	***Vernonia divergens*** (Roxb.) Edgew.	Climbing
Convolvulaceae	***Argyreia nervosa*** (Burm.f.) Boj.	Climbing
Convolvulaceae	***Rivea ornata*** (Roxb.) Choisy	Climbing
Cucurbitaceae	***Citrullus lanatus*** (Thunb.) Matsumura & Nakai	Climber
Dioscoreaceae	***Dioscorea oppositifolia*** L. var. ***dukhumensis*** Prain & Burkill	Climber
Elaeagnaceae	***Elaeagnus kologa*** Schlecht.	Straggling/Climbing
Euphorbiaceae	***Tragia muelleriana*** Pax & Hoffm.	Climbing
Fabaceae	***Vigna radiata*** (L.) Wilczek var. ***sublobata*** (Roxb.) Verdc.	Climber
Lauraceae	***Cassytha capillaris*** Meisner	Climber
Linaceae	***Hugonia mystax*** L.	Rambling Climbing
Loganiaceae	***Fagraea ceilanica*** Thub.	Climber
Menispermaceae	***Tinospora cordifolia*** (Willd.) Miers ex Hook. f. & Thoms.	Climber
Mimosaceae	***Acacia grahamii*** Vajravelu	Climbing
Moraceae	***Ficus pumila*** L.	Climber
Myrsinaceae	***Embelia basaal*** (Roem. & Schultes) A.DC.	Climbing
Nyctaginaceae	***Bougainvillea glabra*** Choisy	Climbing
Passifloraceae	***Passiflora suberosa*** L.	Climber
Piperaceae	***Piper barberi*** Gamble	Climber
Piperaceae	***Piper hymenophyllum*** Miq.	Climber

Plumbaginaceae	***Limonium sinuatum*** (L.) Mill.	Climber
Plumbaginaceae	***Plumbago auriculata*** Lam.	Climber
Polygonaceae	***Antigonon leptopus*** Hook. & Arn.	Climbing
Rutaceae	***Zanthoxylum limonellia*** (Dennst.) Alston	Larege Woody Climber
Santalaceae	***Osyris quadripartita*** Salzm. ex Decne. var. ***puberula*** (Hook.f.) Kumari	Climber
Sapindaceae	***Allophylus cobbe*** (L.) Raeusch.	Climber
Sapindaceae	***Cardiospermum canescens*** Wall.	Climber
Scrophulariaceae	***Lindernia anagallis*** (Burm.f.) Pennell	Creeping
Smilacaceae	***Smilax zeylanica*** L.	Climber
Solanaceae	***Cestrum nocturnum*** L.	Climbing
Verbenaceae	***Petrea volubilis*** L.	Climbing
Vitaceae	***Cissus heyneana*** (Wall. ex Lawson) Planch.	Climber

Source: State Forest Department and partial ground truth by Ultra Tech team

Stratification

Stratification, or layering, is the occurrence of plants at different levels in a stand. The number of strata above the ground varies according to the kind of community. The study sites are characterized by scrub and deciduous elements with low thorny trees and predominant xerophytes vegetation. The stratification in the study area is presented in **Table 3.16.**

Table 3.16 Stratification of Project Area

Stratum 1	Grasses	*Aristida hysterix, Cynodon dactylon*
Stratum 2	Herbs	*Crotons parviflora, Tephrosia purpurea, Indogofera spp.*
Stratum 3	Shrubs	*Calotropis gigantea,*
Stratum 4	Trees	*Azadiracta Indica*

The above four strata were found in the entire field monitoring stations with equal representation. This shows the life – forms of the area and its amplitude. This also reflects the light intensity, temperature, and organic content of the soil and other factors of the area.

Life form

The life form in a broad sense is meant the characteristic vegetative appearance such as the size, shape, branching etc. The life form observed in the study area reveals that there are several communities ranging from open grassland, succulent perennials (*Opuntia* sps. and *Euphorbia* sps), and small annual plants. The kinds of life forms, the number of individuals of each kind and their spacing gives a good structure to the community.

The Heterogeneity observed among the plant community in the Core and Buffer zones reveals that, the characteristic species of scrub forests are dominant. They were recorded in all the stands used for this investigation showing the highest frequency; there is a wide distribution of plant species observed in various stands. 100% Frequency were not recorded for many characteristic species except for *Prosopis juliflora* and *Acacia nilotica*. Though, these two species are dominant, the distribution of vegetation is heterogeneous in nature. The Heterogeneous status indicates that there is no human impact in the core and buffer zones.

Discussion on vegetation analysis

The interpretations based on the floristic composition reveals that, the vegetation encountered in the study area is termed as the original characteristic of Thorn forests / Scrub forests, Southern tropical dry deciduous forests, Northern mixed dry deciduous forests, and tropical dry ever green forests. The core zone comprises of residential, commercial and agricultural and fallow lands.

The types of forest / vegetation found in the study area are Open scrub along with the representative elements of the deciduous and dry ever green forest types. Physiognomically it occurs in the shape of scrub woodland or thicket; the latter may be dense or discontinuous.

Status of the plants
There is no endangered, threatened, or rare species of plants recorded in the study area.

Assessment of Fauna in the study
The details of fauna found in core zone and buffer zone are given in the following **Table 3.17**

Table 3.17 Fauna in the study area

S. NO.	Common Name	Scientific Name	Conservation status: Wildlife (Protection) Act 1972 (WPA 1972)
BUTTERFLIES			
1	Blue mormon	*Papilio polymnestor*	Not enlisted
2	Blue pansy	*Junonia orithya*	Not enlisted
3	Common Indian crow	*Euploea core*	Not enlisted
4	Common grass yellow	*Eurema hecabe*	Not enlisted
5	Common leopard	*Phalanta phalantha*	Not enlisted
7	Lime butterfly	*Papilio demoleus*	Not enlisted
Dragonflies and Damselflies			
1	Crimson marsh glider	*Trithemis aurora*	Not enlisted
2	Ditch jewel	*Brachythemis contaminata*	Not enlisted
3	Ground skimmer	*Diplocodes trivialis*	Not enlisted
4	Long legged marsh skimmer	*Trithemis pallidinervis*	Not enlisted
AMPHIBIANS			
1	Common Indian toad	*Bufo melanostictus*	Not enlisted
2	Freshwater frog	*Rana tigrina*	Sch – IV
REPTILES			
1	Common garden lizard	*Calotes versicolor*	Not enlisted
2	Common skink	*Mabuya carinata*	Not enlisted
BIRDS			
1	Blue rock pigeon	*Columba livia*	Sch – IV
2	Common babbler	*Turdoides caudatus*	Sch – IV

3	Pond Heron	*Ardeola grayii*	Sch – IV
4	Pariah Kite	*Milvus migrans*	Not enlisted
5	Spotted dove	*Spilopelia chinensis*	Sch – IV
6	Indian cuckoo	*Cuculus micropterus*	Sch – IV
7	Koels	*Eudynamys scolopacea*	Sch – IV
8	House swift	*Apus affinus*	Sch – IV
9	Cattle egret	*Bubulcus ibis*	Sch – IV
10	Green Bee-Eater	*Merops orientalis*	Sch – IV
11	Indian robin	*Saxicoloides fulicata*	Sch – IV
12	Indian black drongo	*Dicrurus adsimilis*	Sch – IV
13	Black Drongo	*Dicrurus adsimilis*	Sch – IV
14	Indian myna	*Acridotheres tristis*	Sch – IV
15	House Crow	*Corvus splendens*	Sch – V
16	Jungle Crow	*Corvus macrorhynchos*	Sch – V
17	Redvented Bul Bul	*Pycnonotus cafer*	Sch – IV
18	White headed Babbler	*Turdoides affinis*	Sch – IV
19	House Sparrow	*Passer domesticus*	Sch – IV
MAMMALS			
1	Common cat	*Felis silvestris catus*	Not enlisted
2	Common dog	*Canis lupus familiaris*	Not enlisted
3	Cow	*Bos taurus*	Not enlisted
4	Squirrel	*Funambulus palmarum*	Sch-IV
5	Common Mongoose	*Herpestes edwardsii*	Sch-IV

The following observations were made:

- The insects in the study area are interrelated with each other and other organisms. Some of them act as pests, while others are useful and beneficial to the environment and human beings.

- The toads and frogs were the amphibians recorded in the study area. Many of them were seen along the road sides and lowland areas.

- The reptiles recorded in the study area include lizards~~,~~ and skinks.

