IL&FS Tamil Nadu Power Company Limited

Rapid Cumulative Environmental Impact Assessment Report

for 3600 MW Thermal Power Plant, Captive Port and Desalination Plant at Cuddalore District, Tamil Nadu

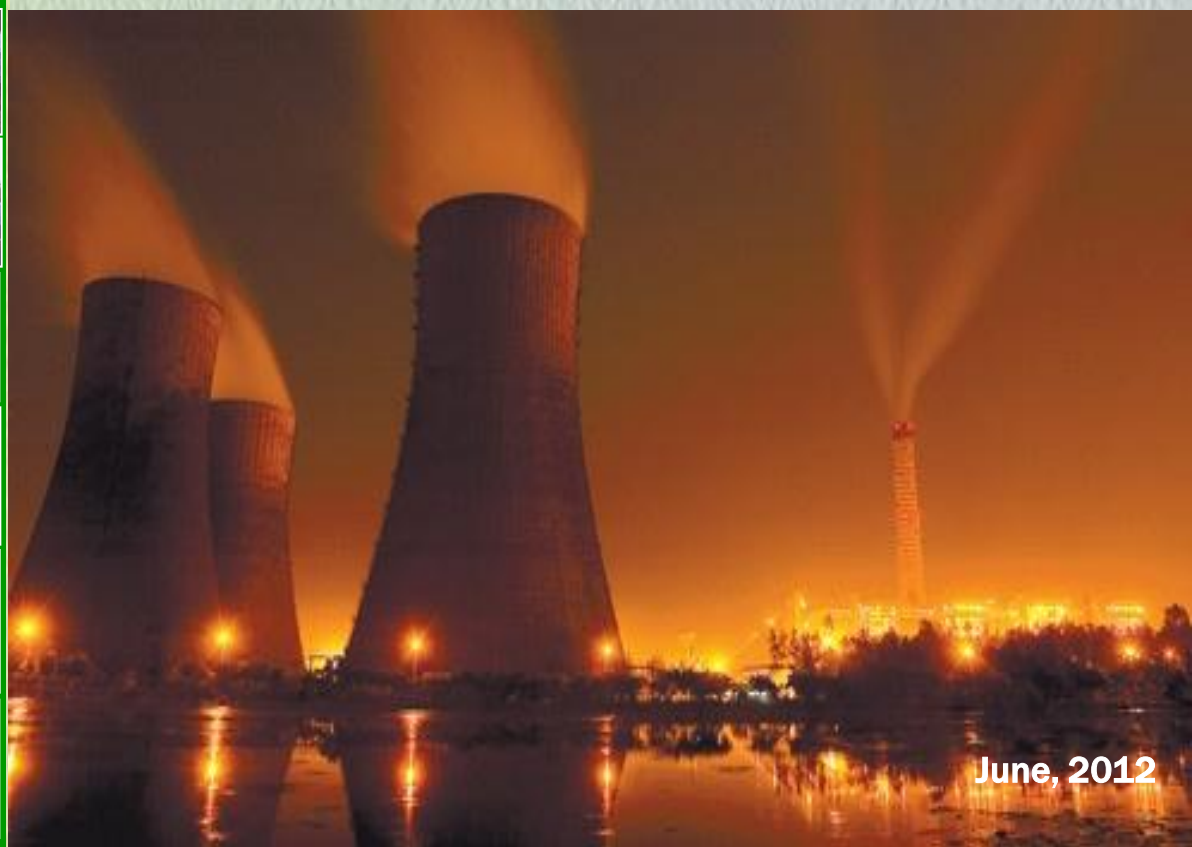
(Final Report After NGT Order)

Submitted by

IL&FS Tamil Nadu Power Company Limited
Chennai





June, 2012

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1 Background

IL&FS Tamil Nadu Power Company Limited (ITPCL) is developing a project comprising of 3600 MW (2×600 MW + 3×800 MW) coal based thermal power plant (TPP), in Parangipettai block of Cuddalore district, Tamil Nadu. The project was accorded Environmental Clearance on May 31, 2010. Subsequently, T. Murugandam, T. Arulselvm and S. Ramanathan of Cuddalore had filed an appeal against Environmental Clearance (EC) granted by the Ministry of Environment and Forests (MoEF) for the proposed ITPCL Thermal Power Plant before the National Environmental Appellate Authority (NEAA) and the appeal was heard by National Green Tribunal (NGT) on its formation.

After hearing, the NGT had issued orders in the matter on May 23, 2012 as follows:

"As we are convinced that EC to the proposed project was granted by and large in consonance with the EIA process as required under EIA Notification, 2006, we do not feel any necessity to quash the EC granted by MoEF. However, we direct MoEF to review the EC based on the cumulative impact assessment study and stipulate any additional environmental conditions, if required". The order also stipulated that the EC shall remain suspended till the EAC has reviewed the study.

In the order it is further directed that cumulative impact assessment studies be carried out by the Project Proponent especially with regard to the proposed Coal Based Power Plant (2×660 MW) of Cuddalore Power Company Ltd. (CPC) and the Nagarjuna Oil Refinery Ltd. (NOCL) and other industrial activities within a radius of 25 km from the ITPCL Power Project. The order also mentions that it is possible to work out likely cumulative impacts theoretically, based on capacity of the projects, by applying mathematical models and directed ITPCL to carry out a cumulative impact assessment study and submit it to MoEF.

ITPCL had submitted to the NGT that the suspension of work at the project site would result in environmental damage as the civil works including piling, construction of storm water drainage and site levelling need to be completed before the monsoon as non-completion of these works would lead to flooding and other environmental damage in the area. NGT opined that the Rapid Cumulative Environment Impact Assessment (RCEIA) study (and subsequently the suspended civil work) can be planned and completed before the onset of the monsoon. As directed by the NGT, ITPCL has carried out the required rapid study, through their consultants L&T Ramboll Consulting Engineers Ltd. The salient points are discussed in subsequent paragraphs.

2 Scope & Methodology

As per the order of the NGT, a Rapid Cumulative Environmental Impact Assessment (RCEIA) study considering the proposed power plant of CPCL, NOCL refinery and Other Industrial activity within 25 km radius from ITPCL power plant was carried out based on available information from the project proponents and from public domain.

2.1 Scope of RCEIA Study

The scope of the RCEIA study is as follows:

- Identification of industrial units falling within 25 km radius of project site.
- Assessment of baseline environmental conditions for terrestrial and marine environment within the study area of 25 km based on results of primary surveys carried out by ITPCL for 10 km radius and Primary data generated by other Industrial units located in 25 km radius for their EIA studies and other relevant secondary data published.
- Identification and prediction of significant impacts on marine environment, air environment and on the Pichavaram Mangroves due to existing/proposed industries within 25 km radius by using appropriate mathematical models.

As per the available information from various sources in the Public domain and as available with the MoEF and the TNPCB, the following other industrial units / marine projects exist or proposed in the study area:

Industrial and Marine Projects in 25 km radius around ITPCL	Distance in km from ITPCL site
Operational Projects in 25 km radius around ITPCL	
• Chemical and Engineering industries in SIPCOT Phase I and II Industrial Complex	• 14.0 km and 10.4 km
• Cuddalore Minor Port	• 22.0 km
Projects in 25 km radius around ITPCL that are given EC before issuance of EC to ITPCL	
• 2x660 MW Coal based Thermal Power Plant near Thiyagavalli and Kudikadu villages by Cuddalore Power Company Limited	• 11.0 km
• 6.5 MTPA Oil Refinery at Thiruchopuram village by Nagarjuna Oil Corporation Limited.	• 6.5 km
• Textile Processing park at Periyapattu Village, Cuddalore District by The South Indian Mills Association (SIMA)	• 3.0 km
Projects in 25 km radius around ITPCL that have sought EC after issuance of EC to ITPCL	
• 3X600 MW coal based Thermal Power Plant at Poovali by SRM Energy Limited. (EC obtained)	• 7.0 km
• Good Earth Shipyard Private Limited (GSPL) (EAC has cleared and EC process in progress)	• Adjacent, <1.0 km

2.2 Study Methodology

The methodology adopted for the study is discussed below:

- Information on emission and wastewater discharges from proposed industries was obtained from the respective EIA reports available with MoEF and TNPCB.
- Meteorological data was collected from LAGAS system for March to June 2011.
- Baseline Ambient Air quality was obtained from various EIA reports and suitably extrapolated using trend line temporally for 2011.
- Air quality modelling using the above datasets was carried out using OCD 5 and ISCST3 models for prediction of maximum ground level concentration. The air quality at various receptor locations was arrived at by extrapolating the predicted values on the baseline ambient air quality data.
- Socio-economic data from government departments and EIA reports of the projects was collated and assessed for cumulative impact.

- Marine impact modelling was carried out based on collected information of the wastewater discharges and the marine structures existing/proposed in the study area.

3 Air Environment

An assessment of the cumulative impact on the air quality was carried out based on the available data on the existing and proposed industries in the area and the ITPCL project. OCD 5 and ISCST3 models were used for carrying out predictive studies. After the study results were extrapolated on the baseline data, the following has been observed:

1. The modeling results show that predicted 24 hour highest concentration for SPM and NOx meets the NAAQ standards 2005 at all 30 receptor locations. SO_2 is well within the norms at 26 receptor locations of 30 receptors considered in the study.

2. For SPM, the major contribution comes from background concentration, which was of the order of ~110 µg/m^3. The average predicted concentration does not exceed 2 µg/m^3 for any of the 30 receptor locations. This shows that more than 98 % of the SPM contribution in the current modelling study is due to ambient concentration.

3. For NOx, the highest predicted cumulative OCD Concentration (Background + Modelled) is 72.91 µg/m^3 and average at all receptors is 29.83 µg/m^3, both well below NAAQ standard of 80 µg/m^3. Highest predicted cumulative ISCST3 Concentration (Background + Modelled) is 64.35 µg/m^3 and average at all receptors is 30.46 µg/m^3.

4. For SO_2, the predicted 24 hour highest concentration meets the NAAQS standards at 26 receptor locations and exceeds at 4 receptor locations, most of which are >15 km away from ITPCL. The SO_2 concentrations are marginally exceeding the standards at receptor locations such as Tiyagavalli (87.44 µg/m^3), Kudikkadu (88.87 µg/m^3), Rasapettai (81.65 µg/m^3), and Vadalur (81.73 µg/m^3).

Impact on Mangroves: The effect of SO_2 emissions on the Pichavaram mangroves is minimal since the predicted values (24 hour highest) at the nearest receptor village Killai located at a distance of 0.5km, is ~20 µg/m^3, and the average values is less than 10 µg/m^3 which is well below the NAAQ limit for ecologically sensitive areas which is 80 µg/m^3.

4 Marine Environment

An assessment of the cumulative impact on the marine quality was carried out based on the available data on the existing and proposed marine and coastal infrastructures in the area. Mathematical modeling of the various impacts were analyzed using like MIKE 21, MIKE 21 PA, MIKE 21 HD and DHI_LITTPACK_LITLINE modules, and the following have been observed:

1. Flow & Advection diffusion model study shows that there is no merging of adjacent plumes from various industries noticed in this region. Also, the carrying capacity of the nearshore waters of the Cuddalore region is high enough to disperse the outfalls proposed in this region without causing adverse impact on the sea water quality. Therefore the cumulative impacts of various discharges being released within 25 km radius of ITPCL project site are observed to be negligible.

2. Previous as well as the current studies have identified the location for the dredge spoil disposal for ITPCL Port to be located at 12 to 14 km distance from the shoreline and the water depth will be 30 m. The spread of the dredge disposal at this location will be limited to 1.5 km radius and the rise in floor level will be limited to the maximum of 0.5 m at the point of disposal.

3. Modeling studies for understanding the impact on the seabed show that the disposal has been so designed that there will not be any significant change on the seafloor elevations and there will not be any turbid plume induced during the release of dredge spoil. Hence the dredge disposal at the offshore locations will not have any significant impact on the marine environment.

4. The storm/cyclone induced water level variations were simulated and it is inferred that the construction of sand bank along the shore front from the part of the dredge spoil can offer good protection from storm surges. Also, the port breakwaters can offer good protection from the impact of storm surge for the coastal segment immediately behind them. Therefore, there will not be any adverse cumulative impact due to different marine facilities coming up along the Cuddalore coastal region on the effect of storm surge.

5. The nearshore water quality will not be altered as all the discharges are localized and do not contain any pollutant or toxic chemical. The dredge spoil disposal will be done beyond 12 km offshore at 30 m depth and it will not cause any change in the nearshore water quality. The dredged material has only trace quantities of heavy metals, petroleum hydrocarbons, oil and grease and phenol and this will not alter the chemistry of water at the disposal site significantly. Thus the various discharges being released from different industries will not have any cumulative impact on the coastal waters off Cuddalore and it will be maintained within the stipulated standards.

6. As all the port projects have to comply with various national and international regulations, the chances of polluting the nearshore become minimal. Also, since commercial fishing is done at depths of 20 to 30 m which occur at a distance of 8 to 10 km from the coast, the ports may not have any impact on the local fisheries, except the loss of area for fishing.

5 Impact on Pichavaram Mangroves

5.1 Mangroves (Pichavaram) in the Study Area

Mangroves constitute a dynamic ecosystem with a complex association of species, both of flora and fauna, of terrestrial and aquatic systems and the vegetation presents an evergreen type with varied life forms. In Tamil Nadu mangrove vegetation is mainly seen in Pichavaram. It covers an area of about 14 sq km of dense mangrove vegetation. There are 16 genera 22 species of mangroves belonging to 13 families are found in the Pichavaram Mangrove forest.

5.2 Air Quality Impact

Based on the mathematical model of cumulative impacts, it is observed that the overall air quality of the Pichavaram mangroves is affected only minimally by the industries to the North of the area. A key aspect contributing to this is that in relation to the industries in the study area, the Wind direction through the year is mostly away from the mangroves. A case in point is the effect of SO_2 emissions on the Pichavaram mangroves. This is minimal since the predicted values (24 hour highest) at the nearest receptor village Killai, located at a distance of 0.5km from Pichavarm, is ~20 $\mu g/m^3$, and the average value is less than 10 $\mu g/m^3$ which is well below the 80 $\mu g/m^3$ NAAQ limit for ecologically sensitive areas.

5.3 Marine Environment Impact

Studies conducted using shoreline model show that Pichavaram mangroves are fed with the seawater through the tidal exchange between Vellar River and Coleroon River. Thus the mouth of the Vellar river has to remain open throughout the year as the closure of mouth will cause flooding and inundation in the villages.

The construction of ITPCL Port,would ensure that the Vellar river mouth will be kept open throughout the year through regular dredging of the sediment getting deposited across the river mouth. This will ensure providing a good tidal prism which will in turn feed the tidal creeks, swamps and tidal flats with large amount of seawater. This will help tremendously improve the density and health of the mangroves in Pichavaram.

6 Social Economic Impact Analysis

The qualitative and quantitative impacts of a project a study was assessed base on key data collected from available reports of the various projects in the area. The key impacts that were assessed, based on the cumulative plans of the various projects in the project area, are:

- Livelihood due to land acquisition and coastal infrastructure
- Other Social and Economic aspects

6.1 Impact on Livelihood

As per the data collected, the workers in the area number 11,34,603, which is about 42% of the total population. Of this, the most vulnerable are the marginal workers whose number is around 2,96,195. Keeping this in view, the projects have by and large kept provisions for using suitable local manpower in their projects.

Based on available data, it is estimated that the manpower requirement would be around 30,000 persons during the construction phase and over 7,000 persons during the operation phase. In addition, these projects are expected create opportunities for indirect employment which are likely to be 3 to 4 times the direct employment potential. It is also expected that with coming of projects like ITPCL, the infrastructure and power availability in the area would improve fuelling multi-fold economic and employment growth in the area.

Also, all the projects have proposed to undertake skill development in their area, including setting up of Skill Development centers to provide vocational training and structured training programmes.

6.2 Other Social and Economic Aspects

The various projects are expected to bring in around Rs. 39,039 crores, of which ITPCL itself would bring in 20,390 crores. This is expected to fuel growth of new jobs, commercial and trade activity and better civil amenities like medical facilities, markets, educational institutions, sports and cultural activities, etc. This would also enhance infrastructure in the area like roads, drinking water, solid waste, sewage and drainage systems, transport and communications facilities, etc.

In addition, the projects have committed to earmark substantial funds towards development of the area around the project site. The total funds allocated by some of the projects as part

of their CSR program, works out to 116.18 crores of one time investment and annual outlay of around Rs. 24 crores.

One of the focus areas of the CSR programs is setting up of Fishermen Endowment Funds and Fish Landing and Ice Plants for upliftment of the fishing community,

7 Terrestrial Environment

7.1 Ambient Noise Levels

Baseline ambient noise quality has been established by monitoring noise levels at 48 locations. The noise monitoring locations in the study area were selected after giving due consideration to the various land use categories. The land use categories include Residential and Commercial areas. Based on the study it is observed that the equivalent values for day and night time noise levels at all locations are within CPCB standards for Industrial, residential, commercial and silent zones.

7.2 Flora and Fauna

Based on the survey carried out for all the EIA projects in the 25.0 km radius the impacts on the flora and fauna in the area are given below:

7.2.1 Vegetation of the Study Area

There are no endangered plants present in the study area. Other than the Pichavaram mangrove forests there are no ecologically sensitive areas in the project area

7.2.2 Terrestrial Fauna of the Study Area

There are no biosphere reserves or sanctuaries or national parks or other protected areas within the 25 km radius of the project site. None of the animal species belong to either rare or endangered or endemic or threatened (REET) category.

8 Conclusion

The mathematical modelling and assessment of the cumulative marine environmental impact indicates that all the marine impacts from the marine infrastructure and marine wastewater discharges in the study area of 25 km radius around the ITPCL project site cause only localised impacts and likely to minimally affect the overall marine environmental status.

The cumulative air quality impact modelling and assessment indicate that NAAQS 2009/2005 standards are met for PM10, PM2.5, NOx at all 30 receptor locations and at 4 locations the predicted SO_2 concentration exceeds the 24 hour average value by about 10 % only for less than 2 % of the modelled period of 3 months, which is in line with the NAAQS 2009 standards.

Based on the mathematical modeling the cumulative air and marine environmental impacts on the Pichavaram Mangroves is expected to be minimal.

The infusion of investment into the area by various projects is expected to provide additional jobs and opportunities for the local populace and is likely to enhance the infrastructure, social and economic fabric of the area. Also, the committed CSR programs by various industries, with special focus on the vulnerable sections including women, fishermen, etc. the infusion of funds is likely to bring about major economic changes in the area.

IL&FS TAMIL NADU POWER COMPANY LIMITED

DEVELOPMENT OF 3600 MW TPP, 30 MLD Desalination Plant and Captive Port

AT CUDDALORE, TAMIL NADU

RAPID CUMULATIVE ENVIRONMENTAL IMPACT ASSESSMENT STUDY

JUNE 2012

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CHAPTER 1:
BACKGROUND AND NEED FOR RAPID CUMULATIVE ENVIRONMENTAL IMPACT ASSESSMENT STUDY

1 Background and Need for Rapid Cumulative Environmental Impact Assessment Study

IL&FS Tamil Nadu Power Company Limited (ITPCL) is developing a project comprising of 3600 MW (2×600 MW + 3×800 MW) thermal power plant (TPP), 30 MLD capacity of captive desalination plant and 15 MTPA coal handling capacity of captive port. The project site is located on the coastal side of Kottatai, Ariyagoshti, Villiyannalur and Silambimangalam revenue villages in Parangipettai block of Cuddalore district, Tamil Nadu.

The project was accorded Environmental Clearance (EC) and CRZ Clearance under the provisions of EIA notification, 2006 and CRZ notification, 1991 (As amended) vide MoEF Letters No. J 13012/34/2008-IA.II (T) dated May 31, 2010 and F.No. 11-43/2010-IA.III dated October 29, 2010. Also Consent to Establish (CTE) was issued by TNPCB in consent orders no: 5495 and no. 5554 dated June 14, 2011.

T. Murugandam, T. Arulselvm and S. Ramanathan of Cuddalore had filed an appeal against the EC granted by the Ministry of Environment and Forests (MoEF) for the proposed coal based Thermal Power Plant by ITPCL before the National Environmental Appellate Authority (NEAA) and the same was heard by National Green Tribunal (NGT) on its formation. After hearing, NGT had issued orders in appeal no.17/2011 (NEAA appeal no.20/2010) on May 23, 2012 as follows:

“As we are convinced that EC to the proposed project was granted by and large in consonance with the EIA process as required under EIA Notification, 2006, we do not feel any necessity to quash the EC granted by MoEF. However, we direct MoEF to review the EC based on the cumulative impact assessment study and stipulate any additional environmental conditions, if required. Updated EIA report may be shared with the Appellants and they may be invited in the EAC meeting and may be heard before a decision is taken by EAC/MoEF, till then the EC shall remain suspended”.

In the order it is further directed that cumulative impact assessment studies be carried out by the Project Proponent especially with regard to the proposed Coal Based Power Plant (2×660 MW) of Cuddalore Power Company Ltd. (CPC), the Nagarjuna Oil Refinery Ltd. (NOCL) and other industrial activities within a radius of 25 km from the Power Project of M/s. IL&FS Tamil Nadu Power Co. Ltd. (3600 MW) and be submitted to MoEF for review of EC accorded on May 31, 2010 in order to stipulate any additional environmental conditions and safeguards required for the protection and preservation of Pichavaram Mangroves and Marine environment.

Hon’ble National Green Tribunal on May 30, 2012 has ordered the following on the appeal by ITPCL seeking relief from its order date May 23, 2012:-

“It is our considered view that the civil works referred to by the applicant may not take very long time to complete if planned and executed properly. The monsoon season in the region where the proposed project is to come up begins generally during late September and **rapid cumulative environmental impact assessment study** can be planned and completed before the onset of monsoon”.

As per Judgement and recommendation of NGT, ITPCL carried out the Rapid Cumulative Impact Assessment considering CPC, NOCL and other industries within a radius of 25 km from the ITPCL power plant site and presented in this report with a request to review for prescribing additional conditions if any to the EC granted on May 31, 2010.

1.1 Project Status

After obtaining CTE, construction activities at the project site commenced in September, 2011. The following are the major initiatives taken by ITPCL:

- Rs. 2,100 crores was invested in the project. At present, civil construction activities were in progress and about 3,000 people were engaged at site.
- Rs. 1 crore was provided to Farmers' Welfare Fund (those farmers who sold land to ITPCL)
- About Rs. 1 crore was spent for establishing Apparel Training Institute and manufacturing centre for rural women. About 100 women folk are getting benefited with regular employment
- Mangrove conservation is being undertaken and about 30,000 saplings have been grown in association with Centre for Advanced Studies in Marine Biology (CASMB), Annamalai University, Parangipettai, Tamil Nadu
- Construction of compound wall for the schools in nearby villages.
- The project would generate a minimum employment for about 15000 during construction phase and 3000 during operation phase.

Also, as part of sustainable initiatives and to comply with the EC conditions, ITPCL had framed Environmental Management Plan (EMP), and started Environmental Monitoring during construction phase in Terrestrial Environment through reputed agencies. The following are the institutions appointed by ITPCL:

- Terrestrial Environmental Monitoring: M/s Vimta Labs, Coimbatore.
- Pichavaram Mangrove Conservation Plan: CASMB, Annamalai University, Parangipettai, Tamil Nadu.

ITPCL appointed IL&FS Environment to provide environmental management services during construction of Thermal Power Plant. Marine and Terrestrial Environmental Monitoring were commenced in May, 2011.

CHAPTER 2:
METHODOLOGY OF RAPID CUMULATIVE ENVIRONMENTAL IMPACT ASSESSMENT

2 Methodology of Rapid Cumulative Environmental Impact Assessment

2.1 Study Objective

The objective of the study is to carry out rapid cumulative environmental impact assessment (RCEIA) study considering the proposed power plant of CPC, the NOCL refinery and other industrial activity within 25 km radius from the ITPCL power plant. The existing/proposed industrial activities within 25 km radius as available for the project proponent and from public domain have been considered for RCEIA study.

2.2 Scope of the Study

The scope of the RCEIA study is as follows:

- Identification of industrial units falling within 25 km radius of project site.
- Assessment of baseline environmental conditions for terrestrial and marine environment within the study area of 25 km based on results of primary surveys carried out by ITPCL for 10 km radius and the primary data generated by other Industrial units located in 25 km radius and other relevant secondary published data.
- Identification and prediction of significant cumulative impact on marine environment, air environment and on the Pichavaram Mangroves due to existing/proposed industries within 25 km radius by using appropriate mathematical models.

2.3 Methodology

The RCEIA study has been carried out considering the impacts associated with ITPCL power plant and existing/proposed industrial units in 25 km radius from the ITPCL power plant on marine and terrestrial environment. The methodology adopted for the study is as follows:

- Information on emission and wastewater discharges from proposed industries was obtained from the respective EIA reports submitted by them to MoEF and TNPCB.
- Meteorological data was collected from LAGAS system for March to June 2011.
- Baseline Ambient Air quality was obtained from various EIA reports and suitably extrapolated using trend line temporally for 2011.
- Air quality modelling was carried out using OCD 5 and ISCST3 models for prediction of maximum ground level concentration and air quality at various receptor locations was arrived using this and baseline ambient air quality.
- Socio-economic data from government departments and EIA reports of the projects was collated and assessed for cumulative impact.
- Marine impact modelling was carried out for the wastewater discharges and marine structures proposed in the study area.
- Compliance to Conditions Stipulated in Environmental Clearance

2.3.1 Industries Existing/Proposed within 25 Km Radius

The following are the industrial units proposed/existing within 25 km radius of study area

- IL&FS Tamil Nadu Power Company Limited (ITPCL)
- 2×660 MW Coal based Thermal Power Plant near Thiyagavalli and Kudikadu villages by Cuddalore Power Company Limited (CPC)

- 6.5 MTPA Oil Refinery at Thiruchopuram village by Nagarjuna Oil Corporation Limited (NOCL).
- Textile Processing park at Periyapattu Village, Cuddalore District by The South Indian Mills Association (SIMA)
- 3×600 MW coal based Thermal Power Plant at Poovali by SRM Energy Limited.
- Chemical and Engineering industries in SIPCOT Phase I and II Industrial Complex
- Good Earth Shipyard Private Limited (GSPL)
- Cuddalore Minor Port

2.3.2 Study Area & Existing Environmental Status

An area within 25 km radius from ITPCL power plant boundary has been earmarked as the study area. The study area map is given as **Figure FD0101.**

The baseline environmental status of the study area was established based on results of primary surveys carried out by ITPCL for 10 km radius and primary data generated by other industrial units located in 25 km radius for their EIA studies. In addition, authenticated secondary data (Source: TNPCB, Fisheries Department, Census of India and Tamil Nadu Maritime Board) was also collected, reviewed and presented.

2.3.3 Terrestrial Baseline Environmental Status and Rapid Cumulative Impact Assessment on Terrestrial Environment

2.3.3.1 Terrestrial environment

The baseline environmental data for terrestrial environment was presented within the study area for following attributes.

- Physical conditions
- Meteorology
- Noise
- Water quality
- Soil
- Ecology

2.3.3.2 Socio-economic aspects

Data on population, literacy and occupation was collected from Census of India, 2001 and presented.

2.3.3.3 Rapid Cumulative Impact Assessment on Terrestrial Environment

The cumulative environmental impact on land environment, water quality, due to increase in noise levels, flora and fauna which are likely to arise due to existing/proposed Industrial units within 25 km radius of ITPCL power plant, have been discussed.

2.3.4 Air Environment: Baseline & Rapid Cumulative Air Quality Impact Modelling and Assessment

2.3.4.1 Ambient Air Quality

Ambient Air Quality in terms of TSPM, SPM, RPM, SO_2, NOx in the study area was discussed.

2.3.4.2 Rapid Cumulative Air Quality Impact Modelling and Assessment

The cumulative environmental impacts which are likely to arise due to existing/proposed industrial units within 25 km radius of ITPCL power plant have been identified. The significant impacts such as the impacts of stack emissions on air quality were predicted using appropriate mathematical model considering the existing baseline environmental conditions.

2.3.5 Marine Baseline Environmental Status and Rapid Cumulative Impact Assessment on Marine Environment

2.3.5.1 Marine Baseline Environmental Status

The marine environmental attributes covering the extent between Near SIPCOT area (Chemplast Sanmar Limited) Cuddalore and south of Pichavaram Mangroves. The marine environment was monitored in terms of:

- Seawater quality
- Sediment quality
- Marine biology (plankton and benthos)

2.3.5.2 Rapid Cumulative Impact Assessment on Marine Environment

The cumulative environmental impacts which are likely to arise due to existing/proposed Industrial units within 25 km radius of ITPCL power plant have been identified. The significant impacts due to discharge of return cooling water/reject brine and other treated industrial effluents on marine environment were predicted using appropriate mathematical model considering the existing baseline environmental conditions.

CHAPTER 3:
DETAILS OF INDUSTRIAL UNITS/ MARINE FACILITIES EXISTING /PROPOSED IN THE STUDY AREA (25.0 KM)

3 Details of Industrial Units/ Marine Facilities Existing /Proposed in the Study Area (25.0 km)

As per the available information in public domain and in accordance with the environmental clearance information, the following are the existing/proposed industries within the radius of 25 km from the project site of ITPCL.

Table 1: Industries Existing/Proposed Within 25 Km Radius of ITPCL

S.No	Name of the Industry	Distance/Direction from ITPCL Boundary	Project Status
I.	**Industries considered as per paragraph 20 of NGT order**		
1	Cuddalore Power Company Limited – 2×660 MW TPP		EC obtained in 2008 and construction not yet started
2	Nagarjuna Oil Refinery		Construction in progress
II.	**Industries which are Existing/ Proposed within 25kms have got Environment Clearance**		
II.A	**EC issued prior to the issuance of EC to ITPCL**		
3	SIMA Textile Processing Park	2.0 km, N	Construction not yet started
4	SIPCOT Phase I and Phase II Industrial Complex – Chemical and engineering industries	14.0 km and 10.4 km N	Existing/Industries are in operation
5	Cuddalore Minor Port	22.0 km, N	Existing/Operation
II.B	**Either EC not issued or issued after issuing EC to ITPCL**		
6	SRM Energy – 3×660 MW TPP	5.5 km, W	EC obtained in 2011 CRZ clearance from MoEF and CTE from TNPCB are yet to be obtained. Construction not yet started.
7	Good Earth Shipyards Limited (GESL)	Adjacent, <1.0 km, N	Yet to obtain EC

The details of each Industrial unit are presented below.

3.1 3600 MW TPP by ITPCL

IL&FS Tamil Nadu Power Company Limited (ITPCL) is in the process of setting up a thermal power plant in Cuddalore District, Tamil Nadu. The ultimate capacity of the power plant will be about 3600 MW (2×600 MW sub-critical technology. and 3×800 MW super critical technology).

Table 2: Salient Features of the ITPCL Project

S.No	Item	Description
	Thermal Power Plant	
1	Capacity	3600 MW
2	Configuration	2×600 MW using Sub-critical Technology and 3×800 MW using Super Critical Technology
3	Technology	Sub-critical and Super Critical Technology
4	Fuel	Imported Coal
5	Fuel Requirement	15 MTPA

S.No	Item	Description
6	Sulphur Content	0.13 %
7	Stack	2×275 m
	Captive Port	
1	Capacity	15 MMTPA
2	Type	All Weather Port
3	No of Berths	Two (mechanised)
4	Length of Breakwaters	North:2,100 m; South: 1,150 m
	Captive Desalination Plant	
1	Capacity	30 MLD
2	Technology	Reverse Osmosis
	General	
1	Intake/ Outfall System	Intake: between breakwaters; outfall: 1500 m from shore
2	Land	1181 Acres
3	Water Requirement/ Discharge	Total seawater required: 34,100 m^3/hr. The total quantity of hot water discharge from the proposed power plant is 25,886 m^3/hr. The total quantity of reject brine from the proposed desalination plant is 2381 m^3/hr.
4	Source	RW: Sea, Potable Water: Proposed Desalination Plant
5	Environmental Aspects	• Higher Calorific Value coal to reduce the consumption • Lower Sulphur and ash percentage coal to reduce the emission • Once through Super Critical technology to minimize the coal consumption and GHG emissions. • Low NOx Burners • ESP to minimize the PM emissions • Stack height of 275 m to get better dispersion. • Dust Control System to minimize the fugitive dust emission. • Fire Protection system • Dust suppression system • High Recovery RO technology to minimise the reject.

3.2 2x660 MW TPP by Cuddalore Power Company Limited (CPC)

CPC is in the process of setting up a thermal power plant in near Thiyagavalli and Kudikadu villages of Cuddalore District, Tamil Nadu. The ultimate capacity of the power plant will be about 1320 MW (2×660 MW super critical technology).

Table 3: Salient Features of the CPC Project

S.No	Item	Description
	Thermal Power Plant	
1	Capacity	1320 MW
2	Configuration	2×660 MW
3	Technology	Super Critical Technology
4	Fuel	Imported Coal
5	Sources of Fuel	Indonesia Mines
6	Fuel Requirement	13680 TPD
7	Sulphur Content	0.7%
8	Stack	1X275 m
	Captive Desalination Plant	
3	Capacity	6 MLD
4	Technology	Reverse Osmosis
	Captive Port	

S.No	Item	Description
5	Capacity	5 MMTPA
6	Type	Open Jetty (Finger Type)
	General	
6	Intake/Outfall System	1 km from shore
7	Land	445 ha
8	Water Requirement/ Discharge	Total seawater required: 12,715 m^3/hr. The total quantity of hot water discharge from the proposed power plant is 8995 m^3/hr. The total quantity of reject brine from the proposed desalination plant is 456.5 m^3/hr.
9	Source	RW: Sea, Potable Water: Proposed Desalination Plant
10	Environmental Aspects	• Higher Calorific Value coal to reduce the consumption • Super Critical technology to minimize the coal consumption and GHG emissions. • Low NOx Burners • ESP to minimize the PM emissions • Stack height of 275 m to get better dispersion. • Dust Control System to minimize the fugitive dust emission. • Fire Protection system • High Concentrated Ash Slurry Disposal (HCSD) system • Dust suppression system • RO technology to minimise the reject.

(Source: CPC EIA Report, 2008)

3.3 6.5 MMTPA Oil Refinery by Nagarjuna Oil Corporation Limited (NOCL)

NOCL is proposing to develop 6.5 MMTPA capacity oil refinery at Thiruchopuram village in the Cuddalore district, Tamil Nadu. The following are the salient features of the NOCL.

Table 4: Salient Features of NOCL Refinery

S.No	Item	Description
1	Capacity	6.5 MMTPA
2	Processing Units	• Crude and Vacuum Distillation Units (Primary) Other Secondary units such as • Pretreater • Reformer • Catalytic Hydro Desulphurization • Isomerisation • MTBE Units • Sulphur and Amine Recovery Units • Diesel Hydro Upgrader • Fluid Catalytic Cracking Unit (FCC) inclusion of FGD • Delayed Coker Unit (DCU)
3	Products	• LPG, Naphtha, MS (Regular and Premium), Jet Fuel, Diesel (Euro III and IV), Furnace Oil, Bitumen, Sulphur, Coke and Fuel Gas/Fuel Oil
4	Number of Stacks	13 Nos.
5	Single Buoy Mooring Facility	For the import of Crude
6	Jetty	For the export of Products
7	Environmental Aspects	• Low NOx Burners • Flue Gas Desulphurisation (FGD) Units

S.No	Item	Description
		• Stack Height as per CPCB norms • Fire Protection System

(Source: NOCL EIA and RA Report, 2012)

3.4 Textile Processing Park by SIMA

The South Indian Mills Association (SIMA) proposes to establish Textile Processing Park at Periyapattu Village in the district of Cuddalore, Tamil Nadu.

Table 5: Salient Features of SIMA Textile Processing Park

S.No	Item	Description
1	Capacity	• 0.3 Million m/ Day of Woven Fabric • 100 MT/day of knitted Fabric
2	Processing Units	• No of Units: 07
3	Products	• Woven/Knit Fabrics
4	Water Requirement	10.95 MLD
5	Source of Water	SIPCOT water supply and groundwater reserves for backup
6	Wastewater Discharge	10.5 MLD to Sea (Actual location is not known)
7	Outfall Location	At a depth of 10 m CD.
8	Fuel for Boilers	Firewood/ Furnace Oil
9	Environmental Aspects	• Effluent Treatment Plant • Sewage Treatment Plant

(Source: SIMA EIA Report, 2005)

3.5 3X600 MW TPP by SRM Energy Limited

SRM Energy Limited is in the process of setting up a thermal power plant in Poovalai village, Cuddalore district, Tamil Nadu. The ultimate capacity of the power plant will be about 1800 MW (3×600 MW sub-critical technology).

Table 6: Salient Features of the SRM Energy Project

S.No	Item	Description
	Thermal Power Plant	
1	Capacity	1800 MW
2	Configuration	3×600 MW
3	Technology	Sub-critical Technology
4	Fuel	Imported Coal
5	Fuel Requirement	1086 TPH
6	Sulphur Content	0.89%
7	Stack	1×275 m
	General	
11	Land	1380 Acre
12	Wastewater Discharge	14465 m^3/hr
13	Source	Bay of Bengal
14	Environmental Aspects	• Low NOx Burners • ESP to minimize the PM emissions • Stack height of 275 m to get better dispersion. • Dust Control System to minimize the fugitive dust emission. • Fire Protection system • Dust suppression system

(Source: SRM Energy EIA Report, 2011)

3.6 Chemical and Engineering Industries in SIPCOT Phase I and II Industrial Complex

The State Industries Promotion Corporation of Tamil Nadu (SIPCOT) industrial complex (Phase I & II) Cuddalore, Tamil Nadu was developed by GoTN in Cuddalore district, Tamil Nadu. There are of the 30 operating Industrial units comprising of dye and dye intermediates, pesticides, basic drugs, pharma, chemical, etc.

Out of this 30 operating units, 17 industries are generating trade effluent. All the industries have individual effluent treatment plant in their premises. Of these, 8 units are provided with additional system to maintain zero discharge of trade effluent. Remaining 9 industries discharges their treated trade effluent into Bay of Bengal. 8 units through CUSECS ***(Cuddalore SIPCOT Industries Common Utilities Limited)*** a common collection, conveyance and disposal facility for marine disposal into sea and another one unit M/s. Clariant Chemicals India Limited discharges the treated effluent directly into marine through a separate pipe line, 1 km into Bay of Bengal.

CHAPTER 4:
TERRESTRIAL BASELINE ENVIRONMENTAL STATUS AND RAPID CUMULATIVE IMPACT ASSESSMENT

4 Terrestrial Baseline Environmental Status and Rapid Cumulative Impact Assessment

The meteorological conditions of the study area and baseline status of the ambient air quality, noise levels, water quality and soil quality in the study area are presented in the following sections.

4.1 Physical Conditions

The physical conditions of the study area are described w.r.t the attributes such as topography, drainage, geology and landuse are discussed in this section.

4.1.1 Drainage

Major water bodies in the study area are Gadilam river, Buckingham Canal, Vellar River, Uppanar River, Coleroon River, Perumal Eri and Bay of Bengal. Vellar River meandering through the southwest, flows through Porto Novo and joins the Bay of Bengal. Celeroon river is flowing towards south and joins the Bay of Bengal in study area. There are canals in the study area which are tributaries to Vellar and Coleroon Rivers. The north-western part of the study area has many small water bodies. The drainage map of the study area (25 km radius from ITPCL plant) is shown in **Figure FD0102**.

4.1.2 Geology

The geological formations of the underlying strata of the study area, located in Cuddalore district comprises of various rock formations, from oldest Archeans to recent sedimentary forms. Sedimentary deposition forms are overlaid by the Archeans form. The geological succession and the geological features of Cuddalore district are given Table 7 below.

Table 7: Geological Succession and Geological Features of Cuddalore District

Era	Age	Formation	Lithology
Quaternary	Recent to Sub Recent	Alluvium & Laterite	Soils, Alluvium, Coastal sands, clays, Kankar and Laterite
-	-	Unconformity	-
Tertiary	Miopliocene	Cuddalore Sandstone	Sandstone – Argillaceous and pebble bearing grits, Clays (variegated) with lignite seams and pebble beds
-	-	Unconformity	-
Cenozoic	Lower Eocene to Palaeocene	Gopurapuram formations	Black clays or shades, grey coloured sandstone, calcareous sandstone, shales and siliceous limestone with fossils
-	-	Unconformity	-
Mesozoic	Upper Cretaceous	Ariyalur	Fossil ferrous and siliceous limestones, Calcareous sandstones clays and marls
-	-	Unconformity	-
Azoic	Archean		Geniss's granites, charnockites and associated acid and basic intrusive

Archeans are observed whereas, cretaceous formations are prominent towards North of Vridhachalam. Gopurapuram formations are characterized by silts, clay stones and calcareous sand stones and algal limestone. Alluvial cover of Gadilam River in the North

and Vellar in the South are prominent formations. Therefore, this difference reflects two detached patterns in the district. The trend of the variations in formation is NNE-SSW.

The geological map of the study area (25 km radius from ITPCL plant) is given as **Figure FD0103**.

4.1.3 Land Use and Land Cover

The landuse/land cover for the study area is determined from a map prepared by using IRS–P6 LISS III data (November 2011), procured from the National Remote Sensing Agency (NRSA), Hyderabad. The satellite data has been processed using ERDAS Imagine software supported with ground checks and ground truth verification. Area and distance calculations were carried out using GIS software after geo-referencing the interpreted data with the help of Toposheets (scale 1:50,000) from Survey of India (SoI).