- Birds play an important role in understanding the ecological balance and its interrelationships. The occurrence of birds in various locations largely depends on the site characteristics and their presence in different study sites reveals that there is a good relationship between the birds and other organisms and the environment. The maintenance of the eco-balance could be seen in the selected study areas.

The distribution of mammals is largely dependent upon the environment of the respective areas. The mammals present in the study area include Mongoose, Indian palm Squirrel, etc. These mammals are spread over the study area

3.10 Socio-Economic Environment

3.10.1 Introduction

Socio-economic assessment is an important part of the Environment Impact Assessment for any industrial project. This section studies the socio-economic profile of the study area for the IOCL Tiruchirapalli project and analyses the baseline status as well as assess the social impacts of the projects in the study area and suggest mitigation measures to the anticipated adverse impacts of the project.

3.10.3 Project Location

The proposed project i.e. M/s Indian Oil LPG bottling plant is located in the Kulathur Census Town, Taluk: Srirangam, Dist: Tiruchirapalli at latitude 10°42'31.8"N and longitude 78°32'12.4"E. The study area i.e. the 10 km radius area consists of 34 villages, two town and is spread over the districts of Tiruchirapalli, Karur & Pudukottai.

3.10.3 Tiruchirapalli: Basic Information

Tiruchirappalli district lies at the heart of Tamil Nadu. The district has an area of 4,404 sq. kms. It is bounded in the north by Salem district, in the northwest by Namakkal district, in the northeast by Perambalur district and Ariyalur district, in the east by Thanjavur District, in the southeast by Pudukkottai district, in the south by Madurai district and Sivagangai district, in the southwest by Dindigul district and, in the west by Karur district.

It is administratively divided into 3 Revenue Divisions, 9 Taluks and 14 Community Development Blocks. As per the 2011 census Tiruchirapalli district has a population of 2,722,290 representing 3.77 percent of the state population. The district has a population density of 604 persons per sq. km. Its population growth rate over the decade 2001-2011 was 12.57 percent. Tiruchirapalli district has a sex ratio of 1013 females for every 1000 males, and a literacy rate of 83.23 percent.

Table 3.18: Demographic Attributes for Tiruchirapalli District

1.	Area	5237 sq. km.
2.	Population	2.7 lakhs
3.	Decadal Growth rate	12.57%
4.	Male population	1.35 lakhs
5.	Female population	1.37 lakhs
6.	Density of population (persons per km^2.)	604
7.	Sex Ratio (females per 1000 males)	1013
8.	Literacy	83.23 %
9.	Male literacy	89.72 %
10.	Female literacy	76.87 %
11.	Urban Population	49.15 %

Source: District Census Handbook, Tiruchirapalli, Census of India 2011

3.10.4 Socio-Economic Details of Study Area

The data is collected and analysed using secondary sources viz. District Census Handbook, Statistical Abstract, Official Documents etc. The study area is spread over the Districts of Tiruchirapalli, Karur & Pudukottai in Tamilnadu. The demographic profile, infrastructure facilities and socio-economic condition is being described under different classifications in the following section.

3.10.5 Methodology

The data is collected and analysed using secondary sources. The 10 km radius area is known as the study area includes villages & towns. The secondary data was collected and collated from sources such as viz. District Census Handbook 2011, Census of India website, District Statistical Abstract etc

3.10.6 Demography

The study area had population of 111,369 of which male and female were 55,238 and 56,131 respectively with 25,965 households. Population size ranges from 11,083 in Kulathur CT to mere 207 in Uthupatti village. There were total 13,816 children under age of 0-6 in the study area comprising of 12.41 per cent of total population. There are 25,965 households in the study area and the average size of household is 4.29 members per household.

Table 3.19: Demographic Features of the Study Area

District	Villages	HH	Total Population	Male	Female	Sex Ratio	Literacy	Population (0-6) years
Tiruchirapalli	Podavur	708	3146	1567	1579	1008	69.03	411
	Navalurkottapattu	1307	5310	2629	2681	1020	76.94	574
	Ariyavoor-Ukkadaiariyavoor	805	3273	1615	1658	1027	68.17	414
	Periyanayakichatram	229	936	462	474	1026	76.48	90
	Ammapettai	738	2878	1418	1460	1030	76.49	300
	Mathur	397	1758	880	878	998	71.17	218
	Sethurapatti	690	2850	1414	1436	1016	66.18	387
	Alundur	651	2643	1303	1340	1028	71.33	313
	Paganur	521	2209	1064	1145	1076	75.28	259
	Nagamangalam (CT)	1561	5785	2831	2954	1043	76.53	724
	Kulathur (CT)	2572	11083	5494	5589	1017	79.33	1441
	K.Periapatti North	1062	4454	2200	2254	1025	68.37	511
	Inam Edayapatti	132	570	279	291	1043	59.57	58

	Chettichatram	87	356	188	168	894	68.81	45
	Chithanatham	395	1698	842	856	1017	67.75	225
	K.Periapatti South	450	2005	1014	991	977	71.91	250
	Samudram	811	3676	1870	1806	966	69.52	500
Karur	Puthur	895	3780	1885	1895	1005	68.08	418
	Alathur	352	1594	784	810	1033	72.25	178
	R.T.Malai	1504	6802	3398	3404	1002	60.74	844
	Puluderi	295	1307	619	688	1111	64.30	178
	Vadaseri	1867	7951	3873	4078	1053	64.49	975
	Kalladai	1780	8124	4073	4051	995	70.56	923
	Padiripatti	600	2785	1420	1365	961	63.71	319
	Uthuppatti	45	207	106	101	953	53.71	32
Pudukottai	Komangalam	412	1830	920	910	989	60.88	253
	Vittampatti	265	1208	614	594	967	57.72	217
	Kalkudi	625	2940	1470	1470	1000	65.29	448
	Poruvai	433	2095	1038	1057	1018	66.91	303
	Buthakudi	763	3099	1556	1543	992	64.99	380
	Melapachchakudi	553	2270	1080	1190	1102	74.29	290
	Kathalur	373	1546	760	786	1034	57.30	183
	Akkalayakkanpatti	299	1308	654	654	1000	75.71	118
	Velur	682	2957	1440	1517	1053	64.74	373
	Vadugappatti	462	1965	986	979	993	80.09	277
	Meppudakkudi	644	2971	1492	1479	991	73.45	387
Total		**25,965**	**111,369**	**55,238**	**56,131**	**1,016**	**69.98**	**13,816**

3.10.7 Sex Ratio

The sex ratio in the study area stood at 1016 female per 1000 male, which is higher than the sex ratio of Tamilnadu which is 996 female per 1000 male and average national sex ratio of India which is 940 female per 1000 male as per Census 2011. On the contrary, the child sex ratio is only 961 girls per 1000 boys as compared to the sex ratio of the study area.

There were total 13,816 children under age of 0-6 in the study area, of which male child and female child were 7046 and 6770 respectively. Child Sex Ratio as per census 2011 was 961 girls per 1000 boys.

3.10.8 SC & ST Population

According to the 2011 census, the ratio of scheduled caste population to the total population is 19.90 percent in the study area and the ratio of scheduled tribe population to the total population is negligible 0.42 percent in the study area. The ratio of scheduled caste population in the study area is low as compared to the ratio in the state which is 20.5 percent.

3.10.9 Literacy

Average literacy rate of the study area is 69.98 per cent, of which male and female literacy was 79.39 and 55.20 respectively. The state's literacy rate is 80.09% in 2011 which is more than the literacy rate of the study area.

3.10.10 Workforce

As per the Census 2011, the total workers in the study area are 56,048 which constitute of 48.65 percent of the total population of the study area. Of the total workers 49,066 are rural and 6,982 are urban workers. This would mean that 87.54 percent of the total workers are rural and 12.46 percent are urban workers. The number of rural workers is very high as compared to the urban workers. The total workforce comprises of 50,271 main workers and 5,777 marginal workers.

Main workers[1] constitute 89.69 percent of the total workers. The remaining 10.31 percent are marginal workers[2]. Among the main workers, male main workers are 59.79 percent and 40.21 percent are female main workers. Majority of main workers are from rural areas.

Table 3.20: Status of working population in the study area

District	Villages	Total Population	Total workers	Main workers	Marginal workers	Non workers	WPR
Tiruchirapalli	Podavur	3146	1694	1046	648	1452	53.85
	Navalurkottapattu	5310	2664	2454	210	2646	50.17
	Ariyavoor-Ukkadaiariyavoor	3273	1527	1254	273	1746	46.65
	Periyanayakichatram	936	461	412	49	475	49.25
	Ammapettai	2878	1400	1053	347	1478	48.64
	Mathur	1758	889	879	10	869	50.57
	Sethurapatti	2850	1325	1216	109	1525	46.49
	Alundur	2643	1253	1207	46	1390	47.41
	Paganur	2209	1135	748	387	1074	51.38
	Nagamangalam (CT)	5785	2506	2175	331	3279	43.32
	Kulathur (CT)	11083	4476	4146	330	6607	40.39
	K.Periapatti North	4454	2676	2485	191	1778	60.08

[1] Main workers were those who had worked for the major part of the year preceding the date of enumeration i.e., those who were engaged in any economically productive activity for 183 days (or six months) or more during the year.

[2] Marginal workers were those who worked any time at all in the year preceding the enumeration but did not work for a major part of the year, i.e., those who worked for less than 183 days (or six months).

	Inam Edayapatti	570	298	297	1	272	52.28
	Chettichatram	356	198	197	1	158	55.62
	Chithanatham	1698	746	697	49	952	43.93
	K.Periapatti South	2005	1255	1085	170	750	62.59
	Samudram	3676	1841	1565	276	1835	50.08
Karur	Puthur	3780	2275	2255	20	1505	60.19
	Alathur	1594	938	929	9	656	58.85
	R.T.Malai	6802	3515	3462	53	3287	51.68
	Puluderi	1307	745	696	49	562	57.00
	Vadaseri	7951	4123	4015	108	3828	51.86
	Kalladai	8124	4320	4272	48	3804	53.18
	Padiripatti	2785	1386	1381	5	1399	49.77
	Uthuppatti	207	114	114	0	93	55.07
Pudukottai	Komangalam	1830	933	786	147	897	50.98
	Vittampatti	1208	649	649	0	559	53.73
	Kalkudi	2940	1585	1581	4	1355	53.91
	Poruvai	2095	1100	655	445	995	52.51
	Buthakudi	3099	1401	905	496	1698	45.21
	Melapachchakudi	2270	1004	869	135	1266	44.23
	Kathalur	1546	1113	909	204	433	71.99
	Akkalayakkanpatti	1308	557	550	7	751	42.58
	Velur	2957	1779	1344	435	1178	60.16
	Vadugappatti	1965	723	592	131	1242	36.79
	Meppudakkudi	2971	1444	1391	53	1527	48.60
Total		**111,369**	**56,048**	**50,271**	**5,777**	**55,321**	**50.33**

3.10.11 Occupational structure

The occupational structure of the population in the study area has been studied. The Main workers are classified on the basis of Industrial category of workers into the following four categories:

1. Cultivators
2. Agricultural Labourers
3. Household Industry Workers
4. Other Workers

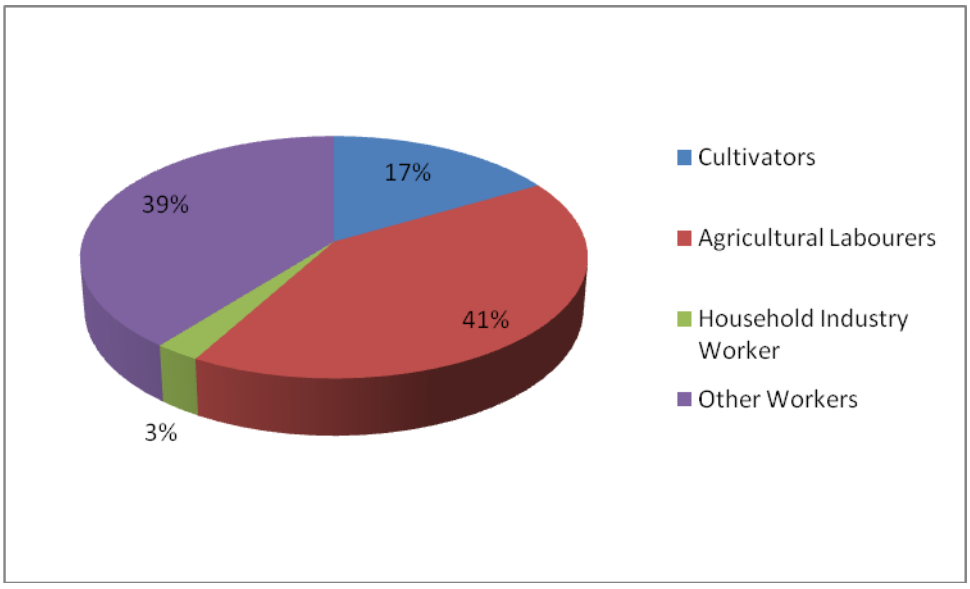
The type of workers that come under this category of 'Other Worker' include all government servants, municipal employees, teachers, factory workers, plantation workers, those engaged in trade, commerce, business, transport banking, mining, construction, political or social work, priests, entertainment artists, etc. In effect, all those workers other than cultivators or agricultural labourers or household industry workers are 'Other Workers'.

Table 3.21: Distribution of main workers by category

Study Area	Main Workers	Main Workers			
		Cultivators	Agricultural Labourers	Household Industry Worker	Other Workers
Total	**50,271**	**8,349**	**20,863**	**1,289**	**19,770**

After other workers category, cultivators (17 percent) and agricultural labour (41 percent) together constitute 58 percent of the total main workers. It reflects that agricultural sector has absorbed 58 percent of the main workers. Most of the main workers engaged in agricultural sector as cultivators & agricultural labourers are rural in nature. Only 3 percent of workers in the district are engaged as the household industry workers. In the other workers category, 39 percent of the total main workers are engaged. Thus it reflects that the opportunities for other category workers are more in urban areas of the Tiruchirapalli district as compared to the rural areas.

Fig 3.10: Percentage Distribution of Main Workers in the study area



3.10.12 Economy of Study Area

The study area is rural in nature, the economy of the area is driven by agriculture and agro based industries. The agriculture is also two types in the study area; in the northern part of the study area river Cauvery flows close to the study area there is a good network of big and small canals ensure irrigation to the lush green fields. Paddy is the principal crop and the study area also has many rice mills. The main crops grown are paddy, banana, coconut and sugarcane. Being situated on the banks of the River Cauvery, there is no scarcity of water throughout the year. The crops are irrigated by flow irrigation. In addition they are supplemented by water from private tube-wells.

Whereas the southern part of the study area is very backward in terms of agricultural as well as industrial development. The main crops of the study area are paddy, cholam and banana. The larger portion of the cultivated area is rainfed. There are no major industries in the study area although the district has substantial industries.

3.10.13 Road and Rail connectivity

A network of all-weather metalled roads connecting every village exists in the study area. The important National Highways criss-cross the study area are NH 45 connecting the study area to three important cities of Chennai, Tiruchirapalli and Dindigul and NH 45B which runs from NH 45 in Tiruchirapalli and southwards to the port town of Tuticorin via Madurai.

The Chennai Madurai railway line also criss-cross the study area, connecting the study area to all major towns of the state.

The study area does not have a airport and the nearest major airports are Tiruchirappalli, at a distance of 30 km.

CHAPTER 4. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

4.1 Introduction

Identification of impacts and mitigation measures of the same in Environmental Impact Assessment study helps in quantification and evaluation of impacts. During baseline study several impacts can be identified but it is necessary to identify the critical impacts both positive and negative on various components of the environment that are likely due to installation of LPG mounded bullets.

The environmental impacts can be categorized as either primary or secondary. Primary impacts are the ones that are caused directly due to the project activity on environmental attributes, whereas secondary impacts are indirectly induced.

The construction and operational phase of the project activity comprises various activities, each of which may have either positive or negative impact on some or other environmental attributes. The proposed project activities would impart impact on the environment in two distinct phases:

- During construction phase - Temporary or short term impact
- During operation phase - May have long term impact

4.2 Impact Assessment

4.2.1 Construction Phase

Impacts on Land/Soil Environment

During site preparation, excavation will be done at places in the project site where sheds, Mounded Storage bullets and the approach road will be constructed. This is required to provide solid base/foundations for structures & roads.