A map prepared based on the methodology summarized above depicts major landuse/ land cover classes comprising of classes such as agriculture, fallow land, open/degraded vegetation; lands falling under water bodies, marshes, sand beds, open/rocky lands and lands under inhabitations is shown **in Figure FD0104**. The area statistics determined for different land use classes and statistical analysis is given Table 8 below.

Table 8: Landuse Patterns in and Around the Project Site within 25 km Radius

Area Statistics of Landuse / Landcover Map				
Sl.No.	**Class Names**	**Area (In Hectares)**	**Area (In Sq.Km.)**	**Area %**
1	Water Body	965.88	9.66	0.49
2	Open/Barren Land	18166.95	181.67	9.29
3	Agriculture Land	19703.88	197.04	10.07
4	Fallow Land	46985.04	469.85	24.02
5	Open/Degraded Vegetation	12209.31	122.09	6.24
6	Vegetation Medium Density	3773.97	37.74	1.93
7	Plantation/Orchards	99.27	0.99	0.05
8	Scrubs	300.51	3.01	0.15
9	River & Canal	2984.13	29.84	1.53
10	Marshy Land	205.11	2.05	0.10
11	Settlement & Habitation	10887.12	108.87	5.57
12	Sand/Beach	307.35	3.07	0.16
13	Salt Pans	757.35	7.57	0.39
14	Mangrove(Sparse)	24.48	0.24	0.01
15	Mangrove(Dense)	677.7	6.78	0.35
16	Marshy Vegetation	23.58	0.24	0.01
17	Industrial Area	714.15	7.14	0.37
18	Sea	75218.94	752.19	38.45
19	River Bed	954.09	9.54	0.49
20	Seasonal Water Body	307.17	3.07	0.16
21	Wet Land	350.1	3.50	0.18
	Total	**195616.08**	**1956.16**	**100**

4.2 Meteorological Conditions

4.2.1 General Meteorological Conditions

The climatological table for Cuddalore IMD Station Latitude 11^0 46' N and Longitude 79^0 46' E, published by the Indian Meteorological Department (IMD), based on daily observations at 08:30 and 17:30 hr IST for a 30 year period, forms the basis for the following sections on the meteorological conditions at the site. The monthly variations of the relevant meteorological parameters are given in Table 9 below.

Table 9: Climatological Data of Cuddalore

Month	Temperature (^{O}C)		Rainfall (mm)		Relative Humidity (%)		Mean Wind Speed (Kmph)	Predominant Wind Direction (From)	
	Daily Max.	Daily Min	Total	Number of days	0830	1730		08:30*	17:30*
Jan	28.1	20.5	36.7	2.1	84	70	9.3	NE,N	NE,E
Feb	29.3	20.8	9.4	0.8	83	69	7.9	NW,NE,N	NE,E
Mar	31.2	22.6	15.6	0.7	80	70	8.8	NW,SE,W	SE,E
Apr	33.2	25.6	14.0	0.8	75	74	11.2	S,SE	SE,E
May	36.1	26.9	47.2	1.8	68	73	11.8	SW,S	SE,S
Jun	36.8	26.6	43.1	3.2	65	65	10.9	SW,W	SE,SW
Jul	35.3	25.6	82.8	5.9	70	64	9.8	SW,W	SE,SW
Aug	34.5	25.0	150.3	8.1	74	68	9.0	SW,W	SE,SW
Sep	33.7	24.8	123.4	6.1	74	72	8.7	SW,W	SE,SW
Oct	31.5	24.1	273.6	10.4	82	77	6.9	SW,W,N	SE,NE
Nov	29.2	22.6	383.5	10.8	84	76	8.8	NE,N	NE,N
Dec	28.0	21.3	198.5	6.8	84	74	10.8	NE,N	NE,N
Source: IMD Climatological Sheet Published by IMD (1950-1980)									

As per the above climatological table the following are the observations:

- Mean daily maximum temperature is ranged between 28.0^0C to 36.8^0C and the mean daily minimum temperature is ranged between 20.5^0C to 26.9^0C.
- Maximum and minimum relative humidity of 84% and 65% were recorded at 08:30 hours. Maximum and minimum relative humidity of 77% and 64 % were recorded at 17:30.
- Maximum and minimum rainfall of 383.5 mm and 9.4 mm was recorded in the months of November and February.
- Mean wind speed ranged between 6.9 KMPH to 11.8 KMPH

4.2.2 Meteorological Conditions of the Study Area (Year – 2011)

The meteorological conditions for the Year 2011 were collected from Lakes Environment. The seasonal and annual wind pattern is given below:

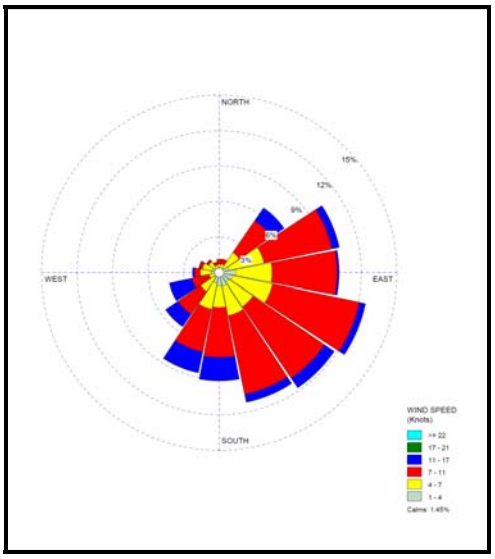


Figure 1: Wind Pattern – Summer

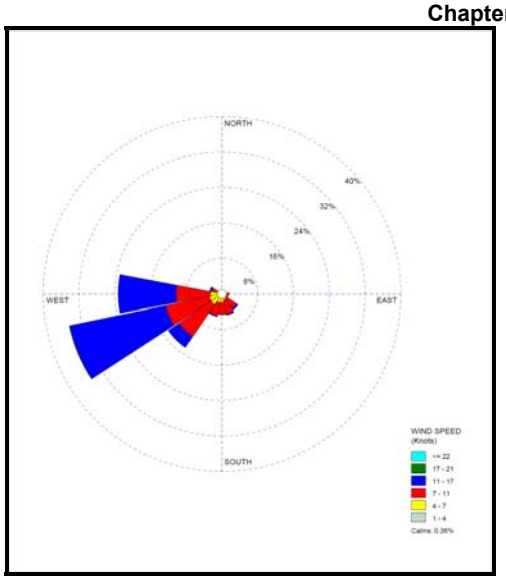


Figure 2: Wind Pattern – SW Monsoon

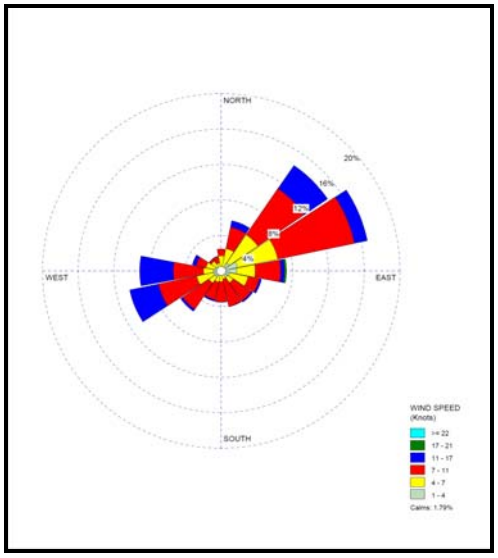


Figure 3: Wind Pattern – NE Monsoon

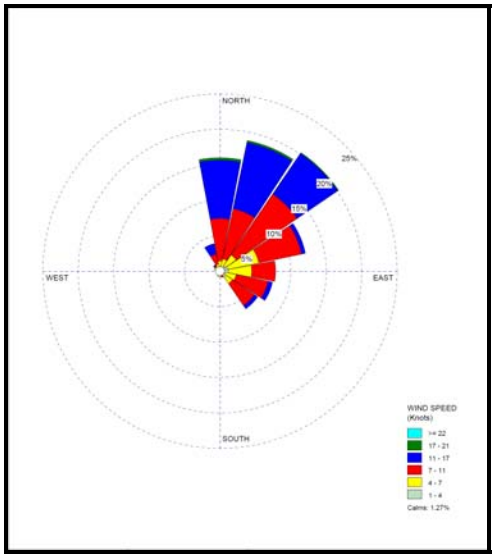


Figure 4: Wind Pattern – Winter

The average wind speed observed from March 2011 to May 2011 (summer) is 3.88 m/s, Average wind speed observed from June 2011 to August 2011 (SW Monsoon) is 5.01 m/s, average wind speed observed from September 2011 to November 2011 (NE Monsoon) is 3.88 m/s and average wind speed observed from December 2011 to February 2011 (winter) is 4.60 m/s.

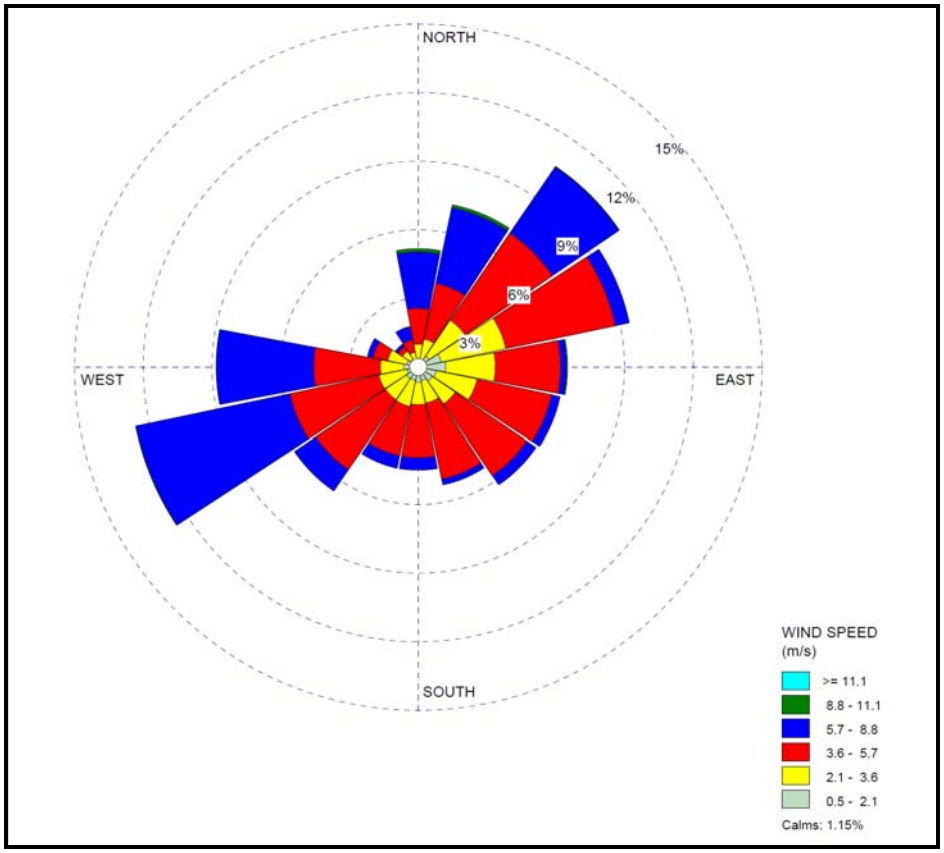


Figure 5: Annual Variation of Wind Pattern

The annual average wind speed is 4.43 m/sec.

4.3 Ambient Noise Levels

4.3.1 Ambient Noise Levels Monitoring Stations

Baseline ambient noise quality has been established by monitoring noise levels at 48 locations. The noise monitoring locations in the study area were selected after giving due consideration to the various land use categories. The land use categories include residential and commercial areas.

A map showing the monitoring locations is shown in **Figure FD0105** and details of the locations are given in Table 10. Noise levels were recorded on an hourly basis for one complete day at each location using pre- calibrated noise levels.

Table 10: Noise Monitoring Locations

S.No.	Location Code	Location Name	Distance from ITPCL boundary	Direction from ITPCL boundary
0-5 km from ITPCL Boundary				
1.	ILN1	Toppiruppu	0.6	W
2.	ILN2	Velingarayampettai	0.7	NNE
3.	ILN3	Chinnur	1	SE
4.	ILN4	Puduchachattram station	1.1	NW
5.	SIN3	Periandikuli	1.1	N

S.No.	Location Code	Location Name	Distance from ITPCL boundary	Direction from ITPCL boundary
6.	ILN5	Vaithiyapalli	1.3	SE
7.	ILN6	Samiyarpettai	2	NNE
8.	ILN7	Silambimangam	2	NNW
9.	ILN8	Porto Novo	2.3	SE
10.	ILN9	Valliyanallur	2.6	WNW
11.	NON17	Madavaipallam	2.6	NE
12.	ILN10	Periyappattu	2.7	NNW
13.	ILN11	Kottattai	3.1	WSW
14.	NON6	Manikollai	3.6	W
15.	SRN1	Pallavattunnan	3.7	WSW
16.	NON16	Andarmulaipallam	3.9	NNW
17.	SIN2	Reddiyarpettai	4.2	NNE
18.	ILN12	Porto Novo Station	4.3	S
19.	NON4	Supammal chatram	4.5	N
20.	NON15	Mettupalayam	4.6	NNW
21.	NON3	Puthiravalli	5	N
5-10 km from ITPCL Boundary				
22.	ILN13	Ayyampettai	5.2	N
23.	ILN14	Sirupalaiyur	5.7	WNW
24.	ILN15	Tanur	5.7	NW
25.	ILN16	Tachchakkadu	6.2	WSW
26.	ILN17	Puvalai	6.9	W
27.	ILN18	Killai	6.9	SSE
28.	NON1	Alapakkam	6.9	NNW
29.	SRN3	Tirttanaggari	7.1	NW
30.	NON2	Periyakuppam	7.5	NNE
31.	NON9	Thiruchopuram	8.4	N
32.	NON8	Thayagavalli	9.1	N
33.	NON5	Palliodai	9.6	SSW
10-15 km from ITPCL Boundary				
34.	NON7	Chitrapettai	10.6	NNE
35.	NON11	Semmankuppam	11	N
36.	CPN1	Naduttittu (Plant Area)	11	N
37.	ILN19	Chidambaram	12	SSW
38.	CPN2	Nachichikadu	12	N
39.	SIN1	Todamanattam	12.2	NNW
40.	SRN4	Tayeilgunam Pattinam	12.8	NW
41.	SRN2	Krishna Puram	13.7	SW
15-20 km from ITPCL Boundary				
42.	CPN3	Valisathanipalayam	16.1	NNW
43.	NON14	Karaikadu	16.2	N
44.	NON13	Pachiyankuppam	17	NNE
45.	NON10	Sangolikuppam	17.6	NW
46.	NON12	Poondiyamkuppam	17.7	N
47.	CPN4	Cuddalore Old Town Market	18.5	NNE
20-25 Km from ITPCL Boundary				
48.	CPN5	Cuddalore Bus Stand	22.4	NNE

4.3.2 Noise Levels Results

Based on the recorded hourly noise levels at each monitoring location, the day equivalent (Leq(d)) and night equivalent (Leq(n)) were calculated and given in below Table 11.

Table 11: Noise Levels in the Study Area

Location Code	Location Name	Representative Zone	Ld dB(A)	CPCB Standard	Ln dB(A)	CPCB Standard
0-5 km from ITPCL Boundary						
ILN1	Toppiruppu	Residential	54.0	55.0	40.0	45.0
ILN2	Velingarayampettai	Residential	49.0	55.0	39.0	45.0
ILN3	Chinnur	School & Sensitive	47.0	50.0	38.0	40.0
ILN4	Puduchachattram station	Commercial	61.0	65.0	46.0	55.0
SIN3	Periandikuli	Residential	Average – 43.0			
ILN5	Vaithiyapalli	Residential	56.0	55.0	44.0	45.0
ILN6	Samiyarpettai	Residential	49.0	55.0	39.0	45.0
ILN7	Silambimangalam	Residential	59.0	55.0	50.0	45.0
ILN8	Porto Novo	Residential	58.0	55.0	43.0	45.0
ILN9	Valliyanallur	Residential	51.0	55.0	35.0	45.0
NON17	Madavaipallam	Residential	Minimum - 42.0 Maximum – 48.0 Average – 45.0			
ILN10	Periyappattu	Commercial	63.0	65.0	51.0	55.0
ILN11	Kottattai	Residential	44.0	55.0	33.0	45.0
NON6	Manikollai	Residential	Minimum - 40.0 Maximum – 47.0 Average – 44.0			
SRN1	Pallavattunnan	Residential	50.7	55.0	41.5	45.0
NON16	Andarmulaipallam	Residential	Minimum - 41.0 Maximum – 50.0 Average – 47.0			
SIN2	Reddiyarpettai	Residential	Average – 44.0			
ILN12	Porto Novo Station	Residential	52.0	55.0	39.0	45.0
NON4	Supammal chatram	Residential	Minimum - 43.0 Maximum – 53.0 Average – 49.0			
NON15	Mettupalayam	Commercial	Minimum - 49.0 Maximum – 61.0 Average – 53.0			
NON3	Puthiravalli	Residential	Minimum - 49.0 Maximum – 62.0 Average – 54.0			
5-10 km from ITPCL Boundary						
ILN13	Ayyampettai	School & Sensitive	48.0	50.0	39.0	40.0
ILN14	Sirupalaiyur	Residential	43.0	55.0	36.0	45.0
ILN15	Tanur	Residential	59.0	55.0	47.0	45.0
ILN16	Tachchakkadu	School & Sensitive	45.0	50.0	35.0	40.0
ILN17	Puvalai	Residential	46.0	55.0	34.0	45.0
ILN18	Killai	Commercial	50.0	65.0	37.0	55.0
NON1	Alapakkam	Residential	Minimum - 43.0 Maximum – 54.0 Average – 50.0			
SRN3	Tirttanaggari	Residential	48.2	55.0	40.1	45.0

Location Code	Location Name	Representative Zone	Ld dB(A)	CPCB Standard	Ln dB(A)	CPCB Standard
NON2	Periyakuppam	Residential	Minimum - 45.0 Maximum – 55.0 Average – 52.0			
NON9	Thiruchopuram	Residential	Minimum - 42.0 Maximum – 55.0 Average – 49.0			
NON8	Thayagavalli	Residential	Minimum - 49.0 Maximum – 63.0 Average – 54.0			
NON5	Palliodai	Residential	Minimum - 42.0 Maximum – 50.0 Average – 49.0			
10-15 km from ITPCL Boundary						
NON7	Chitrapettai	Residential	Minimum - 41.0 Maximum – 51.0 Average – 48.0			
NON11	Semmankuppam	Residential	Minimum - 42.0 Maximum – 53.0 Average – 47.0			
CPN1	Naduttittu (Plant Area)	Industrial	51.2	75.0	48.2	70.0
ILN19	Chidambaram	Commercial	61.0	65.0	50.0	55.0
CPN2	Nachichikadu	Residential	48.9	55.0	46.5	45.0
SIN1	Todamanattam	Residential	Average- 45.0			
SRN4	Tayeilgunam Pattinam	Residential	47.6	55.0	39.5	45.0
SRN2	Krishna Puram	Residential	47.4	55.0	39.4	45.0
15-20 km from ITPCL Boundary						
CPN3	Valisathanipalayam	Residential	48.3	55.0	46.9	45.0
NON14	Karaikadu	Residential	Minimum – 49.0 Maximum – 53.0 Average – 51.0			
NON13	Pachiyankuppam	Residential	Minimum - 46.0 Maximum – 52.0 Average – 49.0			
NON10	Sangolikuppam	Residential	Minimum - 48.0 Maximum – 57.0 Average – 51.0			
NON12	Poondiyamkuppam	Residential	Minimum - 41.0 Maximum – 50.0 Average – 45.0			
CPN4	Cuddalore Old Town Market	Commercial	52.6	65.0	48.6	55.0
20-25 km from ITPCL Boundary						
CPN5	Cuddalore Bust Stand	Commercial	59.6	65.0	54.1	55.0

4.3.3 Inferences

The equivalent values for day and night time noise levels at all locations are within CPCB standards for industrial, residential, commercial and silent zones.

4.3.3.1 Ambient Noise Levels: 0-5 km Radius

- The minimum day equivalent noise levels (L_d) of 44.0 dB(A) was recorded at Kottattai and maximum value of 63.0 dB(A) was recorded at Periyapattu.
- The minimum night equivalent noise levels (L_n) of 33.0 dB(A) was recorded at Kottattai and maximum value of 51.0 dB(A) was recorded at Periyapattu.

4.3.3.2 Ambient Noise Levels: 5-10 km Radius

- The minimum day equivalent noise levels (L_d) of 43.0 dB(A) was recorded at Sirupalaiyur and maximum value of 59.0 dB(A) was recorded at Tanur.
- The minimum night equivalent noise levels (L_n) of 34.0 dB(A) was recorded at Puvalai and maximum value of 47.0 dB(A) was recorded at Tanur.

4.3.3.3 Ambient Noise Levels: 10-15 km Radius

- The minimum day equivalent noise levels (L_d) of 47.4 dB(A) was recorded at Krishna Puram and maximum value of 61.0 dB(A) was recorded at Chidambaram.
- The minimum night equivalent noise levels (L_n) of 39.4 dB(A) was recorded at Krishna Puram and maximum value of 50.0 dB(A) was recorded at Chidambaram.

4.3.3.4 Ambient Noise Levels: 15-20 km Radius

- The minimum day equivalent noise levels (L_d) of 48.3 dB(A) was recorded at Valisathinipaliyam and maximum value of 52.6 dB(A) was recorded at Cuddalore Old Town Market.
- The minimum night equivalent noise levels (L_n) of 46.9 dB(A) was recorded at Valisathinipaliyam and maximum value of 48.6 dB(A) was recorded at Cuddalore Old Town Market

4.3.3.5 Ambient Noise Levels: 20-25 km Radius

- The day equivalent noise levels (L_d) of 59.6 dB(A) and night equivalent noise level (L_n) of 54.1 dB (A) was recorded at Cuddalore Bus Stand.

4.4 Inland Water Quality

4.4.1 Groundwater Sampling Locations

Total Forty two (42) groundwater (GW) monitoring locations monitored data in the study area was presented. Groundwater sample analysis with respect to physico-chemical, nutrient, demand and bacteriological parameters having relevance to public health and aesthetic significance were selected to assess the water quality status with special attention.

Descriptions of sampling locations are given in Table 12 and are shown in **Figure FD0106.**

Table 12: Description of Groundwater Sampling Locations

S.No	Station No.	Location	Distance (Km) from Project Site Boundary	Direction
0-5 km from ITPCL Boundary				
1.	ILG4	Puduchchattram Station	1.3	NW
2.	ILG1	Chinnur	1.6	SE
3.	ILG5	Samiyapettai	1.8	NNE
4.	NOG1	Nayinarkuppam	2.0	N

S.No	Station No.	Location	Distance (Km) from Project Site Boundary	Direction
5.	ILG6	Silambimangalam	2.2	NNW
6.	SRG1	Porto Novo	2.3	SE
7.	ILG2	Vathiyapalli	2.4	SE
8.	SRG2	Periyapattu	2.4	NNW
9.	ILG3	Vellingarayampettai	2.7	NNE
10.	ILG10	Athranadhapuram	3.2	NNE
11.	SRG3	Kottottai	3.2	W
12.	ILG7	C. Manambady	3.6	SSE
13.	NOG2	Vandaiyampalam	3.6	N
14.	ILG9	Palvattunnan	3.8	WNW
15.	ILG8	Periyakummatti	3.9	WSW
16.	NOG3	Kayalpattu	4.8	NNW
5-10 km from ITPCL Boundary				
17.	NOG4	Ayyampettai	5.2	N
18.	NOG5	NOCL Site(North boundary)	5.3	N
19.	NOG6	Poochimedu	5.4	N
20.	ILG14	Allapakkam	5.7	NW
21.	NOG7	Pethankuppam	6.6	N
22.	ILG12	Tanur	6.8	NNW
23.	ILG13	Killai	6.9	SSE
24.	SRG4	Poovalai	6.9	W
25.	ILG11	Ayipuram	7.0	SW
26.	SRG5	Tirttanaggari	7.1	NW
27.	NOG8	Periankuppam	7.5	NNE
28.	NOG9	Srinivasapuram	8.4	NNW
29.	CPG1	Tiruchchpuram village	8.4	NNE
30.	CPG2	Kambilamedu village	8.4	N
31.	NOG10	Thiyagavalli	9.1	N
32.	NOG11	Palladoi	9.6	SSW
10-15 km from ITPCL Boundary				
33.	ILG15	Chidambaram	10.0	SSW
34.	NOG12	Chitrapettai	10.6	NNE
35.	CPG3	Nachikkadu village	12.0	N
36.	SRG6	Kummadimulai	12.6	W
15-20 km from ITPCL Boundary				
37.	CPG4	Kudikadu	15.4	NNE
38.	CPG5	Valichchipalayam village	16.1	NNW
39.	CPG6	Pudukuppam village	16.6	NNW
40.	CPG7	Ramapuram	18.0	NNW

S.No	Station No.	Location	Distance (Km) from Project Site Boundary	Direction
41.	CPG8	Suttukkulam village	18.6	NNE
20-25 km from ITPCL Boundary				
42.	CPG9	Chellankuppam village	22.1	NNE

4.4.2 Groundwater Quality – Results

The result of the groundwater quality is given in the Table 13 below:

Table 13: Groundwater Quality Results

Parameter	Units	Desirable Limit (IS:10500)	Permissible Limit (IS:10500)	0-5 KM		5-10 KM		10-15 KM	
				Max	Min	Max	Min	Max	Min
pH	-	6.5-8.5	No relaxation	8.02	6.80	9.0	6.2	9.1	7.27
Turbidity	NTU	5	10	6.9	0.6	55	0.4	6.7	0.5
Electrical Conductivity	µMho /cm	-	-	2834	449	2247	224	1674	300
Total Dissolved Solids	mg/l	500	2000	2282	271	1317	135	1042	180
Total Alkalinity as $CaCO_3$	mg/l	200	600	639	79	447	80	241	110
Chlorides as Cl^-	mg/l	250	1000	537	19.7	326	15	345	35
Sulphate as SO_4^{-2}	mg/l	200	400	327	7.5	273	0.26	140	10.2
Nitrates as NO_3	mg/l	45	100	27.59	0.5	18	0.2	92.6	1.73
Phosphates as PO_4	mg/l	--	--	1.5	0.14	336	0.14	1.2	0.14
Total Hardness as $CaCO_3$	mg/l	300	600	496	119	544	0.03	321	67
Calcium as Ca	mg/l	75	200	122	9.5	141	40	58	57.6
Magnesium as Mg	mg/l	30	100	90	10.2	146	0.2	35	17.5
Sodium as Na	mg/l	--	--	296	27	295	0.02	141	16
Potassium as K	mg/l	--	--	60	1	45	0.1	42.5	2
Fluorides as F	mg/l	1.0	1.5	0.64	0.27	0.94	0.29	0.45	0.45
Iron as Fe	mg/l	0.3	1.0	1.35	0.11	2.23	0.01	14.9	0.01
Phenolic Compounds as C_6H_5OH	mg/l	0.001	0.002	-	-	-	-	<0.001	<0.001
Cyanides as CN	mg/l	0.05	No relaxation	-	-	-	-	-	-
Residual Free Chlorine	mg/l	0.2	-	-	-	-	-	0.2	0.2
Cadmium as Cd	mg/l	0.01	No relaxation	-	-	0.65	0.008	0.5	0.5
Chromium as Cr^{6+}	mg/l	0.05	No relaxation	0.03	0.03	0.61	0.25	0.59	0.59
Lead as Pb	mg/l	0.05	No relaxation	0.05	0.01	0.61	0.01	0.02	0.02
Zinc as Zn	mg/l	5	15	0.39	0.21	1.07	0.01	0.46	0.03
Manganese as Mn	mg/l	0.1	0.3	1.01	0.01	0.82	0.02	0.17	0.02
Copper as Cu	mg/l	0.05	1.5	0.07	0.01	0.91	0.01	0.02	0.02

Parameter	Units	Desirable Limit (IS:10500)	Permissible Limit (IS:10500)	0-5 KM		5-10 KM		10-15 KM	
				Max	Min	Max	Min	Max	Min
Nickel as Ni	mg/l	-	-	-	-	-	-	-	-
Total Coliforms	MPN/ 100ml	-	-	13	2	9	4	4	4
Faecal Coliforms	-	-	-	-	-	-	-	-	-

Parameter	Units	Desirable Limit (IS:10500)	Permissible Limit (IS:10500)	15-20 KM		20-25 KM
				Max	Min	
pH	-	6.5-8.5	No relaxation	8.7	7.9	8.5
Turbidity	NTU	5	10	4	1	4
Electrical Conductivity	µMho/cm	-	-	1000	210	4643
Total Dissolved Solids	mg/l	500	2000	653	165	3012
Total Alkalinity as $CaCO_3$	mg/l	200	600	182	16	210
Chlorides as Cl^-	mg/l	250	1000	204.2	24.1	964.2
Sulphate as SO_4^{-2}	mg/l	200	400	87.2	1.2	382.7
Nitrates as NO_3	mg/l	45	100	50.5	0.4	66.6
Phosphates as PO_4	mg/l	--	--	--	--	--
Total Hardness as $CaCO_3$	mg/l	300	600	316	68	1000
Calcium as Ca	mg/l	75	200	75.2	16.8	252
Magnesium as Mg	mg/l	30	100	31.1	6.3	89.9
Sodium as Na	mg/l	--	--	68.3	19.7	490
Potassium as K	mg/l	--	--	5.8	1.4	165
Fluorides as F	mg/l	1.0	1.5	-	-	-
Iron as Fe	mg/l	0.3	1.0	0.02	<0.01	0.03
Phenolic Compounds as C_6H_5OH	mg/l	0.001	0.002	<0.001	<0.001	<0.001
Cyanides as CN	mg/l	0.05	No relaxation	-	-	-
Residual Free Chlorine	mg/l	0.2	-	-	-	-
Cadmium as Cd	mg/l	0.01	No relaxation	<0.01	<0.01	<0.01
Chromium as Cr^{6+}	mg/l	0.05	No relaxation	<0.05	<0.05	0.05
Lead as Pb	mg/l	0.05	No relaxation	0.4	0.03	0.05
Zinc as Zn	mg/l	5	15	0.01	0.01	5
Manganese as Mn	mg/l	0.1	0.3	-	-	-
Copper as Cu	mg/l	0.05	1.5	<0.01	<0.01	0.05
Nickel as Ni	mg/l	-	-	-	-	-
Total Coliforms	MPN/100ml	-	-	-	-	-
Faecal Coliforms	-	-	-	-	-	Absent

4.4.2.1 Inferences

- pH is ranged between 6.2 and 9.1
- Electrical Conductivity (EC) varied between 210 µ mhos/cm at and 4643 µ mhos/cm
- Total dissolved solids ranged between 135 mg/l and 3012 mg/l
- Total alkalinity (as $CaCO_3$) varied between 16 mg/l and 639 mg/l
- Total hardness (as $CaCO_3$) ranged between 0.03 mg/l and 1000 mg/l
- Calcium ranged between 9.5 mg/l and 252.0 mg/l
- Chlorides (as Cl^-) ranged between 15 mg/l and 964.2 mg/l
- Fluorides as (F^-) ranged between 0.27 mg/l to 0.94 mg/l
- Sulphates (as SO_4) ranged between 0.26 mg/l and 382.7 mg/l
- Nitrates value ranged between 0.2 mg/l and 92.6 mg/l
- Cadmium (Cd) is ranged between 0.008 mg/l and 0.65 mg/l
- Copper (Cu) is ranged between <0.01 mg/l and 0.9 mg/l
- Manganese (Mn) is ranged between 0.01 mg/l and 1.01 mg/l
- Zinc (Zn) is ranged between 0.01 mg/l and 5.0 mg/l
- Iron (Fe) is ranged between <0.01 mg/l and 14.9 mg/l
- Total Coliforms ranged between 4 MPN/100 ml and 13 MPN/100 ml
- Faecal Coliforms were absent at all locations

Out of the prescribed 34 parameters in Drinking water specification IS: 10500 :1992, the monitored ground water quality exceeds permissible limits in the absence of alternate source for

- TDS at some locations in 0-5 km and locations in 20-25 km
- Calcium at some locations in 20-25 km
- Total hardness at some locations in 20-25 km

4.4.3 Surface Water Quality - Sampling Locations

Total Eleven (11) surface water (SW) monitoring locations monitored data in the study area was presented. Surface water sample analysis with respect to physico-chemical, nutrient, demand and bacteriological parameters having relevance to public health and aesthetic significance were selected to assess the water quality status with special attention.

Descriptions of sampling locations are given in below Table 14 and are shown in **Figure FD0106.**

Table 14: Surface Water Sampling Locations

S.No.	Station No.	Location	Distance (Km) from Project Site Boundary	Direction
0-5 km from ITPCL Boundary				
1.	SRS1	Before confluence of Buckingham Canal	3.0	NNW
2.	SRS2	After confluence of Buckingham Canal	3.2	NNW
3.	ILS1	Vellaru River (near Porto Novo Station)	3.8	S
5-10 km from ITPCL Boundary				
4.	NOS3	Uppanar River Middle stream	5.9	NW
5.	ILS2	Uppanar River(near Alpakkam)	7.0	N
6.	NOS2	Uppanar River	7.4	N

S.No.	Station No.	Location	Distance (Km) from Project Site Boundary	Direction
		Downstream		
7.	ILS3	Perumal Eri (near Krishnapuram)	7.9	NW
8.	NOS1	Uppanar River Upstream	9.5	N
10-15 km from ITPCL Boundary				
9.	CPS2	Sea water behind the plant site	11.7	NNE
15-20 km from ITPCL Boundary				
10.	CPS3	Uppanar River at Tonitturai village	16.2	NNE
20-25 km from ITPCL Boundary				
11.	CPS1	Gidalam River at Chellankuppam Village	21.6	NNE

4.4.4 Surface Water Quality – Results

The result of the surface water quality is given in the below Table 15:

Table 15: Surface Water Quality Results

Parameter	Unit	IS:2296 Class C Limits	0-5		5-10	
			Max	Min	Max	Min
Colour	Hazen units	300	75	4.8	2	1.7
Odour	---	--	-	-	-	-
Taste	---	--	-	-	-	-
Turbidity	NTU	--	98	6.0	4.6	1.1
pH	---	8.5	7.78	7.22	8.5	7.51
Temperature	^{o}C	--	22	-	30	23
Electrical Conductivity	µmhos/cm	--	37692	1305	2530	726
Total Solids	mg/l	--	27289	913	1694	477
Total Hardness as $CaCO_3$	mg/l	--	4720	178	432	163
Total Alkalinity	mg/l	--	277	98	170	98
Iron as Fe	mg/l	50	0.8	0.083	0.8	<0.01
Chlorides as Cl^-	mg/l	600	11524	205	582	71
Residual Free Chlorine	mg/l	--	-	-	<0.02	-
Total Dissolved Solids	mg/l	1500	27110	866	1662	465
Dissolved Oxygen	mg/l	4	3.9	-	5.1	3.7
Calcium as Ca	mg/l	--	305	40	93	74
Magnesium as Mg	mg/l	--	966	19	284	16
Copper as Cu	mg/l	1.5	0.08	BDL	0.06	0.02
Manganese as Mn	mg/l)	--	0.06	0.024	0.2	0.02
Sulphate as SO_4	mg/l	400	2355	60	300	135
Nitrates as NO_3	mg/l	50	32	7.3	7	0.8

Parameter	Unit	IS:2296 Class C Limits	0-5		5-10	
			Max	Min	Max	Min
Free Ammonia as NH_4	mg/l	--	-	-	-	-
Fluorides as F	mg/l	1.5	1.04	0.68	0.52	0.22
Sodium as Na	mg/l	--	12124	-	382	54
Potassium as K	mg/l	--	428	-	5.3	1.0
Phenolic Compounds as C_6H_5OH	mg/l	0.005	-	-	<0.001	-
Chemical Oxygen Demand	mg/l	--	79	15	30	2.2
Biological Oxygen Demand	mg/l	3	3.9	BDL	1.1	BDL
Mercury as Hg	mg/l	--	<0.001	-	<0.001	-
Cadmium as Cd	mg/l	0.01	<0.01	-	0.57	<0.01
Selenium as Se	mg/l	0.05	<0.01	-	<0.01	-
Arsenic as As	mg/l	0.2	<0.05	-	<0.05	-
Cyanides as CN	mg/l	0.05	<0.05	-	<0.05	-
Lead as Pb	mg/l	0.1	0.02	-	0.02	BDL
Zinc as Zn	mg/l	15	0.35	-	0.7	0.12
Anionic detergent as MBAS	mg/l	1	<0.01	-	<0.01	-
Chromium as Cr^{6+}	mg/l	0.05	<0.05	-	0.72	0.46
Total Coliforms	MPN/100ml	5000	24	<1.8	9.0	8.0
Faecal Coliforms	MPN/100ml	--	<1.8	1.0	-	-

Parameter	Unit	IS:2296 Class C Limits	10-15 KM	15-20 KM	20-25 KM
Colour	Hazen	300	17.0	12	18
Odour	---	--	-	-	-
Taste	---	--	-	-	-
Turbidity	NTU	--	-	-	-
pH	---	8.5	8.5	8.5	8.4
Temperature	^oC	--	-	-	-
Electrical Conductivity	µmhos/ cm	--	61420	38250	62102
Total Solids	mg/l	--	-	-	-
Total Hardness as $CaCO_3$	mg/l	--	6450	3950	6850
Total Alkalinity	mg/l	--	150	150	100
Iron as Fe	mg/l	50	0.17	<0.05	0.12
Chlorides as Cl	mg/l	600	19072	10564	18753
Residual Free Chlorine	mg/l	--	-	-	-
Total Dissolved Solids	mg/l	1500	33646	1908	33480
Dissolved Oxygen	mg/l	4	6.3	6.2	5.9

Parameter	Unit	IS:2296 Class C Limits	10-15 KM	15-20 KM	20-25 KM
Calcium as Ca	mg/l	--	420	280	400
Magnesium as Mg	mg/l	--	1312.2	789.8	1421
Copper as Cu	mg/l	1.5	<0.01	<0.01	<0.01
Manganese as Mn	mg/l)	--	-	-	-
Sulphate as SO4	mg/l	400	2043.5	980.6	2071.8
Nitrates as NO3	mg/l	50	1.6	2.4	1.6
Free Ammonia as NH_4	mg/l	--	-	-	-
Fluorides as F	mg/l	1.5	-	-	-
Sodium as Na	mg/l	--	9840	5590	10000
Potassium as K	mg/l	--	420	230	430
Phenolic Compounds as C_6H_5OH	mg/l	0.005	<0.001	<0.01	<0.001
Chemical Oxygen Demand	mg/l	--	-	-	-
Biological Oxygen Demand	mg/l	3	<3	<3	3
Mercury as Hg	mg/l	--	<0.001	<0.001	<0.001
Cadmium as Cd	mg/l	0.01	<0.01	<0.01	<0.01
Selenium as Se	mg/l	0.05	<0.01	<0.01	<0.01
Arsenic as As	mg/l	0.2	<0.01	<0.01	<0.01
Cyanides as CN	mg/l	0.05	-	-	-
Lead as Pb	mg/l	0.1	0.04	<0.07	0.05
Zinc as Zn	mg/l	15	0.04	0.03	0.03
Anionic detergent as MBAS	mg/l	1	-	-	-
Chromium as Cr^{6+}	mg/l	0.05	<0.05	<0.05	<0.05
Total Coliforms	MPN/100ml	5000	632	932	498
Faecal Coliforms	MPN/100ml	--	-	-	-

4.4.4.1 Inferences

- pH is ranged between 7.22 and 8.5
- Electrical Conductivity (EC) varied between 726 µ mhos/cm at and 62102 µ mhos/cm
- BOD ranged between 1.1 mg/l and 3.9 mg/l
- DO ranged between 3.7 mg/l and 6.3 mg/l
- Total dissolved solids ranged between 465 mg/l and 33646 mg/l
- Total alkalinity (as $CaCO_3$) varied between 98 mg/l and 277 mg/l
- Total hardness (as $CaCO_3$) ranged between 163 mg/l and 6850 mg/l
- Calcium ranged between 40 mg/l and 420 mg/l
- Chlorides (as Cl^-) ranged between 71 mg/l and 19072 mg/l

- Fluorides as (F^-) ranged between 0.68 mg/l to 1.04 mg/l
- Sulphates (as SO_4) ranged between 60 mg/l and 2355 mg/l
- Nitrates value ranged between 0.8 mg/l and 32 mg/l
- Cadmium (Cd) is ranged between <0.01 mg/l and 0.57 mg/l
- Copper (Cu) is ranged between <0.01 mg/l and 0.08 mg/l
- Manganese (Mn) is ranged between 0.02 mg/l and 0.2 mg/l
- Zinc (Zn) is ranged between 0.03 mg/l and 0.7 mg/l
- Iron (Fe) is ranged between <0.01 mg/l and 0.8 mg/l
- Total Coliforms ranged between 2 MPN/100 ml and 932 MPN/100 ml
- Faecal Coliforms are <2 MPN/100 ml

It can be observed that the surface water quality in the study area has low organic, faecal coliform and some heavy metal contamination.

4.5 Soil Quality

4.5.1 Soil Quality Monitoring Stations

To understand the existing soil quality of the study area (25.0 km), primary surveys carried out by ITPCL for 10 km radius and primary data generated by other industrial units located in 25 km radius for their EIA studies were collected, analysed and presented.

The soil found in the coastal region is of the erinaceous type (sandy) which is suitable for casuarina plants.

There are 39 monitoring locations reported through different EIA studies in the study area. A map showing the monitoring locations is depicted in **Figure FD0107** and the details of the locations are given in the Table 16.