- Improper disposal of the excavated earth during installation of storage tanks/structures may result into temporary loss of topsoil productivity of that particular area.
- Storage of construction material/chemicals (if any) if not done at designated place can cause nuisance and hazards
- Accidental spillage of Hazardous chemicals/oil during handling may lead to soil contamination
- Improper segregation and disposal of solid waste generated during construction phase by workers working at site
- Filth generation if dry waste/garbage generated during construction period is not handling efficiently

Impacts on Air Environment

- The emission anticipated during construction period will include fugitive dust due to excavation of soil, leveling of soil, use of DG sets, movement of heavy construction equipments/vehicles, site clearing and other activities
- This type of fugitive dust is expected to result in change in the baseline air quality specifically during the construction phase
- If burning of solid wastes is required it may cause air pollution

Impacts on Noise Environment

The proposed project will lead to emission of noise that may have significant impact on the surrounding communities in terms of increase in noise levels and associated disturbances.
Following activities would result in increase in noise level;

- Noise generated from operation of pumps and blower
- Noise generated from vehicular movement
- Noise generated from DG Set
- Nuisance to nearby areas due to noise polluting work at night

Impacts on Water Environment

- Increased water demand during construction phase for site preparation, dust spraying, construction activities, curing, domestic and other water requirements for labour and staff onsite
- Increase in site runoff and sedimentation
- Stagnant water and unsanitary conditions may cause mosquito breeding at site

Impacts on Ecology and Biodiversity

- During construction activities vegetation may be disturbed which can be considered insignificant.
- Earth enabling work involving excavation and filling up operations may result in fugitive dust emission. Deposition of fugitive dust on pubescent leaves of nearby vegetation may lead to temporary reduction of photosynthesis.
- The runoff from construction area may lead to a short-term increase in suspended solids and decrease in dissolved oxygen near the discharge point in receiving water body. This may lead to a temporary decrease in the photosynthetic activity of phyto-planktons, rise in anaerobic conditions and food chain modification.

Impacts on Socio-Economic Environment

- The proposed project does not involve any displacement of inhabitants for the construction of LPG Bottling Plant.
- Construction phase could lead to creation of employment and procurement opportunities.
    - A multiplier effect will be felt on the creation of indirect employment through the local community establishing small shops like tea stalls, supply of intermediate raw materials, repair outlets, hardware stores garrages etc.
    - Self- employment options for individuals possessing vocational or technical training skills like electricians, welders, fitters etc, which are likely to be sourced locally;
    - There would be influx of workers during construction phase which could lead to pressure on key local infrastructure such as water, healthcare, electricity.
    - The construction activity could lead to increased nuisance level from air emissions and noise due to transportation of material and equipment as well as labourers.

- The construction activity could also lead to water stagnation at pockets which may lead to breeding of mosquito and related health impacts.

4.2.2 Operation Phase

Impacts on Land/Soil Environment

- Soil quality may be affected by accidental leakage and spillage of hazardous chemicals/oils during handling
- Improper segregation and disposal of solid waste generated during operation of the proposed project

Impacts on Air Environment

- No emission is envisaged during the storage and handling of LPG in mounded bullets
- No fugitive emission during loading and unloading of LPG in and from mounded bullets is envisaged
- Impacts on ambient air during operation phase would be due to emissions from operation of DG sets only during power outages.

Impacts on Noise Environment

- Impact of noise due to vehicular traffic
- Noise generated due to DG sets

Impacts on Water Environment

- Stress on existing water supply
- Generation of waste water & domestic effluent
- Increased run off from site.

Impacts on Ecology and Biodiversity

- The probability and consequences of significant ecological impacts occurring as a result of the operation of the Mounded Bullets/facility are considered to be almost negligible. The risk of any leakage is almost negligible owing to stringent leak prevention technologies.
- In normal condition, no waste water is discharged outside the bottling plant. During monthly mock-drill and in monsoon, the waste/rain water will be discharged through properly designed storm water drain after passing through vapour trap.

Impacts on Socio-Economic Environment

- Project and associated construction of LPG Bottling Plant will eventually lead to permanent job opportunities in the organized and unorganized sector. There is likely to be increased demand for security, kitchen help, need for drivers etc.
- Development of physical infrastructure due to construction of the plant which could benefit the local population.

4.3 Impact Mitigation Measures

4.3.1 Construction Phase

Land/Soil Environment Impact Mitigation

- Top soil will be stored carefully and will be used again after construction/installation phase is over so as to restore the fertility of project site
- Bituminous materials / other chemicals, if any, shall not be allowed to leach into the soil
- Methods to reuse earth material generated during excavation will be followed
- Waste oil generated from D. G. sets will be handed over to authorized recyclers approved by CPCB
- Usage of appropriate monitoring and control facilities for construction equipments deployed
- All hazardous wastes shall be securely stored, under a shed for eventual transportation and disposal to the authorized dealers
- The solid waste generation due to workers working at site will be segregated and will be transported and disposed of to Trichy Municipal Corporation waste disposal facility
- Chemicals/Paints etc. used during construction phase will be stored safely

Air Impact Mitigation

- Checking of vehicles and construction machinery to ensure compliance to Indian Emission Standards[3]
- Transportation vehicles, DG sets and machineries to be properly and timely maintained and serviced regularly to control the emission of air pollutants in order to maintain the emissions of NO_X and SO_X within the limits established by CPCB
- Minimize idling time for vehicles and adequate parking provision and proper traffic arrangement for smooth traffic flow
- Use of good quality fuel and lubricants will be promoted. Moreover, low sulphur content diesel shall be used as fuel for DG sets to control emission of SO_2
- Water sprinkling shall be carried out to suppress fugitive dust during earthworks and along unpaved sections of access roads
- Attenuation of pollution/ protection of receptor through strengthening of existing greenbelt/ green cover

However, the construction activities will be for temporary period and hence, its impact on the existing ambient air quality as well as vegetation will be reversible. Dust emissions are likely to be confined within the limited area.

Noise Impact Mitigation

- No noise polluting work in night shifts
- Acoustic enclosures for DG Sets will be provided as per CPCB guidelines

- Pumps – Enclosure in acoustic screen, allowing for engine cooling and exhaust, use of anti-vibration mounting, flexible couplings of hoses, maintaining adequate inlet pressure
- Provision of Intake mufflers, unidirectional fan for Cooling and enclosures for electrical motors
- Provision of ear plugs for labour in high noise area
- Provision of barricades along the periphery of the site
- All contractors and subcontractors involved in the construction phase shall comply with the CPCB noise standards[4]
- Activities that take place near sensitive receptors to be carefully planned (restricted to daytime, taking into account weather conditions etc.)
- Vehicles and generator sets to be serviced regularly and maintained properly to avoid any unwanted generation of noise or vibration from them
- Use of suitable muffler systems/ enclosures/ sound proof glass paneling on heavy equipment/ pumps/ blowers
- Pumps and blowers may be mounted on rubber pads or any other noise absorbing materials
- In case of steady noise levels above 85 dB (A), initiation of hearing conservation measures
- Strengthening of greenbelt for noise attenuation may be taken up, etc.

Water Impact Mitigation

- Water Avoidance of wastage of curing water
- Use of tanker water for construction activity.
- Provision of temporary toilets for labour
- Wastewater generated will be recycled/reused duringoperation of the LPG Plant

Ecology and Biodiversity Impact Mitigation

- The impacts as mentioned earlier, however, be confined mostly to the initial periods of the construction phase and would be minimized through adoption of control measures such as paving and surface treatment, water sprinkling and plantation schemes.
- The impact would be restricted within the plant boundary. Thus, the impacts of construction activities will be marginal in scale.
- However, for major part of the year during construction phase, no detectable impact is expected because water quality will not change significantly. Hence, no tangible impact on the aquatic eco-system is anticipated.

[4] http://CPCB.nic.in/divisionsofheadoffice/pci2/Noise-vehicle.pdf

http://cpcb.nic.in/divisionsofheadoffice/pci2/noise_rules_2000.pdf

Socio-Economic Environment Impacts Mitigation

- Employing local people for construction work to the maximum extent possible.
- Providing proper facilities for domestic supply, sanitation, domestic fuel, education, transportation etc. for the construction workers.
- Barricades, fences and necessary personnel protective equipment such as safety helmet, shoes, goggles, gloves, harness etc. will be provided to the workers and employees.
- Constructional and occupational safety measures to be adopted during construction phase of the industry.
- The health of workers will be checked for general illness; first time upon employment and thereafter at periodic intervals, as per the local laws and regulations.
- The workers will be diagnosed for respiratory functions at periodic intervals and during specific complaints etc. Medical Aid as per Factory Act and Panel doctor facility will be provided to the workers.
- Job rotation schemes will be practiced for over-exposed persons. Insignificant impact is expected on the workers health and safety during the operation phase stage.

4.3.2 Operation Phase

Land/Soil Environment Impact Mitigation Measures

- Installation of drainage ditches at project site to prevent erosion
- All hazardous wastes shall be securely stored, under a shed for eventual transportation and disposal to the authorized dearler by CPCB
- The solid domestic waste shall be segregated and stored within the premises temporarily and then sent to Trichy Municipal Corporation waste management facility

Air Impact Mitigation

- Checking of vehicles and construction machinery to ensure compliance to Indian Emission Standards[5]
- Transportation vehicles, generators and machineries to be properly and timely maintained and serviced regularly to control the emission of air pollutants in order to maintain the emissions of NO_X and SO_X within the limits established by CPCB
- Stack height of DG sets shall be as per norms of CPCB to allow effective dispersion of pollutants
- Storage facilities shall be equipped with leak detection systems
- Minimize idling time for vehicles and adequate parking provision and proper traffic arrangement for smooth traffic flow

[5] http://cpcb.nic.in/divisionsofheadoffice/pci2/Noise-vehicle.pdf

http://cpcb.nic.in/divisionsofheadoffice/pci2/noise_rules_2000.pdf

[5] http://cpcb.nic.in/Vehicular_Exhaust.php

- Attenuation of pollution/ protection of receptor through strengthening of existing greenbelt/ green cover

Noise Impact Mitigation

- Provision of proper parking arrangement, traffic management plan for smooth flow of vehicles help to abate noise pollution due to vehicular traffic.
- Green belts and landscaping shall act as noise buffer.

Water Impact Mitigation

- waste water shall be recycled /resued for flushing, gardening and cooling tower makeup)
- Provision of Storm water drainage system with adequate capacity, Proper maintenance of storm water drainage.

Ecology and Biodiversity Impact Mitigation

- The proponent has a plan of extensive green belt programme. The area, varieties of plants, density etc. have been mentioned in the report
- In normal condition, no waste water shall be discharged outside the Depot. During mock-drill (once in a month) and rainy season, the waste/rain water shall be discharged through properly designed storm water drain after passing through Vapour Trap. Hence, no impact is envisaged on aquatic ecology from the operation of facilities.
- The probability and consequences of significant ecological impacts occurring as a result of the operation of the facility are considered to be almost negligible. The risk of any leakage is almost negligible owing to stringent leak prevention technologies.

Socio-Economic Environment Impacts Mitigation

- Both skilled and unskilled local person shall be given preference for the jobs in the operation and maintenance of the plant.

4.4 Impact Matrix

The matrix was designed for the assessment of impacts associated with almost any type of project. Its method of a checklist that incorporates qualitative information on cause-and-effect relationships but it is also useful for communicating results.

Matrix method incorporates a list of impacting activities and their likely environmental impacts, presented in a matrix format. Combining these lists as horizontal and vertical axes in the matrix allows the identification of cause effect relationships, if any, between specific activities and impacts. The impact matrix for the actions identified in Table 4.1 along with various environmental parameters. A rating scale has been devised to give severity of impacts in the following manner.

A. Beneficial (positive) impact – Long term
B. Low beneficial impact – Short term
C. Strong adverse (negative) impact – Long term
D. Low adverse impact (localized in nature) – Short term

E. No impacts on environment

Table 4.1: Impact Matrix

S.N.	Activity	Positive Impact		Negative Impact		No Impact
		Short Term	Long Term	Short Term	Long Term	
Pre-Project Activity						
1	Displacement and resettlement of local people					√
2	Change in land use					√
3	Loss of trees/vegetation		√			
4	Shifting of equipment, machinery and material					√
5	Employment for local people		√			
Construction Phase						
1	Pressure on infrastructure and transportation system			√		
2	Impact on air quality including dust generation			√		
3	Noise Pollution			√		
4	Traffic					√
5	Impact on the land/soil environment			√		
6	Impact on groundwater					√
7	Stacking and disposal of construction material			√		
8	Impact on water quality			√		
9	Health and safety conditions of people			√		
10	Social impact	√				
11	Economic impact	√				
Operation Phase						
1	Increase in air pollution and noise levels				√	
2	Water harvesting and recharge		√			
3	Disposal of solid waste				√	
4	Infrastructure development		√			
5	Quality of life		√			
6	Handling operations for transfer, charging of raw materials, final product				√	

4.5 Summary of Environment Impacts and Mitigation Measures

The summary of the Impacts and Mitigation measures for the above mentioned environmental attributes is as summarized in **Table 4.2.**

Table 4.2: Summary of Impacts and Mitigation Measures

Impacting Activity		Potential Impact		Mitigation Measures Environment/ Social Attribute	Compliance/ Standards/ Best Practice Guidelines Source Contaminants
Environment/ Social Attribute	Source Contaminants	Environment	Health and Safety		
Construction Phase					
Construction Workers	Generation of sewage, organic wastes, construction debris etc.	Possible contamination of project site and nearby water bodies	Potential risk of respiratory irritation, discomfort, or illness to workers	• Local workers will be employed, as far as possible. • Proper sanitation facilities will be provided for the workers • There are no temporary shelters as because local workers will be engaged	--
Air Emissions	Dust and air emission particularly due to the excavation, construction and movement of vehicles resulting in air pollution	Rise in RSPM level at project site	Potential risk of respiratory irritation, discomfort, or illness to workers	• Barricading sheets shall be provided • Provision of spraying water to reduce dust emission • Excavated topsoil to be preserved and reused for landscaping • Ensuring all vehicles, generators and compressors are shall be maintained and regularly serviced	CPCB - National Ambient Air Quality Standards
Noise Generation	Construction noise mainly due to excavation, Moving of vehicles, operations of cranes etc.	Rise in decibel level of ambient noise	Unwanted sound can cause problems within the body. Excessive noise pollution in working	• The vehicles used will be with the proper acoustic measures • Wherever this cannot be achieved the area will be earmarked as high noise level area requiring use of ear protection	CPCB - Noise Pollution (Regulation and Control) Rules

Impacting Activity		Potential Impact		Mitigation Measures Environment/ Social Attribute	Compliance/ Standards/ Best Practice Guidelines Source Contaminants
Environment/ Social Attribute	Source Contaminants	Environment	Health and Safety		
			areas at construction sites can influence psychological health viz. occurrence of aggressive behaviour, disturbance of sleep, constant stress, fatigue and hypertension. Hampered sleeping pattern and may lead to irritation and uncomfortable situations.	gadgets • Avoid night time work	
Soil and Groundwater Contamination	• Spillage of concrete mixture containing additives and plasticizers. • Spillage of construction material containing heavy metals, paints, coatings, liners, etc.			• All fuel, Liquid Cargo storage will be sited on an impervious base within a bund and secured place. The base and bund walls will be impermeable to the material stored and of an adequate capacity. Storage at or above roof level will be avoided • Leaking or empty drums will be handled as per environment management plan • Special care will be taken during	

Impacting Activity		Potential Impact		Mitigation Measures Environment/ Social Attribute	Compliance/ Standards/ Best Practice Guidelines Source Contaminants
Environment/ Social Attribute	Source Contaminants	Environment	Health and Safety		
				deliveries of construction materials, especially when fuels and hazardous materials are being handled Ensure that workers know what to do in the event of a spillage	
Operation Phase					
Air Emissions	• Release of emission from the DG Sets in case of power failure and operation of fire Engine in case of fire drill or emergency	• Negligible Impact	Negligible Impact	• The DG sets shall be provided with Stack Height per CPCB guidelines above roof level.	
Wastewater	Domestic waste water arising from Restroom and Canteen	• Negligible Impact	Negligible Impact	• Septic Tank and Soak Pit shall be provided for domestic sewage.	
Hazardous Materials, Fire and Explosion		• Risk of fire and explosions due to the flammable and combustible nature of petroleum products.	Potential risk of loss of life or injury due to fire	Storage equipment should meet standards for structural design and integrity. .	OISD-STD 144 - Fire Protection Facilities for LPG Bottling Plant.

Impacting Activity		Potential Impact		Mitigation Measures Environment/ Social Attribute	Compliance/ Standards/ Best Practice Guidelines Source Contaminants
Environment/ Social Attribute	Source Contaminants	Environment	Health and Safety		
		• Risk of leaks and accidental releases from equipment, tanks, pipes etc during loading and unloading (handling)			
Hazardous Waste	• No Hazardous Waste except used lubricating Oil	Same to be Stored in barrels	• To be Srored in Designated place on Concree platform		To be disposed to CPCB accredited Party.