Table 16: Soil Monitoring Locations

S.No.	Location Code	Location Name	Distance from ITPCL boundary	Distance from ITPCL boundary
0-5 km from ITPCL Boundary				
1.	ILS3	Velingarayampettai	0.7	NNE
2.	ILS1	Chinnur	1.0	SE
3.	SIS3	Andirakulli	1.1	N
4.	ILS2	Vaithiyapalli	1.3	SE
5.	ILS4	Puduchchattram Station	1.3	NW
6.	SIS9	Porto Nova	1.6	S
7.	SRS2	Silambimangalam village	1.8	NW
8.	NOS4	Nayinakuppam	2.0	N
9.	ILS6	Periyapattu	2.7	NNW
10.	SIS1	Gopalpuram	3.0	NNW
11.	SRS3	Kothattai village	3.2	SW
12.	NOS3	Vandiyampalayam	3.6	N
13.	ILS5	Valiiyanallur	4.1	WNW
14.	SIS2	Reddiyapettai	4.2	NNE
5-10 km from ITPCL Boundary				
15.	SIS4	Thachanchavadi	5.1	N
16.	ILS9	Ayyampettai	5.2	N
17.	NOS9	South camp wall (site)	5.3	N
18.	NOS2	Poochimedu	5.8	NNW
19.	ILS7	Tachakhadu	6.2	WSW

S.No.	Location Code	Location Name	Distance from ITPCL boundary	Distance from ITPCL boundary
20.	NOS6	Pethankuppam	6.6	N
21.	ILS8	Puvalai	6.9	W
22.	ILS10	Killai	6.9	SSE
23.	SIS8	Alappakam	6.9	NNW
24.	SIS5	Theerthanagari	7.0	NW
25.	SRS1	SRM Project area	7.4	WSW
26.	NOS1	Periankuppam	7.5	NNE
27.	SIS7	Perumal Eri	8.2	WNW
28.	CPS6	Kambalimedu	8.4	N
29.	ILS11	Tanur	8.2	NW
30.	NOS7	Thiyagavalli	9.1	N
31.	NOS5	Palliyodai	9.6	SSW
32.	ILS12	Chidambaram	9.9	SSW
10-15 km from ITPCL Boundary				
33.	NOS8	Chittrapettai	10.6	NNE
34.	SIS6	Thondamanatham	12.2	NNW
35.	CPS5	CPC-Plant site	12.9	NNE
15-20 km from ITPCL Boundary				
36.	CPS3	Kudikkadu	15.4	NNE
37.	CPS1	Valichchipalayam	16.1	NNW
38.	CPS4	Pudukkuppam	16.6	NNW
39.	CPS2	Suttukkulam	18.6	N

4.5.2 Soil Quality Results

Soil analysis results are given in below Table 17.

Table 17: Soil Analytical Results

S.No.	Location Code	Particle Size Distribution			Soil Texture	Colour	pH	EC (µmhos/ cm)	Bulk Density (gm/cm^3)	Water Holding Capacity %	Sodium Absorption Ratio
		Sand (%)	Silt (%)	Clay (%)							
0-5 km from ITPCL Boundary											
1.	ILS3	34.08	42.14	23.77	Loamy Sand	Brown	7.41	112	1.34	32.4	2
2.	ILS1	32.71	53.19	14.08	Loamy Sand	Brown	7.57	132	1.38	32.14	1.82
3.	SIS3	88	11	1	Sand	-	-	-	-	-	-
4.	ILS2	36.46	48.7	14.83	Loamy Sand	Dark Brown	9.04	104	1.31	30.2	2.02
5.	ILS4	30.35	46.7	22.94	Loamy Sand	Brown	6.81	287	1.44	34.1	2.3
6.	SIS9	73	26	1	Clay Sand	-	-	-	-	-	-
7.	SRS2	72	16	12	Sandy Loam	-	8.1	0.07 ms/cm	-	-	-
8.	NOS4	89	4	7	Sandy	Ash grey	6.2	1.6 dS/cm	1.23	14.9	-
9.	ILS6	40.73	40.3	18.96	Loamy Sand	Dark Brown	6.7	108	1.37	32.75	2.08
10.	SIS1	94	5	1	Sand	-	-	-	-	-	-
11.	SRS3	70	15	15	Sandy Loam	-	7.7	0.04 ms/cm	-	-	-
12.	NOS3	90	3	7	Sandy	Light brown	5.9	2.7 dS/cm	1.30	15.2	-
13.	ILS5	41.29	42.18	16.52	Loamy Sand	Brown	7.57	106	1.39	31.65	1.96
14.	SIS2	99	1	0	Sand	-	-	-	-	-	-
5-10 km from ITPCL Boundary											
15.	SIS4	95	4	1	Sand	-	-	-	-	-	-
16.	ILS9	41.86	40.77	17.36	Loamy Sand	Dark Black	8.36	132	1.41	31.44	2.08
17.	NOS9	92	4	4	Sandy	Light brown	6.7	0.2 dS/cm	1.33	14.7	-
18.	NOS2	86	4	10	Loamy Sand	Greyish brown	6.3	1.6 dS/cm	1.06	18.6	-
19.	ILS7	41.43	43.7	14.855	Loamy Sand	Black	7.96	103	1.38	36.44	1.98
20.	NOS6	90	1	9	Sandy	Brown	6.9	0.3	1.41	14.6	-

S.No.	Location Code	Particle Size Distribution			Soil Texture	Colour	pH	EC (µmhos/ cm)	Bulk Density (gm/cm^3)	Water Holding Capacity %	Sodium Absorption Ratio
		Sand (%)	Silt (%)	Clay (%)							
								dS/cm			
21.	ILS8	41.21	46.14	12.64	Loamy Sand	Red	7.21	111	1.37	29.8	1.9
22.	ILS10	22.46	34.51	43.02	Loamy Sand	Black	7.42	184			
23.	SIS8	71	28	1	Clay Sand	-	-	-	-	-	-
24.	SIS5	86	13	1	Sand						
25.	SRS1	10	60	30	Silty Clay	-	8.1	0.21 ms/cm	-	-	-
26.	NOS1	90	3	7	Sandy	Light brown	7.4	0.3 dS/cm	1.44	14.1	-
27.	SIS7	99	1	0	Sand	-	-	-	-	-	-
28.	CPS6	46	6	48	Sandy Clay	-	7.8	501	1.2	-	0.32
29.	ILS11	33.44	44.55	21.99	Loamy Sand	Brown	7.75	137	1.34	30.14	
30.	NOS7	90	1	9	Sandy	Dark Brown	6.3	0.3 ds/cm	1.26	13.2	-
31.	NOS5	88	3	9	Loamy Sand	Greyish brown	6.7	3.7 dS/cm	1.23	18.5	-
32.	ILS12	21.43	30.47	48.08	Loamy Sand	Black	7.49	174	1.42	15.44	2.12
10-15 km from ITPCL Boundary											
33.	NOS8	94	2	4	Sandy	Light brown	7.4	0.43 ds/cm	1.64	13.0	-
34.	SIS6	97	2	1	Sand	-	-	-	-	-	-
35.	CPS5	49	14	37	Sandy Clay		7.0	183	1.2	-	0.32
15-20 km from ITPCL Boundary											
36.	CPS3	31	33	36	Sandy Clay	-	7.8	747	1.2	-	0.47
37.	CPS1	44	10	46	Sandy Clay	-	7.5	270	1.3	-	0.22
38.	CPS4	45	11	44	Sandy Clay	-	8.1	320	1.3	-	0.28
39.	CPS2	46	12	42	Sandy Clay	-	7.5	275	1.1	-	0.27

S.No.	Location Code	Available N	Available P	Available K	Cd	Cr	Cu	Fe	Mn	Pb	Zn
0-5 km from ITPCL Boundary											
1.	ILS3	-	11.04 (mg/100gm)	18 (mg/100gm)	<0.01 (mg/kg)	0.05 (mg/kg)	0.55 (mg/kg)	910 (mg/kg)	0.21 (mg/kg)	0.08 (mg/kg)	-
2.	ILS1	-	12.3 (mg/100gm)	19 (mg/100gm)	<0.01 (mg/kg)	0.05 (mg/kg)	0.6 (mg/kg)	1510 (mg/kg)	0.2 (mg/kg)	0.08 (mg/kg)	-
3.	SIS3	-	-	-	0.96 (mg/l)	910.5 (mg/l)	12.8 (mg/l)	4.18 (%)	660.5 (mg/l)	20.5 (mg/l)	9.8 (mg/l)
4.	ILS2	-	9.8 (mg/100gm)	17 (mg/100gm)	<0.01 (mg/kg)	0.06 (mg/kg)	0.52 (mg/kg)	1970 (mg/kg)	0.18 (mg/kg)	0.05(mg/kg)	-
5.	ILS4	-	13.8 (mg/100gm)	16 (mg/100gm)	<0.01 (mg/kg)	0.08 (mg/kg)	0.42 (mg/kg)	438 (mg/kg)	0.30 (mg/kg)	0.04 (mg/kg)	-
6.	SIS9	-	-	-	0.97 (mg/l)	947.2 (mg/l)	16.8 (mg/l)	5.73 (%)	928.4 (mg/l)	14.9 (mg/l)	16.2 (mg/l)
7.	SRS2	45 (kg/Acre)	18 (kg/Acre)	260 (kg/Acre)	-	-	0.9 (ppm)	16 (ppm)	0.4 (ppm)	-	0.6 (ppm)
8.	NOS4	29.25 (Kg/Ha)	300 (Kg-ha)	36.00 (Kg/Ha)	0.1 (mg/kg)	0.1 (mg/kg)	0.02 (mg/kg)	0.15(mg/kg)	0.19(mg/kg)	0.12(mg/kg)	0.63 (mg/kg)
9.	ILS6	-	11.4 (mg/100gm)	15 (mg/100gm)	<0.01 (mg/kg)	0.03 (mg/kg)	0.39 (mg/kg)	1442 (mg/kg)	0.2 7 (mg/kg)	0.05 (mg/kg)	-
10.	SIS1	-	-	-	0.14 (mg/l)	259.6 (mg/l)	12.4 (mg/l)	6.56 (%)	749.2(mg/l)	15.6 (mg/l)	11.6 (mg/l)
11.	SRS3	42 (kg/Acre)	18 (kg/Acre)	60 (kg/Acre)	-	-	0.9 (ppm)	22 (ppm)	0.2 (ppm)	-	0.8 (ppm)
12.	NOS3	12.9 (kg/Ha)	183.1 (kg/Ha)	45 (kg/Ha)	0.1 (mg/kg)	0.1 (mg/kg)	0.07 (mg/kg)	0.6 (mg/kg)	0.35 (mg/kg)	0.93 (mg/kg)	0.56 (mg/kg)
13.	ILS5	-	9.92 (mg/100gm)	19 (mg/100gm)	<0.01 (mg/kg)	0.04 (mg/kg)	0.33 (mg/kg)	721 (mg/kg)	0.24 (mg/kg)	0.05 (mg/kg)	-
14.	SIS2	-	-	-	0.83 (mg/l)	872.5 (mg/l)	14.2 (mg/l)	3.69 (%)	621.6 (mg/l)	18.5 (mg/l)	10.4 (mg/l)
5-10 km from ITPCL Boundary											
15.	SIS4	-	-	-	0.83 (mg/l)	222.1 (mg/l)	12.8 (mg/l)	3.96 (%)	551.5 (mg/l)	18.4 (mg/l)	10.4 (mg/l)
16.	ILS9	-	12.72 (mg/100gm)	19 (mg/100gm)	<0.01 (mg/kg)	0.03 (mg/kg)	0.31 (mg/kg)	717 (mg/kg)	0.52 (mg/kg)	0.07 (mg/kg)	-

S.No.	Location Code	Available N	Available P	Available K	Cd	Cr	Cu	Fe	Mn	Pb	Zn
17.	NOS9	7.05 (kg/Ha)	113.25 (kg/Ha)	24 (kg/Ha)	0.1 (mg/kg)	0.1 (mg/kg)	0.03 (mg/kg)	0.92(mg/kg)	0.18 (mg/kg)	0.5 (mg/kg)	0.14 (mg/kg)
18.	NOS2	25.05 (kg/Ha)	169.39 (kg/Ha)	84 (kg/Ha)	0.1 (mg/kg)	0.1 (mg/kg)	0.02 (mg/kg)	0.16 (mg/kg)	0.54 (mg/kg)	0.5 (mg/kg)	0.4 (mg/kg)
19.	ILS7	-	12.1 (mg/100gm)	20 (mg/100gm)	<0.01 (mg/kg)	0.04 (mg/kg)	0.41 (mg/kg)	728 (mg/kg)	0.24 (mg/kg)	0.05 (mg/kg)	-
20.	NOS6	6.75 (kg/Ha)	130.65 (kg/Ha)	40.5 (kg/Ha)	0.1 (mg/kg)	0.1 (mg/kg)	0.09(mg/kg)	0.18 (mg/kg)	0.35(mg/kg)	0.33 (mg/kg)	0.09 (mg/kg)
21.	ILS8	-	14.1 (mg/100gm)	20 (mg/100gm)	<0.01 (mg/kg)	0.02 (mg/kg)	0.29 (mg/kg)	488 (mg/kg)	0.26 (mg/kg)	0.04 (mg/kg)	-
22.	ILS10	-	14.92 (mg/100gm)	18 (mg/100gm)	<0.01 (mg/kg)	0.06 (mg/kg)	0.57 (mg/kg)	426 (mg/kg)	0.41 (mg/kg)	0.04 (mg/kg)	-
23.	SIS8	-	-	-	0.47 (mg/)	269.2 (mg/)	13.6 (mg/l)	3.55 (%)	774.5 (mg/l)	17.1 (mg/l)	9.8 (mg/l)
24.	SIS5				0.46 (mg/l)	167.5 (mg/l)	13.5 (mg/l)	0.72(%)	147.4 (mg/l)	19.7 (mg/l)	6.6 (mg/l)
25.	SRS1	62 (Kg/Acre)	9 (Kg/Acre)	285 (kg/Acre)	-	-	1.8 (ppm)	34 (ppm)	2.5 (ppm)	-	0.5 (ppm)
26.	NOS1	3.9 (kg/Ha)	96.3 (kg/Ha)	28.5 (kg/Ha)	0.1 (mg/kg)	0.1 (mg/kg)	0.01 (mg/kg)	0.82 (mg/kg)	0.26 (mg/kg)	0.1 (mg/kg)	0.22 (mg/kg)
27.	SIS7	-	-	-	0.34 (mg/l)	575.7 (mg/l)	13.8 (mg/l)	4.57 (%)	798.5 (mg/l)	14.9 (mg/l)	6.6 (mg/l)
28.	CPS6	78.5 (kg/Ha)	59.8 (kg/Ha)	76.8 (kg/Ha)	-	-	-	-	136 (mg/kg)	-	15.8 (mg/Kg)
29.	ILS11	-	13.8 (mg/100gm)	21 (mg/100gm)	<0.01 (mg/kg)	0.05 (mg/kg)	0.52 (mg/kg)	1638 (mg/kg)	0.45 (mg/kg)	0.08 (mg/kg)	-
30.	NOS7	9.75 (kg/Ha)	216.3 (kg/Ha)	121.5 (kg/Ha)	0.1 (mg/kg)	0.1 (mg/kg)	0.03 (mg/kg)	0.11(mg/kg)	0.55 (mg/kg)	0.25 (mg/kg)	1.17 (mg/kg)
31.	NOS5	16.95 (kg/Ha)	165.45 (kg/Ha)	87 (kg/Ha)	0.1 (mg/kg)	0.1 (mg/kg)	0.02 (mg/kg)	0.33 (mg/kg)	0.29 (mg/kg)	0.17 (mg/kg)	0.93 (mg/kg)
32.	ILS12	-	11.82 (mg/100gm)	20 (mg/100gm)	<0.01 (mg/kg)	0.04 (mg/kg)	0.57 (mg/kg)	334 (mg/kg)	0.29 (mg/kg)	0.03 (mg/kg)	-
10-15 km from ITPCL Boundary											
33.	NOS8	8.7	157.5	46.5 (kg/Ha)	0.1	0.1	0.04	0.21	0.34 (mg/kg)	0.22	1.24

S.No.	Location Code	Available N	Available P	Available K	Cd	Cr	Cu	Fe	Mn	Pb	Zn
		(kg/Ha)	(kg/Ha)		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)		(mg/kg)	(mg/kg)
34.	SIS6	-	-	-	0.25 (mg/l)	464.5 (mg/l)	13.6 (mg/kg)	7.04 (%)	924.6 (mg/l)	13.2 (mg/l)	8.4 (mg/l)
35.	CPS5	63.4 (kg/Ha)	40.6 (kg/Ha)	76.8 (kg/Ha)	-	-	-	-	91.5 (mg/kg)	-	11.3 (mg/Kg)
15-20 km from ITPCL Boundary											
36.	CPS3	129 (kg/Ha)	28.1 (kg/Ha)	187 (kg/Ha)	-	-	-	-	630 (mg/kg)	-	11.4 (mg/kg)
37.	CPS1	74.5 (kg/Ha)	170 (kg/Ha)	155 (kg/Ha)	-	-	-	-	164 (mg/kg)	-	10.5 (mg/kg)
38.	CPS4	57.6 (kg/Ha)	33.2 (kg/Ha)	333 (kg/Ha)	-	-	-	-	164 (mg/kg)	-	9.4 (mg/kg)
39.	CPS2	38.2 (kg/Ha)	96.3 (kg/Ha)	140 (kg/Ha)	-	-	-	-	126(mg/kg)	-	10.4 (mg/kg)

4.5.2.1 Inferences

- Available Nitrogen concentration varied between 3.9 Kg/Ha at Periankuppam (NOS1) and 155 Kg/Ha at SRM Project Area (SRS1).
- Available Phosphorus concentration varied between 28.1 Kg/Acre at Kudikkadu (CPS3) and 300 Kg/Ha at Nayinakuppam (NOS4).
- Available Potassium concentration varied between 24 Kg/Ha at South Compound Wall Site (NOS9) and 712 Kg/Ha at SRM Project Area (SRS1)
- Soil types are sandy, Loamy Sand, Sandy Clay at maximum number of locations during the study area.
- pH of soils ranged between 5.9 at Vandiyampalayam (NOS3) and 9.04 at Vaithiyapalli (ILS2) indicating slightly acidic to alkaline nature
- Electrical Conductivity varied between 103 µmhos/cm at Tachakhadu (ILS7) and 747 µmhos/cm at Kudikkadu (CPS3)
- Bulk Density varied between 1.06 gm/cc at Poochimedu (NOS2) and 1.64 gm/cc at Chittrapettai (NOS8)
- Water Holding Capacity varied between 13% at Chittrapettai (NOS8) and 36.44 % at Tachakhadu (ILS7)

4.6 Flora and Fauna

The Flora and Fauna survey (Annexure 1) carried out for ITPCL Project covering 10 km radius and survey carried out for other EIA projects in the 25.0 km radius is reviewed and presented in this Chapter.

4.6.1 Vegetation of the Study Area

Basically, the vegetation of the area could be classified under three categories viz., (i) the coastal sands and beach; (ii) the Mangroves and (iii) the Inland vegetation.

The coastal sands beyond high tide level have been brought under plantations of *Casuarina equisetifolia*. The natural vegetation is mostly represented by the sand binders such as the *Ipomoea pes-tigridis (Ipomoea biloba*), *Spinifex littoreus, Pandanus fascicularis, Prosopis juliflora, Tamarix alba,* etc. The coastal sands further beyond the HTL are colonized by isolated populations of palatable and nonpalatable weeds and grasses. A comparative list of plant species found in the core and buffer areas is given in ***Table 1 & 2 of Annexure 1***.

The inland vegetation is represented by crops, weeds, roadside vegetation and vegetation of the wastelands. As there are no forests, typical forest elements are very rare. A comparative list of plant species found in the core and buffer areas is given in ***Table 1 & 2 of Annexure 1***.

There are no endangered plants present in the study area. Other than the Pichavaram mangrove forests there are no ecologically sensitive areas in the project area

4.6.2 Mangroves (Pichavaram) the Study Area

Mangroves are a group of salt tolerant plant species that occur in the Tropical and subtropical intertidal estuarine regions, sheltered coast lines and creeks and are dominated by partly submerged sclerophyllous plant species that are taxonomically unrelated. Mangroves constitute a dynamic ecosystem with a complex association of species, both of

flora and fauna, of terrestrial and aquatic systems and the vegetation presents an evergreen type with varied life forms. Mangroves stabilize loose soil and detritus, act as a filter for land runoffs, prevent sea erosion and protect the hinterland from tidal surges, cyclonic storms and high velocity winds. Mangroves have four major functions

- Help in soil formation by trapping debris.
- Serve as a sieve for rich organic soil washed down through river systems into sea.
- Provide appropriate ecosystem and refuge for fish, marine invertebrates, mollusc and birds.
- They contribute detritus enhancing the productivity of the ecosystem.

Mangroves have different mechanisms for salinity tolerance. Some species store the salt in older leaves and others secrete the excessive salts through excretory glands. Root system of Mangroves also shows a number of adaptations to suit the salt marsh habitat. Some mangrove genera like *Rhizophora* have 'aerial' or 'prop' or 'stilt roots' and genera like Avicennia possess 'pneumatophores' or 'breathing roots'. Another important adaptation is Viviparous seedlings (germinating of seeds into seedlings while attached to the parental plant) and dispersal of seedling through water. In India there are 59 species of mangroves under 41 genera and 20 families. In Tamil Nadu mangrove vegetation is mainly seen in Pichchavaram. It covers an area of about 14 sq km of dense mangrove vegetation.

There are 16 genera 22 species of mangroves belonging to 13 families are found in the Pichavaram Mangrove forest, a small part of which extends in to the buffer zone of the project site. A list of Mangroves found in the Pichchavaram Mangrove forest is given in ***Table 3 of Annexure 1***.

4.6.3 Terrestrial Fauna of the Study Area

Check lists of terrestrial vertebrates are prepared based on direct observations as well as from the authentic secondary data from published scientific reports. A list of amphibians either spotted or reported from the study area is given in ***Table 4 of Annexure 1.*** Similarly, the reptiles and birds are presented in ***Table 5 & 6 of Annexure 1*** respectively. The mammals of the area are shown in ***Table 7 of Annexure 1***. A list of butterflies is given in ***Table 8 of Annexure 1***.

A perusal of the lists reveals the following:

- None of the animal species belong to either rare or endangered or endemic or threatened (REET) category.
- There are no biosphere reserves or sanctuaries or national parks or other protected areas within the 25 km radius of the project site.
- Only Pichavaram reserve forest of mangroves falls within the 25 km radius of the project site.

4.7 Socio-Economic Conditions

The socio-economic profile of the project influence area was established through compilation of data provided in 2001 census for assessing the 25.0 km radius (study area) area profile. The study area majorly falls under Cuddalore District and a small part falls under Nagapattinam District. The socio-economic data of study area is discussed in this section.

4.7.1 Population Characteristics

The Project Influence Area (PIA) covers a total population of 2657901. The population details of the villages falling in the study area are presented in Table 18..

Table 18: Population Details in Study Area

S. No	Name of the Village	Population		Total
		Male	Female	
0- 2km from Project Site				
1	Parangipettai (TP)	10177	10735	20912
2 - 5 km from Project Site				
2	Gopalapuram	1211	1161	2372
3	Kumarapettai	202	195	397
4	Silambimangalam	2593	2660	5253
5	U.Agaram	2453	2076	4529
5 – 7 km from Project Site				
6	Punjimangattuvalkkai	248	233	481
7	Mattur	1847	1826	3673
8	Tachchakkadu	901	862	1763
9	Killai (TP)	4892	5007	9899
10	Vallam	1722	1639	3361
11	Sendirakillai	1009	991	2000
12	Puvalai	873	871	1744
13	Alamelumangapuram	195	205	400
14	Sirupalaiyur	432	454	886
15	Tanur	969	940	1909
16	Pettai	441	419	860
17	Ayipettai	791	784	1575
18	B.Maduvankarai	650	650	1300
7 – 10 km from Project Site				
19	Adivaraganallur	1086	1099	2185
20	Agaram	2511	2445	4956
21	Agaram	1103	1212	2315
22	Agaram	701	635	1336
23	Alamelumangapuram	195	205	400
24	Alappakkam	505	526	1031
25	Idankondambattu	816	846	1662
26	Kambalimedu	1480	1418	2898
27	Kuriyamangalam	1195	1192	2387
28	Mutlur	2349	2361	4710
29	Nakkaravanthangudi	787	809	1596
30	Sattappadi	802	802	1604
31	Tillaividagan	1551	1562	3113
32	Tiruchchepuram	2028	1927	3955
10 – 15 km from Project Site				
33	Kanakkarapattu	542	583	1125
34	Sivapuri	1144	1173	2317
35	Chidambaram	3407	2369	5776
36	Kannangudi	940	877	1817
37	Budarayampettai	1347	1374	2721
38	Alambadi	1009	956	1965
39	Krishnapuram (Vada)	641	596	1237
40	Krishnapuram (Then)	530	499	1029
41	Jayankondam	480	487	967
42	Nathamedu	839	894	1733
43	Ellaikudi	284	263	547
44	Kummadimulai	873	780	1653
45	Kothavacheri	795	757	1552
46	Kummadimulai	873	780	1653
47	Guruvappanpettai	402	406	808
48	Aduragaram	1521	1526	3047
49	Virupakshi	2233	2243	4476

S. No	Name of the Village	Population		Total
		Male	Female	
50	Adurkuppam	357	332	689
51	Peddunayakkankuppam	1270	1237	2507
52	Kesavanarayanapuram	495	505	1000
53	Tayilgunampattinam	1090	1098	2188
54	Ayikuppam	249	232	481
55	Tambipettai	383	400	783
56	Thambipalayam	938	905	1843
57	Toppukollai	398	371	769
58	Anukkambattu	1065	1050	2115
59	Kodandaramapuram	1638	1499	3137
60	Sembankuppam	1427	1381	2808
61	Thondamanatham	155	130	285
62	Sedappalayam	2319	2240	4559
15 – 20 km from Project Site				
63	Achalpuram	485	466	951
64	Vadakkumangudi	745	768	1513
65	Nanjalur	1116	1108	2224
66	Sengalmedu	164	155	319
67	Pungudi	244	231	475
68	Edayanpalacheri	441	391	832
69	Mathuranthaganallur	881	882	1763
70	Palayancherthangudi	368	351	719
71	Sakkangudi	755	744	1499
72	Orathur	574	546	1120
73	Kilavadinatham	322	305	627
74	Siyappadi	294	289	583
75	Uluttur	579	567	1146
76	Prasannaramapuram	259	293	552
77	Ambapuram	622	636	1258
78	Thalaikulam (Then)	118	129	247
79	Thalaikulam (Vada)	1582	1556	3138
80	Maruvay	962	917	1879
81	Arangamangalam	970	960	1930
82	Kurinjipadi	641	633	1274
83	Rajakuppam	888	852	1740
84	Kilur	3037	2853	5890
85	Poiganatham	240	253	493
86	Vengadampettai	2223	2155	4378
87	Koranapattu	2119	1975	4094
88	Krishnankuppam	1100	1124	2224
89	Madanagopalapuram	868	871	1739
90	Puliyur	1488	1442	2930
91	Vellakarai	3988	3874	7862
92	karaikkadu	2635	2636	5271
93	Pachchyankuppam	4046	4065	8111
94	Ponnaiyankuppam	21	24	45
95	Ramapuram	3419	3258	6677
96	Ramapuram	2001	1879	3880
97	Vettukkulam	1162	90	1252
98	Kumarapettai	202	195	397
20 – 25 km from Project Site				
99	Vettakudi	588	568	1156
100	Puthur (Terkunadu)	488	468	956
101	Nandimangalam	622	610	1232
102	Meyyathur	489	513	1002
103	Chettikkattalai	310	313	623

S. No	Name of the Village	Population		Total
		Male	Female	
104	Mugaiyur	495	487	982
105	Sirugalur	384	430	814
106	T.Manalur	272	296	568
107	Manakkudaiyaniruppu	139	157	296
108	Ayyanurakkaramangalam	788	814	1602
109	Tharasur	392	385	777
110	Devangudi	396	380	776
111	Odakakkanalur	491	529	1020
112	Velliyakudi	312	326	638
113	Paradur	1511	1489	3000
114	Erumbur	1670	1667	3337
115	Karunguli	2346	2336	4682
116	Vadalur (TP)	13134	12882	26016
117	Vadakuthu	3335	3158	6493
118	Vadakkumelur	1413	1421	2834
119	Vegakollai	3470	3215	6685
120	Ayipettai	791	784	1575
121	Marungur	2757	2619	5376
122	Purangani	1115	1091	2206
123	Silambinathanpettai	2620	2502	5122
124	Kilmambattu	3387	3276	6663
125	Naduvirappattu	4608	4353	8961
126	Marungur	2757	2619	5376
127	Vilangalpattu	1259	1205	2464
128	Chennappanayakkanpalayam	3720	3650	7370
129	Mavadipalayam	161	161	322
130	Vanamadevi	911	886	1797
131	Otteri	305	314	619
132	Kilarungunam	1510	1492	3002
133	Kilakuppam	685	698	1383
134	Sundaravandi	681	632	1313
135	Ariyirundamangalam	106	104	210
136	Agaram	2511	2445	4956
137	Natham	1526	1449	2975
138	Karaiyeravittakuppam	694	668	1362
139	Karuppadithundu	389	379	768
140	Kondur	2581	2585	5166
141	Cuddalore	1150908	1134487	2285395
142	T.Neduncheri	948	1002	1950
	Total	**1339893**	**1318008**	**2657901**

4.7.2 Occupational Pattern

Details of main, marginal and non-workers are given in Table 19.

Table 19: Occupation Details in Study Area

S. No	Name of the Village	Main Workers					Marginal Workers	Non Workers
		Cult.	Agri. Labourers	HH Industry	Other than HH Industry	Total		
0-2 km from Project Site								
1	Parangipettai (TP)	174	492	238	3906	4810	852	15250

S. No	Name of the Village	Main Workers					Marginal Workers	Non Workers
		Cult.	Agri. Labourers	HH Industry	Other than HH Industry	Total		
2 - 5 km from Project Site								
2	Gopalapuram	338	479	10	54	881	178	1313
3	Kumarapettai	10	37	4	73	124	10	263
4	Silambimangalam	274	751	103	857	1985	319	2949
5	U.Agaram	477	492	42	315	1326	548	2655
5 - 7 km from Project Site								
6	Punjimangattuvalkkai	17	181	5	30	233	4	244
7	Mattur	362	1094	50	264	1770	121	1782
8	Tachchakkadu	175	298	19	101	593	338	832
9	Killai (TP)	216	1031	31	1994	3272	924	5703
10	Vallam	115	24	30	379	548	598	2215
11	Sendirakillai	168	61	7	116	352	651	997
12	Puvalai	123	9	8	87	227	608	909
13	Alamelumangapuram	27	116	1	33	177	27	196
14	Sirupalaiyur	81	37	2	12	132	425	329
15	Tanur	150	284	6	137	577	306	1026
16	Pettai	15	340	1	69	425	4	431
17	Ayipettai	231	134	11	47	423	167	985
18	B.Maduvankarai	4	11	0	58	73	709	518
7 - 10 km from Project Site								
19	Adivaraganallur	287	452	7	150	896	148	1141
20	Agaram	227	1595	16	189	2027	655	2274
21	Agaram	222	125	11	126	484	487	1344
22	Agaram	222	153	2	103	480	155	701
23	Alamelumangapuram	27	116	1	33	177	27	196
24	Alappakkam	24	235	2	107	368	157	506
25	Idankondambattu	80	723	1	59	863	29	770
26	Kambalimedu	131	886	28	144	1189	168	1541
27	Kuriyamangalam	170	402	16	124	712	390	1285
28	Mutlur	260	341	66	321	988	1022	2700
29	Nakkaravanthangudi	53	313	24	121	511	98	987
30	Sattappadi	107	435	12	151	705	59	840
31	Tillaividagan	172	540	29	248	989	535	1589
32	Tiruchchepuram	67	417	30	584	1098	271	2586
10 - 15 km from Project Site								
33	Kanakkarapattu	104	61	1	111	277	117	731
34	Sivapuri	96	177	1	302	576	220	1521
35	Chidambaram	62	74	15	1010	1161	280	4335
36	Kannangudi	68	310	1	80	459	366	992
37	Budarayampettai	280	255	3	138	676	665	1380
38	Alambadi	756	486	6	28	1276	8	681
39	Krishnapuram (Vada)	103	219	5	80	407	126	704
40	Krishnapuram (Then)	205	54	10	29	298	126	605
41	Jayankondam	59	206	6	24	295	203	469
42	Nathamedu	6	3	3	95	107	803	823
43	Ellaikudi	96	204	5	10	315	0	232
44	Kummadimulai	356	350	21	48	775	85	793
45	Kothavacheri	81	204	1	48	334	359	859
46	Kummadimulai	356	350	21	48	775	85	793
47	Guruvappanpettai	159	308	0	31	498	2	308
48	Aduragaram	179	384	7	141	711	934	1402
49	Virupakshi	100	726	98	242	1166	877	2433

S. No	Name of the Village	Main Workers					Marginal Workers	Non Workers
		Cult.	Agri. Labourers	HH Industry	Other than HH Industry	Total		
50	Adurkuppam	11	273	4	32	320	0	369
51	Peddunayakkankuppam	126	397	126	45	694	696	1117
52	Kesavanarayanapuram	17	489	1	8	515	22	463
53	Tayilgunampattinam	119	218	71	231	639	557	992
54	Ayikuppam	81	97	1	19	198	0	283
55	Tambipettai	74	303	1	60	438	8	337
56	Thambipalayam	146	181	30	63	420	584	839
57	Toppukollai	125	42	3	23	193	0	576
58	Anukkambattu	162	235	1	53	451	489	1175
59	Kodandaramapuram	101	830	3	369	1303	280	1554
60	Sembankuppam	80	211	2	220	513	618	1677
61	Thondamanatham	8	148	0	14	170	3	112
62	Sedappalayam	183	348	87	452	1070	647	2842
15 - 20 km from Project Site								
63	Achalpuram	22	61	3	50	136	367	448
64	Vadakkumangudi	248	278	8	80	614	44	855
65	Nanjalur	86	116	56	94	352	662	1210
66	Sengalmedu	25	79	8	19	131	28	160
67	Pungudi	3	282	0	6	291	1	183
68	Edayanpalacheri	185	10	0	18	213	239	380
69	Mathuranthaganallur	61	12	4	90	167	585	1011
70	Palayancherthangudi	11	297	4	54	366	17	336
71	Sakkangudi	81	292	29	131	533	116	850
72	Orathur	56	75	4	208	343	57	720
73	Kilavadinatham	81	54	1	45	181	1	445
74	Siyappadi	5	4	0	17	26	227	330
75	Uluttur	30	3	2	48	83	503	560
76	Prasannaramapuram	6	4	2	21	33	204	315
77	Ambapuram	37	2	1	70	110	269	879
78	Thalaikulam (Then)	13	71	4	10	98	0	149
79	Thalaikulam (Vada)	269	637	23	138	1067	172	1899
80	Maruvay	244	294	30	121	689	402	788
81	Arangamangalam	556	377	60	93	1086	9	835
82	Kurinjipadi	164	192	7	50	413	133	728
83	Rajakuppam	75	654	29	85	843	33	864
84	Kilur	944	277	34	363	1618	1634	2638
85	Poiganatham	13	265	0	45	323	3	167
86	Vengadampettai	177	303	22	166	668	1304	2406
87	Koranapattu	640	519	29	141	1329	993	1772
88	Krishnankuppam	109	699	80	177	1065	82	1077
89	Madanagopalapuram	191	229	9	74	503	412	824
90	Puliyur	368	1308	19	72	1767	5	1158
91	Vellakarai	812	551	81	209	1653	2814	3395
92	karaikkadu	170	460	39	582	1251	809	3211
93	Pachchyankuppam	66	169	151	2081	2467	475	5169
94	Ponnaiyankuppam	8	2	0	0	10	22	13
95	Ramapuram	1680	295	23	225	2223	924	3530
96	Ramapuram	575	512	19	90	1196	697	1987
97	Vettukkulam	0	0	0	276	276	3	973
98	Kumarapettai	10	37	4	73	124	10	263
20 – 25 km from Project Site								
99	Vettakudi	144	57	1	30	232	441	483

S. No	Name of the Village	Main Workers					Marginal Workers	Non Workers
		Cult.	Agri. Labourers	HH Industry	Other than HH Industry	Total		
100	Puthur (Terkunadu)	28	213	47	77	365	4	587
101	Nandimangalam	1	3	1	83	88	616	528
102	Meyyathur	51	25	15	120	211	244	547
103	Chettikkattalai	0	1	2	51	54	246	323
104	Mugaiyur	68	339	0	48	455	33	494
105	Sirugalur	47	186	4	18	255	113	446
106	T.Manalur	71	57	2	33	163	72	333
107	Manakkudaiyaniruppu	1	2	1	2	6	158	132
108	Ayyanurakkaramangalam	15	212	6	94	327	430	845
109	Tharasur	62	106	3	37	208	101	468
110	Devangudi	85	227	0	31	343	1	432
111	Odakakkanalur	126	214	5	35	380	14	626
112	Velliyakudi	38	80	0	28	146	164	328
113	Paradur	87	526	2	191	806	552	1642
114	Erumbur	196	804	19	307	1326	141	1870
115	Karunguli	285	1026	96	293	1700	211	2771
116	Vadalur (TP)	822	1440	85	4329	6676	1847	17493
117	Vadakuthu	369	258	6	388	1021	1667	3805
118	Vadakkumelur	112	51	17	342	522	359	1953
119	Vegakollai	792	350	35	265	1442	943	4300
120	Ayipettai	231	134	11	47	423	167	985
121	Marungur	973	341	16	291	1621	675	3080
122	Purangani	276	144	169	94	683	377	1146
123	Silambinathanpettai	744	225	18	154	1141	947	3034
124	Kilmambattu	680	780	63	227	1750	1537	3376
125	Naduvirappattu	663	914	433	824	2834	983	5144
126	Marungur	973	341	16	291	1621	675	3080
127	Vilangalpattu	335	207	3	50	595	617	1252
128	Chennapanayakkanpalayam	353	1260	315	552	2480	462	4428
129	Mavadipalayam	43	39	1	20	103	4	215
130	Vanamadevi	58	683	26	70	837	91	869
131	Otteri	16	0	1	60	77	258	284
132	Kilarungunam	259	1288	30	103	1680	18	1304
133	Kilakuppam	42	375	13	109	539	6	838
134	Sundaravandi	58	9	3	44	114	532	667
135	Ariyirundamangalam	2	2	1	6	11	141	58
136	Agaram	227	1595	16	189	2027	655	2274
137	Natham	228	348	12	97	685	737	1553
138	Karaiyeravittakuppam	11	94	1	177	283	239	840
139	Karuppadithundu	20	285	7	26	338	94	336
140	Kondur	80	116	41	945	1182	516	3468
141	Cuddalore	163445	266458	20485	279376	729764	243302	1312329
142	T.Neduncheri	32	1	14	159	206	399	1345
	Total	**190475**	**311983**	**24174**	**311781**	**838413**	**296195**	**1523298**

4.7.3 Literacy

Details of literacy in project influence area are given in Table 20.