CHAPTER 5: PROJECT BENEFITS

5.1 Project Benefits

The Proposed project will have indirect positive impact on surrounding area which is as mentioned below:

- Plant will be set up on barren land; hence no displacement of people is required.
- Substantial Socio-economic benefits.
- Good Techno-commercial viability.
- Around the project site semi-skilled and unskilled workmen are expected to be available from local population in these areas to meet the manpower requirement during construction and Operational phase.
- There will be employment opportunity for local people during construction and operation phase.
- Infrastructural facilities will be improved due to the project.
- Critical analyses of the existing socio-economic profile of the area indicate that the impact of the Project is expected to be of varying nature. The following are the impacts predicted.
- Secondary employment will be generated thereby benefiting locals.
- Project will have substantial benefits in savings of transportation cost
- Thus a significant benefit to the socio-economic environment is likely to be created due to the project.

5.2 Improvements in the Physical Infrastructure

The project will improve supply position of LPG in Tamil Nadu State.

- Maintain continuity of LPG gas cylinder supply to the consumers through distributors.
- Increase the days cover for LPG storage.
- Safety measures for hazard detection and prevention system will be upgraded as per OISD-144/OISD-150.
- By adding 3x300 MT Mounded Bullets, risk profile of the existing plant will not be enhanced
- Discourage deforestation and reduce the use of fire wood and fossil fuels.

Establishment of large developmental projects improve the availability of the physical infrastructures like approach roads, drainage, communication and transportation facilities etc.

5.3 Improvements in the Social Infrastructure

IOCL Trichy LPG Plant shall take up some community welfare activities under Corporate Social Responsibility and also improve the social infrastructures like education and health care system etc.

5.4 Employment Potential

The project shall provide employment potential under unskilled, semi-skilled and skilled categories. The employment potential shall increase with the start of construction activities, reach a peak during construction phase and then reduce with completion of construction activities. During operation phase also there will be employment opportunities, mainly in service sector, although its magnitude will be much less.

The direct employment opportunities with IOCL are extremely limited and the opportunities exist mainly with the contractors and sub-contractors. These agencies will be persuaded to provide the jobs to local persons on a preferential basis wherever feasible.

The total employment potential of plant is 60 people which will include 20 direct and 40 indirect that includes contract labours and even security personnels.

5.5 CSR and Socio-Economic Development

IOCL not only carries out business but also understands the obligations towards the society. The unit is aware of the obligations towards the society and to fulfill the social obligations unit will employ semi-skilled and unskilled labor from the nearby villages for the proposed project as far as possible. Unit will also try to generate maximum indirect employment in the nearby villages by appointing local contractors during construction phase as well as during operation phase. The Project Proponents will contribute reasonably as part of their Corporate Social Responsibility (CSR) in and will carry out various activities in nearby villages.

Moreover, unit has planned to carry out various activities for the up-liftment of poor people, welfare of women and labors, education of poor students as part of CSR in the nearby villages and therefore , during and after proposed project, unit will spent more than that required by statutory norms every year towards CSR activities. The various CSR activates planned at present by the unit is described below;

- Plantation along the road side and development of garden/greenbelt on government barren land/common plots
- Education aids and scholarship to poor students
- Organize medical camp and providing support for the development and maintenance of the health facilities
- Financial support and assistance for the development and maintenance of the infrastructure facilities
- Participate and contribute in local social programs
- Organize various types of training program for the community like training on scientific agricultural practices, educational training, (training for tailoring, embroidery), etc. which ultimately helpful for income generation
- Organize various types of awareness program for the community like awareness on the child labor, educational promotion etc.

The activities listed above are not limited to and IOCL will plan and perform other activities according to the need of local community in future. The utilization of this fund in various

areas with time bound action plan will be decided based on the requirement of the local community.

5.6 Direct Revenue Earning to the National and State Exchequer

This project will contribute additional revenue to the Central and State exchequer in the form of excise duty, income tax, state sales tax or VAT, tax for interstate movement, corporate taxes etc. Indirect contribution to the Central and State exchequer will be there due to Income by way of registration of trucks, payment of road tax, income tax from individual as well as taxes from associated units. Thus, the proposed project will help the Government by paying different taxes from time to time, which is a part of revenue and thus, will help in developing the area.

5.7 Other Tangible Benefits

Both tangible and non-tangible benefits will result from this activity and many of those are described above. Apart from direct employment, many other benefits will accrue like

- Erosion control by nalla training, terracing and bunding
- Flood control by rain-water arresting, and harvesting
- Aesthetics improvement by general greening with emphasis on biodiversity
- Developed economy strengthens democratic set-up.
- Developed economy brings with it literacy and healthful living
- Improved safety-security in surrounding with better Law and Order
- Symbiosis and sustainable development will be the ultimate objective

CHAPTER 6: ANALYSIS OF ALTERNATES

6.1 Alternative Technology

LPG is a gas stored and handled in liquefied form under pressure. LPG is commonly stored in horizontal dish-end cylindrical mild steel tanks (commonly known as bullets). The major types of LPG storage facilities are given below:

1. Above ground LPG bullet
2. Buried LPG bullet
3. Mounded LPG bullets

Above ground LPG bullet

These are mounted on two RCC saddles. Each tank is fitted with liquefied gas inlet line entering into the tank from top. The vapour outlet line for direct use of the gas in the plant is also taken out from the top of each tank. The bottom connections include liquid discharge line to vaporizer and drain line with two isolation valves and with its end outside the shadow of the tank. Each tank is provided with multiple pressure relief valves with discharge capacities enough to avoid undue pressure rise under fire in the vicinity of the tank. Each tank is also fitted with rotogauge (a device to check the level of liquefied gas), pressure gauge and temperature gauge.

Till recent years, bulk storage of highly inflammable Liquefied Petroleum Gas (LPG) was being done in above ground storage tanks. However major fire / explosions underlined the need to review the design, procedure, maintenance, fire fighting and safety aspects of LPG handling.

Buried LPG Bullets

Buried LPG bullets are supported by saddles resting on foundations in order to minimize the chance of unexpected settling and any motion of the bullets underground. The large span of these bullets requires more than two saddles adding to the complexity of the design due to statically indeterminate construction, differential settlement, and uneven supports. First, the loads induced by mound weight, pressure due to mound, and the loads due to longitudinal thermal expansion and soil resistance to this expansion is analyzed.

Diameters and lengths of bullets are significant and using a common foundation for all of the saddles is not economical. As a result, saddles are usually supported on separate independent foundations resting on piles. The construction represents a challenge for the designer, because it is much more complex than conventional design analysis for a vessel supported on two saddles. Horizontal vessels supported by two saddles can be analyzed as a beam resisting the uniform load.

Mounded LPG bullets

A safer option was introduced in the form of Mounded LPG Storage Bullets since it provides intrinsically passive and safe environment and eliminates the possibility of BLEVE (Boiling Liquid Expanding Vapour Explosion). Mounded LPG Bullets are large, buried, horizontal cylindrical steel tanks with dished ends of size ranging between 3 meter to 6 meter diameter and lengths of 30 meter to 45 meters or more. Mounded bullets allow storage of large quantities of LPG up to 2,000 MT or more in a single location. The cover of the mound protects the vessel from fire engulfment, radiation from a fire in close proximity and acts of sabotage or vandalism. The area of land required to locate a mounded system is minimal compared to conventional storage. Mounded bullets were supported directly by soil without using additional supports such as saddles.

The project proposal relates to installation of 03 nos. of Mounded Bullets of 300MT capacity each for storage of LPG.IOCL has mastered the art and technology of installation of Mounded Bullets. The LPG department of Marketing Division of IOCL has earned a good credential for installation of Mounded Bullets.

The above expertises of IOCL are well proven and working efficiently at different locations of the country without fail. IOCL is having excellent track record and progressive outlook in regularly updating its technology. The technology adopted by IOCL for installation of Mounded Bullets for storage of LPG is a fail-safe.

6.2 Alternative Site

The proposed expansion will be carried out in the vacant land of existing Tiruchirapalli bottling plant terminal. Hence, no alternate sites were considered for the project. The land required for the expansion of the terminal facilities is already in possession of IOCL.

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CHAPTER 7. ADDITIONAL STUDIES

7.1 Public Consultation

As per requirement of the Notification, TNPCB will conduct Public Consultation and the report will be submitted to SEIAA TN. The summary of points raised during Public consultation will be considered for action at our end.

7.2 Quantitative Risk Assessment

We have carried out detailed quantitive Risk assessment and report is attached as **Annexure VI**

CHAPTER 8. ENVIRONMENT MANAGEMENT PLAN

8.1 Introduction

The Environmental Management Plan (EMP) provides an essential link between predicted impacts and mitigation measures during implementation and operational activities. EMP outlines the mitigation, monitoring and institutional measures to be taken during project implementation and operation to avoid or mitigate adverse environmental impacts, and the actions needed to implement these measures.

The likely impacts on various components of environment due to the project during developmental activities have been identified and measures for their mitigation are suggested. The EMP lists all the requirements to ensure effective mitigation of every potential biophysical and socio-economic impact identified in the EIA. For each attribute, or operation, which could otherwise give rise to impact, the following information is presented:

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

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

8.2 EMP during Construction Phase

Environmental pollution during construction stage will be limited and for a temporary period during the construction activity. Construction shall be planned in such a way that excavated material shall be disposed safely. The manpower required for these activities shall preferably be employed from nearby villages so that avenues of employment will be open to local people.

Directly or indirectly all the environmental components get affected due to the construction activity. The following environmental protection and enhancement measures are suggested for implementation by the contractor or the authority during the construction as applicable.

8.2.1 Air Environment

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

- All equipment used during construction shall have valid PUC certitifcate.

- The storage and handling of soil, sub-soils, top-soils and materials will be carefully managed to minimize the risk of wind blown material and dust
- To avoid generation of air borne dust, water sprinkling shall be done.
- There will be no on-site burning of any waste arising from any construction activities
- All vehicles delivering construction materials or removing soil will be covered to prevent escape of dust
- Engines and exhaust systems of all vehicle and equipment will be maintained so that exhaust emissions do not exceed statutory limits and that all vehicles and equipment are maintained in accordance with manufactures' manuals. Periodic monitoring of this shall be undertaken to ensure compliance
- Exhausts of other equipment used for construction (e.g. generators) will be positioned at a sufficient height to ensure dispersal of exhaust emissions and meet the standards set by CPCB.

8.2.2 Noise Environment

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

- Earth movers and construction machinery with low noise levels shall be used
- Periodic maintenance of construction machinery and transportation vehicles shall be undertaken
- Onsite workers shall be provided with noise protection devices such as ear plugs/ muffs wherever necessary
- Periodic monitoring for the noise levels within the project site shall be undertaken to ensure compliance per CPCB set standards

8.2.3 Water Environment

Drinking water requirements during the construction phase by the contractors shall be met from proposed borewells on site. Construction labourers shall be provided with adequate quantity of drinking water of potable quality.

Sufficient and appropriate sanitary facilities shall be provided in order to maintain hygienic conditions in the camps of construction labourers. The wastes, such as, sanitary wastes shall be treated in STP of 10 m^3/day capacity.

The solid waste generated shall be collected and disposed in an appropriate manner either at a landfill site or used as compost to be used in lawns/gardening purpose.

8.2.4 Land Environment

- On completion of construction works all temporary structures, surplus materials and wastes shall be completely removed. Dumping of construction waste on agricultural land will be prohibited and used appropriately.

- The solid wastes such as paints, lubricants, oil or any other non-biodegradable wastes that have leachable constituents will be disposed to authorized recyclers.
- A waste management plan shall be prepared or integrated with existing plan before the commissioning, implemented and monitored. In areas, where soil quality for natural vegetation is of critical concern, loosening of soil in such areas will be done to mitigate soil compaction caused due to operation of heavy machinery.

8.2.5 Biological Environment

The region does not have dense vegetation and landuse is dominated by agriculture activities. Following environemtnal managemenr measures are recommended to mitigate adverse impacts on biological environment during construction phase:

- Plantation will be commenced at the time when site clearing will be undertaken.
- Number of trees will be replanted against the trees removed from site.
- Native species will be preferred for plantation in addition to beautification plants/species.

8.2.6 Socio-economic Environment

Given that the project and related developments like construction camps will not be dependent on local resources (power, water), during both construction and operations, the only likely impact on infrastructure would be on the roads, especially SH17 during the construction phase. Considering the high traffic emanating during construction phase an effective traffic management scheme will be put in place to avoid congestion on the nearby and local roads.

Local persons will get employment during Construction phase.

8.2.7 Health and Safety

- The movement of heavy equipment will be undertaken with proper precaution to prevent any accidents on the road. Occupational risk shall be minimized at the project site through implementation of a full proof safety system. Speed limit set for movement of vehicles with 20 km/hr on village roads to reduce risks of accidents or injuries.
- Safety training shall be provided to all construction workers on operation of equipment. Security shall also be extended during non-working hours to ensure there is controlled access to the machinery and equipment.
- The contractors shall also be vigilant to detect workers showing symptoms of communicable diseases. Health check up of the contract labors shall be done/ recorded at times. All illness and incidents shall be reported and recorded.

8.3 EMP during Operation Phase

In order to mitigate the impacts due to capacity expansion of facility on various environmental components, the following environmental management measures are recommended:

8.3.1 Air Environment

- Leak detection and repair (LDAR) program shall be implemented in the facility
- Ambient air quality with respect to SPM, RPM, SO_2, NOx, H_2S, CO and HC monitoring shall be continued in the impact zone as per regulations
- To minimize occupational exposure/hazards, the present practice of using personal protective equipment e.g. helmets, safety (gas) mask/safety dress, safety harness for working at heights, safety shoes, safety goggles, low temperature hand gloves & shock resistant hand gloves etc. be ensured for workers engaged in operation of process units within the facility complex
- Stacks of adequate height (CPCB norms) for DG Sets to ensure adequate dispersal of pollutants will be provided.
- Waste Lube oil will not be incinerated and will be sold to MoEF/TNPCB authorised waste oil recyclers
- All access roads (internal as well as external) to be used by the project authorities will be paved (either with WBM, concrete or bitumen) to suppress the dust generation along the roads

8.3.2 Noise Environment

Similar measures as proposed in the construction phase for noise making machinery, to ensure practicably low noise levels within the work environment.

- The major areas of concern for noise generation will be adequately addressed by considering it during procurement of the machinery from vendors, project implementation stage. Further feedback from the monitored noise levels at sensitive locations will be taken to ensure that the impact due to high noise levels is practically minimized
- Monitoring job and location specific noise levels for compliance with HSE regulations by verifying acceptability of noise levels caused by the project activities and comparison with noise criteria
- Conducting periodic audiometric tests for employees working close to high noise levels, such as compressors, DG sets, etc
- Provision of PPE's will be done and their proper usage will be ensured for eardrum protection of the workers as well as visitors
- Acoustic barriers and silencers shall be used in equipment wherever necessary
- Sound proofing/ glass panelling shall be provided at critical operating stations/ control rooms, etc
- Monitoring of ambient noise levels shall also be carried out regularly both inside the facility area as well as outside the peripheral greenbelt.

8.3.3 Water Environment

- For domestic sewage, Septic Tank and Soak Pit shall be provided.

- There will be no industrial effluent generated in this plant. However, waste water generated during plant operations (during washing of empty cylinders) shall be recirculated/ resued.
- There shall no increase in quantity of waste water generation from operation of proposed Mounded Bullets. The existing sources of waste water generation are as follows:
    - ✓ Sanitary waste water from toilets, wash-rooms and canteen.
    - ✓ Non-sanitary waste water from mock drills.

8.3.4 Land Environment

- Greenbelt in and around the facility will be strengthened/maintained
- A record w.r.t quantity, quality and treatment/management of solid/hazardous waste shall be maintained at environmental monitoring cell

Solid/Hazardous Waste Management

- No solid hazardous waste will be generated in the operation of LPG Bottling Plant.

8.3.5 Biological Environment

Development of green belt with carefully selected plant species is of prime importance due to their capacity to reduce noise and air pollution impacts by attenuation/assimilation and for providing food and habitat for local micro faTriuchirapalli.

8.3.6 Socio-economic Environment

In order to mitigate the impacts likely to arise out of the proposed project and also to maintain good will of local people, steps will be taken for improving the social environment. Necessary social welfare measures by the industry shall be undertaken in gaining public confidence and to meet local area development requirement. The following measures are suggested:

- IOCL shall continue to undertake social welfare programs for the betterment of the Quality of Life of villages around in collaboration with the local bodies
- Some basic amenities, viz. education, safe drinking water supply to the nearby villages may be taken up
- Regular medical check up shall be continued at times in the villages around the facility
- Focus shall be on to educate villagers regarding safety measure provided in the plant.