Table 20: Literacy Details in Study Area

S. No	Name of the Village	Lit. Male	Lit. Female	Total
0 - 2 km from Project Site				
1	Parangipettai (TP)	7937	7155	15092
2- 5 km from Project Site				
2	Gopalapuram	906	624	1530
3	Kumarapettai	142	83	225
4	Silambimangalam	1750	1301	3051
5	U.Agaram	1849	1061	2910
5 – 7 km from Project Site				
6	Punjimangattuvalkkai	172	123	295
7	Mattur	1233	876	2109
8	Tachchakkadu	547	377	924
9	Killai (TP)	3240	2422	5662
10	Vallam	1212	585	1797
11	Sendirakillai	654	443	1097
12	Puvalai	603	413	1016
13	Alamelumangapuram	138	88	226
14	Sirupalaiyur	227	161	388
15	Tanur	680	501	1181
16	Pettai	307	216	523
17	Ayipettai	572	402	974
18	B.Maduvankarai	448	385	833
7 – 10 km from Project Site				
19	Adivaraganallur	794	525	1319
20	Agaram	1504	948	2452
21	Agaram	712	534	1246
22	Agaram	518	291	809
23	Alamelumangapuram	138	88	226
24	Alappakkam	388	284	672
25	Idankondambattu	395	291	686
26	Kambalimedu	923	632	1555
27	Kuriyamangalam	779	591	1370
28	Mutlur	1705	1281	2986
29	Nakkaravanthangudi	606	475	1081
30	Sattappadi	507	393	900
31	Tillaividagan	1177	917	2094
32	Tiruchchepuram	1399	901	2300
10 – 15 km from Project Site				
33	Kanakkarapattu	406	358	764
34	Sivapuri	883	681	1564
35	Chidambaram	3032	1824	4856
36	Kannangudi	667	433	1100
37	Budarayampettai	896	562	1458
38	Alambadi	678	383	1061
39	Krishnapuram (Vada)	465	326	791
40	Krishnapuram (Then)	389	262	651
41	Jayankondam	312	175	487
42	Nathamedu	492	370	862
43	Ellaikudi	182	96	278
44	Kummadimulai	578	381	959
45	Kothavacheri	569	390	959
46	Kummadimulai	578	381	959
47	Guruvappanpettai	320	224	544
48	Aduragaram	1063	707	1770
49	Virupakshi	1573	1085	2658
50	Adurkuppam	227	110	337

S. No	Name of the Village	Lit. Male	Lit. Female	Total
51	Peddunayakkankuppam	802	533	1335
52	Kesavanarayanapuram	277	161	438
53	Tayilgunampattinam	677	414	1091
54	Ayikuppam	193	149	342
55	Tambipettai	296	216	512
56	Thambipalayam	615	406	1021
57	Toppukollai	283	175	458
58	Anukkambattu	624	404	1028
59	Kodandaramapuram	1203	819	2022
60	Sembankuppam	930	669	1599
61	Thondamanatham	128	94	222
62	Sedappalayam	1588	1152	2740
15 – 20 km from Project Site				
63	Achalpuram	347	231	578
64	Vadakkumangudi	506	365	871
65	Nanjalur	792	580	1372
66	Sengalmedu	134	94	228
67	Pungudi	193	113	306
68	Edayanpalacheri	307	187	494
69	Mathuranthaganallur	692	537	1229
70	Palayancherthangudi	296	203	499
71	Sakkangudi	538	383	921
72	Orathur	481	395	876
73	Kilavadinatham	211	109	320
74	Siyappadi	205	149	354
75	Uluttur	467	326	793
76	Prasannaramapuram	214	167	381
77	Ambapuram	459	300	759
78	Thalaikulam (Then)	76	57	133
79	Thalaikulam (Vada)	1101	740	1841
80	Maruvay	650	458	1108
81	Arangamangalam	617	440	1057
82	Kurinjipadi	453	303	756
83	Rajakuppam	568	346	914
84	Kilur	1815	1037	2852
85	Poiganatham	150	90	240
86	Vengadampettai	1438	899	2337
87	Koranapattu	1324	735	2059
88	Krishnankuppam	830	614	1444
89	Madanagopalapuram	526	309	835
90	Puliyur	962	564	1526
91	Vellakarai	2294	1284	3578
92	karaikkadu	1687	1208	2895
93	Pachchyankuppam	2733	2112	4845
94	Ponnaiyankuppam	8	4	12
95	Ramapuram	2328	1506	3834
96	Ramapuram	1336	845	2181
97	Vettukkulam	967	69	1036
98	Kumarapettai	142	83	225
20 – 25 km from Project Site				
99	Vettakudi	426	258	684
100	Puthur (Terkunadu)	383	322	705
101	Nandimangalam	470	404	874
102	Meyyathur	373	293	666
103	Chettikkattalai	259	216	475
104	Mugaiyur	360	238	598
105	Sirugalur	267	239	506

S. No	Name of the Village	Lit. Male	Lit. Female	Total
106	T.Manalur	203	183	386
107	Manakkudaiyaniruppu	114	109	223
108	Ayyanurakkaramangalam	480	360	840
109	Tharasur	289	206	495
110	Devangudi	295	210	505
111	Odakakkanalur	347	267	614
112	Velliyakudi	214	170	384
113	Paradur	1055	764	1819
114	Erumbur	1252	853	2105
115	Karunguli	1663	1113	2776
116	Vadalur (TP)	10179	7836	18015
117	Vadakuthu	2208	1261	3469
118	Vadakkumelur	863	475	1338
119	Vegakollai	2479	1289	3768
120	Ayipettai	572	402	974
121	Marungur	1801	1005	2806
122	Purangani	826	421	1247
123	Silambinathanpettai	1669	866	2535
124	Kilmambattu	2336	1232	3568
125	Naduvirappattu	3177	2015	5192
126	Marungur	1801	1005	2806
127	Vilangalpattu	712	424	1136
128	Chennappanayakkanpalayam	2553	1804	4357
129	Mavadipalayam	117	49	166
130	Vanamadevi	543	346	889
131	Otteri	186	111	297
132	Kilarungunam	1039	721	1760
133	Kilakuppam	499	341	840
134	Sundaravandi	523	360	883
135	Ariyirundamangalam	48	32	80
136	Agaram	1504	948	2452
137	Natham	702	327	1029
138	Karaiyeravittakuppam	507	368	875
139	Karuppadithundu	207	105	312
140	Kondur	2093	1859	3952
141	Cuddalore	820726	599762	1420488
142	T.Neduncheri	709	609	1318
	Total	**951964**	**689327**	**1641291**

4.8 Rapid Cumulative Impact Assessment on Land, Water Quality, Noise and Terrestrial Ecology

4.8.1 Impact on Land Environment

Land is one of the most essential requirements for construction and operation of various developmental projects. Such developmental projects would cause direct as well as indirect impacts on land environment. The direct impacts due to proposed development projects would change existing land use / land cover of the site identified for proposed projects, disposal of solid waste if any on to the land, etc. The changes in land use/ land cover is expected due to the construction of structures required for industrial units, site levelling, reclamation and other utility developments.

However ITPCL project development is planned in such a way that the existing drainage pattern would not be disturbed.

The shoreline/coastline changes such as erosion/accretion is usually expected due to the construction of marine structures such as breakwaters, groynes, etc. The natural setting if disturbed by construction of breakwaters or dredging a channel to deepen locally the seabed, causes imbalance in sand movement along the coast. Mathematical model studies were carried out considering the existing and proposed marine structures in the study area and the details are discussed in subsequent section.

The spent oils and lubricants / waste oils and hazardous waste likely to be generated due to the proposed projects shall be handled and disposed as per Hazardous Wastes (Management and Handling) Rules Amendment – 2003 published by MoEF, Govt. of India.

The non-hazardous solid waste and municipal solid waste which is likely to be generated from the proposed projects shall be used as manure in greenbelt area or even for reclamation of low lying areas as per MoEF guidelines in consultation with TNPCB.

Industries shall follow mitigation measures prescribed in the EIA report and shall comply with the environmental clearance conditions.

4.8.2 Impact on Water Environment

The impact on water environment is envisaged due to sourcing of water from the existing water resources, due to discharge of wastewater into the water bodies, letting of contaminated storm water into the drainage system and stagnation of wastewater within industry premises.

As MoEF is not permitting extraction of groundwater in this region for industrial use, groundwater resource would not be depleted. Moreover, as rain water harvesting is made mandatory by MoEF, TNPCB and other regulatory agencies, artificial recharge carried out by industries and other projects would increase leading to improvement in the groundwater resource both in terms of increased availability and enhanced quality.

To minimise the impacts from wastewater and runoff generated from industrial activities, proper wastewater collection, treatment, drainage system shall be adopted so that the contaminated water does not flow into the natural water bodies or into the groundwater system. The sewerage system shall be provided to collect the sewage from townships, canteen and operation buildings and it shall be treated in proposed sewage treatment plant of respective industries.

Industries existing in the study area adopt zero discharge and some industries have marine outfall facilities, in the same way proposed industries also have plan for marine disposal of treated wastewater, return cooling water and reject brine. Mathematical model studies were carried out considering the marine outfall facilities of various existing and proposed industries and the details are discussed in subsequent section.

As there would be proper storage and disposal of solid and hazardous wastes and reuse of ash, there would not be groundwater and surface water contamination.

Industries shall follow mitigation measures prescribed in the EIA report and shall comply the environmental clearance conditions.

4.8.3 Impact due to Increase in Noise Levels

Noise generating sources are rotating, moving and handling equipment and vehicular movement. Major noise generating equipment shall be designed with 75 dB(A) ensuring cumulative noise at a distance of 1m remains at 75 dB(A). Noise will also be generated considerably from the warehouse, repair and maintenance block, service area, goods loading and unloading points. The occupational noise exposure to the workers in the form of 8 hourly time weighted average shall be maintained within the prescribed OSHA standard limits/ Factories Act and Rules.

Noise attenuation would be practised for noisy equipment by employing suitable techniques such as acoustic controls, insulation and vibration dampers. The attenuation devices shall be properly maintained. It shall be ensured that the threshold noise levels stipulated by Central Pollution Control Board (CPCB) for daytime are not exceeded during the industrial operations. Workers exposed to excessive noise will use appropriate PPE including ear plugs, muffs, or both when engineering or administrative controls are not feasible to reduce exposure.

Industries shall follow mitigation measures prescribed in the EIA report and shall comply the environmental clearance conditions.

Noise levels at the boundaries of the different project sites would be well within limits prescribed under The Noise Pollution (Regulation and Control) Rules, 2000.

4.8.4 Impact on Terrestrial Ecology

Clearance of vegetation is anticipated due to proposed industries. However, there are no endangered plant or animal species present in the study area. Other than the Pichavaram mangrove forests there are no ecologically sensitive areas in the project area. Pichavaram mangroves are located at 9.5 km south of ITPCL power plant stack and the other industries existing/proposed in the study area are located towards north/west of ITPCL power plant.

The stack emissions are envisaged from the proposed industries and also observed from the existing industries within 25 km radius of ITPCL plant. In order to predict the impact due to stack emissions of various industries on Pichavaram mangroves, mathematical modelling studies were carried out.

Similarly, impact on Pichavaram mangroves due to discharge of return cooling water, reject brine, treated wastewater of various industries and construction of coastal structures was assessed. Mathematical model studies were carried out to predict the impact associated and results are presented in the subsequent sections.

As a part of EMP, ITPCL has proposed a conservation plan in association with CAS, Annamalai University and mangrove conservation is being undertaken and about 30000 saplings have been grown.

4.8.5 Socio-economic Assessment

The growth of industrial sectors and infrastructure developments in and around rural communities invariably creates an impact on the social and economic fabric of the area. The qualitative and quantitative impacts of a project a study was assessed base on key data

collected from available reports of the various projects in the area. The key impacts that were assessed, based on the cumulative plans of the various projects in the project area, are:

- Livelihood due to land acquisition and coastal infrastructure
- Other Social and Economic aspects

Impact on Livelihood: As per the data collected, the workers in the area number 11,34,603, which is about 42% of the total population. Of this, the most vulnerable are the marginal workers whose number is around 2,96,195. Keeping this in view, the projects have by and large kept provisions for using suitable local manpower in their projects. The manpower requirement for some of the projects is listed Table 21 below:

Table 21: Employment Generation from Some Proposed Projects in Study area

Project	Total
ITPCL	Construction Phase: 15000 Operation Phase: 3000
CPC	Construction phase: 2000 (mostly unskilled) Operation Phase: 500 (mostly skilled)
NOCL	Construction phase: 1500 to 2000
Goodearth	1500 direct employment and 6000 indirect employment

Based on above data, the manpower requirement for the ITPCL, CPCL and NOCL projects would be around 19,000 persons during the construction page. Extrapolating it to cover SRM, Goodearth and SIMA projects, it is expected that around 30,000 persons would be required during the construction phase. Similarly, ITPCL, NOCL and Goodearth have projected a requirement of 5,000 persons during the operation phase. Extrapolating this to cover NOCL, SRM and SIMA, the employment potential is expected to be over 7,000 persons during the operation phase.

These projects are also expected create opportunities for indirect employment which are likely to be 3 to 4 times the direct employment potential. Further, it is expected that with the coming of projects like ITPCL, the infrastructure and power availability in the area would improve fuelling multi-fold economic and employment growth in the area.

In addition, all the projects have proposed to undertake skill development in their area, similar to the program suggested by ITPCL, including:

- To setup Skill Development Training Institute to provide vocational training in a professional manner and to develop highly trained workforce that suits the requirement of proposed project.
- Structured training programmes will be conducted to enable both new entrants and less experience workers in the power industry progressively improve their skill levels, knowledge and competency

Other Social and Economic Aspects: The various projects would bring in around Rs. 33,387 crores, of which ITPCL itself would bring in 20,390 crores, with the other project investments as given below:

1. CPC: 6,004 crores
2. ITPCL: 20,390 crores

3. NOCL: 2,850 crores
4. SRM: 9,045 crores
5. SIMA: 450 crores
6. Goodearth: 300 Crores

It is expected that with the infusion of such investment the area would be economically benefited, as this would throw up a number of opportunities including:

- New jobs created during both the construction and operation phase of the projects for both skilled and unskilled labour.
- General growth in commercial and industrial activity driven by the requirements generated during the construction and operation phases of the various projects
- Growth in civil amenities like medical facilities, markets, educational institutions, sports and cultural activities, etc.
- Infrastructure enhancements like roads, drinking water, solid waste, sewage and drainage systems, transport and communications facilities, etc.

In addition, the projects have been directed by MoEF and have committed to earmark substantial funds towards development of the area around the project site. The total funds allocated by some of the projects as part of their CSR program, based on available information is as given in Table 22 below:

Table 22: CSR Commitment of Some Industries in the Study Area

Budget	ITPCL	SRM	CPC	Total
One Time	80 crores	36.18		116.18 crores
Annual Outlay	16 crores	7.24 Crores	0.75 Crores	23.99 crores

One of the focus areas of the CSR programs is setting up of Fishermen Endowment Funds and Fish Landing and Ice Plants for upliftment of the fishing community, which have been identified as one of the vulnerable communities in the area.

CHAPTER 5:
AIR ENVIRONMENT: BASELINE & RAPID CUMULATIVE AIR QUALITY IMPACT MODELLING AND ASSESSMENT

5 Air Environment: Baseline & Rapid Cumulative Air quality Impact Modelling and Assessment

5.1 Ambient Air quality reported in Study Area

To understand the existing ambient air quality of the study area (25.0 km), primary surveys carried out by ITPCL for 10 km radius and Primary data generated by Other Industrial units located in 25 km radius for their EIA studies were collected, analysed and presented.

5.1.1 Ambient Air Quality Monitoring Stations

To evaluate the baseline air quality of the study area, 40 monitoring locations have been identified through different EIA studies carried out by ITPCL and other industries within 25 km radius. A map showing the monitoring locations is depicted in **Figure FD0108** and the details of the locations are given in the Table 23.

Table 23: Ambient Air Monitoring Locations

S.No.	Location Code	Location Name	Distance from ITPCL boundary (Km)	Direction from ITPCL boundary
0-5 km from ITPCL Boundary				
1.	ILA1	Toppiruppu	0.6	WSW
2.	ILA4	Velingarayampettai	0.7	NNE
3.	ILA2	Chinnur	1.0	SE
4.	SIA6	Andakkuli	1.1	N
5.	ILA3	Vaithiyapalli	1.3	SE
6.	SIA3	Pudhuchathiram	1.3	W
7.	ILA6	Samiyarpettai	2.0	NNE
8.	ILA7	Silambimangalam	2.0	NNW
9.	ILA5	Porto Novo	2.3	SE
10.	NOA8	Villiyanallur	2.6	W
11.	ILA8	Periyappattu	2.7	NNW
12.	SIA1	Gopalapuram	3.0	NNW
13.	SRA1	Kotthattai	3.2	W
14.	NOA3	Manikollai	3.6	W
15.	SRA2	Pallavattunnan	3.7	WWS
16.	SIA5	Reddiyarpettai	4.2	NNE
17.	ILA9	Porto Novo Station	4.3	S
18.	NOA7	Supammal chatram	4.5	N
19.	NOA6	Puthiravalli	5.0	N
5-10 km from ITPCL Boundary				
20.	ILA13	Ayyampettai	5.2	N
21.	ILA11	Sirupalaiyur	5.7	WNW
22.	ILA10	Tachchakkadu	6.2	WSW
23.	CPA5	Anaiyarpettai	6.3	NNW
24.	ILA12	Puvalai	6.9	W
25.	ILA14	Killai	6.9	SSE
26.	SIA2	Alpakkam	6.9	NNW
27.	SRA4	Tirttanaggari	7.1	NW
28.	NOA5	Periyakuppam	7.5	NNE
29.	NOA1	Pathirikuppam	8.1	NNE
30.	NOA2	Thiruchopuram	8.4	N
31.	CPA2	Tiyagavalli	9.1	N
32.	NOA9	Palliodai	9.6	SSW
10-15 km from ITPCL Boundary				

S.No.	Location Code	Location Name	Distance from ITPCL boundary (Km)	Direction from ITPCL boundary
33.	NOA4	Chitrapettai	10.6	NNE
34.	ILA15	Chidambaram	12.0	SSW
35.	CPA1	Nachichikadu	12.0	N
36.	SIA4	Thonodamanatham	12.2	NNW
37.	SRA5	Tayeilgunam Pattinam	12.8	NW
38.	SRA3	Krishna Puram	13.7	SW
15-20 km from ITPCL Boundary				
39.	CPA3	Kudikkadu	15.4	NNE
40.	CPA4	Rosapettai	16.2	NNE

5.1.2 Ambient Air Quality Results

Table 24: Ambient Air Quality Results

S.No.	Location Code	SPM/TSPM (µg/m^3)			RPM (µg/m^3)			SO_2 (µg/m^3)			NOx (µg/m^3)		
		Min	Max	98%	Min	Max	98%	Min	Max	98%	Min	Max	Avg/ 98%
0-5 km from ITPCL Boundary													
1.	ILA1	85.0	106.0	105	15.0	22.0	22.0	5.0	6.0	6.0	5.0	8.0	8.0
2.	ILA4	67.0	80.0	80.0	13.0	16.0	16.0	5.0	6.0	6.0	5.0	8.0	8.0
3.	ILA2	66.0	84.0	84.0	13.0	21.0	21.0	5.0	6.0	6.0	5.0	8.0	8.0
4.	SIA6	61.0	100.0	98.6	26.1	36.4	35.4	4.4	6.9	6.8	10.3	15.5	15.4
5.	ILA3	101.0	131.0	131.0	22.0	32.0	32.0	5.0	9.0	9.0	7.0	12.0	12.0
6.	SIA3	96.0	125.0	124.1	40.6	54.3	54.2	9.2	13.4	13.4	17.1	26.2	26.2
7.	ILA6	65.0	79.0	79.0	12.0	15.0	15.0	5.0	6.0	6.0	5.0	8.0	8.0
8.	ILA7	84.0	130	129.0	29.0	48.0	48.0	9.0	13.0	13.0	11.0	16.0	16.0
9.	ILA5	97.0	122.0	121.0	22.0	32.0	32.0	6.0	8.0	8.0	7.0	11.0	11.0
10.	NOA8	-	-	-	-	-	-	4.0	19.0	18.0	3.0	13.0	12.0
11.	ILA8	101.0	153.0	153.0	52.0	78.0	78.0	12.0	16.0	16.0	16.0	21.0	21.0
12.	SIA1	64.0	95.0	94.2	22.5	34.5	34.0	5.37	11.47	11.4	13.6	22.6	22.3
13.	SRA1*	74.1	84.8	83.1	26.0	30.0	29.4	7.1	9.1	8.9	8.7	12.4	12.2
14.	NOA3	-	-	-	-	-	-	4.0	19.0	18.0	3.0	13.0	12.0
15.	SRA2*	74.1	94.6	92.7	26.0	33.0	32.3	6.7	8.9	8.7	9.1	13.1	12.8
16.	SIA5	69.0	112.0	110.1	22.3	36.4	36.2	4.3	7.7	7.6	7.9	12.3	12.0
17.	ILA9	113.0	150.0	149.0	40.0	63.0	63.0	10.0	16.0	16.0	11.0	18.0	17.0
18.	NOA7	-	-	-	-	-	-	4.0	15.0	14.0	3.0	7.0	7.0
19.	NOA6	-	-	-	-	-	-	4.0	17.0	15.0	3.0	40.0	38.0
5-10 km from ITPCL Boundary													
20.	ILA13	68.0	85.0	85.0	13.0	16.0	16.0	5.0	6.0	6.0	6.0	8.0	8.0
21.	ILA11	64.0	79.0	78.0	12.0	14.0	14.0	5.0	6.0	6.0	5.0	8.0	8.0
22.	ILA10	68.0	86.0	84.0	13.0	18.0	18.0	5.0	7.0	7.0	5.0	9.0	9.0
23.	CPA5*	141.6	176.5	175.0	33.5	46.9	45.7	13.5	17.0	16.9	15.4	18.5	18.4
24.	ILA12	66.0	85.0	84.0	13.0	19.0	19.0	5.0	7.0	7.0	5.0	9.0	9.0
25.	ILA14	69.0	81.0	81.0	13.0	16.0	16.0	5.0	7.0	7.0	6.0	9.0	9.0
26.	SIA2	94.0	132.0	130.3	26.1	39.4	39.1	10.5	14.7	14.6	22.7	27.9	27.8
27.	SRA4*	73.0	98.0	96.0	24.0	34.0	33.3	5.8	7.3	7.2	8.2	11.3	11.1
28.	NOA5	-	-	-	-	-	-	4.0	33.0	31.0	3.0	6.0	6.0
29.	NOA1	-	-	-	18.0	96.0	91.0	4.0	18.0	17.0	3.0	9.0	9.0
30.	NOA2	-	-	-	-	-	-	4.0	15.0	14.0	3.0	4.0	4.0
31.	CPA2*	77.6	114.6	113.3	21.3	32.6	32.6	8.5	11.2	11.2	10.5	13.3	13.2
32.	NOA9	-	-	-	-	-	-	4.0	18.0	17.0	3.0	9.0	9.0
10-15 km from ITPCL Boundary													
33.	NOA4	-	-	-	32.0	74.0	73.0	4.0	15.0	14.0	3.0	7.0	7.0
34.	ILA15	75.0	108.0	105.0	16.0	22.0	22.0	6.0	9.0	9.0	5.0	12.0	12.0

S.No.	Location Code	SPM/TSPM (µg/m^3)			RPM (µg/m^3)			SO_2 (µg/m^3)			NOx (µg/m^3)		
		Min	Max	98%	Min	Max	98%	Min	Max	98%	Min	Max	Avg/ 98%
35.	CPA1*	79.5	116.2	116.0	22.8	33.9	33.5	8.6	11.7	11.7	10.2	13.2	13.1
36.	SIA4	69.0	114.0	113.4	21.5	38.3	38.0	5.9	8.7	8.7	12.3	17.2	17.1
37.	SRA5*	77.0	92.0	90.2	27.0	41.0	40.2	7.2	9.2	9.0	9.4	12.5	12.3
38.	SRA3*	76.2	89.3	87.5	27.0	31.0	30.4	7.6	9.6	9.4	8.9	12.2	12.0
15-20 km from ITPCL Boundary													
39.	CPA3*	97.8	134.6	133.3	27.5	39.1	39.0	10.7	13.8	13.6	13.1	16.2	16.2
40.	CPA4*	76.9	116.2	114.9	21.6	32.1	31.6	7.5	10.9	10.8	9.6	12.4	12.4

5.1.3 Inferences

The 98th percentiles values of TSPM, SPM, RPM, SO_2 and NOx given in the above table and it is observed that RPM, SO_2 and NOx are well within the stipulated National Ambient Air Quality Standards (NAAQS) for residential and rural areas at all monitoring locations.

5.1.3.1 Ambient Air Quality: 0-5 km Radius

- The 98th percentile of TSPM ranged between 83.1 to 92.7 µg/m^3. The maximum concentration (98th percentile value) was observed at Pallavattunnan (92.7 µg/m^3) and the minimum at Kotthattai (83.1 µg/m^3)
- The 98th percentile of SPM ranged between 79 to 153 µg/m^3. The maximum concentration (98th percentile value) was observed at Periyappattu (153 µg/m^3) and the minimum at Samiyarpettai (79 µg/m^3).
- The 98th percentile of RPM ranged between 15 to 78 µg/m^3. The stipulated CPCB standards for Residential and rural areas (100 µg/m^3) is not exceeded. The maximum concentration (98th percentile value) was observed at Periyappattu (78 µg/m^3) and the minimum at Samiyarpettai (15 µg/m^3)
- The 98th percentile values of SO_2 concentrations varied from 6 to 18 µg/m^3. The stipulated CPCB standards for Residential and rural areas (80 µg/m^3) is not exceeded. The maximum concentration (98th percentile value) was observed at Villiyanallur and Manikollai (18 µg/m^3) and the minimum at Toppiruppu, Velingarayampettai, Chinnur and Samiyarpettai (6 µg/m^3)
- The 98th percentile values of NO_X concentrations varied from 7 to 38 µg/m^3. The stipulated CPCB standards for Residential and rural areas (80 µg/m^3) is not exceeded. The maximum concentration (98th percentile value) was observed at Puthiravalli (38 µg/m^3) and the minimum at Subbamma chattram (7 µg/m^3)

5.1.3.2 Ambient Air Quality: 5-10 km Radius

- The 98th percentile of TSPM ranged between 96 to 175 µg/m^3. The maximum concentration (98th percentile value) was observed at Anaiyarpettai (175 µg/m^3) and the minimum at Tirttanaggari (96 µg/m^3)
- The 98th percentile of SPM ranged between 78 to 130.3 µg/m^3. The maximum concentration (98th percentile value) was observed at Alpakkam (130.3 µg/m^3) and the minimum at Sirupalaiyur (78 µg/m^3).
- The 98th percentile of RPM ranged between 14 to 91 µg/m^3. The stipulated CPCB standards for Residential and rural areas (100 µg/m^3) is not exceeded. The maximum concentration (98th percentile value) was observed at Pathirikuppam (91 µg/m^3) and the minimum at Sirupalaiyur (14 µg/m^3)

- The 98th percentile values of SO_2 concentrations varied from 6 to 31 µg/m^3. The stipulated CPCB standards for Residential and rural areas (80 µg/m^3) is not exceeded. The maximum concentration (98th percentile value) was observed at Periyakuppami (31 µg/m^3) and the minimum at Ayyampettai and Sirupalaiyur (6 µg/m^3)
- The 98th percentile values of NO_X concentrations varied from 4 to 27.8 µg/m^3. The stipulated CPCB standards for Residential and rural areas (80 µg/m^3) is not exceeded. The maximum concentration (98th percentile value) was observed at Alpakkam (27.8 µg/m^3) and the minimum at Thiruchopuram (4 µg/m^3)

5.1.3.3 Ambient Air Quality: 10-15 km Radius

- The 98th percentile of TSPM ranged between 87.5 to 116.0 µg/m^3. The maximum concentration (98th percentile value) was observed at Nachichikadu (116.0 µg/m^3) and the minimum at Krishna Puram (87.5 µg/m^3)
- The 98th percentile of SPM ranged between 90.2 to 113.4µg/m^3. The maximum concentration (98th percentile value) was observed at Thonodamanatham (113.4 µg/m^3) and the minimum at Tayeilgunam Pattinam (90.2 µg/m^3).
- The 98th percentile of RPM ranged between 22 to 73 µg/m^3. The stipulated CPCB standards for Residential and rural areas (100 µg/m^3) is not exceeded. The maximum concentration (98th percentile value) was observed at Chitrapettai (73 µg/m^3) and the minimum at Chidambaram (22 µg/m^3)
- The 98th percentile values of SO_2 concentrations varied from 8.7 to 14 µg/m^3. The stipulated CPCB standards for Residential and rural areas (80 µg/m^3) is not exceeded. The maximum concentration (98th percentile value) was observed at Chittrapettai (14 µg/m^3) and the minimum at Thonodamanatham (8.7 µg/m^3)
- The 98th percentile values of NO_X concentrations varied from 7 to 17.1 µg/m^3. The stipulated CPCB standards for Residential and rural areas (80 µg/m^3) is not exceeded. The maximum concentration (98th percentile value) was observed at Thonodamanatham (17.1 µg/m^3) and the minimum at Chittrapettai (7 µg/m^3)

5.1.3.4 Ambient Air Quality: 15-20 km Radius

- The 98th percentile of TSPM ranged between 114.9 to 133.3 µg/m^3. The maximum concentration (98th percentile value) was observed at Kudikkadu (133.3 µg/m^3) and the minimum at Rasapettai (114.9 µg/m^3)
- The 98th percentile of RPM ranged between 31.6 to 39.0 µg/m^3. The maximum concentration (98th percentile value) was observed at Kudikkadu (39.0 µg/m^3) and the minimum at Rasapettai (31.6 µg/m^3)
- The 98th percentile values of SO_2 concentrations varied from 10.8 to 13.6 µg/m^3. The stipulated CPCB standards for Residential and rural areas (80 µg/m^3) is not exceeded. The maximum concentration (98th percentile value) was observed at Kudikkadu (13.6 µg/m^3) and the minimum at Rosapettai (10.8 µg/m^3)
- The 98th percentile values of NO_X concentrations varied from 12.4 to 16.2 µg/m^3. The stipulated CPCB standards for Residential and rural areas (80 µg/m^3) is not exceeded. The maximum concentration (98th percentile value) was observed at Kudikkadu (16.2 µg/m^3) and the minimum at Rasapettai (12.4 µg/m^3)

5.2 Air Quality Modelling Studies for RCEIA

Assessment of prevailing ambient air quality status in the vicinity of industrial site is an important part of environmental impact assessment study. The tropical climatic conditions, especially winds prevailing in India mainly control the dispersion of air pollutants during

different seasons. According to the Indian climatology, for all practical purposes in air pollution studies, there are three seasons in a year, viz. winter, pre-monsoon and post-monsoon. For the quantitative assessment of the environmental impact on the ambient air environment during these seasons, atmospheric dispersion modelling is required.

Atmospheric dispersion modelling is the mathematical simulation of how air pollutants disperse in the ambient atmosphere. It is performed with computer programs that solve the mathematical equations and algorithms which simulate the pollutant dispersion. The dispersion models are used to estimate or to predict the concentration of air pollutants emitted from sources on the desired study area. Such models are important to governmental agencies entrusted with the task of protecting and managing the ambient air quality. The models are typically employed to determine whether the ambient air quality level due to proposed or existing project will comply with the National Ambient Air Quality Standards (NAAQS) or not. Over and above models also serve to assist in the design of effective control strategies to reduce emissions of harmful air pollutants.

5.2.1 Models used for Air Quality Studies

As the most of the industries considered in this study are located near the coastline, therefore, for impact assessment US-EPA approved more appropriate atmospheric dispersion model i.e. OCD (Offshore and Coastal Dispersion), version-5 has been employed in comparison to ISCST3 (Industrial Source Complex Short Term, version-3) model to predict ground level incremental concentrations (GLCs) of concerned critical pollutants. The OCD is an extension of the classical Gaussian plume model, specifically designed to evaluate the impact of coastal or offshore emission sources including the fumigation episodes. However, prior to carrying out the air quality modelling exercise, meteorological condition during one season over the region was extensively studied. Concentrations are estimated for the critical pollutants assessed over appropriate averaging times (24 hours) based on the applicability of the National Ambient Air Quality Standards (NAAQS 2009/2005).

Methodology for Baseline Ambient Air Quality Determination:

For the determining the background concentration, the following methodology was followed:

- The EIA reports for various industries in Cuddalore area had measured values for different pollutants during various EIA studies between 2005 and 2011.
- The details of the data used :

Table 25: Sources of Data for AAQM

S. No.	AAQM Station	Location of Station w.r.t. ITPCL Plant	Source of the AAQM Data - EIA report of:	Period
1.	Port Novo	Southern Region	SIMA	2005
			ITPCL	2008
			SRM	2009
2.	Poovalai	Western Region	SIMA	2005
			ITPCL	2008
			SRM	2009
3.	Kudikkadu	Northern Region	CPC	2007
			TNPCB study report of SIPCOT area	2009-10
				2010-11
				2011-12

- A trend line was constructed using the data from above receptor locations (villages). This trend line was used for linearly extrapolating the available data to year 2011 level. The exercise of linear extrapolation was performed for a total of 30 receptors.
- The values so obtained were termed as 'background concentration for various pollutants'. Table shows the obtained background concentration for SO_2, NOx and SPM for 30 receptor sites.

5.3 Baseline Ambient Air Quality at Receptor Locations

Table 26 shows the baseline data for various receptor locations (30 in number) for the year 2011.

Some of the observations are:

- Average 24 hour SO_2 concentration is 10.86µg/m^3. Highest value of 27µg/m^3 is observed in Alpakkam
- Average 24 hour NOx concentration is 12.37µg/m^3. Highest value of 28.3µg/m^3 is observed in Periyappattu
- Average 24 hour SPM concentration is 109µg/m^3. Highest value of 174.12µg/m^3 is observed in Port Novo station

Table 26: Baseline Concentration at Various Receptor Locations for 2011

S. No.	Direction *	Receptor Identification	24-hr average Max. SO_2 Background Conc. (2011)	24-hr average Max. NOx Background Conc. (2011)	24-hr average Max. SPM Background Conc. (2011)	24-hr average Max. PM_{10} Background Conc. (2011)	24-hr average Max. $PM_{2.5}$ Background Conc. (2011)
1.	N	D1-(Velingaravamp	5.64	15.3	76.3	30.5	6.1
2.	S	D2-(Chinnur)	6.66	5.87	108.12	43.2	8.6
3.	W	D3-(Toppiruppu)	6.42	5.06	101.62	40.6	8.1
4.	N	D4-(Samiyarpettai)	5.64	15.3	75.3	30.1	6.0
5.	S	D5-(Vathiyapalli)	9.66	9.87	155.12	62.0	12.4
6.	S	D6-(Port Novo)	8.66	8.87	146.12	58.4	11.7
7.	N	D7-(Silambimangalo	12.64	23.3	126.3	50.5	10.1
8.	N	D8-(Periyappattu)	15.64	28.3	149.3	59.7	11.9
9.	S	D9-(Port Novo station)	16.66	15.87	174.12	69.6	13.9
10.	N	D10-(Ayyampettai)	5.64	15.3	81.3	32.5	6.5
11.	W	D11-(Sirupalaiyur)	6.42	5.06	74.62	29.8	6.0
12.	W	D12-(Tachchakkadu)	7.42	6.06	81.62	32.6	6.5
13.	W	D13-(Puvalai)	7.42	6.06	80.62	32.2	6.4
14.	S	D14-(Killai)	7.66	6.87	105.12	42.0	8.4

S. No.	Direction *	Receptor Identification	24-hr average Max. SO_2 Background Conc. (2011)	24-hr average Max. NOx Background Conc. (2011)	24-hr average Max. SPM Background Conc. (2011)	24-hr average Max. PM_{10} Background Conc. (2011)	24-hr average Max. $PM_{2.5}$ Background Conc. (2011)
15.	S	D15-(Chidambaram)	9.66	9.87	132.12	52.8	10.6
16.	W	D16-(Kothattai)	8.28	10.44	81.88	32.8	6.6
17.	N	D17-(Palavattunnan)	8.86	17.97	92.13	36.9	7.4
18.	S	D18-(Krishna Puram)	10.04	10.78	105.38	42.2	8.4
19.	W	D19-(Tirttanaggari)	7.58	9.34	95.08	38.0	7.6
20.	W	D20-(Thaivalkunamp	9.48	10.54	89.08	35.6	7.1
21.	N	D21-(Alpakkam)	27	4	132	52.8	10.6
22.	W	D22-(Pudhuchathira	14.23	20.31	116.23	46.5	9.3
23.	N	D23-(Nanjalingampet	10	10	121	48.4	9.7
24.	N	D24-(Tiruchchopura	15	4	130.4	52.2	10.4
25.	W	D25-(Kulanchavidi)	17	14	101	40.4	8.1
26.	W	D26-(Adinarayanapur	10	10	77	30.8	6.2
27.	N	D27-(Tivagavalli)	10.72	23.04	115.36	46.1	9.2
28.	N	D28-(Kudikkadu)	15	27	140.4	56.2	11.2
29.	N	D29-(Raasapettai)	10.42	22.14	122.86	49.1	9.8
30.	W	D30-(Vadalur)	20.52	0.6	80.12	32.0	6.4

** Direction is with reference to ITPCL, Here N= North, S= South, W= West*

5.4 Meteorology

Meteorology is the fluid mechanics applied to the atmosphere. Meteorological conditions play an important role in determining existing air quality and environmental conditions. The essential relationship between meteorology and atmospheric dispersion involves the wind in the broadest sense of the term. Wind fluctuations over a very wide range of time and space scales accomplish dispersion and strongly influence other processes associated with them. The characterization of the existing meteorological conditions near a source of pollutants is, therefore, a critical aspect for assessing air quality in the ambient environment. For the rapid cumulative air quality impact assessment, meteorological data for the period 01st March 2011 to 31th May 2011 considered as summer season impact zone was used for air quality modelling study. The following subsections describe the prime meteorological parameters during the observation period which govern the dispersion of pollutants.

5.4.1 Wind Direction and Speed

Wind direction is reported as the direction from which the wind blows and is based on surface observations. Over the course of a year, wind usually blows in all directions with varying frequencies. Certain direction, which occurs more frequently than others, is known as the prevailing wind direction. Wind speed and direction and their frequency during summer season (March-May) period are represented by wind rose diagram. The wind rose denotes a class of diagrams designed to display the distribution of wind direction experienced at a given location over a period of time — long for a climatological record of prevailing winds or short to show wind character for a particular event or purpose. Wind rose summarizes a considerable amount of wind frequency information into a single graphic and shown in Figure 6 below during the monitoring period.

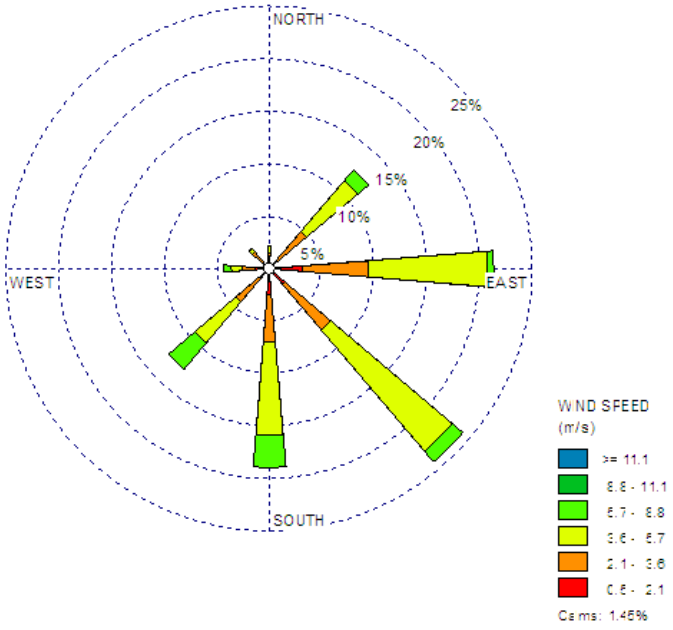


Figure 6: Wind Rose (Mar-May, 2011)

The wind rose diagram reveals that wind was blowing predominantly from the northeast direction with frequency of approximately 24% with speed in the range of 0.5-8.3 m s-1 during the monitoring period. The average wind speed was observed 3.88 m/s with frequency of calm winds 1.45 % during the monitoring period.

5.4.2 Atmospheric Stability

A measure of the tendency of air to move upward or downward within the atmosphere generates turbulence. The atmosphere may be more or less turbulent at any given time, depending on the amount of incoming solar radiation as well as other factors. There are six defined Pasquill atmospheric stability classes, from A to F, each representing a different degree of turbulence in the atmosphere. When moderate to strong incoming solar radiation heats air near the ground, causing it to rise and generating large eddies, the atmosphere is considered unstable. Unstable conditions are associated with atmospheric stability classes

A, B and C. In this stability class air has strong tendency to move up or down, and the atmosphere is more turbulent. When solar radiation is relatively weak or absent, air near the surface has reduced tendency to rise and less turbulence develops. In this case, the atmosphere is considered stable, the wind is weak, and the stability class would be E or F. Stability classes D represents conditions of neutral stability (moderately turbulent). Neutral conditions are associated with relatively strong wind speeds and moderate solar radiation. The frequency of stability classes during the study period is provided in Table 26.