8.4 Environmental Monitoring Programme

Introduction

Environmental Management is nothing but resource management and environmental planning is just the same as development planning. They are just the other side of the same coin. The resource management and development planning look at the issue from narrow micro-economical point of view while environmental management views the issue from the

broader prospective of long term sustained development option, which ensures that the environment is not desecrated.

For the effective and consistent functioning of the project, proper environmental monitoring programme shall be carried at the LPG Bottling Plant.

The programme shall include the following:

- Environmental Monitoring
- Personnel Training
- Regular Environmental audits and Correction measures
- Documentation–standards operation procedures Environmental Management Plan and other records

Environmental Monitoring

Work of monitoring shall be carried out at the locations to assess the environmental health in the post period. A post study monitoring programme is important as it provides useful information on the following aspects.

- It helps to verify the predictions on environmental impacts presented in this study.
- It helps to indicate warnings of the development of any alarming environmental situations, and thus, provides opportunities for adopting appropriate control measures in advance.

The monitoring programmes in different areas of environment, outlined in the next few sections, have been based on the findings of the impact assessment studies described in Chapter 4. Post study monitoring programme have been summed up in **Table 8.1.**

Table 8.1: Post Study Environmental Monitoring Program

Area of Monitoring	Sampling locations	Frequency of Sampling	Parameters to be Analysed
Ambient Air Quality	station within premises.	Once in six months	PM_{10}, $PM_{2.5}$,SO_2, NO_x, HC, VOCs and other parameters as specified by TNPCB consents
	Stack monitoring of DG Set	Once in three months	PM_{10}, $PM_{2.5}$,SO_2, NO_x, CO and other parameters as specified by TNPCB consents
Water	Ground water sample within the Plant	Twice in a year	• Physical and Chemical parameters • Bacteriological parameters • Heavy metals and toxic constituents
Noise	Within Plant shed for bottling operations	Twice a year	Sound Pressure Levels (Leq) during Plant operations.

Solid Waste	Records of generation of used drums, bags and records of their dispatch to suppliers for refilling	As & when required	--
Environmental Audit	Environmental statement under the EP (Act) 1986	Once in a year	--

8.4.1 Ambient Air Quality

Monitoring of ambient air quality at the LPG Bottling Plant site shall be carried out on a regular basis to ascertain the levels of hydrocarbons in the atmosphere; ambient air quality shall be monitored as per Table 7.1.

8.4.2 Surface Water Quality

Water quality constitutes another important area in the post study monitoring programme. There are no major streams or perennial sources of surface water in the study area. Contamination of surface water in the vicinity of LPG Bottling Plant area during the operation is possible only in one form.

i. Contamination of rain water passing through the LPG Bottling Plant.

Surface water near the LPG Bottling Plant area shall be generally sampled as per the above table.

8.4.3 Noise Level

Ambient noise levels have been monitored at 10 stations inside and outside the plant in **January 2016 to March 2016** for day time and night time Leq.

8.5 Environmental Management Cell

The Locattion-in-charge of the LPG Bottling Plant with the assistance of operation and maintenance engineers at respective stations presently look after environmental management. Technical officers of the LPG Bottling Plant station shall regularly carry out the following:

- Sampling and analysis of noise and water samples.
- Systematic and routine housekeeping at the LPG Bottling Plant

Apart from the regulatory requirements, officials conduct inter station environment auditing to improve the performance. As part of company's endeavor, the IOCL has been accredited

with national and international certification of repute such as ISO: 14001 and ISO: 9002. Under this following aspects are covered.

- Reviewing the whole operation of LPG Bottling Plant, once in every two years, to identify the environmental aspects.
- Following the changes/amendments to central/state legislation pertaining to environment management.
- Assessing the level of experience, competence and training to ensure the capability of personnel, especially those carrying out specialized environmental management functions.
- Conducting environmental awareness programme for the employees at LPG Bottling Plant site.
- Measurement of pollution emissions and levels at LPG Bottling Plant through an external agency approved by TNPCB.

8.6 Budgetary Allocation for Environmental Protection Measures

IOCL has proposed a capital investment of Rs.15 crores and a recurring cost of Rs. 1.50 crores per annum for environmental protection measures. The details of investment for procuring the equipment for efficient control and monitoring of pollution along with annual recurring cost are given in **Table 8.2**.

Table 8.2: Cost of Environmental Protection Measures

Sr. No.	Particulars	Proposed Cost (Rs. Crores)
1	Dust suppression	0.40
2	Water quality monitoring & management	0.25
3	Air quality and noise monitoring	0.50
4	Greenbelt / Plantation	0.35
	Total	**1.50**

CHAPTER 9. DISCLOSURE OF CONSULTANTS ENGAGED

9.1 Consultants Engaged

This EIA report is prepared on behalf of the proponents, taking inputs from proponent's office staff, their R and D wing, Architects, Project Management Professionals etc. by Environmental Consultants **M/s. Ultra-Tech Environmental Consultancy and Laboratory, Thane**.

M/s Ultra-Tech Environmental Consultancy and Laboratory:

Ultra-Tech Environmental Consultancy and Laboratory [Lab Gazetted by MoEF – Govt. of India] not only give environmental solutions for sustainable development, but make sure that they are economically feasible. With innovative ideas and impact mitigation measures offered, make them distinguished in environmental consulting business. The completion of tasks in record time is the key feature of Ultra-Tech. A team of more than hundred environmental brigadiers consists of engineers, experts, ecologists, hydrologists, geologists, socio-economic experts, solid waste and hazard waste experts apart from environmental media sampling and monitoring experts and management experts , strive hard to serve the clients with up to mark and best services.

Ultra-Tech offers environmental consultancy services to assist its clients to obtain environmental clearance for their large buildings, construction, CRZ, SEZ, high rise buildings, township projects and industries covering sugar and distilleries from respective authorities.

Ultra-Tech also provide STP/ETP/WTP project consultancy on turn-key basis apart from Operation and Maintenance of these projects on annual contract basis. Also, having MoEF approved environmental laboratory, Ultra-Tech provide laboratory services for monitoring and analysis of various environmental media like air, water, waste water, stack, noise and meteorological data to its clients all over India and abroad.

The EIA team involved for the proposed EIA Report is as mentioned in **Table 9.1.**

Table 9.1: EIA Team

SN	Name of the expert	Area of functional Expert(NABET Accredited)
1	Mr. Santosh Gupta Mr. Timir Shah	EIA Coordinator Associate Team Member
2	Mr. Timir Shah	Air Pollution
2	Mr. Timir Shah	Water Pollution
3	Mr. Santosh Gupta	Solid Hazardous Waste
5	Dr. T. K. Ghosh	Ecology and Biodiversity
6	Dr. Kishore Wankhede	Socio Economic
7	Mr.Ajay Patil Mr. Harsh Natu Ms. Tejasvita Misra	Team Member

Functional area experts and assistance to FAE involved in the EIA study for "M/s.Indian Oil Corporation Ltd." is as shown in **Table 9.2**:

Table 9.2: Functional Area Experts Involved in the EIA

S.N.	NAME OF SECTOR	NAME OF PROJECT	NAME OF CLIENT	FUNCTIONAL AREA EXPERTS INVOLVED	
				FA	NAME/S
1.	Schedule 6 (b) Category 'B'	Isolated storage and handling of hazardous chemicals	M/s.Indian Oil Corporation Limited.	AP	Mr. Timir Shah
				WP	Mr. Timir Shah
					Associate: Mr.Ajay Patil
				EB	Dr. T. K. Ghosh
					Associate: Ms.Bharti Khairnar
				SE	Dr. Kishore Wankhede
				SHW	Mr. Santosh Gupta
					Associate: Mrs.DeepaTamhane – Karnik
				LU	Mr. Swapnil Avghade
					Associate: Mr. Prasad Khedkar
				RH	Dr.Ravindra Kode
					Associate: Mr. Ajay Patil

9.2 Laboratory for Analysis

NAME OF LABORATORY	SCOPE OF SERVICES	ACCREDITATION STATUS
M/s Eco Services India Pvt. Ltd.	**Monitoring and Analysis of:** • Ambient Air Monitoring • Stack Emission Monitoring • Bore Water(Analysis) • Domestic and Potable Water(Analysis) • Waste Water(Analysis)	Accreditated by NABL Valid upto 01.05.2017