Table 27: Frequency of Stability Classes

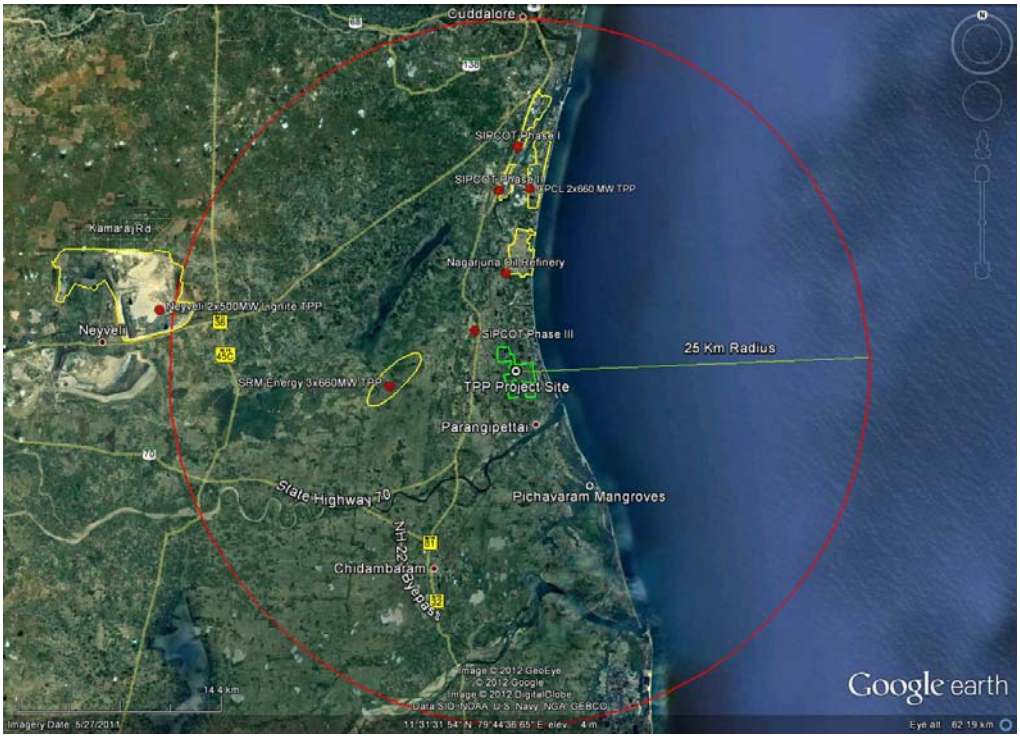
Stability Class	Frequency (%)
A – Extremely Unstable	12.5
B – Unstable	27.9
C – Slightly Unstable	9.6
D – Neutral	15.4
E – Slightly Stable	24.3
F – Stable	10.4

5.4.3 Mixing Height

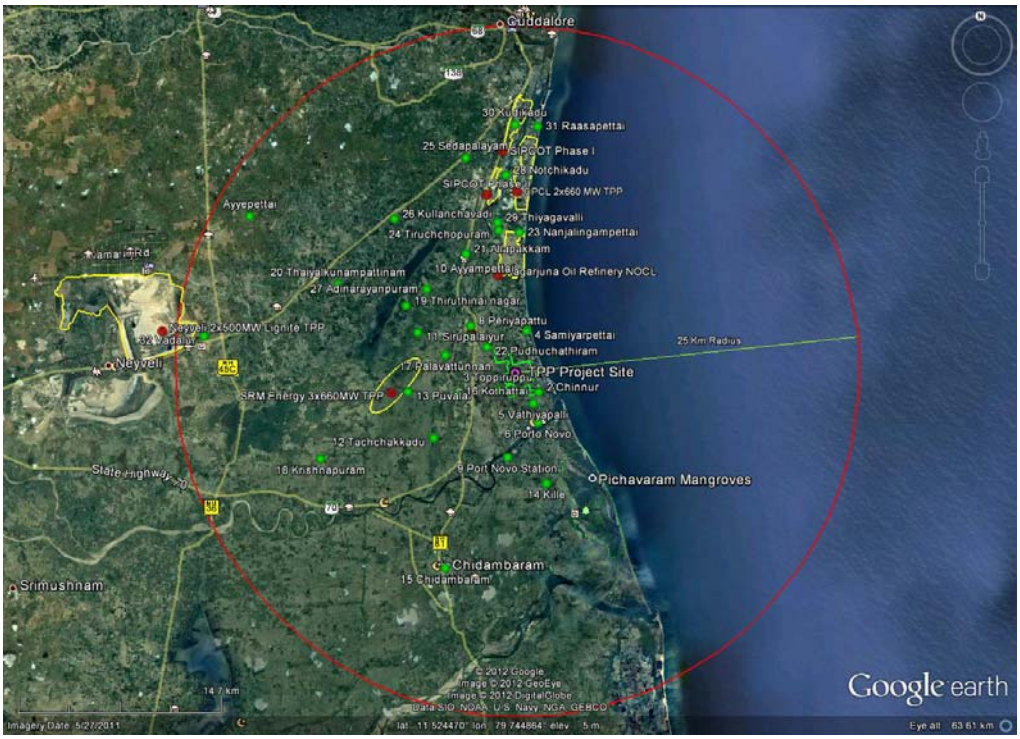
Mixing Height (MH) is the vertical extent through which the contaminant plume can be mixed. Forecasting of mixing height is done with the aid of the vertical temperature profile. The MH is a function of stability. In unstable air, the MH is higher and in stable air the MH is lower. With a lower MH, there is a smaller volume of air in which the pollutant can be dispersed, resulting in higher concentrations in the ambient environment. There is a seasonal variation of MH. During summer daylight hours, MH can be few thousand feet whereas for winter it can be a few hundred feet. It varies also in the course of a day. It is lowest at night and increases during the day. Secondary information has been used to determine the mixing height over the study region (T.N) and it varies from 50-1500 meters (IMD).

5.5 Details of emission sources in study area

During the operation phase, major industrial sources will be expected the main air pollution sources. Locations of industrial sites on the 50km x 50 km study zone considering 3600 MW ITPCL Power plant as origin is shown in Google map as Figure 7.



(a) Location of Various Emission Sources (red dot)



(b) Location of Receptors (Green Dot)

Figure 7: Google Map of Study Area – Location of Emission sources and Receptors

In order to assess the cumulative impact assessment industrial emission source characteristics taken into account is provided in Table 28.

Table 28: Emission Source Characteristics

Name of the Industry	Source/ Stack	Stack Characteristics						
		SO_2 (µg/ m^3)	NO_x (µg/m^3)	PM (µg/ m^3)	Height (m)	velocity (m/s)	Temp (k)	Flue/ Stack Top Diameter (m)
IL&FS TPCL	1(Twin-Flues)	392	340.7	45.5	275	20	398	7.5
	2(Three-flues)	762	454.3	60.6	275	20	398	7.5
Cuddalore Power Plant	1	1110	721.5	83.1	275	25	413.15	7.5
	2	1110	721.5	83.1	275	25	413.15	7.5
NOCL	1	59	24	2	80	10.4	438	2.95
	2	15	1.877	0.037	82	10	493	2.90
NOCL	3	2	0.307	0.004	60.5	10	711	1.4
	4	3.69	0.91	0.46	45.8	14.1	667	1.29
	5	0.011	10.79	nil	40	8.65	427	2.5
	6	4.305	Nil	0.861	59.7	17	339	2.3
	7	22	5.42	2.75	66	7.1	436	2.18
	8	12.41	Nil	nil	90	25.85	766	1.22
	9	1.693	0.795	1.21	40	39	404	2.8
	10	1.693	0.795	1.21	40	39	404	2.8
	11	47.78	11.774	5.97	115	18	414	3.25
	12	0.7	Nil	nil	105	40	1473	2.1336
	13	0.76	Nil	nil	105	37	1473	0.508
SIMA	1	0.01	0.18	0.15	30	10	300	0.5
	2	2.09	0.73	0.13	30	10	300	0.5
SRM Energy Limited	1	1790	905	35.65	275	24	413.15	7.25
	2	1790	905	35.65	275	24	413.15	7.25
	3	1790	905	35.65	275	24	413.15	7.25

5.6 Scenarios for Air Quality Modelling Studies

Air Quality modelling studies are carried out for two scenarios:

Scenario 1 - Projects in the study area which has got environmental clearance before the issue of EC to ITPCL i.e. CPC, NOCL, ITPCL and SIMA.

Scenario 2 - Projects in the study area that has sought EC after issue of EC to ITPCL i.e. CPC, NOCL, SIMA, ITPCL and SRM Energy.

5.7 Results and Discussions for Scenario 1

Air quality model OCD-5 is simulated with the meteorological parameters observed during the summer season for the period March-May, 2011 assuming all the sources are emitting the pollutants simultaneously for the conservative cumulative impact assessment study. Model simulation is carried out for the impact zone area of 50kmx50km considering the modelling grid size 1kmx1km along with 30 desired discrete receptor locations. The shoreline geometry together with source locations (S) and discrete receptor (D) locations considered for model simulation are shown in the Figure 8.

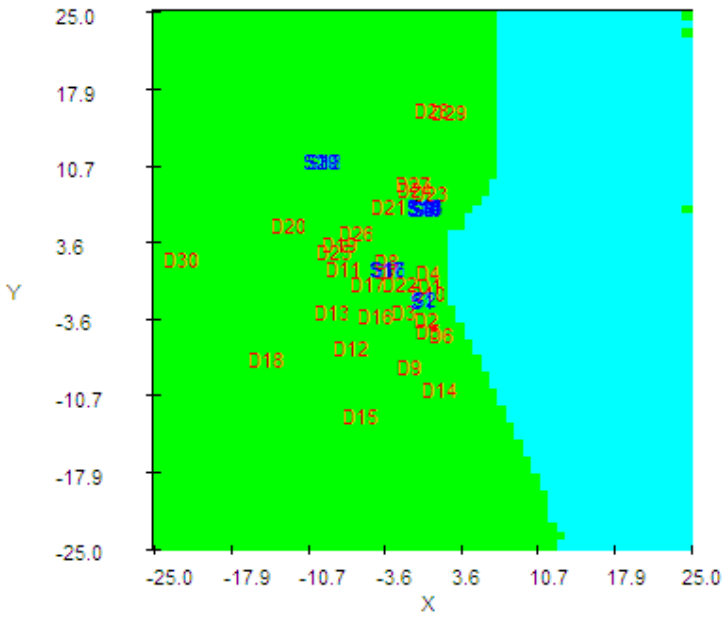


Figure 8: Shoreline Geometry with Source and Receptor Locations

The model predicted incremental concentration for SO_2, NOx, PM10 and PM2.5 for the first five highest predicted concentrations on 24-hour average and for meteorological period (March-May, 2011) at 30 discrete receptors along with the background concentrations are provided in Tables 29 to 34. Spatial distribution of predicted incremental concentration of modelled pollutants on the impact zone area is shown in Figures 9-13 by iso-concentration contours of critical pollutants. Based on the OCD 5 and ISCST3 model studies, the following has been observed.

The modelling results show that predicted 24 hour highest concentration for SPM (as per NAAQ Standard 2005) and NOx meets the NAAQ standards at all 30 receptor locations. SO_2 is well within the norms at 26 receptor locations off 30 receptors considered in the study.

For SPM, the major contribution comes from background concentration. The average predicted concentration due to industrial stack emission as indicated by the results of both models does not exceed 2µg/m^3 for any of the 30 receptor locations. However, the average background concentration is ~110µg/m^3. This shows that more than 98 % of the SPM contribution in the current modelling study is due to ambient concentration. PM10 and PM2.5 have been taken as fractions of SPM values (PM10= 40% of SPM; PM2.5= 20% of PM10). The modelled values satisfy NAAQS for all the receptor locations for both PM10 and PM2.5.

For NOx, highest predicted cumulative OCD Concentration (Background + Modelled) is 72.91µg/m^3 and average at all receptors is 29.83µg/m^3, both well below NAAQ standard of 80µg/m^3. Highest predicted OCD Concentration due to ITPCL plant (Background + Modelled) for NOx= 55.26µg/m^3 at village Ayampettai. Next highest value is 32 % lower than highest value (37.95µg/m^3 at village Periyampettu). Average at all receptor locations due to ITPCL is 21µg/m^3. Highest predicted cumulative ISCST3 Concentration (Background + Modelled) for NOx= 64.35 µg/m^3 and average at all receptors is 30.46 µg/m^3. Highest predicted ISCST3 Concentration Due to ITPCL plant (Background + Modelled) for NOx= 41.76 µg/m^3 at village

Ayampettai. Average at all receptor locations as modelled by ISCST3 due to ITPCL plant alone is 22.32µg/m^3.

For SO_2, Predicted 24 hour highest concentration meets the NAAQS standards at 26 receptor locations and exceeds at 4 receptor locations which are >10 km away from ITPCL. The contribution of ITPCL to these locations where the standards are exceeded varies from 18 % to 38 %. These receptor sites violating the standard are located at villages Tiyagavallu (87.44 µg/m^3), Kudikkadu (88.87 µg/m^3), Rasapettai (81.65 µg/m^3), and Vadallur (81.73 µg/m^3). However, for Tiyagvalli, for a total of 90 days of simulation, only 1 day showed values exceeding the NAAQ standard. This is within the NAAQ standard which requires compliance at least 98% of time in a year. For example, for the receptor located at Tiyagavalli, where the highest modelled concentration exceed NAAQ standard, the next highest predicted concentration is ~ 56µg/m^3, which is well within the NAAQ limit. Same is true for other places where the predicted values exceed NAAQ standard.

Impact on Mangroves: The effect of SO_2 emissions on the Pichavaram mangroves is minimal since the predicted values (24 hour highest) at the nearest receptor village Killai located at a distance of 0.5km, is ~20 µg/m^3, and the average values is less than 10 µg/m^3 which is well below the NAAQ limit for ecologically sensitive areas which is 80 µg/m^3.

Incremental predicted 24-hour average Ground Level Concentration is expected to be significantly reduced at all the receptors locations, if it is averaged for the entire period (March-May, 2011) as provided in the Tables below. Further, by adopting the pollution control measures, the predicted concentration values would be further reduced.

Thus, the cumulative air quality modelling shows that the impact on the air environment is minimal and the NAAQ standard are complied at all the places.

Table 29: Cumulative Highest 24-hours Average SO_2 Concentration (µg/m^3) & Period-Average SO_2 Concentration (µg/m^3) for Period (Mar-April-May-2011) at Discrete Receptor Locations

Receptor Identification	X (km)	Y (km)	OCD highest 24-hr avg. conc.	OCD Avg Conc. (Mar-May 2011)	ISCST3 highest 24-hr avg. conc.	OCD highest 24-hr avg. conc. due to ITPCL	OCD Avg Conc. (Mar-May 2011) due to ITPCL	ISCST3 highest 24-hr avg. conc. due to ITPCL	Max. Background Conc.	OCD 24-Hr Highest Resultant Conc. (Worst Case)	ISCST3 24-Hr Highest Resultant Conc.	Predicted OCD Conc. Due to ITPCL (Background + Modelled)	Predicted ISCST3 Conc. Due to ITPCL (Background + Modelled)	NAAQS	OCD highest 24-hr avg. conc. (Worst Case)
			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(1 + 7)	(3 + 7)	(4 + 7)	(6 + 7)		
D1- (Velingarayampettai)	0.73	1.4	30.57	12.74	21.43	30.57	10.96	21.05	5.64	36.21	27.07	36.21	26.69	80 µg/m^3	30.57
D2- (Chinnur)	0.41	-1.83	27.32	3.03	19.43	15.64	1.67	5.23	6.66	33.98	26.09	22.3	11.89		27.32
D3- (Toppiruppu)	-1.75	-1.13	39.67	8.48	16.85	39.16	6.93	15.59	6.42	46.09	23.27	45.58	22.01		39.67
D4- (Samiyarpettai)	0.52	2.67	19.94	9.03	18.45	19.24	6.97	5.6	5.64	25.58	24.09	24.88	11.24		19.94
D5- (Vathiyapalli)	0.6	-2.77	22.49	2.38	18.57	11.08	1.11	5.73	9.66	32.15	28.23	20.74	15.39		22.49
D6- (Port Novo)	1.78	-3.15	19.03	2.06	23.89	8.04	0.86	8.87	8.66	27.69	32.55	16.7	17.53		19.03
D7- (Silambimangaloru)	-3.33	2.82	24.26	9.6	26.07	15.86	5.68	26.07	12.64	36.9	38.71	28.5	38.71		24.26
D8- (Periyappattu)	-3.23	3.64	21.82	9.06	22.58	14.26	5.07	19.33	15.64	37.46	38.22	29.9	34.97		21.82
D9- (Port Novo station)	-1.13	-6.16	15.62	1.81	16.15	6.62	0.71	5.96	16.66	32.28	32.81	23.28	22.62		15.62

Receptor Identification	X (km)	Y (km)	OCD highest 24-hr avg. conc.	OCD Avg Conc. (Mar-May 2011)	ISCST3 highest 24-hr avg. conc.	OCD highest 24-hr avg. conc. due to ITPCL	OCD Avg Conc. (Mar-May 2011) due to ITPCL	ISCST3 highest 24-hr avg. conc. due to ITPCL	Max. Background Conc.	OCD 24-Hr Highest Resultant Conc. (Worst Case)	ISCST3 24-Hr Highest Resultant Conc.	Predicted OCD Conc. Due to ITPCL (Background + Modelled)	Predicted ISCST3 Conc. Due to ITPCL (Background + Modelled)	NAAQS	OCD highest 24-hr avg. conc. (Worst Case)
			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(1 + 7)	(3 + 7)	(4 + 7)	(6 + 7)		
D10- (Ayyampettai)	0.52	0.67	61.53	23.66	20.64	61.53	22	0.82	5.64	67.17	26.28	67.17	6.46		61.53
D11- (Sirupalaiyur)	-7.33	2.99	29.27	7.46	38.74	8.56	3.46	21.9	6.42	35.69	45.16	14.98	28.32		29.27
D12- (Tachchakkadu)	-6.56	-4.49	19.07	3.87	22.91	16.24	2.29	22.9	7.42	26.49	30.33	23.66	30.32		19.07
D13- (Puvalai)	-8.44	-1.05	19.95	5.45	24.74	9.51	2.97	23.87	7.42	27.37	32.16	16.93	31.29		19.95
D14- (Killai)	1.67	-8.36	14.25	1.32	13.3	4.51	0.4	3.88	7.66	21.91	20.96	12.17	11.54		14.25
D15- (Chidambaram)	-5.73	-10.69	14.64	1.66	8.6	5.63	0.62	4.99	9.66	24.3	18.26	15.29	14.65		14.64
D16- (Kothattai)	-4.35	-1.47	22.93	6.36	38.55	18.25	4.59	37.92	8.28	31.21	46.83	26.53	46.2		22.93
D17- (Palavattunnan)	-5.05	1.53	21.25	7.65	34.4	11.75	4.99	34.4	8.86	30.11	43.26	20.61	43.26		21.25
D18- (Krishna Puram)	-14.48	-5.43	22.05	3.78	24.54	6.4	1.4	15.67	10.04	32.09	34.58	16.44	25.71		22.05
D19- (Tirttanaggari)	-7.7	5.23	28.86	8.09	36.51	7.44	2.89	21.85	7.58	36.44	44.09	15.02	29.43		28.86

Receptor Identification	X (km)	Y (km)	OCD highest 24-hr avg. conc.	OCD Avg Conc. (Mar-May 2011)	ISCST3 highest 24-hr avg. conc.	OCD highest 24-hr avg. conc. due to ITPCL	OCD Avg Conc. (Mar-May 2011) due to ITPCL	ISCST3 highest 24-hr avg. conc. due to ITPCL	Max. Background Conc.	OCD 24-Hr Highest Resultant Conc. (Worst Case)	ISCST3 24-Hr Highest Resultant Conc.	Predicted OCD Conc. Due to ITPCL (Background + Modelled)	Predicted ISCST3 Conc. Due to ITPCL (Background + Modelled)	NAAQS	OCD highest 24-hr avg. conc. (Worst Case)
			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(1 + 7)	(3 + 7)	(4 + 7)	(6 + 7)		
D20-(Thaiyalkunampattinam)	-12.5	7.04	41.43	10.3	54.97	4.95	1.9	15.66	9.48	50.91	64.45	14.43	25.14		41.43
D21-(Alpakkam)	-3.16	8.73	38.55	13.09	42.65	5.99	2.39	9.55	27	65.55	69.65	32.99	36.55		38.55
D22-(Pudhuchathiram)	-2.02	1.53	24.49	11.29	21.92	22.36	9.22	21.92	14.23	38.72	36.15	36.59	36.15		24.49
D23-(Nanjalingampettai)	0.81	10.05	23.6	11.42	21.23	5.78	1.95	11.14	10	33.6	31.23	15.78	21.14		23.6
D24-(Tiruchchopuram)	-0.69	10.3	36.73	15.56	22.85	5.56	1.99	8.85	15	51.73	37.85	20.56	23.85		36.73
D25-(Kulanchavidi)	-8.2	4.52	26.27	7.72	32.62	8	2.95	21.82	17	43.27	49.62	25	38.82		26.27
D26-(Adinarayanapuram)	-6.14	6.35	28.77	9	37.93	8.02	2.96	14.47	10	38.77	47.93	18.02	24.47		28.77
D27-(Tiyagavalli)	-0.74	10.86	76.72	17.26	26.59	5.3	1.89	8.41	10.72	87.44	37.31	16.02	19.13		76.72
D28-(Kudikkadu)	0.89	17.83	31.91	12.73	73.87	3.27	1.12	4.95	15	46.91	88.87	18.27	19.95		31.91

Receptor Identification	X (km)	Y (km)	OCD highest 24-hr avg. conc.	OCD Avg Conc. (Mar-May 2011)	ISCST3 highest 24-hr avg. conc.	OCD highest 24-hr avg. conc. due to ITPCL	OCD Avg Conc. (Mar-May 2011) due to ITPCL	ISCST3 highest 24-hr avg. conc. due to ITPCL	Max. Background Conc.	OCD 24-Hr Highest Resultant Conc. (Worst Case)	ISCST3 24-Hr Highest Resultant Conc.	Predicted OCD Conc. Due to ITPCL (Background + Modelled)	Predicted ISCST3 Conc. Due to ITPCL (Background + Modelled)	NAAQS	OCD highest 24-hr avg. conc. (Worst Case)
			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(1 + 7)	(3 + 7)	(4 + 7)	(6 + 7)		
D29- (Raasapettai)	2.53	17.61	31.47	10.98	71.23	3.3	1.08	4.11	10.42	41.89	81.65	13.72	14.53		31.47
D30- (Vadalur)	-22.4	3.86	36.49	7.99	61.21	3.23	1.12	10.43	20.52	57.01	81.73	23.75	30.95		36.49

NAAQs: 80 µg/m^3

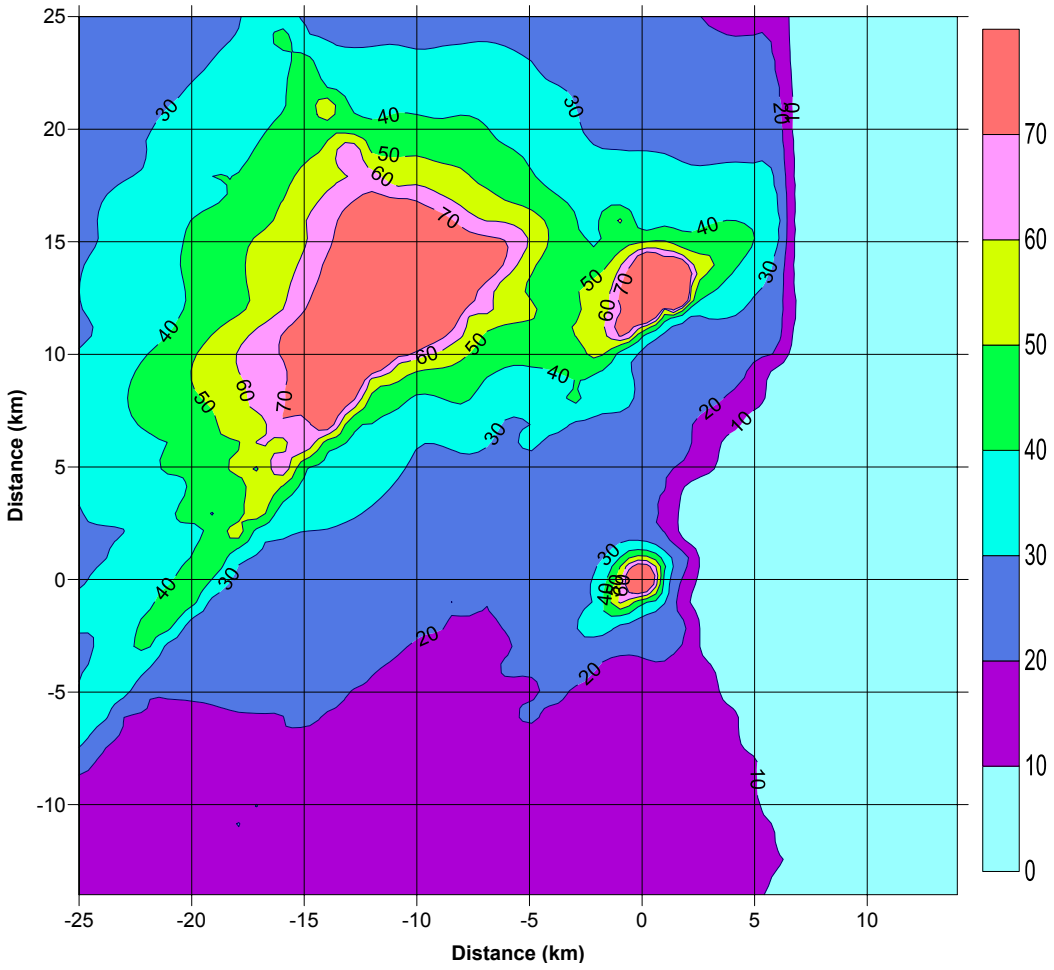


Figure 9: Spatial Variation of Cumulative 24-hr Average SO_2 (µg/m^3)

Table 30: Cumulative Highest 24-hours Average NOx Concentration (µg/m^3) & Period-Average NOx Concentration (µg/m^3) for Period (Mar-May, 2011) at Discrete Receptor Locations

Receptor Identification	X (km)	Y (km)	OCD highest 24-hr avg. conc.	OCD Avg Conc. (Mar-May 2011)	ISCST3 highest 24-hr avg. conc.	OCD highest 24-hr avg. conc. due to ITPCL	OCD Avg Conc. (Mar-May 2011) due to ITPCL	ISCST3 24-hr avg. max conc. due to ITPCL	Max. Background Conc.	OCD 24-Hr Highest Resultant Conc. (Worst Case)	ISCST3 24-Hr Highest Resultant Conc.	Predicted OCD Conc. Due to ITPCL (Background + Modelled)	Predicted ISCST3 Conc. Due to ITPCL (Background + Modelled)	NAAQS
			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(1 + 7)	(3 + 7)	(4 + 7)	(6 + 7)	
D1- (Velingarayampettai)	0.73	1.4	20.53	8.32	14.65	19.95	7.35	14.65	15.3	35.83	29.95	35.25	29.95	80 µg/m^3
D2- (Chinnur)	0.41	-1.83	17.14	1.89	10.66	10.51	1.19	3.42	5.87	23.01	16.53	16.38	9.29	
D3- (Toppiruppu)	-1.75	-1.13	27.4	5.68	11.01	26.94	4.84	10.33	5.06	32.46	16.07	32	15.39	
D4- (Samiyarpettai)	0.52	2.67	13.13	5.83	10.4	12.83	4.75	3.83	15.3	28.43	25.7	28.13	19.13	
D5- (Vathiyapalli)	0.6	-2.77	13.8	1.45	10.52	7.43	0.8	3.96	9.87	23.67	20.39	17.3	13.83	
D6- (Port Novo)	1.78	-3.15	11.36	1.24	13.89	5.44	0.62	6.08	8.87	20.23	22.76	14.31	14.95	
D7- (Silambimangaloru)	-3.33	2.82	13.17	5.91	17.74	10.74	3.93	17.74	23.3	36.47	41.04	34.04	41.04	
D8- (Periyappattu)	-3.23	3.64	12.13	5.5	14.78	9.65	3.5	13.46	28.3	40.43	43.08	37.95	41.76	
D9- (Port Novo station)	-1.13	-6.16	9	1.08	9.28	4.68	0.52	4.11	15.87	24.87	25.15	20.55	19.98	

Receptor Identification	X (km)	Y (km)	OCD highest 24-hr avg. conc.	OCD Avg Conc. (Mar-May 2011)	ISCST3 highest 24-hr avg. conc.	OCD highest 24-hr avg. conc. due to ITPCL	OCD Avg Conc. (Mar-May 2011) due to ITPCL	ISCST3 24-hr avg. max conc. due to ITPCL	Max. Background Conc.	OCD 24-Hr Highest Resultant Conc. (Worst Case)	ISCST3 24-Hr Highest Resultant Conc.	Predicted OCD Conc. Due to ITPCL (Background + Modelled)	Predicted ISCST3 Conc. Due to ITPCL (Background + Modelled)	NAAQS
			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(1 + 7)	(3 + 7)	(4 + 7)	(6 + 7)	
D10- (Ayyampettai)	0.52	0.67	40.67	15.37	10.52	39.96	14.48	0.71	15.3	55.97	25.82	55.26	16.01	
D11- (Sirupalaiyur)	-7.33	2.99	17.87	4.58	24.62	5.74	2.38	15.23	5.06	22.93	29.68	10.8	20.29	
D12- (Tachchakkadu)	-6.56	-4.49	12.96	2.45	15.81	11.2	1.58	15.8	6.06	19.02	21.87	17.26	21.86	
D13- (Puvalai)	-8.44	-1.05	11.05	3.39	16.49	6.33	2.04	16.48	6.06	17.11	22.55	12.39	22.54	
D14- (Killai)	1.67	-8.36	8.33	0.77	7.59	2.97	0.28	2.71	6.87	15.2	14.46	9.84	9.58	
D15- (Chidambaram)	-5.73	-10.69	8.87	0.99	5.61	3.8	0.44	3.44	9.87	18.74	15.48	13.67	13.31	
D16- (Kothattai)	-4.35	-1.47	13.48	4.14	25.92	11.94	3.17	25.92	10.44	23.92	36.36	22.38	36.36	
D17- (Palavattunnan)	-5.05	1.53	11.82	4.86	23.64	7.83	3.45	23.64	17.97	29.79	41.61	25.8	41.61	
D18- (Krishna Puram)	-14.48	-5.43	13.83	2.28	15.33	4.1	0.95	10.79	10.78	24.61	26.11	14.88	21.57	
D19- (Tirttanaggari)	-7.7	5.23	15.35	4.83	22.97	4.95	1.99	14.87	9.34	24.69	32.31	14.29	24.21	
D20- (Thaiyalkunampattinam)	-12.5	7.04	21.69	5.83	30.15	3.28	1.3	10.84	10.54	32.23	40.69	13.82	21.38	

Receptor Identification	X (km)	Y (km)	OCD highest 24-hr avg. conc.	OCD Avg Conc. (Mar-May 2011)	ISCST3 highest 24-hr avg. conc.	OCD highest 24-hr avg. conc. due to ITPCL	OCD Avg Conc. (Mar-May 2011) due to ITPCL	ISCST3 24-hr avg. max conc. due to ITPCL	Max. Background Conc.	OCD 24-Hr Highest Resultant Conc. (Worst Case)	ISCST3 24-Hr Highest Resultant Conc.	Predicted OCD Conc. Due to ITPCL (Background + Modelled)	Predicted ISCST3 Conc. Due to ITPCL (Background + Modelled)	NAAQS
			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(1 + 7)	(3 + 7)	(4 + 7)	(6 + 7)	
D21-(Alpakkam)	-3.16	8.73	24.87	7.09	27.72	4	1.65	6.55	4	28.87	31.72	8	10.55	
D22-(Pudhuchathiram)	-2.02	1.53	15.63	7.45	15.21	15.29	6.36	15.21	20.31	35.94	35.52	35.6	35.52	
D23-(Nanjalingampettai)	0.81	10.05	13.26	5.97	10.86	3.9	1.35	8.51	10	23.26	20.86	13.9	18.51	
D24-(Tiruchchopuram)	-0.69	10.3	21.32	8.26	12.57	3.79	1.39	6.11	4	25.32	16.57	7.79	10.11	
D25-(Kulanchavidi)	-8.2	4.52	14.01	4.64	20.5	5.44	2.03	15.2	14	28.01	34.5	19.44	29.2	
D26-(Adinarayanapuram)	-6.14	6.35	16.69	5.29	24.02	5.44	2.04	9.96	10	26.69	34.02	15.44	19.96	
D27-(Tiyagavalli)	-0.74	10.86	49.87	9.57	14.23	3.61	1.32	5.8	23.04	72.91	37.27	26.65	28.84	
D28-(Kudikkadu)	0.89	17.83	18.1	7.53	37.35	2.24	0.78	3.4	27	45.1	64.35	29.24	30.4	
D29-(Raasapettai)	2.53	17.61	17.87	6.52	37.27	2.26	0.75	2.81	22.14	40.01	59.41	24.4	24.95	
D30-(Vadalur)	-22.4	3.86	18.59	4.42	31.28	2.17	0.77	7.21	0.6	19.19	31.88	2.77	7.81	

NAAQS – μ80g/m^3

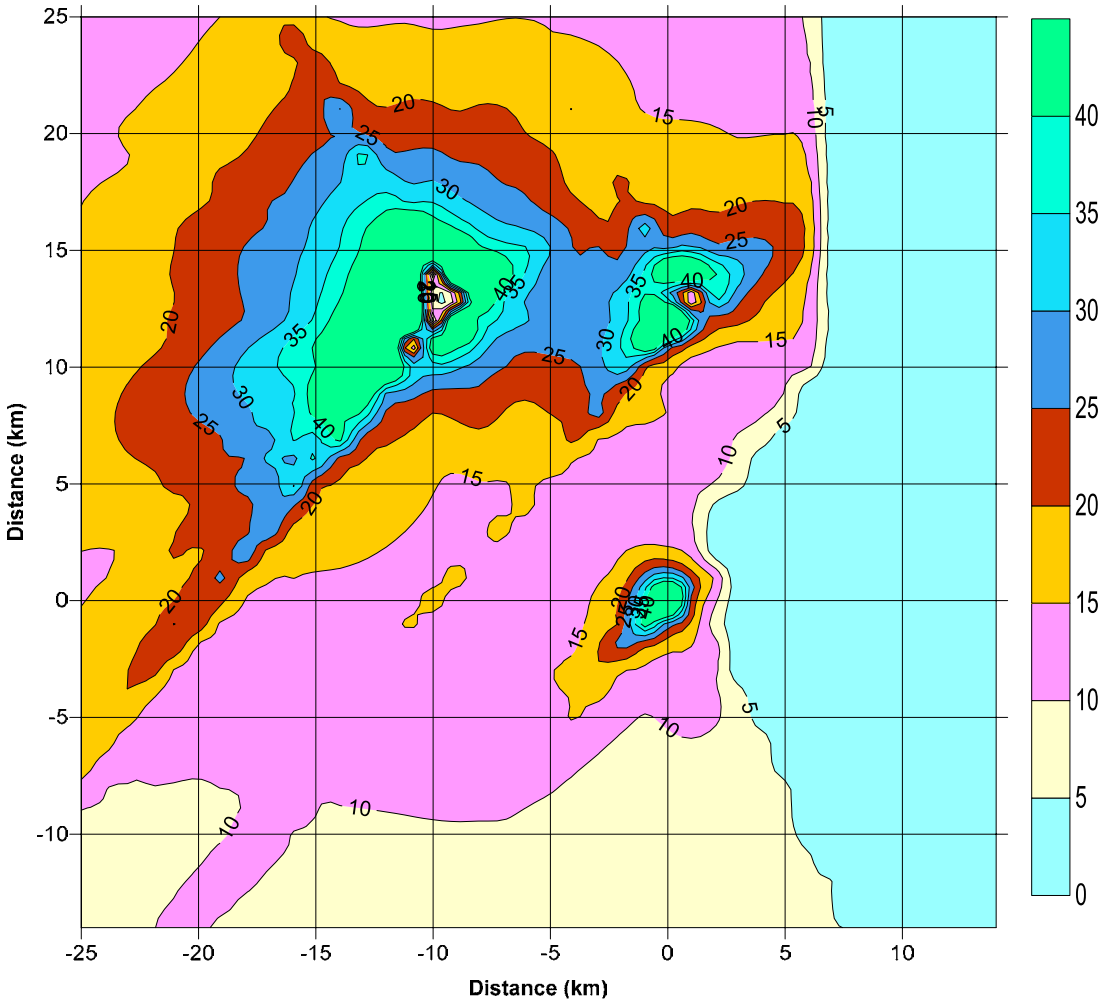


Figure 10: Spatial Variation of Cumulative 24-hr Average NOx (µg/m^3)

Table 31: Cumulative Highest 24-hour Average SPM Concentration (µg/m^3) & Period-Average SPM Concentration (µg/m^3) for Period (Mar-May, 2011) at Discrete Receptor Locations

Receptor Identification	X (km)	Y (km)	OCD highest 24-hr avg. conc.	OCD Avg Conc. (Mar-May 2011)	ISCST3 highest 24-hr avg. conc.	OCD highest 24-hr avg. conc. due to ITPCL	OCD Avg Conc. (Mar-May 2011) due to ITPCL	ISCST3 highest 24-hr avg. conc. due to ITPCL	Max. Background Conc.	OCD 24-Hr Highest Resultant Conc. (Worst Case)	ISCST3 24-Hr Highest Resultant Conc.	Predicted OCD Conc. Due to ITPCL (Background + Modelled)	Predicted ISCST3 Conc. Due to ITPCL (Background + Modelled)	NAAQS
			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(1 + 7)	(3 + 7)	(4 + 7)	(6 + 7)	
D1- (Velingarayampettai)	0.73	1.4	2.74	1.07	1.96	2.74	0.98	1.95	76.3	79.04	78.26	79.04	78.25	200 µg/m^3
D2- (Chinnur)	0.41	-1.83	1.99	0.22	0.78	1.45	0.15	0.46	108.12	110.11	108.9	109.57	108.58	
D3- (Toppiruppu)	-1.75	-1.13	3.66	0.72	1.49	3.62	0.65	1.38	101.62	105.28	103.11	105.24	103	
D4- (Samiyarpettai)	0.52	2.67	1.75	0.73	0.81	1.75	0.63	0.51	75.3	77.05	76.11	77.05	75.81	
D5- (Vathiyapalli)	0.6	-2.77	1.54	0.16	0.83	1.03	0.1	0.53	155.12	156.66	155.95	156.15	155.65	
D6- (Port Novo)	1.78	-3.15	1.25	0.13	1.22	0.73	0.08	0.81	146.12	147.37	147.34	146.85	146.93	
D7- (Silambimangaloru)	-3.33	2.82	1.66	0.87	2.37	1.46	0.52	2.37	126.3	127.96	128.67	127.76	128.67	
D8- (Periyappattu)	-3.23	3.64	1.56	0.76	2.28	1.31	0.47	1.8	149.3	150.86	151.58	150.61	151.1	

Receptor Identification	X (km)	Y (km)	OCD highest 24-hr avg. conc.	OCD Avg Conc. (Mar-May 2011)	ISCST3 highest 24-hr avg. conc.	OCD highest 24-hr avg. conc. due to ITPCL	OCD Avg Conc. (Mar-May 2011) due to ITPCL	ISCST3 highest 24-hr avg. conc. due to ITPCL	Max. Background Conc.	OCD 24-Hr Highest Resultant Conc. (Worst Case)	ISCST3 24-Hr Highest Resultant Conc.	Predicted OCD Conc. Due to ITPCL (Background + Modelled)	Predicted ISCST3 Conc. Due to ITPCL (Background + Modelled)	NAAQS
			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(1 + 7)	(3 + 7)	(4 + 7)	(6 + 7)	
D9- (Port Novo station)	-1.13	-6.16	1.02	0.11	0.78	0.61	0.07	0.55	174.12	175.14	174.9	174.73	174.67	
D10- (Ayyampettai)	0.52	0.67	5.43	2.01	0.51	5.43	1.93	0.1	81.3	86.73	81.81	86.73	81.4	
D11- (Sirupalaiyur)	-7.33	2.99	2	0.55	2.98	0.79	0.32	2.03	74.62	76.62	77.6	75.41	76.65	
D12- (Tachchakkadu)	-6.56	-4.49	1.72	0.29	2.11	1.5	0.21	2.1	81.62	83.34	83.73	83.12	83.72	
D13- (Puvalai)	-8.44	-1.05	1.2	0.4	2.2	0.87	0.27	2.2	80.62	81.82	82.82	81.49	82.82	
D14- (Killai)	1.67	-8.36	0.83	0.08	0.61	0.42	0.04	0.36	105.12	105.95	105.73	105.54	105.48	
D15- (Chidambaram)	-5.73	-10.69	0.97	0.1	0.7	0.52	0.06	0.46	132.12	133.09	132.82	132.64	132.58	
D16- (Kothattai)	-4.35	-1.47	1.78	0.51	3.46	1.68	0.42	3.46	81.88	83.66	85.34	83.56	85.34	
D17- (Palavattunnan)	-5.05	1.53	1.22	0.61	3.16	1.08	0.46	3.15	92.13	93.35	95.29	93.21	95.28	
D18- (Krishna Puram)	-14.48	-5.43	1.54	0.25	1.91	0.59	0.13	1.44	105.38	106.92	107.29	105.97	106.82	

Receptor Identification	X (km)	Y (km)	OCD highest 24-hr avg. conc.	OCD Avg Conc. (Mar-May 2011)	ISCST3 highest 24-hr avg. conc.	OCD highest 24-hr avg. conc. due to ITPCL	OCD Avg Conc. (Mar-May 2011) due to ITPCL	ISCST3 highest 24-hr avg. conc. due to ITPCL	Max. Background Conc.	OCD 24-Hr Highest Resultant Conc. (Worst Case)	ISCST3 24-Hr Highest Resultant Conc.	Predicted OCD Conc. Due to ITPCL (Background + Modelled)	Predicted ISCST3 Conc. Due to ITPCL (Background + Modelled)	NAAQS
			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(1 + 7)	(3 + 7)	(4 + 7)	(6 + 7)	
D19- (Tirttanaggari)	-7.7	5.23	1.77	0.56	2.89	0.68	0.27	1.98	95.08	96.85	97.97	95.76	97.06	
D20- (Thaiyalkunampattinam)	-12.5	7.04	1.42	0.53	2.46	0.46	0.17	1.45	89.08	90.5	91.54	89.54	90.53	
D21- (Alpakkam)	-3.16	8.73	2.9	0.9	3.19	0.55	0.22	0.87	132	134.9	135.19	132.55	132.87	
D22- (Pudhuchathiram)	-2.02	1.53	2.07	0.95	2.03	2.07	0.85	2.03	116.23	118.3	118.26	118.3	118.26	
D23- (Nanjalingampettai)	0.81	10.05	1.73	0.84	1.14	0.53	0.18	1.14	121	122.73	122.14	121.53	122.14	
D24- (Tiruchchopuram)	-0.69	10.3	2.31	1.14	1.81	0.51	0.18	0.82	130.4	132.71	132.21	130.91	131.22	
D25- (Kulanchavidi)	-8.2	4.52	1.64	0.54	2.58	0.72	0.27	2.03	101	102.64	103.58	101.72	103.03	
D26- (Adinarayanapuram)	-6.14	6.35	1.96	0.63	3	0.74	0.27	1.33	77	78.96	80	77.74	78.33	
D27- (Tiyagavalli)	-0.74	10.86	5.74	1.23	1.4	0.49	0.17	0.77	115.36	121.1	116.76	115.85	116.13	
D28- (Kudikkadu)	0.89	17.83	2.06	0.79	3.49	0.3	0.1	0.45	140.4	142.46	143.89	140.7	140.85	

Receptor Identification	X (km)	Y (km)	OCD highest 24-hr avg. conc.	OCD Avg Conc. (Mar-May 2011)	ISCST3 highest 24-hr avg. conc.	OCD highest 24-hr avg. conc. due to ITPCL	OCD Avg Conc. (Mar-May 2011) due to ITPCL	ISCST3 highest 24-hr avg. conc. due to ITPCL	Max. Background Conc.	OCD 24-Hr Highest Resultant Conc. (Worst Case)	ISCST3 24-Hr Highest Resultant Conc.	Predicted OCD Conc. Due to ITPCL (Background + Modelled)	Predicted ISCST3 Conc. Due to ITPCL (Background + Modelled)	NAAQS
			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(1 + 7)	(3 + 7)	(4 + 7)	(6 + 7)	
D29- (Raasapettai)	2.53	17.61	1.95	0.69	2.7	0.3	0.1	0.38	122.86	124.81	125.56	123.16	123.24	
D30- (Vadalur)	-22.4	3.86	1.18	0.34	2.16	0.3	0.1	0.96	80.12	81.3	82.28	80.42	81.08	

NAAQS 2005: 200 µg/m^3

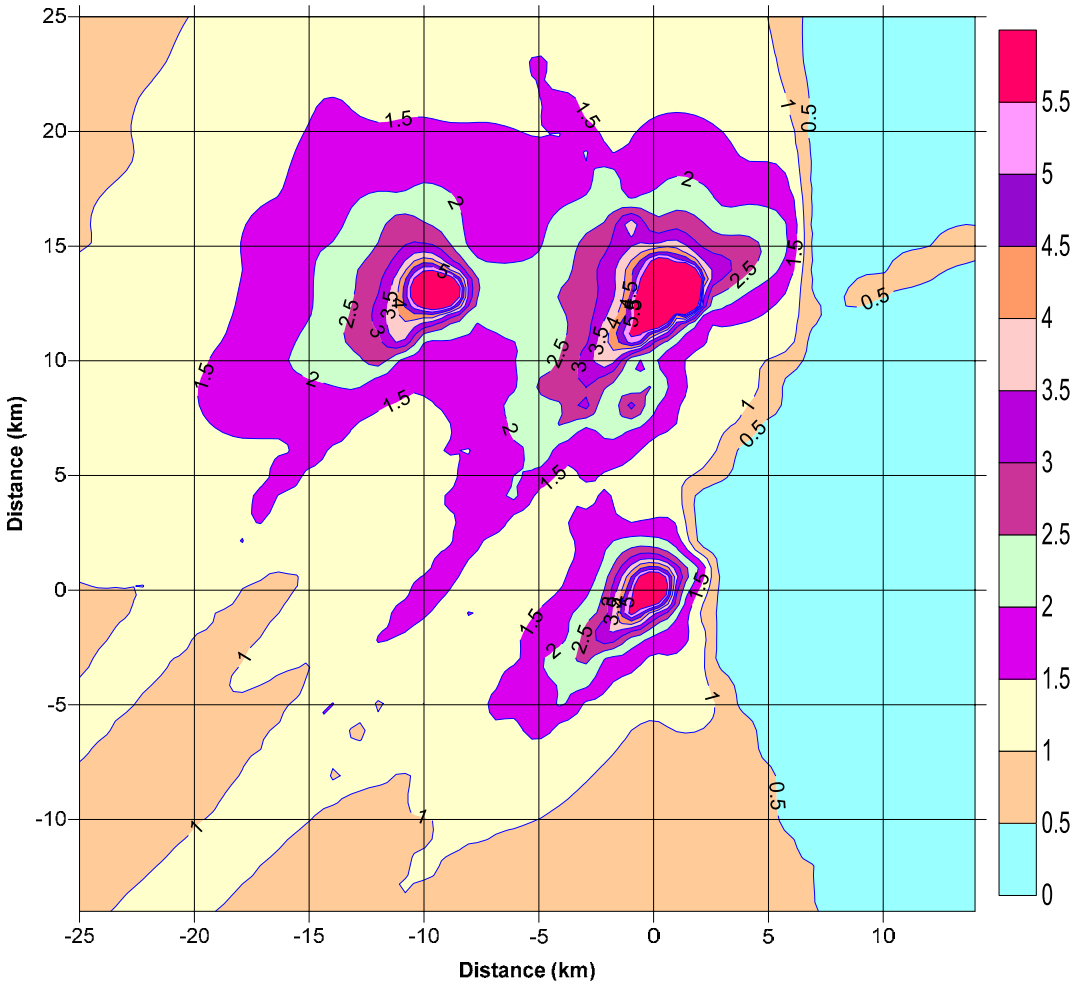


Figure 11: Spatial Variation of Cumulative 24-hr Average SPM (µg/m^3)

Table 32: Cumulative Highest 24-hour Average PM10 Concentration (µg/m^3) & Period-Average PM10 Concentration (µg/m^3) for Period (Mar-May, 2011) at Discrete Receptor Locations

Receptor Identification	X (km)	Y (km)	OCD highest 24-hr avg. conc.	OCD Avg Conc. (Mar-May 2011)	ISCST3 highest 24-hr avg. max conc.	OCD highest 24-hr avg. conc. due to ITPCL	OCD Avg Conc. (Mar-May 2011) due to ITPCL	ISCST3 24-hr avg. max conc. due to ITPCL	Max. Background Conc.	OCD 24-Hr Highest Resultant Conc. (Worst Case)	ISCST3 24-Hr Highest Resultant Conc.	Predicted OCD Conc. Due to ITPCL (Background + Modelled)	Predicted ISCST3 Conc. Due to ITPCL (Background + Modelled)	NAAQS
			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(1 + 7)	(3 + 7)	(4 + 7)	(6 + 7)	
D1- (Velingarayampettai)	0.73	1.4	1.096	0.428	0.784	1.096	0.392	0.78	30.52	31.616	31.304	31.616	31.3	100 µg/m^3
D2- (Chinnur)	0.41	-1.83	0.796	0.088	0.312	0.58	0.06	0.184	43.248	44.044	43.56	43.828	43.432	
D3- (Toppiruppu)	-1.75	-1.13	1.464	0.288	0.596	1.448	0.26	0.552	40.648	42.112	41.244	42.096	41.2	
D4- (Samiyarpettai)	0.52	2.67	0.7	0.292	0.324	0.7	0.252	0.204	30.12	30.82	30.444	30.82	30.324	
D5- (Vathiyapalli)	0.6	-2.77	0.616	0.064	0.332	0.412	0.04	0.212	62.048	62.664	62.38	62.46	62.26	
D6- (Port Novo)	1.78	-3.15	0.5	0.052	0.488	0.292	0.032	0.324	58.448	58.948	58.936	58.74	58.772	
D7- (Silambimangaloru)	-3.33	2.82	0.664	0.348	0.948	0.584	0.208	0.948	50.52	51.184	51.468	51.104	51.468	
D8- (Periyappattu)	-3.23	3.64	0.624	0.304	0.912	0.524	0.188	0.72	59.72	60.344	60.632	60.244	60.44	
D9- (Port Novo station)	-1.13	-6.16	0.408	0.044	0.312	0.244	0.028	0.22	69.648	70.056	69.96	69.892	69.868	
D10- (Ayyampettai)	0.52	0.67	2.172	0.804	0.204	2.172	0.772	0.04	32.52	34.692	32.724	34.692	32.56	
D11- (Sirupalaiyur)	-7.33	2.99	0.8	0.22	1.192	0.316	0.128	0.812	29.848	30.648	31.04	30.164	30.66	
D12- (Tachchakkadu)	-6.56	-4.49	0.688	0.116	0.844	0.6	0.084	0.84	32.648	33.336	33.492	33.248	33.488	
D13- (Puvalai)	-8.44	-1.05	0.48	0.16	0.88	0.348	0.108	0.88	32.248	32.728	33.128	32.596	33.128	

Receptor Identification	X (km)	Y (km)	OCD highest 24-hr avg. conc.	OCD Avg Conc. (Mar-May 2011)	ISCST3 highest 24-hr avg. max conc.	OCD highest 24-hr avg. conc. due to ITPCL	OCD Avg Conc. (Mar-May 2011) due to ITPCL	ISCST3 24-hr avg. max conc. due to ITPCL	Max. Background Conc.	OCD 24-Hr Highest Resultant Conc. (Worst Case)	ISCST3 24-Hr Highest Resultant Conc.	Predicted OCD Conc. Due to ITPCL (Background + Modelled)	Predicted ISCST3 Conc. Due to ITPCL (Background + Modelled)	NAAQS
			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(1 + 7)	(3 + 7)	(4 + 7)	(6 + 7)	
D14- (Killai)	1.67	-8.36	0.332	0.032	0.244	0.168	0.016	0.144	42.048	42.38	42.292	42.216	42.192	
D15- (Chidambaram)	-5.73	-10.69	0.388	0.04	0.28	0.208	0.024	0.184	52.848	53.236	53.128	53.056	53.032	
D16- (Kothattai)	-4.35	-1.47	0.712	0.204	1.384	0.672	0.168	1.384	32.752	33.464	34.136	33.424	34.136	
D17- (Palavattunnan)	-5.05	1.53	0.488	0.244	1.264	0.432	0.184	1.26	36.852	37.34	38.116	37.284	38.112	
D18- (Krishna Puram)	-14.48	-5.43	0.616	0.1	0.764	0.236	0.052	0.576	42.152	42.768	42.916	42.388	42.728	
D19- (Tirttanaggari)	-7.7	5.23	0.708	0.224	1.156	0.272	0.108	0.792	38.032	38.74	39.188	38.304	38.824	
D20- (Thaiyalkunampattinam)	-12.5	7.04	0.568	0.212	0.984	0.184	0.068	0.58	35.632	36.2	36.616	35.816	36.212	
D21- (Alpakkam)	-3.16	8.73	1.16	0.36	1.276	0.22	0.088	0.348	52.8	53.96	54.076	53.02	53.148	
D22- (Pudhuchathiram)	-2.02	1.53	0.828	0.38	0.812	0.828	0.34	0.812	46.492	47.32	47.304	47.32	47.304	
D23- (Nanjalingampettai)	0.81	10.05	0.692	0.336	0.456	0.212	0.072	0.456	48.4	49.092	48.856	48.612	48.856	
D24- (Tiruchchopuram)	-0.69	10.3	0.924	0.456	0.724	0.204	0.072	0.328	52.16	53.084	52.884	52.364	52.488	
D25- (Kulanchavidi)	-8.2	4.52	0.656	0.216	1.032	0.288	0.108	0.812	40.4	41.056	41.432	40.688	41.212	
D26- (Adinarayanapuram)	-6.14	6.35	0.784	0.252	1.2	0.296	0.108	0.532	30.8	31.584	32	31.096	31.332	
D27- (Tiyagavalli)	-0.74	10.86	2.296	0.492	0.56	0.196	0.068	0.308	46.144	48.44	46.704	46.34	46.452	

Receptor Identification	X (km)	Y (km)	OCD highest 24-hr avg. conc.	OCD Avg Conc. (Mar-May 2011)	ISCST3 highest 24-hr avg. max conc.	OCD highest 24-hr avg. conc. due to ITPCL	OCD Avg Conc. (Mar-May 2011) due to ITPCL	ISCST3 24-hr avg. max conc. due to ITPCL	Max. Background Conc.	OCD 24-Hr Highest Resultant Conc. (Worst Case)	ISCST3 24-Hr Highest Resultant Conc.	Predicted OCD Conc. Due to ITPCL (Background + Modelled)	Predicted ISCST3 Conc. Due to ITPCL (Background + Modelled)	NAAQS
			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(1 + 7)	(3 + 7)	(4 + 7)	(6 + 7)	
D28- (Kudikkadu)	0.89	17.83	0.824	0.316	1.396	0.12	0.04	0.18	56.16	56.984	57.556	56.28	56.34	
D29- (Raasapettai)	2.53	17.61	0.78	0.276	1.08	0.12	0.04	0.152	49.144	49.924	50.224	49.264	49.296	
D30- (Vadalur)	-22.4	3.86	0.472	0.136	0.864	0.12	0.04	0.384	32.048	32.52	32.912	32.168	32.432	

NAAQS: 100 µg/m^3

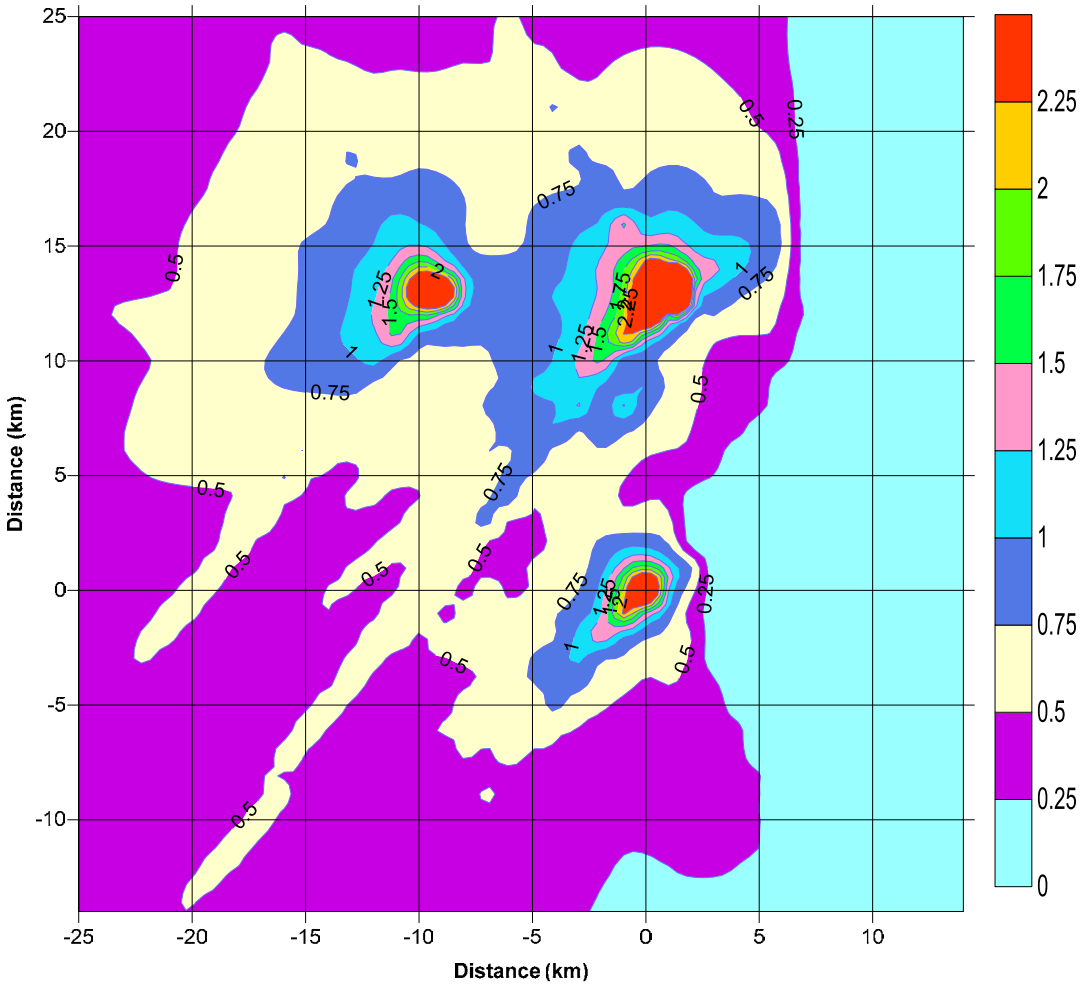


Figure 12: Spatial Variation of Cumulative 24-hr Average PM10 (µg/m^3)

Table 33: Cumulative Highest 24-hour Average PM2.5 Concentration (µg/m^3) & Period-Average PM2.5 Concentration (µg/m^3) for Period (Mar-May, 2011) at Discrete Receptor Locations

Receptor Identification	X (km)	Y (km)	OCD highest 24-hr avg. conc.	OCD Avg Conc. (Mar-May 2011)	ISCST3 24-hr avg. max conc.	OCD highest 24-hr avg. conc. due to ITPCL	OCD Avg Conc. (Mar-May 2011) due to ITPCL	ISCST3 24-hr avg. max conc. due to ITPCL	Max. Background Conc.	OCD 24-Hr Highest Resultant Conc. (Worst Case)	ISCST3 24-Hr Highest Resultant Conc.	Predicted OCD Conc. Due to ITPCL (Background + Modelled)	Predicted ISCST3 Conc. Due to ITPCL (Background + Modelled)	NAAQS
			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(1 + 7)	(3 + 7)	(4 + 7)	(6 + 7)	
D1- (Velingarayampettai)	0.73	1.4	0.664	0.086	0.157	0.219	0.078	0.156	6.104	6.768	6.261	6.323	6.26	60 µg/m^3
D2- (Chinnur)	0.41	-1.83	0.624	0.018	0.062	0.116	0.012	0.037	8.6496	9.2736	8.7116	8.7656	8.6866	
D3- (Toppiruppu)	-1.75	-1.13	0.408	0.058	0.119	0.29	0.052	0.11	8.1296	8.5376	8.2486	8.4196	8.2396	
D4- (Samiyarpettai)	0.52	2.67	2.172	0.058	0.065	0.14	0.05	0.041	6.024	8.196	6.089	6.164	6.065	
D5- (Vathiyapalli)	0.6	-2.77	0.8	0.013	0.066	0.082	0.008	0.042	12.4096	13.2096	12.4756	12.4916	12.4516	
D6- (Port Novo)	1.78	-3.15	0.688	0.01	0.098	0.058	0.006	0.065	11.6896	12.3776	11.7876	11.7476	11.7546	
D7- (Silambimangaloru)	-3.33	2.82	0.48	0.07	0.19	0.117	0.042	0.19	10.104	10.584	10.294	10.221	10.294	
D8- (Periyappattu)	-3.23	3.64	0.332	0.061	0.182	0.105	0.038	0.144	11.944	12.276	12.126	12.049	12.088	
D9- (Port Novo station)	-1.13	-6.16	0.388	0.009	0.062	0.049	0.006	0.044	13.9296	14.3176	13.9916	13.9786	13.9736	
D10- (Ayyampettai)	0.52	0.67	0.712	0.161	0.041	0.434	0.154	0.008	6.504	7.216	6.545	6.938	6.512	
D11- (Sirupalaiyur)	-7.33	2.99	0.488	0.044	0.238	0.063	0.026	0.162	5.9696	6.4576	6.2076	6.0326	6.1316	
D12- (Tachchakkadu)	-6.56	-4.49	0.616	0.023	0.169	0.12	0.017	0.168	6.5296	7.1456	6.6986	6.6496	6.6976	

Receptor Identification	X (km)	Y (km)	OCD highest 24-hr avg. conc.	OCD Avg Conc. (Mar-May 2011)	ISCST3 24-hr avg. max conc.	OCD highest 24-hr avg. conc. due to ITPCL	OCD Avg Conc. (Mar-May 2011) due to ITPCL	ISCST3 24-hr avg. max conc. due to ITPCL	Max. Background Conc.	OCD 24-Hr Highest Resultant Conc. (Worst Case)	ISCST3 24-Hr Highest Resultant Conc.	Predicted OCD Conc. Due to ITPCL (Background + Modelled)	Predicted ISCST3 Conc. Due to ITPCL (Background + Modelled)	NAAQS
			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(1 + 7)	(3 + 7)	(4 + 7)	(6 + 7)	
D13- (Puvalai)	-8.44	-1.05	0.708	0.032	0.176	0.07	0.022	0.176	6.4496	7.1576	6.6256	6.5196	6.6256	
D14- (Killai)	1.67	-8.36	0.568	0.006	0.049	0.034	0.003	0.029	8.4096	8.9776	8.4586	8.4436	8.4386	
D15- (Chidambaram)	-5.73	-10.69	0.68	0.008	0.056	0.042	0.005	0.037	10.5696	11.2496	10.6256	10.6116	10.6066	
D16- (Kothattai)	-4.35	-1.47	0.576	0.041	0.277	0.134	0.034	0.277	6.5504	7.1264	6.8274	6.6844	6.8274	
D17- (Palavattunnan)	-5.05	1.53	1.16	0.049	0.253	0.086	0.037	0.252	7.3704	8.5304	7.6234	7.4564	7.6224	
D18- (Krishna Puram)	-14.48	-5.43	0.828	0.02	0.153	0.047	0.01	0.115	8.4304	9.2584	8.5834	8.4774	8.5454	
D19- (Tirttanaggari)	-7.7	5.23	0.692	0.045	0.231	0.054	0.022	0.158	7.6064	8.2984	7.8374	7.6604	7.7644	
D20- (Thaiyalkunampattinam)	-12.5	7.04	0.924	0.042	0.197	0.037	0.014	0.116	7.1264	8.0504	7.3234	7.1634	7.2424	
D21- (Alpakkam)	-3.16	8.73	0.784	0.072	0.255	0.044	0.018	0.07	10.56	11.344	10.815	10.604	10.63	
D22- (Pudhuchathiram)	-2.02	1.53	2.648	0.076	0.162	0.166	0.068	0.162	9.2984	11.9464	9.4604	9.4644	9.4604	
D23- (Nanjalingampettai)	0.81	10.05	2.296	0.067	0.091	0.042	0.014	0.091	9.68	11.976	9.771	9.722	9.771	
D24- (Tiruchchopuram)	-0.69	10.3	0.824	0.091	0.145	0.041	0.014	0.066	10.432	11.256	10.577	10.473	10.498	
D25- (Kulanchavidi)	-8.2	4.52	0.472	0.043	0.206	0.058	0.022	0.162	8.08	8.552	8.286	8.138	8.242	
D26- (Adinarayanapuram)	-6.14	6.35	0.664	0.05	0.24	0.059	0.022	0.106	6.16	6.824	6.4	6.219	6.266	

Receptor Identification	X (km)	Y (km)	OCD highest 24-hr avg. conc.	OCD Avg Conc. (Mar-May 2011)	ISCST3 24-hr avg. max conc.	OCD highest 24-hr avg. conc. due to ITPCL	OCD Avg Conc. (Mar-May 2011) due to ITPCL	ISCST3 24-hr avg. max conc. due to ITPCL	Max. Background Conc.	OCD 24-Hr Highest Resultant Conc. (Worst Case)	ISCST3 24-Hr Highest Resultant Conc.	Predicted OCD Conc. Due to ITPCL (Background + Modelled)	Predicted ISCST3 Conc. Due to ITPCL (Background + Modelled)	NAAQS
			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(1 + 7)	(3 + 7)	(4 + 7)	(6 + 7)	
D27- (Tiyagavalli)	-0.74	10.86	0.408	0.098	0.112	0.039	0.014	0.062	9.2288	9.6368	9.3408	9.2678	9.2908	
D28- (Kudikkadu)	0.89	17.83	2.172	0.063	0.279	0.024	0.008	0.036	11.232	13.404	11.511	11.256	11.268	
D29- (Raasapettai)	2.53	17.61	0.8	0.055	0.216	0.024	0.008	0.03	9.8288	10.6288	10.0448	9.8528	9.8588	
D30- (Vadalur)	-22.4	3.86	0.688	0.027	0.173	0.024	0.008	0.077	6.4096	7.0976	6.5826	6.4336	6.4866	

Note: NAAQs: 60 $\mu g/m^3$

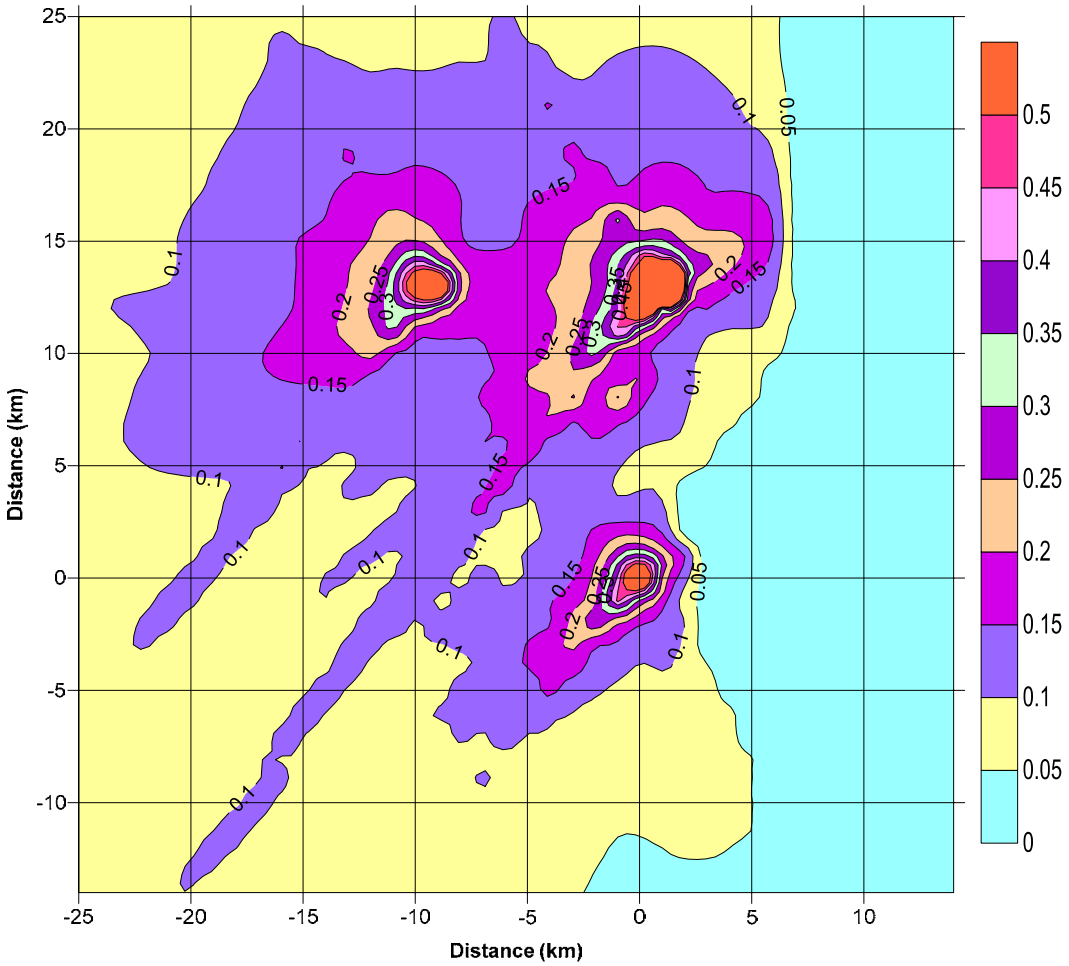


Figure 13: Spatial Variation of Cumulative 24-hr Average PM2.5 (µg/m^3)

5.8 Results and Discussions for Scenario 2

Table 34 below shows the scenario in which all sources (ITPCL, NOCL, SIMA, CPC) but SRM ENERGY have been considered. This is the case where we have modelled the SO_2 concentration from industries which were granted EC till the time ITPCL plant was given EC. We have here considered for SO_2 only because the NAAQS is satisfied for all other pollutants considered in this study (i.e. NOx, SPM, PM10, PM2.5) when the cumulative emissions are considered.

Table 34: Cumulative Highest 24-hour Average PM2.5 Concentration (µg/m^3) & Period-Average PM2.5 Concentration (µg/m^3) for Period (Mar-May, 2011) at Discrete Receptor Locations

Receptor Identification	X (km)	Y (km)	OCD highest 24-hr avg. conc. (1)	OCD Avg Conc. (Mar-May 2011) (2)	ISCST3 24-hr avg. conc. (3)	OCD highest 24-hr avg. conc. due to ITPCL (4)	OCD Avg Conc. (Mar-May 2011) due to ITPCL (5)	ISCST3 24-hr avg. conc. due to ITPCL (6)	Max. Background Conc. (7)	OCD 24-Hr Highest Resultant Conc. (Worst Case) (1 + 7)	ISCST3 24-Hr Highest Resultant Conc. (3 + 7)	Predicted OCD Conc. Due to ITPCL (Background + Modelled) (4 + 7)	Predicted ISCST3 Conc. Due to ITPCL (Background + Modelled) (6 + 7)	NAAQS
D1- (Velingarayampettai)	0.73	1.4	30.57	11.75	21.05	30.57	10.96	21.05	5.64	36.21	26.69	36.21	26.69	80 µg/m^3
D2- (Chinnur)	0.41	-1.83	21	2.26	5.95	15.64	1.67	5.23	6.66	27.66	12.61	22.3	11.89	
D3- (Toppiruppu)	-1.75	-1.13	39.67	7.64	16.85	39.16	6.93	15.59	6.42	46.09	23.27	45.58	22.01	
D4- (Samiyarpettai)	0.52	2.67	19.24	7.92	6.3	19.24	6.97	5.6	5.64	24.88	11.94	24.88	11.24	
D5- (Vathiyapalli)	0.6	-2.77	16.17	1.66	6.45	11.08	1.11	5.73	9.66	25.83	16.11	20.74	15.39	
D6- (Port Novo)	1.78	-3.15	13.34	1.36	10.72	8.04	0.86	8.87	8.66	22	19.38	16.7	17.53	
D7- (Silambimangaloru)	-3.33	2.82	16.57	8.43	26.07	15.86	5.68	26.07	12.64	29.21	38.71	28.5	38.71	
D8- (Periyappattu)	-3.23	3.64	16.01	7.8	22.58	14.26	5.07	19.33	15.64	31.65	38.22	29.9	34.97	
D9- (Port Novo station)	-1.13	-6.16	11.35	1.18	6.5	6.62	0.71	5.96	16.66	28.01	23.16	23.28	22.62	
D10- (Ayyampettai)	0.52	0.67	61.53	22.74	4.16	61.53	22	0.82	5.64	67.17	9.8	67.17	6.46	
D11- (Sirupalaiyur)	-7.33	2.99	24.58	6.03	38.74	8.56	3.46	21.9	6.42	31	45.16	14.98	28.32	
D12- (Tachchakkadu)	-6.56	-4.49	19.07	3.04	22.91	16.24	2.29	22.9	7.42	26.49	30.33	23.66	30.32	

Receptor Identification	X (km)	Y (km)	OCD highest 24-hr avg. conc. (1)	OCD Avg Conc. (Mar-May 2011) (2)	ISCST3 24-hr avg. conc. (3)	OCD highest 24-hr avg. conc. due to ITPCL (4)	OCD Avg Conc. (Mar-May 2011) due to ITPCL (5)	ISCST3 24-hr avg. conc. due to ITPCL (6)	Max. Background Conc. (7)	OCD 24-Hr Highest Resultant Conc. (Worst Case) (1 + 7)	ISCST3 24-Hr Highest Resultant Conc. (3 + 7)	Predicted OCD Conc. Due to ITPCL (Background + Modelled) (4 + 7)	Predicted ISCST3 Conc. Due to ITPCL (Background + Modelled) (6 + 7)	NAAQS
D13-(Puvalai)	-8.44	-1.05	13.15	4.33	24.74	9.51	2.97	23.87	7.42	20.57	32.16	16.93	31.29	
D14-(Killai)	1.67	-8.36	8.35	0.77	4.86	4.51	0.4	3.88	7.66	16.01	12.52	12.17	11.54	
D15-(Chidambaram)	-5.73	-10.69	10.43	1.05	8.35	5.63	0.62	4.99	9.66	20.09	18.01	15.29	14.65	
D16-(Kothattai)	-4.35	-1.47	19.4	5.47	38.55	18.25	4.59	37.92	8.28	27.68	46.83	26.53	46.2	
D17-(Palavattunnan)	-5.05	1.53	12.9	6.54	34.4	11.75	4.99	34.4	8.86	21.76	43.26	20.61	43.26	
D18-(Krishna Puram)	-14.48	-5.43	18.44	2.63	24.54	6.4	1.4	15.67	10.04	28.48	34.58	16.44	25.71	
D19-(Tirttanaggari)	-7.7	5.23	23.49	6.2	36.51	7.44	2.89	21.85	7.58	31.07	44.09	15.02	29.43	
D20-(Thaiyalkunampattinam)	-12.5	7.04	15.66	5.16	32.75	4.95	1.9	15.66	9.48	25.14	42.23	14.43	25.14	
D21-(Alpakkam)	-3.16	8.73	38.55	10.37	42.65	5.99	2.39	9.55	27	65.55	69.65	32.99	36.55	
D22-(Pudhuchathiram)	-2.02	1.53	22.36	10.26	21.92	22.36	9.22	21.92	14.23	36.59	36.15	36.59	36.15	
D23-(Nanjalingampettai)	0.81	10.05	20.39	8.83	11.14	5.78	1.95	11.14	10	30.39	21.14	15.78	21.14	
D24-(Tiruchchopuram)	-0.69	10.3	30.88	12.55	20.65	5.56	1.99	8.85	15	45.88	35.65	20.56	23.85	
D25-(Kulanchavidi)	-8.2	4.52	21.6	5.92	32.62	8	2.95	21.82	17	38.6	49.62	25	38.82	
D26-(Adinarayanapuram)	-6.14	6.35	26.06	7.07	37.93	8.02	2.96	14.47	10	36.06	47.93	18.02	24.47	
D27-(Tiyagavalli)	-0.74	10.86	76.72	14.09	15.86	5.3	1.89	8.41	10.72	87.44	26.58	16.02	19.13	

Receptor Identification	X (km)	Y (km)	OCD highest 24-hr avg. conc. (1)	OCD Avg Conc. (Mar-May 2011) (2)	ISCST3 24-hr avg. conc. (3)	OCD highest 24-hr avg. conc. due to ITPCL (4)	OCD Avg Conc. (Mar-May 2011) due to ITPCL (5)	ISCST3 24-hr avg. conc. due to ITPCL (6)	Max. Background Conc. (7)	OCD 24-Hr Highest Resultant Conc. (Worst Case) (1 + 7)	ISCST3 24-Hr Highest Resultant Conc. (3 + 7)	Predicted OCD Conc. Due to ITPCL (Background + Modelled) (4 + 7)	Predicted ISCST3 Conc. Due to ITPCL (Background + Modelled) (6 + 7)	NAAQS
D28- (Kudikkadu)	0.89	17.83	25.62	9.3	38.19	3.27	1.12	4.95	15	40.62	53.19	18.27	19.95	
D29- (Raasapettai)	2.53	17.61	24.47	8.16	26.1	3.3	1.08	4.11	10.42	34.89	36.52	13.72	14.53	
D30- (Vadalur)	-22.4	3.86	9.37	2.95	24.22	3.23	1.12	10.43	20.52	29.89	44.74	23.75	30.95	

A representation of the scenario 2 is shown in the graph below.

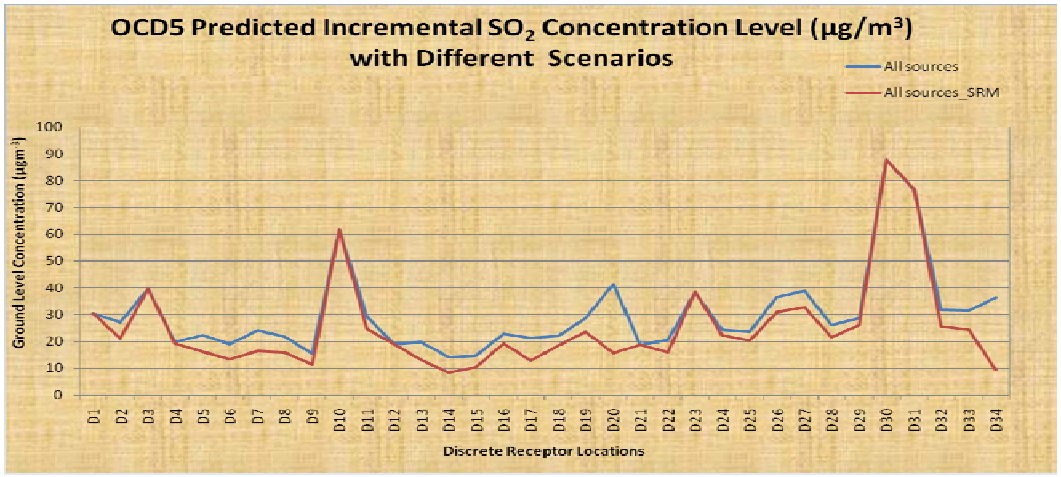


Figure 14: OCD5 Predicted Incremental SO_2 Concentration Level

CHAPTER 6:
MARINE BASELINE ENVIRONMENTAL STATUS AND RAPID CUMULATIVE MARINE ENVIRONMENTAL MODELLING AND IMPACT ASSESSMENT

6 Marine Baseline Environmental Status and Rapid Cumulative Marine Environmental Modelling and Impact Assessment

6.1 Presence of Various Industries in 25 km Radius

The proposed ITPCL Thermal Power Plant integrated with the Desalination Plant and the Captive Port will be located at the coastal region of Kottatai, Ariyagoshti, Villiyannalur and Silambimangalam villages in Parangipettai block of Cuddalore district, Tamil Nadu. The proposed marine facilities will comprise of seawater intake, marine outfall and captive port with breakwaters in Bay of Bengal. The locations of ITPCL, other proposed industries and existing industries falling within 25 km radius are shown in Figure 15.

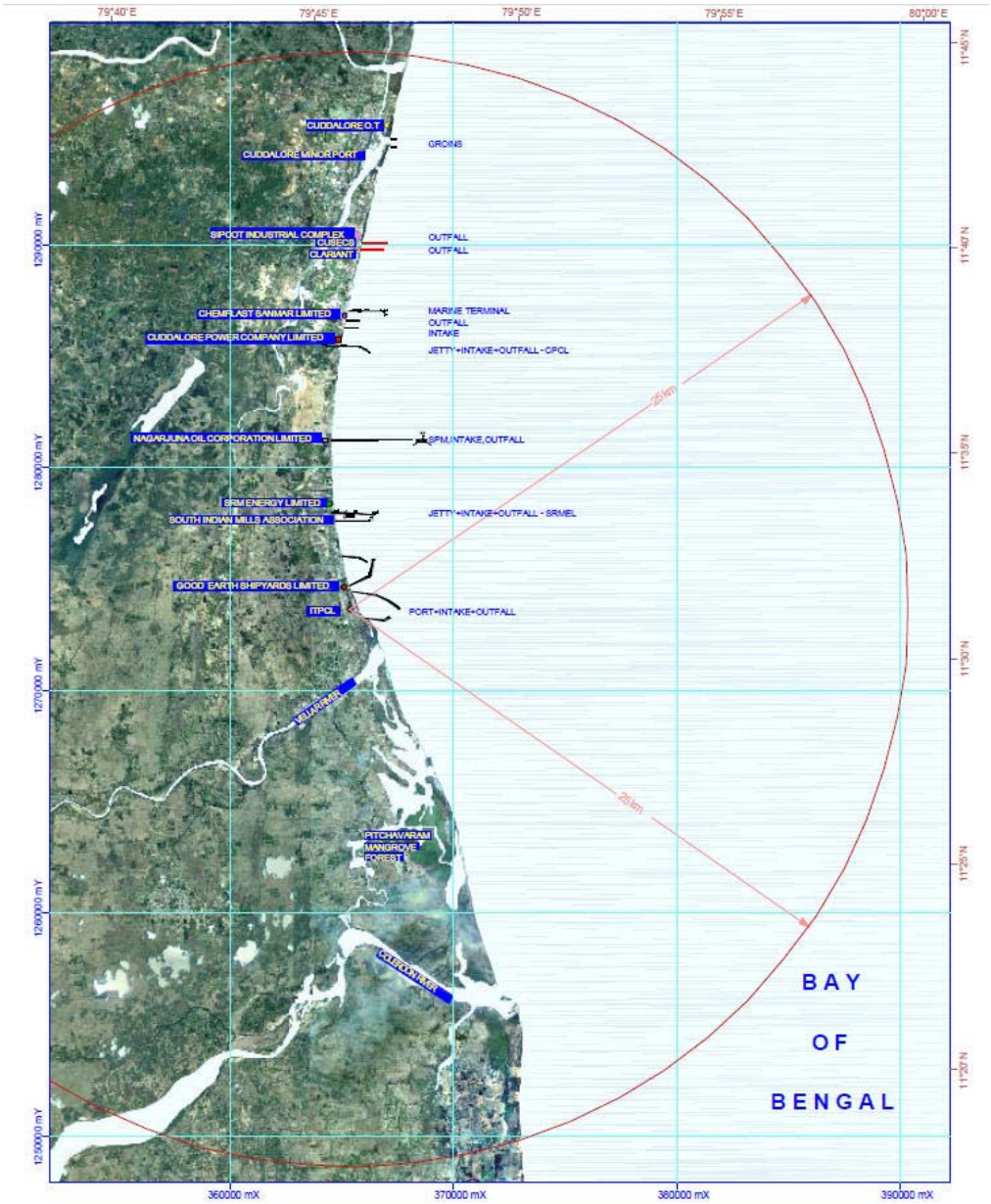


Figure 15: Industrial Outfall and Ports Locations within 25km Radius

The details of these industries with respective marine facilities and amenity to ITPCL are listed below.

Table 35: Industries with respective to Marine Facilities

Sl. No.	Industry	Distance north of ITPCL along the coast (km)	Marine facilities
1	Cuddalore Minor Port	22	Port facilities, fishing harbour.
2	SIPCOT Industrial complex	17	Treated trade effluent outfall.
3	Chemplast Sanmar Limited (CSL)	13	Marine terminal, seawater intake, return water outfall, chemical parcel pipeline.
4	Cuddalore Power Company Limited (CPC)	12	Seawater intake, return water outfall, coal jetty.
5	Nagarjuna Oil Corporation Limited (NOCL)	8	SPM, crude oil pipeline, export petroleum jetty.
6	SRM Energy Limited (SRMEL)	5	Seawater intake, return water outfall, coal jetty.
7	Textile Park of South India Mills Association (SIMA)	4.5	Treated trade effluent outfall.
8	Good Earth Shipyard Limited (GESL)	1	Shipyard with breakwaters.
9	IL&FS Tamil Nadu Power Company Limited (ITPCL)	-	Seawater intake, return water outfall, port with breakwaters.

Cuddalore Minor Port: It is a historical minor port being operated by Tamil Nadu Maritime Board. The port is located in the mouth of Uppanar River joining the Bay of Bengal. The northern side of the Port is developed as the fishing harbour. This port presently handles the lighterage operations of bulk cargo. This port entrance is protected by two small groins of each about 200 m length on either side of the river mouth.

SIPCOT: SIPCOT Industrial Complex, Cuddalore was established in 1984. The Phase I and Phase II development comprises of varied industries like Dye & Dye intermediates, Pesticide, Basic drugs and Pharma, Pigments & intermediate, PVC resin, other chemicals, Electroplating, Aluminium circles, foundries, Captive power plants, Ice plant and Paper products. There are thirty operating units in which seventeen are generating trade effluent. All the industries have their own Effluent Treatment Plant within their premises. In that, eight units have augmented their ETP to maintain zero discharge. The rest of nine industries are discharging the treated effluent into Bay of Bengal as classified below. i) CUSECS Effluent: Eight units through CUSECS – Cuddalore SIPCOT Industries Common Utilities Limited, formed a common collection, conveyance and marine disposal facility. They combinedly discharge 500 m^3/hour of treated trade effluent into the sea at a distance of 1000 m offshore. ii) Clariant Effluent: Clariant Chemicals India Limited discharges separately its treated effluent directly into the sea at a distance of 1000 m into the sea, at about 50 m south of CUSECS outfall location. The volume of discharge is around 50 m^3/hour. The locations of these two outfalls are shown in Figure 15.

The Report of Analysis in the vicinity of various discharges from the SIPCOT effluent conducted by Tamil Nadu Pollution Control and NEERI confirmed that the treated effluent discharged into the sea conforms to the prescribed standard and remain within the stipulated limits.

Chemplast Sanmar Limited: Chemplast Sanmar Limited (CSL) has established a Marine Terminal Facility (MTF) to receive the chemical parcel for the PVC manufacturing facility located in the SIPCOT Phase-II complex. Marine Terminal Facility is located at 1 km offshore at a water depth of 10.7 m. The parcel received at MTF is transported to the shore through a submarine pipeline. There is also a temporary jetty which was built during the construction of the plant for receiving the plant construction machineries and it is presently used for berthing supporting crafts. In addition, CSL has laid two numbers of seawater intake pipeline and one return water outfall pipeline. The locations of the MTF, temporary jetty, seawater intake pipelines and the outfall pipeline are shown in Figure 15.

Cuddalore Power Company Limited: Cuddalore Power Company Limited (CPC) has proposed to develop 2 x 660 MW Coal Based Thermal Power Plant. It is proposed to construct a dedicated coal jetty to receive vessels of Panamax size. It intends to augment the jetty further for handling seawater intake and warm water outfall pipelines. The various marine facilities stretching out into the sea would consist of, i) construction of coal jetty of 1000 m long into the sea up to 12 m water depth, ii) fixing of intake and outfall pipelines on the jetty, iii) construction of seawater intake well along the coal jetty at 500 m distance into the sea, and v) construction of outfall diffuser on the seabed at 900 m distance into the sea. The locations of these marine facilities are shown in Figure 15.

Nagarjuna Oil Corporation Limited: Nagarjuna Oil Corporation Limited is in the process of developing an oil refinery with a capacity of 6.5 MTPA. For this purpose, they are now installing an SPM at 30 m depth with a crude oil submarine pipeline of 48” dia. connecting the SPM and the refinery. The SPM will accommodate VLCCs of 300,000 DWT class. It will also develop a shore based Product Jetty to form as part of the development process which can handle product tankers of 45000 to 60000 DWT size.

SRM Energy Limited: It has proposed to set up a Coal Based Thermal Power Plant consisting of 3 x 600 MW. It has proposed to use seawater for condenser cooling and discharge the return water back into the sea. The marine facilities proposed are: i) construction of piled trestle coal jetty for 1250 m length into the sea, ii) construction of intake and outfall pipelines on the trestle, iii) construction of seawater intake well at seaward end of the jetty at 650 m distance at 9 m water depth, and iv) construction of outfall diffuser on the seabed at 1250 m distance at 10 m water depth. The locations of these facilities are shown in Figure 15.

Textile Processing Park of SIMA: The South Indian Mills Association (SIMA) proposes to establish a Textile Processing Park at Periyapattu village north of ITPCL. There will be seven units manufacturing 0.3 million metres of woven fabric and 100 million ton of knitted fabric per daily. They plan to use 10.95 MLD of fresh water essentially from the SIPCOT water supply and ground water will be used as a backup supply. The treated effluent amounting to 10.5 MLD will be disposed into sea at a water depth of 10m CD (Figure 16). Since this park will be functioning according to the standards prescribed by CPCB, the quality of effluent will be as per CPCB specifications. The effluent will have a BOD of 1000 mg/l.

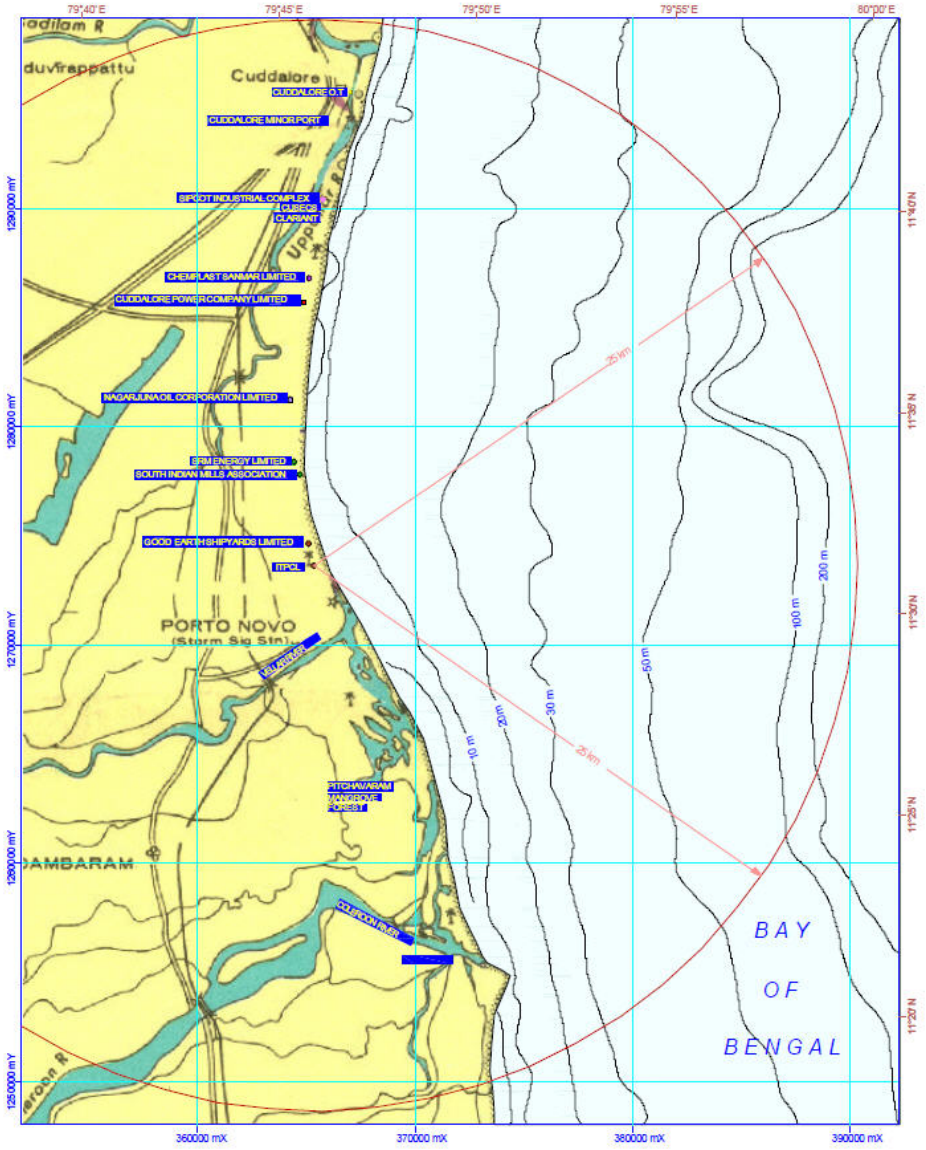


Figure 16: Bathymetry off Cuddalore Region

Good Earth Shipyard Private Limited: This is a ship building yard proposed with two breakwaters. The proponent is planning to adopt modern building technology 'load out technology' where all major modules will be fabricated elsewhere as modules and brought to the proposed shipyard for assembly in stages and other related finishing works. The project falls within the close vicinity of ITPCL site and the distance between these two projects will be only 1 km.

ITPCL Port: In addition to the ITPCL seawater intake and marine outfall, ITPCL has also proposed to establish a captive port to handle the coal requirements for the development of coal based power plant of 3600 MW capacity in different phases. The coal handling requirement is 15 MTPA. The harbor basin is formed by two breakwaters with an entrance at the eastern side. Initially two coal berths with mechanized coal handling facility are proposed. The marine facilities will be designed for 80000 DWT vessels. The locations of the intake, outfall and the port are shown in Figure 15.

6.2 Reports Reviewed

SIPCOT: Status report on the implementation of the action plan for critically polluted industrial clusters, SIPCOT, August 2011.

Chemplast Sanmar Limited (CSL): Rapid Marine Environmental Impact Assessment and Environmental Management Plan for the proposed expansion of boat landing jetty, Indomer, July 2010.

Cuddalore Power Company Limited (CPC): Rapid Marine Environmental Impact Assessment and Environmental Management for 2 x 660 MW Thermal Power Plant, Cuddalore, Indomer, June 2007.

Nagarjuna Oil Corporation Limited: Detailed Project Report for Marine Terminal facilities near Cuddalore (Volume I-III).

SRM Energy Limited (SRM): Rapid Marine Environmental Impact Assessment and Environmental Management Plan for 3 x 600 MW SRMEL Power Plant at Poovalai Village, Cuddalore District, Tamil Nadu, Indomer, 2011.

Textile Processing Park of South Indian Mills Association (SIMA): The Rapid EIA of Textile Processing Park of South Indian Mills Association (SIMA) at Periyapattu village of Cuddalore District, Tamil Nadu, 2010.

Good Earth Shipyard Private Limited: EIA and EMP Report for proposed Silambimangalam shipbuilding yard project – Phase I development at Cuddalore District, Tamil Nadu, Anna University, Chennai.

ITPCL Port: Environmental Impact Assessment report for 3600 MW Thermal Power Plant Captive Port and Desalination Plant at Cuddalore District, Tamil Nadu, ITPCL and L&T Ramboll, February 2010.

Mathematical modelling of dispersion of warm water and brine in sea for with and without breakwaters of 3600 MW coal based Power Plant near Puthukuppam Village, South of Cuddalore, Indomer, September 2009.

For more details of different projects on marine facilities, environmental parameters, etc. the respective EIA/project reports may be referred.

6.3 Description of Cuddalore Coastal Region

Rivers & Estuaries: The coastal region falling within 25 km radius from the ITPCL site encompasses from Cuddalore O.T. on the north to the Coleroon river mouth on the south. The coastal segment of Cuddalore has many rivers joining the sea such as Malathar, Uppanar, Parvanar, Vellar, Gadilam and Kollidam. During heavy rains in northeast monsoon, all these rivers drain the large fresh water runoff into the sea. River Uppanar (Paravanar) originating from Perumal Eri flows along the Eastern boundary of SIPCOT industrial area and joins with Bay of Bengal at Cuddalore Port. The river Uppanar is active with tidal prism and its water remains brackish for a considerable reach along the upstream of the river.

Morphology: The coastline in this region is nearly straight and is oriented in North-south direction. It comprises of low and wide beaches. The foreshore is relatively flat and the backshore is occupied with Casuarinas and cashew plantations. The morphology of this region is influenced by 3 climatic conditions, viz., southwest monsoon, northeast monsoon and fair weather period. Unlike the northern part of the east coast of India, this part of the coast is influenced more by the northeast monsoon than those during the other two seasons. The nearshore remains relatively steeper due to the action of high waves during monsoon seasons. This nearshore region is composed of alluvial sediments brought over the geological years by Vellar river and its distributaries draining between Parangipettai and Mudasalvodai. The stretch of the coastline is in retreading phase as the supply of sediments into the littoral system is largely reduced due to the reduction of freshwater flow from Vellar and its distributaries.

Wind: The wind speed exists around 10 knots in January and December, 8 knots in February to April and November, 7 knots in May and June, 6 knots in July to September and 5 knots in October. The predominant wind direction is SW and W in May to September, NW in November and December, NE in January and February. The wind patterns during morning hours and evening hours show the influence of land-sea breeze system in this region. During the days of depressions and cyclones the wind speed commonly exceeds 80 knots.

Cyclone & Storm Surge: The tracks of cyclones which crossed the coast near Cuddalore during 1877 to 1990 shows that totally 58 storms occurred in this region. The occurrence of storms in this region is more frequent in November (23) followed by October (19). Among these occurrences, five storms had crossed the coast within 150 km. During the recent cyclone Thane occurred in 2011, the wind speed crossed 200 km/hour and the eye of the cyclone hit the CSL jetty. The storm surge of above 2.5 m height was reported.

Tsunami: Amongst the natural disaster in the coastal region, tsunami causes the extensive damage to the life and property and natural resources along the coast. Tsunami is a series of waves with long wave length and period. Time lapse between crests of the wave can vary from a few minutes to over an hour. Tsunami waves are usually generated by any large impulsive displacement of sea bed in vertical direction. Occurrence of Tsunami along the Indian coast is an extremely rare event, but for the one that was witnessed on 26th December 2004 along the east coast of India, which produced devastating effect along the entire Tamil Nadu coast. The magnitude of impact was very severe along the coastal stretch between Nagapattinam and Cuddalore. The coastal belt of Cuddalore was one of the worst affected regions due to 2004 Tsunami disaster to an extent measuring 10 km inland and 60 km along the coast. The water level measurements indicate a tsunami run up of about 1.5 m to 3.5 m with a maximum witnessed between Karaikal and Nagapattinam. The mangrove forest at Pichavaram acted as a good buffer to reduce the impact of tsunami along this coastal front.

Currents: The current measurements were taken at six locations for about one month for ITPCL project during the month of June 2008. The current speed varied upto 0.24 m/s. The flow direction showed a slight tendency of bidirectional flow with varying direction over a tidal cycle. The predominant direction remained about 340º during peak flood flow and rotates over the tidal cycle and remains at 160º during peak ebb flow. In general the flow appears to be more dominated by tides than the influence of wind and the general circulation in the sea.

Tides: The typical variations of tides were measured at Parangipettai from 09.05.08 to 12.06.08 for 30 days. The recorded tides show that the spring tidal range existed around 1.0 m and the neap tidal range around 0.20 m during the measurement period.

Waves: The annual wave roses representing the coastal region of 25 km radius showed that the significant wave height vary around 0.75 m from February to May and July to September and 1.0 m from October to January and June. The predominant zero crossing wave periods remain around 6 s over the whole year. The predominant wave direction prevails around 115° during March and October, 120° to 150° in April to September, and 95° to 100° from November to February. The occurrence of storms and depressions during northeast monsoon often increases the wave activity in this region.

Bathymetry: In general the bathymetry off the Cuddalore region is shown in Figure 16. The seabed falls relatively steeper. The 3 m, 4 m, 5 m, 6 m, 7 m, 8 m, 9 m, 10 m, water depth occurs at a distance of 160 m, 200 m, 250 m, 300 m, 390 m, 550 m, 890 m and 2000 m respectively from the shoreline. The depth contours are parallel to coastline up to 9 m water depth. The seabed exists with a steep slope of 1:90 up to 850 m from the coastline further the seabed continue with flat slope up to 11 m water depth. The near shore bathymetry changes frequently due to the occurrence of storms and other meteorological disturbances. It has been observed that there was an increase of water depth up to to 1 m after the passage of Thane cyclone.

6.4 Description of Marine Environment

Vast data have been collected under various projects from different locations at nearshore region off Cuddalore on water quality, benthic animals, sediment quality, biological parameters and fisheries. The various locations of sample collection in open sea and in rivers are shown in Figure 17.

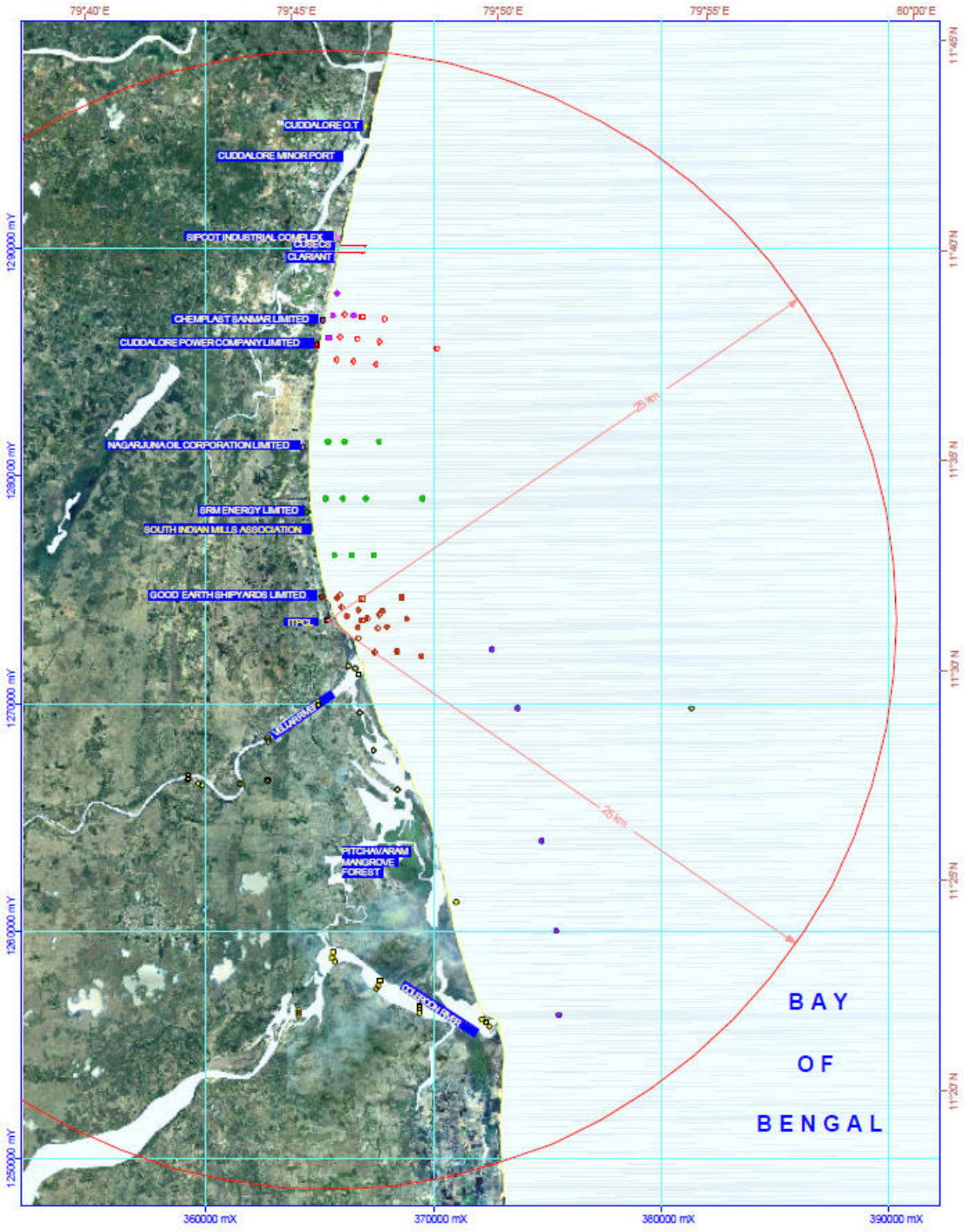


Figure 17: Locations of Environmental Data Collected under Different Projects

After compilation of all these available information, the general characteristics of the marine environment are summarized below.

6.4.1 Biological Paramaters

Phytoplankton, zooplankton and benthos were estimated as a part of the primary data collection along the Cuddalore coast. The projects for which studies conducted are: i) Chemplast Sanmar Limited (Chemplast), ii) Cuddalore Power Corporation Limited (CPC), iii) SRM and iv) ITPCL. A comparative study of occurrence and distribution of various groups of organisms was carried out to understand the evenness of the distribution of different groups of organisms. In addition waters and sediments of Pichavaram, Vellar river, Coleroon river and coastal waters near the Pichavaram mangrove were also analyzed.

The distribution of phytoplankton appears to be almost uniform all along the Cuddalore coast. Out of the 28 genera recognized in this coast, the number varied from 20 to 28 at different project sites as shown in Table 35. This indicates that the water appears to be well mixed. The analysis of zooplankton also shows a similar pattern. The generic/group composition in the coastal waters of Cuddalore was found to be 40 genera/group. The number varied from 26 to 39 at different project sites as shown in Table 36.This also confirms the evenness of species at different locations of the Cuddalore coast. Most common groups of benthic organisms were also collected at different locations and compared for evenness. In total 7 groups were present in Table 37. Polychaete worms are the most dominant ones in this coastal region.

Table 36: Generic Distribution of Phytoplankton

Sl. No.	Genus / Species	CHEMPLAST	CPC	SRM	ILFS
PHYLUM: Heterokontophyta					
Class: Bacillariophyceae (Diatoms)					
Order:Centrales					
1	*Bacteriastrum*	+	+	+	-
2	Bellerochea	+	+	+	+
3	Biddulphia	+	+	+	+
4	*Chaetoceros*	+	+	+	+
5	*Coscinodiscus*	+	+	+	+
6	*Cyclotella*	+	-	+	-
7	*Ditylum*	+	+	+	+
8	*Hemidiscus*	+	+	+	+
9	Lauderia	+	-	+	-
10	Leptocylindrus	+	+	+	+
11	Planktonella	+	+	+	+
12	*Rhizosolenia*	+	+	+	+
13	*Skeletonema*	+	+	+	+
14	*Thalassiosira*	+	+	+	+
15	*Triceratium*	+	+	+	-
Order: Pennales					
16	*Asterionella*	+	+	+	+
17	*Bacillaria*	-	+	+	+
18	*Fragelaria*	+	-	+	-
19	*Navicula*	+	+	+	-
20	*Nitzschia*	+	+	+	-
21	*Pleurosigma*	+	+	+	+
22	*Thalassionema*	+	+	+	+
23	*Thalassiothrix*	+	+	+	+
Class: Dinophyceae (Dinoflagellates)					
24	*Ceratium*	+	+	+	+
25	*Dinophysis*	+	+	+	+
26	*Peridinum*	+	+	+	+

27	*Prorocentru*	-	+	+	+
Class: Cyanophyceae (Blue-greens)					
28	*Trichodesmium*	+	+	+	-
Total		**26**	**25**	**28**	**20**

+Species Present, -Species absent

Table 37: Generic Distribution of Zooplankton

Sl. No.	Genus / Species	CHEMPLAST	CPC	SRM	ILFS
PHYLUM: PROTOZOA					
Order: Tintinnids (Ciliate groups)					
1	*Tintinnopsis*	+	+	+	+
2	*Favella*	+	+	+	+
3	*Eutintinnus*	+	-	+	-
PHYLUM: CNIDARIA					
4	*Diphysis*	+	-	+	+
5	*Dictyocysta*	-	-	+	+
6	*Obelia*	+	-	+	-
7	Smaller Medusa larvae	+	-	+	-
PHYLUM: CHAETOGNATHA					
8	*Sagitta*	+	+	+	+
PHYLUM: ANNELIDA					
Class: Polycheata					
9	Polychaete larvae	+	+	+	+
PHYLUM: MOLLUSCA					
10	Bivalve veliger Larvae	+	+	+	+
11	Gastropod veliger larvae	+	+	+	+
12	*Cresis*	-	+	-	+
PHYLUM: ATHROPODA					
Class: Crustacea					
Order: Copepoda					
Sub- order: Calanoida					
13	*Acartia*	+	+	+	+
14	*Acrocalanus*	+	+	+	+
15	*Calanopia*	+	+	+	-
16	*Centropages*	+	+	+	-
17	*Eucalanus*	+	+	+	+
18	*Labidocera*	+	+	+	+
19	*Nannocalanus*	+	+	+	+
20	*Paracalanus*	+	+	+	+
21	*Parapontella*	+	-	+	-
22	*Pseudocalanus*	+	-	+	-
23	*Rhincalanus*	+	+	+	-
24	*Temora*	+	+	+	+
25	Copepod nauplii	+	+	+	+
Sub- order: Cyclopoida					
26	*Coryceas*	+	+	+	+
27	*Copili*	+	+	+	-
28	*Oithona*	+	+	+	+
Sub- order: Harpacticoida					
29	*Euterpina*	+	+	+	+
30	*Microsetella*	+	-	+	+
Other Crustaceans					
31	Cirripid larvae	+	+	+	-
32	*Penilia*	+	+	+	-
33	*Evadne*	+	+	+	-
34	Brachyuran crab	+	+	+	-

35	*Lucifer*	+	+	+	+
36	Mysis larvae	+	+	+	+
PHYLUM: ECHINODERMATA					
37	Echinoderm larvae	+	+	+	-
PHYLUM: CHORDATA					
38	*Oikopleura* larvae	+	+	+	+
39	Fish eggs	+	+	+	+
40	Fish larvae	+	+	+	+
Total		**38**	**32**	**39**	**26**

Table 38: Most Common Group of Benthos

Groups	CHEMPLAST		CPC		SRM		ILFS	
	Sub tidal Benthos	Intertidal Benthos	Sub tidal Benthos	Intertidal Benthos	Sub tidal Benthos	Intertidal Benthos	Sub tidal Benthos	Intertidal Benthos
Phylum : Annelida; Class : Polycheate								
Polychaete worms	+	+	+	+	+	+	+	NA
Phylum : Arthropoda; Class: Crustacea								
Amphipods	+	+	+	-	+	+	+	NA
Cumacea	+	+	+	-	+	+	+	NA
Order: Mysidacea;								
Mysids	+	+	-	-	+	+	+	NA
Phylum : Mollusca; Class : Gastropoda								
Gastropods	+	+	+	+	+	-	-	NA
Class: Bivalvia								
Bivalves	+	-	+	+	+	-	+	NA
Phylum : Chordata; Subphylum : Cephalochordata								
Amphixous	-	-	-	-	+	-	+	NA

+Species Present, -Species absent, NA: Not Analyzed

In Vellar estuary, the seasonal distribution of phytoplankton indicates high number of cells during summer (4136 cells/ml) and post monsoon (3615 cells/ml) whereas in Coleroon river high number of cells were encountered only during post monsoon (4354 cells/ml). In Pichavaram mangroves the cell densities were between 2355 per ml in monsoon and 3691 per ml in summer. The phytoplankton concentration at inshore waters during different seasons also showed similar values, i.e., 1928 in monsoon to 3525 in summer. In the case of zooplankton, the seasonal averages in all areas were between 34435 and 90826 numbers/litre. The highest population occurred in Pichavaram during summer. Macro and meio-benthic populations during different seasons varied considerably but in general maximum numbers were noticed during summer.

6.4.2 Water and sediment quality parameters

General characteristics of the quality of seawater and sediments off Thammanampettai collected in June 2010 along the Cuddalore coast are summarized in Tables 38 and 39.

Table 39: Water quality parameters – Thammanampettai

Parameters	Unit	Minimum	Maximum
Temperature	oC	28.00	30.0
pH		8.10	8.30
Salinity	ppt	34.30	34.90
Dissolved Oxygen (DO)	mg/l	4.30	6.00
Biochemical Oxygen Demand (BOD)	mg/l	1.20	3.03
Chemical Oxygen Demand (COD)	mg/l	16.66	55.74
Turbidity	NTU	0.60	16.40
Ammonia-Nitrogen (NH3-N)	µmol/l	0.23	1.11
Nitrite-Nitrogen (NO2-N)	µmol/l	0.16	0.95
Nitrate-Nitrogen (NO3-N)	µmol/l	0.78	2.60
Inorganic Phosphate (PO4-P)	µmol/l	0.29	1.43
Total Suspended Solids (TSS)	mg/l	11.00	27.00
Cadmium (Cd)	µg/l	< 1.0	
Mercury (Hg)	µg/l	< 1.0	
Lead (Pb)	µg/l	< 1.0	
Chromium (Cr)	µg/l	< 5.0	
Phenol	µg/l	< 1.0	
Petroleum Hydrocarbons	µg/l	< 0.05	

Table 40: Sediment Quality Parameters

Parameters	Unit	Minimum	Maximum
Sediment size	Texture	Medium sand	Coarse sand
Total Organic Carbon	mg/g	0.18	1.56
Total Nitrogen	mg/g	0.53	2.83
Total Phosphorous	mg/g	0.02	0.10
Calcium carbonate	%	0.90	14.72
Cadmium (Cd)	mg/kg	0.01	1.4
Mercury (Hg)	mg/kg	<0.01	0.81
Lead (Pb)	mg/kg	0.36	1.3
Chromium (Cr)	mg/kg	10.57	14.00
Petroleum Hydrocarbons	mg/kg	< 0.03	

The chemical and biological parameters observed off this Cuddalore near shore water indicate that this region is free from any major pollution and can be classified as environmentally clean and healthy. The area remained almost clean inspite of the presence of many industries. The proposed industries are not expected to add any toxic pollutant to the coastal waters as the discharges will not have any toxic chemicals.

6.4.3 Fisheries

The most common marine fish species present along the coast of Cuddalore are: Elasmobranchs (sharks, skates and rays), Clupieds (Chirocentrus sp. and Sardinella spp), Anchovies (Stolephorus commersonii), Perches (Lutjanus spp., Lethrinus spp, Pomadaysys spp., Lates calcarifer), Lizard fishes (Saurida spp.), Thredfin breams (Nemipterus spp.), Goat fishes (Upeneus spp.), Polynemids, Sciaenids, Barracudas, Carangids, Stromateids, Trichiurids, Scombridae (mackerels, tunas and seer fishes), Exocoetidae, Mugilidae (Mullets), Sillagos, Catfishes, Penaeid prawn, Crabs, Cephalopods and other miscellaneous species. The Cuddalore District contributes to about 8.0% of the total catch of Tamil Nadu.

The estimated marine fish production of Cuddalore coast for the last 10 years is given in Table 40. Amidst the presence of many industrial activities, interestingly the total catch has almost doubled during the last two years compared to earlier years. The estimated production was 73916 MT in the year 2011. This further supports the observation that the fishery production of this coast has been maintaining a good trend and there is no evidence of any stress in this coast.

Table 41: Estimated Marine Fish Production of Cuddalore District

Sl. No.	YEAR*	QUANTITY (IN TONNES)
1	2001- 2002	20525
2	2002 - 2003	45023
3	2003 - 2004	47136
4	2004 - 2005	35385
5	2005 - 2006	21381
6	2006 - 2007	29625
7	2007 - 2008	30503
Annual**		
8	2008	46019
9	2009	40920
10	2010	76938
11	2011	73916

Source: * Department of fisheries, Tamilnadu; **CMFRI, Cochin

There about 22 fishing villages along the Cuddalore coast (25 km radius of ITPCL) coming under both Cuddalore Taluk and Chidambaram Taluk. The details of different coastal villages located within 25 km radius from the ITPCL site are shown in Figure 18.

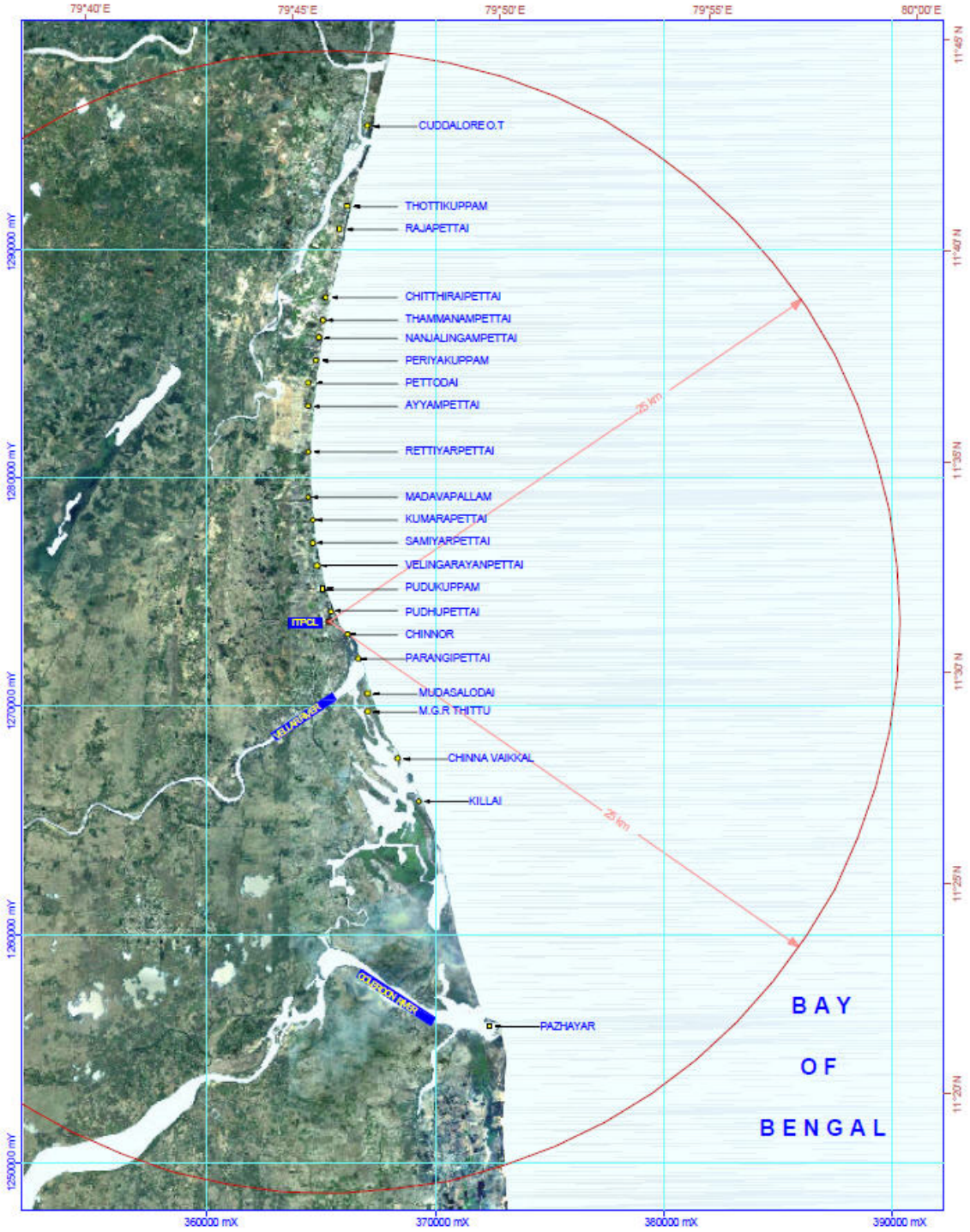


Figure 18: Villages within 25 km Radius (approximate)

6.4.4 Mangroves

Pichavaram mangroves is spread over an area of around 1471.33 ha. It is located about about 9.5 km south of ITPCL stack. The mangrove is separated from the sea by a sand bar.

The backwaters are interconnected by the Vellar and Coleroon river systems. The Pichavaram mangroves are considered among the healthiest mangrove occurrence in the world. The Pichavaram mangrove biotope, with its peculiar topography and environmental condition, supports the existence of many rare varieties of shell and fine fishes. The Pichavaram mangroves harbour different species of birds, belonging to 15 orders and 41 families, due to availability of different habitat types such as channels, creeks, gullies, mudflats and sand flats and adjacent sea shore.

6.4.5 Coral reefs

In east coast of India, Gulf of Mannar is the only area with well developed coral reefs. The Gulf of Mannar reefs are developed around a chain of 21 islands that lie along the 140 km stretch between Tuticorin and Rameswaram. The Cuddalore coast, where ITPCL project is coming up is about 300 km from these coral reefs. No coral growth has been reported all along the Cuddalore coast possibly because of littoral drift and strong current.

6.4.6 Marine Protected Area

There are five Marine Protected Areas (MPAs) in India. They are Gulf of Mannar Marine National Park from Ramanathapuram to Tuticorin (6.23 sq.km); Gulf of Kachchh Marine National Park (400 sq.km), Mahatma Gandhi Marine National Park in Andamans (282 sq.km), Great Nicobar Biosphere Reserve (885 sq.km) and Rani Jhansi Marine National Park (256 sq.km)(Ritchie's Archipelago). The ITPCL Project site is about 80 km from the nearest MPA i.e. Point Calimere Sanctuary and about 250 km from Pulicat Lake. The Gulf of Mannar Biosphere Reserve is about 300 km from the project site. The project site of ITPCL lies quite far away from the Marine Protected Areas.

6.4.7 Marine Mammals

Marine mammals belong to three orders viz. Sirenia, Cetacea and Carnivora. About 120 species are estimated to occur in World seas and of these 24 are reported from sea around India. But majority of these are oceanic forms and occasionally a few individuals may get stranded on the shore. The dugongs found in Gulf of Mannar, Gulf of Kachch and Andaman and Nicobar Islands essentially feed on sea grass. Dolphins and some of the whales that live or breed in tropical waters, such as humpbacks are occasionally seen near the coral reefs. But these animals are not present in the coastal waters off Cuddalore.

6.4.8 Turtles

Sea turtles spend major part of their life in oceans, where they move solitarily in search of food. But, during reproductive season, they normally migrate to nearshore waters for court ship and mating. After mating, the females move onto the beach and nest by digging their own egg chamber preferably beyond the highest high watermark while majority of species exhibit sporadic resting behavior, both the ridley species are known for their mass-resting. The phenomenon of mass nesting by sea turtles is also known as an arribada, which means "the arrival" in Spanish. There are only three places in the world where sea turtles gather in such large numbers to rest, and Orissa is one of them. The other two places are Costa Rica and Mexico. However sea turtle nesting is absent along the Cuddalore coast.

6.5 Marine Modelling Studies are Carried Out for Two Scenarios:

Scenario 1 - Projects in the study area which has got environmental clearance before the issue of EC to ITPCL.

- Cuddalore Minor Port
- SIPCOT Industrial complex
- Chemplast Sanmar Limited (CSL)
- Cuddalore Power Company Limited (CPC)
- Nagarjuna Oil Corporation Limited (NOCL)
- SRM Energy Limited (SRMEL)
- Textile Park of South India Mills Association (SIMA)
- Good Earth Shipyard Limited (GESL)
- IL&FS Tamil Nadu Power Company Limited (ITPCL)

Scenario 2 - Projects in the study area that has sought EC after issue of EC to ITPCL

- Cuddalore Minor Port
- SIPCOT Industrial complex
- Chemplast Sanmar Limited (CSL)
- Cuddalore Power Company Limited (CPC)
- Nagarjuna Oil Corporation Limited (NOCL)
- Textile Park of South India Mills Association (SIMA)
- IL&FS Tamil Nadu Power Company Limited (ITPCL)

6.6 Modelling Study on Cumulative Impacts

The various projects coming up within 25 km radius and other respective marine facilities are listed in Chapter 2. The marine facilities for the different industries coming up can be categorized into: Ports and Harbours, Shipyards, Marine Terminals, Coal Jetties, seawater intakes and marine outfalls. In general, the various activities foreseen by the development of different projects are: i) construction of breakwaters, ii) construction of piled trestle jetty, iii) dredging and dredge disposal, iv) laying of submarine pipelines for seawater intake with seawater intake head, and v) laying of submarine pipeline for marine outfall diffuser. The Cumulative Impacts of various activities were studied using MIKE 21 mathematical model.

Mathematical modelling study has been carried out to identify the Cumulative Impact Assessment on: i) Dispersion of brine discharged into the sea from various power plants, ii) Dispersion of warm water discharged into the sea from various power plants, iii) Dispersion of trade effluent discharged into the sea, iv) Construction of breakwaters by different ports and their impact on the shoreline, v) Dredging and disposal of dredge spoil by different ports, and vi) Impact of storm surge in combined scenario.

6.6.1 Cumulative Impact of Marine Discharges – Flow & Advection Diffusion Model

The tide and wind induced flow field in the coastal region representing the various discharges from different projects is simulated using the MIKE 21 HD module. The dispersion of the return water diffusion is studied using the MIKE 21 AD module. These modules have been developed by Danish Hydraulic Institute (DHI), Denmark, and are being used worldwide in many coastal engineering applications. The various marine facilities coming up in 25 km radius considered for model are presented in earlier section (Figure 15). The following cases

are considered as a combined scenario and a exclusive model study was conducted and presented in this report.

Table 42: Marine Discharge Characteristics

Sl. No.	Industries		Outfall Volume (m^3/hour)	Temperature difference ΔT (°C)	Salinity difference ΔS (ppt)
1	ITPCL		25886	5	20
2	SRM		14465	5	13
3	SIMA		440	Trade effluent	
4	Nagarjuna		15000	5	20
5	CPC		10000	5	10
6	Chemplast		270	Nil	23
7	SIPCOT				
	i)	CUSECS	500	Trade effluent	
	ii)	CLARIANT	200	Trade effluent	

MIKE 21 Flow module (HD): This module is a multi-dimensional 2D or 3D (present case 2D), hydrodynamic flow simulation model, which solves shallow-water equations for given boundary conditions to compute non-steady free-surface flow fields in response to a variety of environmental forcing and processes in natural water bodies. The environmental forcing and processes include: bottom shear stress, wind shear stress, barometric pressure gradients, Coriolis force, momentum dispersion, sources and sinks, evaporation, flooding and drying and wave radiation stresses. This module is applicable for the simulation of flow fields in natural water bodies, such as lakes, estuaries, bays, coastal areas and seas, wherever stratification can be neglected. The MIKE 21-Flow model can be used to model the following processes: Tide and wind-driven flows, Stratified and density driven flows, Thermal stratification in lakes, seas and reservoirs, Cooling water recirculation, Transport of dissolved material and pollutants and Wave-driven currents.

This module uses an Alternate Direction Implicit (ADI) Finite Difference Method on staggered orthogonal grids and also has the option to use Finite Element Method. The basic shallow-water equations in the Cartesian co-ordinate system used in the MIKE 21 HD flow module are:

Continuity equation:

$$\frac{\partial \zeta}{\partial t} + \frac{\partial p}{\partial X} + \frac{\partial q}{\partial Y} = S - e$$

Momentum equations in x- and y- directions:

$$\frac{\partial p}{\partial t} + \frac{\partial}{\partial X}\left[\frac{p^2}{h}\right] + \frac{\partial}{\partial Y}\left[\frac{p\,q}{h}\right] + gh\frac{\partial \zeta}{\partial X} + F_{bx} - K_a W W_X - \frac{h}{\rho_W}\frac{\partial p_a}{\partial X} - \Omega\, q - F_{EX} = S_{iX}$$

$$\frac{\partial q}{\partial t} + \frac{\partial}{\partial X}\left[\frac{p\,q}{h}\right] + \frac{\partial}{\partial Y}\left[\frac{q^2}{h}\right] + gh\frac{\partial \zeta}{\partial Y} + F_{by} - K_a W W_Y - \frac{h}{\rho_W}\frac{\partial p_a}{\partial Y} + \Omega\, p - F_{EY} = S_{iY}$$

Symbol list

$$F_{EX} = \left[\frac{\partial}{\partial X}\left[\varepsilon_X\, h\frac{\partial u}{\partial X}\right] + \frac{\partial}{\partial Y}\left[\varepsilon_Y\, h\,\frac{\partial u}{\partial Y}\right]\right]$$

$$F_{EY} = \left[\frac{\partial}{\partial X}\left[\varepsilon_X h \frac{\partial u}{\partial X}\right] + \frac{\partial}{\partial Y}\left[\varepsilon_Y h \frac{\partial u}{\partial Y}\right]\right]$$

$$F_{bx} = \frac{g}{C^2}\sqrt{\frac{p^2}{h^2} + \frac{q^2}{h^2}}\,\frac{p}{h}$$

$$F_{by} = \frac{g}{C^2}\sqrt{\frac{p^2}{h^2} + \frac{q^2}{h^2}}\,\frac{q}{h}$$

ζ (x, y, t)	-	*Water surface level above datum (m)*
p(x, y, t)	-	*flux density in the x-direction ($m^3/s/m$)*
q(x, y, t)	-	*flux density in the y-direction ($m^3/s/m$)*
h(x, y, t)	-	*water depth (m)*
S	-	*Source magnitude per unit horizontal area ($m^3/s/m^2$)*
S_{iX} , S_{iY}	-	*source impulse in x and y-directions ($m^3/s/m^2.m/s$)*
e	-	*Evaporation rate (m/s)*
g	-	*Gravitational acceleration (m/s^2)*
C	-	*Chezy resistance No. ($m^{1/2}/s$)*
K_a	-	$C_w \frac{\rho_{air}}{\rho_{Water}}$
C_w	-	*wind friction factor*
W, W_X, W_Y(x, y, t)	-	*wind speed and components in x- and y-directions (m/s)*
p_a (x, y, t)	-	*barometric pressure ($Kg/m/s^2$)*
ρ_w	-	*density of water (kg/m^3)*
Ω	-	*Coriolis coefficient (latitude dependent) (s^{-1})*
ε(x, y)	-	*eddy or momentum dispersion coefficient (m^2/s)*
x, y	-	*space coordinates (m)*
t	-	*Time (s)*

Advection and dispersion module: The advection-dispersion module (AD) of the MIKE 21 model suite simulates dispersion of return water in an aquatic environment under the influence of the fluid transport and associated natural dispersion process. The dispersing substance may be conservative or non-conservative, inorganic or organic: e.g. salt, heat, dissolved oxygen, inorganic phosphorus, nitrogen and other such water quality parameters. Applications of the MIKE 21 AD module are in principle essential for two types of investigations, viz., i) cooling water recirculation studies for power plants and salt recirculation studies for desalination plants, and ii) water quality studies connected with sewage outfalls and non-point pollution sources.

This module determines the concentration of the dispersing substance by solving the equation of conservation of mass for a dissolved or suspended substance. The concentration of the substance is calculated at each point of a rectangular grid covering the area of interest using a two-dimensional finite difference scheme. Information on the transport, i.e. currents and water depths at each point of the grid, are provided by the MIKE 21 HD module. Other data required in the model include effluent volume discharged, the concentration of the pollutant, initial and the boundary conditions.

Governing equation:

The MIKE 21 AD module solves the advection-dispersion equation for dissolved or suspended substances in two dimensions. This is in reality the mass-conservation equation to which quantities of substances discharged and their concentrations at source and sink points are included together with their decay rate.

$$\frac{\partial}{\partial t}(hc)+\frac{\partial}{\partial x}(uhc)+\frac{\partial}{\partial y}(vhc) \;=\; \frac{\partial}{\partial x}\left[h D_x \frac{\partial C}{\partial x}\right]+\frac{\partial}{\partial y}\left[h D_y \frac{\partial C}{\partial y}\right]-F h c \;+S$$

Symbol list

C	-	*Compound concentration (arbitrary units)*
u, v	-	*horizontal velocity components in the x, y directions (m/s)*
h	-	*Water depth (m)*
D_x, D_y	-	*dispersion coefficients in the x, y directions (m^2/s)*
F	-	*Linear decay coefficient (1/s)*
S	-	Q_s *.* $(C_s - C)$
Q_s	-	*Source / sink discharge per unit horizontal area ($m^3/s/ m^2$)*
C_s	-	*concentration of compound in the source / sink discharge.*

Information on u, v and h at each time step is provided by the MIKE 21 HD module.

Model setup: The coastal region considered for study extends approximately 60 km parallel to coast and 40 km perpendicular to coast. It has three open boundaries and it is digitized as a rectangular grid system with 50 m spacing in both east-west and north-south directions. The water depths in the project area were extracted from the Indomer survey records and DHI - C Map data base.

Simulations: The flow simulations were carried out for 3 seasons viz., fair weather, southwest (SW) monsoon and northeast (NE) monsoon. The simulation for each season has been carried out for a period of 14 days representing one lunar cycle. Also the simulations have been independently carried out to identify the mixing pattern of three different type of discharges viz., i) Warm water, ii) Brine discharge and iii) Trade effluent.

The simulated flow field in fair weather, SW monsoon and NE monsoon are shown in Figure 19. The dispersion of warm water in fair weather, SW monsoon and NE monsoon are shown in Figure 20 to 22. The mixing of brine reject in fair weather, SW monsoon and NE monsoon are shown in Figure 23 to 25.

The warm water is discharged only from the ITPCL, SRMEL and CPC outfalls. There will not be any temperature difference for the discharges of SIMA, CIL and SIPCOT and they remain at ambient level.

Fair weather

The extent of mixing will be conservative during the fair weather period. The flow field, mixing of warm water, dispersion of brine reject are shown in Figure 19, 20 and 23.

The flow field simulated for the fair weather period shows that the current speed exists around 0.10 m/s with the direction of flow changing with tides between east and west.

The temperature difference reduces to 1° C within 200 m distance from the point of discharges of ITPCL, SRMEL and NOCL outfalls. In case of the discharge from CPC outfall, the temperature difference falls down to 1° C within 50 m distance.

It is seen that the difference in salinity level falls down to 1 ppt within 400 m distance from the ITPCL and SRMEL outfalls. The difference in salinity level of 1 ppt is achieved within 100 m distance for the CPC, Chemplast and NOCL outfalls.

The trade effluent from the two outfalls of SIPCOT and also from SIMA undergoes very high dilution to the extent of 1000 times within 100 m distance.

SW Monsoon

To represent the southwest monsoon, the wind magnitude of 10 m/s was considered from the direction of 150° N.

The tide and wind induced flow field in southwest monsoon in Cuddalore nearshore region is shown in Figure 19. Normally sea becomes more turbulent during southwest monsoon due to high waves and strong wind. The current speed at nearshore generally exceeds 0.25 m/s over the lunar tidal cycle. The current direction exists almost unidirectional from south to north and it tends to be parallel to the coast. The characteristics of unidirectional current show the influence of monsoon wind than the effect of tides.

The dispersion pattern of the warm water during the SW monsoon is shown in Figure 21. It shows the rate of dilution is very high and the temperature difference of 5°C falls down to 1°C within 50 m distance from the outfalls of ITPCL, SRMEL, NOCL and CPC.

The dispersion pattern of the brine reject during the SW monsoon is shown in Figure 24. The model shows that the difference in salinity level falls down to 1 ppt within 50 m distance from outfalls of ITPCL, SRMEL, CPC, CSL and NOCL outfalls.

The trade effluent coming out from the outfalls of SIPCOT and SIMA experiences very high mixing in SW monsoon and it undergoes dilution more than 1000 times within 50 m distance.

NE Monsoon

To represent the northeast monsoon, the wind speed corresponding to 10 m/s arriving from 45° N was considered in the model.

The nearshore flow field simulated for the NE monsoon is shown in Figure 19. Normally sea remains more turbulent during NE monsoon than the rest of the year. There will be frequent meteorological disturbance with the occurrence of low pressure and cyclones. The current speed at nearshore reaches upto 0.23 m/s over the lunar tidal cycle. The current direction exists almost unidirectional from north to south and it tends to be parallel to the coast. The characteristics of unidirectional current show the influence of NE monsoon wind than the effect of tides.

The mixing pattern of the warm water during the NE monsoon is shown in Figure 22. The rate of dilution is very high like SW monsoon and the temperature difference of 5°C reduces to 1°C within 50 m distance from the outfalls of ITPCL, SRMEL, NOCL and CPC.

The dispersion pattern of the brine reject during the NE monsoon is shown in Figure 25. The model result shows that the difference in salinity level falls down to 1 ppt within 50 m distance from outfalls of ITPCL, SRMEL, CPC, CSL and NOCL outfalls.

The trade effluent coming out from SIPCOT and SIMA experiences very high mixing in NE monsoon and it undergoes dilution more than 1000 times within 50 m distance.

The mixing scenario of the discharges comprises of warm water, brine reject and trade effluents are summarized below.

Table 43: Mixing Distance of Marine Discharges During Different Seasons

Sl. No.	Industries	Type of discharge	Mixing distance (m)		
			Fair weather	SW Monsoon	NE Monsoon
1	ITPCL	Warm water (1° C)	<100	<50	<50
		Brine (1 ppt)	300	<50	<50
2	SIMA	Dilution (1000)	100	50	50
3	SRM	Warm water (1° C)	100	<50	<50
		Brine (1 ppt)	100	<50	<50
4	Nagarjuna	Warm water (1° C)	<100	<50	<50
		Brine (1 ppt)	100	<50	<50
5	CPC	Warm water (1° C)	<100	<50	<50
		Brine (1 ppt)	100	<50	<50
6	Chemplast	Brine (1 ppt)	<50	<50	<50
7	SIPCOT	Dilution (1000)	100	50	50

Discussion: The coastal region of Cuddalore falling within 25 km radius of the ITPCL site remain more turbulent during both SW monsoon (June to September) and NE monsoon (October to January) due to the prevalence of strong wind, high waves and ocean currents. The nearshore in this region also remains relatively steeper. Such oceanographic conditions help in enhancing the mixing of the marine discharges. It is noticed that the discharge plume tends to spread towards north during SW monsoon and fair weather and towards south during NE monsoon. However, the spread is restricted within 400 m during the fair weather period and 100 m during SW monsoon and NE monsoon to attain the sea water ambient temperature and salinity levels. Trade effluent being discharged from SIPCOT by CUSECS and CLARIANT and from SIMA outfalls get diluted by more than 1000 times within 50 m radius. Further, the discharge volume is relatively very low compared to the discharge of warm water and brine by other industries. Therefore, the discharge of trade effluent will not bear any impact on the combined scenario.

It is important to note that all plumes discharged from various industries remain independent till they attain the ambient level. No merging of adjacent plumes is noticed in this region. The carrying capacity of the nearshore waters of the Cuddalore region is high enough to

disperse the outfalls proposed in this region without causing adverse impact on the sea water quality of the Cuddalore region. Therefore the cumulative impacts of various discharges being released within 25 km radius are observed to be negligible.

6.6.2 Cumulative impact of shoreline erosion – Shoreline model

The changes in shoreline of the Cuddalore region due to the construction of different port breakwaters have been verified using the DHI- LITPACK- LITLINE module. LITLINE calculates the coastline position based on input of the wave climate as time series. This model is based on a one-line theory, in which the cross-shore profile is assumed to remain unchanged during erosion/accretion. The coastal morphology is solely described by the coastline position (cross-shore direction) and the coastal profile at a given long-shore position. LITLINE calculations are based on a coordinate system in which the x axis is a baseline that runs parallel to the primary coastline orientation, while the y-axis runs from the baseline in offshore direction. “Coastal or coastline profile” is used to denote the variation of yc in the longshore (x) direction, while the cross-shore profile denotes the water depth as a function of the cross- shore position relative to the coastline position y_c.

Continuity Equation for Sediment Volumes

The main equation in LITLINE is the continuity equation for sediment volumes expressed by,

$$\frac{\partial y_c(x)}{\partial t} = -\frac{1}{h_{act}(x)}\frac{\partial Q(x)}{\partial x} + \frac{Q_{sou}(x)}{h_{act}(x)\Delta x}$$

Where,

$y_c(x)$	-	distance from the baseline to the coastline
t	-	time
$h_{act}(x)$	-	height of the active cross-shore profile
Q(x)	-	longshore transport of sediment expressed in volumes
X	-	longshore position
Δx	-	longshore discretization step
$Q_{sou}(x)$	-	source/sink term expressed in volume/Δx.

hact(x) and Qsou(x) are calculated based on user specifications, while the longshore transport rate Q(x) is determined from tables relating the transport rate to the hydrodynamic conditions at breaking. Δx is user specified, while Δt is determined from stability criteria. From an initial coastline position yinit (x), the evolution in time is determined by solving continuity equation using an implicit Crank-Nicholson scheme.

The main features of LITLINE coastline evolution module are as follows,

- Deterministic description of transport rate distribution over the profile
- Measured or pseudo time series as input
- Time varying sediment sources
- Wide range of coastal structures
- Graphics of results while calculating Model input

The input data for the LITLINE module are:

- Orientation of the coast
- Bathymetry of the cross shore profile
- Time series of wave climate
- Sediment properties
- Orientation of structures

Proposed Ports: There are proposals to construct of all-weather ports by ITPCL and Good Earth Shipyards. These ports will have breakwaters on the northern side and southern side to achieve wave tranquility during SW monsoon and NE monsoon. In case of CPC and SRMEL, they have proposed to construct piled jetty for handling coal, crude oil and coal respectively. Already Offshore Marine Terminal constructed by piled jetty is under operation by CSL. The existing piled jetty at CSL and the proposed piled jetties by CPC and SRMEL will not cause any obstruction to the prevailing littoral drift and hence there will not be any impact on the shoreline. On the other hand, the construction of all weather port by breakwaters will arrest the littoral drift and cause impact on the stability of the shoreline. There will be cumulative impact on shoreline erosion on the northern side and considerable deposition on the southern side. Keeping this point into consideration, modelling study was carried out to understand the impact on shoreline in a combined scenario. L&T Ramboll had taken up the modelling study to identify the impact of ITPCL breakwaters on the shoreline. The details are presented in 'EIA report for 3600 MW Thermal Power Plant, Captive Port, Desalination Plant at Cuddalore District, Tamil Nadu'.

Longshore sediment transport: In ITPCL report, it is stated that the mathematical modelling studies for the littoral drift were carried by HR Wallingford (HRW) using COSMOS-2D, which is designed for several purposes including calculations of longshore and cross-shore sediment transport rates. In each case, the wave, current and sediment transport parameters are calculated at grid points along a shore-normal line extending from the upper part of the beach to depths beyond the surf zone. Simulations were carried out using a median grain diameter of 0.1 mm, with further sensitivity tests using coarser 0.2 mm diameter sand. Simulations were carried out calculating contributions from the total sea, and also from shorter-period wind waves, longer period swell waves and the weighted combination of the two as total (swell and wind) waves. In each case the wave data were supplied in the form of a long time series of the raw data from the wave propagation analysis representing ten years of data. Hence the drift calculations represent the average gross and net drift over this ten-year period.

The annual net transport is calculated to be 23,000m3/year northward, with an annual northerly drift of 148,000 m3/year and annual southerly drift of 125,000 m3/year. Hence the overall gross annual drift is 273,000 m3/year, based on the total ten year data set, but the transport to north and south are nearly balanced with a small net northerly drift.

Shoreline changes: With net northerly drift and limited bypassing, the breakwaters will obstruct the movement of littoral drift. Hence there will be a reduction of sediment supply on the northern side of the northern breakwater and this will lead to erosion on northern side. Based on the model study, the expected erosion of the northern side and the deposition on the southern side are shown in Figure 26. It is seen that the shoreline will get eroded about 100 m close to the northern breakwater and erosional trend will progress to the extent of 2 km along the coastline on the northern side of the north breakwater. On the other hand, the shoreline will get deposited and the extent of deposition continues upto 1 km southern side. It is important to note that in case of absence of removal of the deposition of sediments on the southern side, the process of deposition will be closing the Vellar river mouth.

The closure of the Vellar river mouth will reduce the tidal exchange between the open sea and Vellar River. Pichavaram mangroves are fed with the seawater through the tidal exchange between Vellar river and Coleroon river. The mouth has to remain open particularly during October to January since it will be draining out the rain water from the catchment areas and other draining rivers. The closure of mouth during this period will cause flooding and inundation in the villages. It is essential to keep the Vellar river mouth open throughout the year. Therefore, the sediment getting deposited across the Vellar river mouth should be continuously removed by dredging. The removed sediments can be bypassed to the northern side of the northern breakwater. Also additional sediments from the southern side of the southern breakwater may also be bypassed to the northern side of the northern breakwater using a suitable sand pumping arrangement.

In addition to the development of ITPCL Port, the Good Earth Shipyard has also proposed to develop all weather Port on the northern side of the ITPCL Port. The modelling study carried out for ITPCL has been extended to understand the shoreline in the combined scenario. The locations of these port facilities are shown in Figure 15. Modelling study was extended to understand the cumulative impact of the shoreline due to the breakwaters proposed for ITPCL Port, and Good Earth shipyard. The MIKE 21 DHI – LITPACK – LITLINE model was used to understand the stability of the shoreline. The net impact on shoreline changes i.e., the accretion and erosion on the adjacent shoreline for the combined scenario is shown in Figure 26. The erosion has been noticed along the stretch between ITPCL northern breakwater and Good Earth southern breakwater. Further, erosion will appear on the northern side of the northern breakwater of Good Earth Shipyard and this erosion is expected to continue over a spread of 3 km.

Beach nourishment: The method of shore stabilization proposed by ITPCL Port has also to be followed by Good Earth Shipyards. They have to make a sand pumping arrangement to pump sand from the southern side of south breakwater to the northern side of the northern breakwater. The bypassing arrangement should be planned from March to September during which the waves arrive from ESE direction causing littoral drift towards north. The quantity of bypassing should be as per the littoral drift estimate presented in ITPCL EIA report.

In case of the beach nourishment scheme, i.e. by pumping the sand on the northern side, the resultant stabilized shoreline form is shown in Figure 27.

Since the shoreline falls in the nodal drift region, a stringent shoreline monitoring programme has to be carried out. Based on the behaviour of the coastline during the post construction period, the bypassing arrangement has to be suitably altered and/or modified.

Also, it is suggested to use part of the capital and maintenance dredging sediments to pump on the shore to form a beach fill as sand bank. The beach fill can be done from the high tide line towards inland with the height of 10 m for a width of 200 m. Such formation of sand banks can supply the sediments for the equilibrium of littoral drift on the updrift side. More importantly, such sand bank can also act as a protective barrier to the coastline from the impact of storm surge and Tsunami. The formation of sand bank can be extended along the northern side of the ITPCL breakwater. Necessary openings can be made in between the sand banks for the local fishermen to have access to the sea. These sand banks can be replenished with sediments obtained from the maintenance dredging from the respective ports.

6.6.3 Cumulative impact of dredge disposal

The proposed all weather ports by ITPCL and Good Earth Shipyard will undertake capital dredging in order to form the navigational channel, port basin and berthing areas. They will also undertake annual maintenance dredging. The study has been made to understand the quantity of capital dredging and maintenance dredging by each port and the method to discharge them at offshore without causing any impact in the marine environment.

The selection of a disposal site in sea depends on several factors depending upon the environmental and economic considerations. The environmental considerations are based on the characteristics of the dredged material, short-term fate of the dredged material, initial deposition pattern at the bottom, the density of bottom living animals, the presence of neighbouring facilities, the presence of rivers and estuaries, navigational hazards etc. These factors in turn determine the long term movement of the disposed material from the disposal site.

ITPCL Port: The capital dredging at the proposed ITPCL port is envisaged as 11 x 106 m^3 and the maintenance dredging is expected around 0.5 x 106 m^3/year. It has been proposed to use 1 x 106 m^3 of dredged sediment for reclamation of project site. It is also presently proposed to deposit around 1 x 106 m^3 of dredged sediment to form a beach fill on the northern side of the northern breakwater for shoreline stabilization. Further, it is proposed now to construct a tsunami protection bund along the northern side of the breakwaters by using the dredged sediment of about 1x 106 m^3. The rest of the dredged sediment, i.e. 9 x 106 m^3 can be disposed at the designated offshore location arrived by model study. The quantities of dredging, reclamation and stabilization are only indicative and they may vary according to the ground realities during construction and operation.

Good Earth Shipyard: In case of Good Earth Shipyard it will be difficult to precisely estimate the quantity at this stage in view of this project being still in early stage. The reasonable estimate of 2 x 106 m3 is assumed as a possible capital dredging.

The dredge disposal location for ITPCL port is selected based on the model study using MIKE 21 PA module and more details are reported in Chapter 4 of the ITPCL report on ‘EIA report for 3600 MW Thermal Power Plant, Captive Port, Desalination Plant at Cuddalore District, Tamil Nadu.

Model description: MIKE 21 Particle Analysis (PA) module is based on the Lagrangian discrete parcels method in which an ensemble of particles is followed instead of solving the Eulerian advection-diffusion equation. The Lagrangian discrete parcel scheme calculates the displacement of each particle as the sum of an advective deterministic component and an independent, random Markovian component, which statistically approximates the random and/or chaotic nature of time-averaged tidal mixing.

In MIKE 21 PA module, which is designed to simulate the surface and subsurface transport, the spoil/waste/pollutant released into the water bodies are divided into discrete parcels, and sets of spatial coordinates are assigned to each parcel. It is assumed that these parcels advect with the surrounding water body and diffuse as a result of random processes. These flow processes occur simultaneously at different spatial and temporal scales with continuous spectrum ranging from molecular agitation to tidal, baroclinic residual flows. The advective velocities are (usually) obtained from hydrodynamic simulations (MIKE 21 HD), whereas the turbulent contributions are controlled by the dispersion coefficients. In this PA module, the

discrete path of the pollutant parcels released in the water body are followed and recorded as a function of time relative to the reference grid system fixed in space. Then the density distributions of the ensemble are interpreted as the concentration of the spoil/waste/pollutant.

The properties of the released particles are described by distribution of grain sizes or settling velocities. It is possible to specify the number of particles released per time step. The sediment is released at a specified depth, and the particles settle with a constant or randomly generated settling velocity. The particles are deposited when they reach the bottom. The mass of the particle cloud can also change due to re-suspension and furthermore due to a linear decay.

This simulation method gives the possibilities of calculating the concentration of suspended material at different depths. The particles can be advected by a three-dimensional velocity field or by logarithmic velocity profiles established from the depth-integrated velocities specified in the Hydrodynamic model. The velocity profiles can be superimposed with a wind induced current profile if wind is applied to the model. The model calculates the frequency function for settling velocity by using Stokes law. A settling velocity chosen at random from this distribution is assigned to each particle when it is released.

The PA module gives the following outputs,

- Instantaneous concentration of suspended material (kg/m3)
- Averaged concentration of suspended material (kg/m3)
- Instantaneous total cohesive erosion and deposition (kg/m3)
- Accumulated total cohesive erosion and deposition (kg/m3)
- Accumulated net cohesive sedimentation (kg/m3)

ITPCL Port: The L&T Ramboll model study recommended the most suitable at offshore (Lat: 11° 31.3' N, Long: 79°51.5' E). The proposed offshore dredge spoil disposal location will be located at 12 to 14 km distance from the shoreline and the water depth will be 30 m. The modelling study shows the spread of the dredge disposal at this location will be limited to 1.5 km radius and the rise in floor level will be limited to the maximum of 0.5 m at the point of disposal.

Good Earth Shipyard: The modelling study using MIKE 21 PA has been extended by Indomer to identify the location for the dredge spoil disposal for Good Earth Shipyard. It is presumed that the capital dredging at Good Earth is 2 x 106 m^3. In that 1 x 106 m^3 can be used as a beach fill as sand bank in order to stabilize the shoreline on the northern side of the breakwater. The rest of the sediments can be carried offshore for disposal. The modelling study shows that this dredge spoil can be safely disposed similar to ITPCL Port, at the offshore location at 12 to 14 km offshore in 30 m water depth. The disposal location is shown in Figure 28.

6.6.4 Cumulative effect of two offshore dredge spoil disposals

The modeling study has been carried out using MIKE 21 PA model for the combined scenario of the offshore dredge disposals from ITPCL Port, and Good Earth Shipyard to understand the cumulative impact on the seabed. The scenario of the spread of the disposed sediments on the sea floor is shown in Figure 28. The study shows while the disposed sediment spread to an extent of 1.5 km at ITPCL offshore location, it is within 250 m radius in case of the offshore disposal for Good Earth shipyard. It is noticed that the

spread of the dredged material is confined within respective location and there is no overlapping of the spread of the disposed sediments on the seafloor. Therefore, the disposal has been so designed that there will not be any significant change on the seafloor elevations. The disposal method will be planned in such a way that there will not be any turbid plume induced during the release of dredge spoil. Hence the dredge disposal at these offshore locations will not have any significant impact on the marine environment.

6.6.5 Cumulative impact due to cyclone & storm surge

The potential for extreme cyclonic wind and storm surges at the Cuddalore region is assessed by examining the available records of the parameters of cyclonic storms, which have crossed the East coast of India. The data has been obtained from the Atlas, "The tracks of Storms and Depressions in the Bay of Bengal and the Arabian Sea, 1891 to 2008" published by India Meteorological Department.

Storm surge estimation: The storm/cyclone induced water level variations (storm surges) along the Cuddalore coast were simulated using the MIKE21-HD module. In order to estimate the surge height, the distribution of the wind and pressure fields induced by the cyclone have to be specified over the Bay of Bengal near the study area. The wind and pressure fields induced by a moving cyclone are assumed circular and they are described in terms of storm parameters in the MIKE21 module. The parameters used to describe the wind field associated with a cyclone are:

- Radius to maximum wind, Rm,
- Maximum wind speed, Wmax,
- Cyclone track, forward speed Vf and direction,
- Central pressure, Pc and
- The ambient pressure, Pa

At a distance R from the center of the cyclone, the rotational wind speed Wr is given by,

$$W_r = W_{max}\,(R/R_m)^7\,\exp[7(1-R/R_m)] \qquad \text{for } R < R_m$$

$$= W_{max}\,\exp[(0.0025R_m + 0.005)\,(1-R/R_m)] \qquad \text{for } R \geq R_m$$

where R and Rm are in km. Cyclone induced wind rotates anti-clockwise in the northern hemisphere and clockwise in the Southern hemisphere. The direction of the wind at a distance R from the centre of the cyclone is deflected towards its centre by friction at the air-sea interface. The deflection angle θ with respect to the tangent to the circle at a particular location R from the centre of the cyclone is given by,

$$\theta = 10° \qquad for\ \ 0 < R \leq R_m$$

$$= 10° + (R - R_m)/(0.2\ R_m)15° \qquad for\ \ R_m < R \leq 1.2R_m$$

$$= 25° \qquad for\ \ 1.2\,R_m < R$$

Finally, the pressure, P, at a particular location is given by,

$$P = P_c + (P_a - P_c)\ \exp(-R_m/R)$$

Extreme wind

The maximum wind speed of 180 km/hour, the one experienced during Thane cyclone was used. The Cuddalore coastal belt particularly between Nagapattinam and Pondicherry is very much affected by frequent occurrence of cyclone. The eye of the THANE cyclone has exactly crossed at Cuddalore near the CSL Offshore Terminal. The wind speed crossed 200 km/hour. Although there is no record on the measured storm surge, the eye account indicates a storm surge of about 2.5 m height close to the coastline. The magnitude of the storm surge for different scenarios of cyclone, expected to frequently occur along this region has been studied exclusively for this report.

The MIKE 21 HD model was used to estimate the movement of cyclone and the anticipated storm surge along this coastal stretch. In order to estimate the surge height, the distribution of the wind and pressure fields induced by the cyclone were specified over the Bay of Bengal near the study area. The wind and pressure fields induced by a moving cyclone are assumed circular and they are described in terms of storm parameters in the MIKE21 HD module.

Simulation: The storm surge simulation has been carried out for cyclonic wind speeds of 180 km/hour corresponding to a wind field associated with Thane cyclone occurred in 2011 in project location. The bathymetry used in the model is shown in Figure 29. The cyclonic wind fields with the wind vectors are shown in Figure 30. The magnitude of the storm surge in the project region within 25 km radius is shown in Figure 31. The estimated maximum surge due to such severe cyclonic storm will be around 2.5 m which incidentally confirms the eye witness account of 2.5 m.

The occurrence of storm surge and its magnitude of elevation is independent of various marine facilities being developed along the Cuddalore coast. The construction of sand bank along the shore front from the part of the dredge spoil can offer good protection from the destruction of storm surge. Again, the port breakwaters can offer good protection from the impact of storm surge for the coastal segment immediately behind them. Therefore, there will not be any cumulative impact due to different marine facilities coming up along the Cuddalore coastal region for the effect of storm surge.

6.7 Cumulative Impact on Water Quality

As all the discharges are localized and do not contain any pollutant or toxic chemicals, the nearshore water quality will not be altered. The impact zones at each discharge points are within 300 m and the parameters that are expected to change within the mixing zone are only temperature and salinity. The dredge spoil disposal will be done beyond 12 km offshore at 30 m depth and it will not cause any change in the nearshore water quality. Moreover, the dredged materials have been analyzed for heavy metals, petroleum hydrocarbons, oil and grease and phenol and they were found to be in trace quantities and will not alter the chemistry of water at the disposal site significantly. Although the construction of port structures such as breakwaters, jetties, trestle and berths cause temporary impact during construction stage, they will not alter the water quality on the long term during the operational stage. In case of SIPCOT effluent, these are discharged into the sea after treatment as per the TNPCB norms and the quality is being monitored at regular interval by the TNPCB. The recent report clearly indicates that the step taken by TNPCB has made tremendous impact on improving the quality of effluent which ensures the preservation of nearshore water quality. Hence it is concluded that the various discharges being released from different

industries will not have any cumulative impact on the coastal waters off Cuddalore and it will be maintained clean within the stipulated standards.

6.8 Cumulative Impact on Fisheries

Since there are two port projects, the construction of breakwaters with port basins occupy limited areas along the coast and these areas may become inaccessible to fishing communities. Most of the commercial fishing is done at depths of 20 to 30 m water depth which occur at a distance of 8 to 10 km from the coast. The port projects have to comply with various national and international regulations. The chances of polluting the nearshore become minimal and may not exert any impact on the local fisheries except the loss of area for fishing.

Cooling water intakes have been identified as a source of impact for aquatic organisms due to impingement/entrapment and entrainment. Entrainment means the incorporation of all early life stages of fish and shellfish with intake water flow entering and passing through a cooling water intake structure and into a cooling water system. Impingement means the entrapment of all life stages of fish and shellfish on the outer part of an intake structure or against a screening device during withdrawal of intake water. While impingement is also known to affect the fishery to a limited extent, it involves mostly young (juvenile) organisms, in the immediate vicinity of the intake structure. The intake velocity and volume are known to be the important contributory factors to impingement.

By regulating velocity below 0.2 m/s around the intake well, the impingement effect can be avoided. The fishes can safely escape and avoid the chances of entrapment. Similarly, proper trash bars and screens have to be provided around the intake well in order to avoid the entry of small fishes. The vortex formation around the entry of intake well has to be avoided by reducing the velocity at the point of entry into the intake. The intake head has to be placed at sufficient depth so that there will not be any problem for safe navigation.

6.9 Cumulative Impact on Mangroves

The Pichavaram mangrove forest is located within 25 km radius of the project site as it falls 9.5 km on south from the stack of ITPCL project site. It has been identified as ecologically important area by MoEF. It is very essential to safeguard the health of mangrove forest. It is important to point that during the invasion of 2004 Tsunami, this region was totally protected due to the presence of dense mangroves. This mangrove forest has an extent of 1471.33 ha connected with the supply of tidal water through Coleroon river, Chinnavaykal and Vellar river. Pichavaram mangroves harbours different species of birds, belonging to 15 orders and 41 families, due to availability of different habitat types such as channels, creeks, gullies, mudflats, sand flats and adjacent sea shore. About a decade back, the health of the mangroves was in degradation due to the formation of sand bar blocking the mouth of Vellar river, Chinnavaykal and Coleroon river. Further, the tidal flat was getting silted up causing reduction in tidal water supply to the plants. The MSSRF Foundation has taken up mitigation programme in order to safeguard the health of mangroves and implemented various schemes with the participation of local habitants. They dug out tidal channels and planted mangroves. Subsequently the density mangroves improved and they become more healthy over the years. The CAS, Marine Biology Centre, Annamalai University located at Parangipettai is implementing various schemes to improve mangrove forest in association

with ITPCL. They have also planted various species of mangroves along the Vellar river estuary.

Keeping this in view, the Cumulative Impact of the various marine discharges proposed in Cuddalore region was carried out using model study. The study shows that most of the time i.e., during nine months in a year, all the discharges tend to spread towards north due to the prevalence of currents from south to north. Only during NE monsoon, the discharges tend to spread towards south, reaching ambient quality within 300 m radius. Hence, it is ensured that, neither of the discharges i.e., warm water, brine and trade effluent will find way to reach the vicinity of Pichavaram mangrove forest. Further, the proposed breakwaters by ITPCL and other neighbouring port will try to divert the plume away from the coast.

A very important positive impact due to the construction of ITPCL Port is that the Vellar river mouth will be kept open throughout the year. This will ensure providing a good tidal prism which will in turn feed the tidal creeks, swamps and tidal flats with large amount of seawater. This will help tremendously improve the density and health of the mangroves in Pichavaram.

Therefore, the proposed development along the Cuddalore coast will improve the health of Pichavaram mangroves.

6.10 Discussions and Conclusions

The main directives, among other things, issued by the NGT to the project proponent is to carryout cumulative impact assessment studies especially with regard to the proposed coal based power plant (2 x 660 MW) of Cuddalore Port Company Limited and the Nagarjuna Oil refinery and other industrial activities within a radius of 25 km from the power project of IL & FS Tamil Nadu Power Co. Ltd (3600 MW).

Accordingly, a detailed study was carried out to list the number of industries, port and harbours, power plant etc. which are already in existence and process of implementation, assess the impact on individual project basis and extend the study to identify the cumulative impact holistically on the marine environment. For this purpose, the industries have been classified into three groups:

Table 44: Marine Facilities for Various Industries

Sl. No.	Industry	Distance north from ITPCL (km)	Marine facilities
A. Existing			
1	Cuddalore Minor Port	22	Port facilities, fishing harbour.
2	SIPCOT Industrial Complex	17	Treated trade effluent outfall.
3	Chemplast Sanmar Limited (CSL)	13	Marine terminal, seawater intake, return water outfall, chemical parcel pipeline.
B. In Progress			
4	Nagarjuna Oil Corporation Limited (NOCL)	8	SPM, crude oil pipeline, export petroleum jetty.
5	IL&FS Tamil Nadu Power Company Limited (ITPCL)	-	Seawater intake, return water outfall, port with breakwaters.
C. Planned (clearances are available)			
6	Cuddalore Power Company Limited (CPC)	12	Seawater intake, return water outfall, coal jetty.

7	Textile Park of SIMA	4.5	Treated trade effluent outfall.
C. Planned (clearances yet to be obtained)			
8	Good Earth Shipyards Limited (GESL)	1	Shipyard with breakwaters.
9	SRM Energy Limited (SRMEL)	5	Seawater intake, return water outfall, coal jetty.

For study purposes, these are divided into two groups:

- Group I: Port projects.
- Group II: Industries involving wastewater discharge into the sea.

Group I: Port projects

i) Cuddalore Minor Port OT

ii) Nagarjuna Oil Company limited

iii) ITPCL Port

iv) Good Earth shipyard

Group II: Industries involving waste water discharge into the sea

i) SIPCOT

ii) Chemplast Sanmar Limited

iii) SIMA

iv) Cuddalore Power Company Limited

v) ITPCL Port (marine outfall)

(vi) SRM Energy Limited

6.10.1 Group I: Port Projects

Cuddalore Minor Port:

It is in existence for several decades and handle only domestic cargo, bulk commodities, fishes and they function under the aegis of State Government and is 22 km away from the ITPCL project site. This will not have any influence on other projects coming up along the coast of Cuddalore belt.

Nagarjuna Oil Company Limited:

This is a refinery project with planned initial capacity of 6.5 MTPA. The crude oil tankers will be handled in an SPM at 30 m depth and for the export of finished product (petroleum products) they intend constructing a shore based jetty at 10 to 11 m contour. The project is in the construction phase.

By virtue of special features and distance of 8 km form ITPCL's site, the construction and operation of these facilities do not involve any cumulative impact issues; the impacts to the marine eco system are purely temporary and confined locally without affecting other projects in its vicinity.

Good Earth Shipyard:

This is a ship building yard proposed with two breakwaters. In fact, the proponent is going to adopt modern building technology where all major modules will be fabricated elsewhere as modules and brought to the proposed shipyard for assembly in stages and other related finishing works. The two breakwaters will bring in impacts in terms of accretion on the southern side and erosion on the northern side. Appropriate sand bypassing system for beach nourishment may have to be made to maintain coastal equilibrium as adopted in any similar port situation.

ITPCL Port:

ITPCL has proposed to establish a captive port to handle the coal requirements for the development of coal based power plant of 3600 MW capacity in different phases. The coal handling requirement is 15 MTPA. The harbor basin is formed by two breakwaters with an entrance at the eastern side. Initially two coal berths with mechanized coal handling facility are proposed. The marine facilities will be designed for 80,000 DWT vessels. There will be accretion on the southern side and the erosion on the northern side resulting in the mouth of Vellar river getting closed. The need for keeping open the river mouth has been elaborately discussed in Section 6.6.2 and 6.9.

6.10.2 Group II - Industries

The marine discharges from the industries have been studied through mathematical modelling and the results are as follows:

Results of Modelling study:

- The mathematical modelling study using MIKE 21 HD shows that the marine discharges from various Industries get mixed well in the sea within the shorter distance of 300 m. The discharges will not merge with the neighbouring plumes. It helps to retain the coastal water clean and the impact caused by various discharge will be negligible. The trade effluents are treated as per TNPCB norms and the warm water temperature is maintained within 5°C as per the MoEF norms. The brine reject released into the sea will reach the ambient salinity within 300 m.
- The cumulative marine discharges show that the plume spread is more localized and it does not spread up to Pichavaram mangrove forest. Hence, there will not be any impact on the existing scenario of the Pichavaram mangrove forest.
- The dredge spoil from various ports carrying out the capital and maintenance dredging should be disposed at the designated offshore location, i.e. at 14 km offshore in 30 m water depth. The modelling study showed localized spread of the disposed sediments without getting merged with each other.

Maintenance of Vellar river mouth:

- There may be deposition of sediments on the southern side of the south breakwater of ITPCL project which would block the Vellar river mouth. The river mouth should be kept open throughout the year by appropriate dredging programme on a continuing basis. This will also help to increase the tidal prism inside the Vellar river estuary and to improve the density and health of Pichavaram mangroves.

Water quality:

- The combined activities of marine outfall and development of port facilities will not deteriorate the water quality/sediment quality of the nearshore waters. The impact on benthic communities will be temporary and restricted to construction stage. The animal community will re-colonize immediately after the construction.

Fisheries:

- During construction stage of port projects, there will be some disturbances to benthic and other organisms. However, these are temporary and confined to the specific areas of individual projects. The provision of appropriate trash bars and screens will prevent entry of small organisms. However, the impacts are more localized in this region.

Coral reef and turtles:

- As the coastal region of Cuddalore is devoid of coral reefs, marine endangered species and regular nesting of Olive ridley turtles, there will not be any impact on the biological status of the environment.

In summary, the rapid cumulative marine environmental impact assessment studies made based on the available reports relating to various projects within the 25 km radius of the ITPCL project site reveal that the proposed facilities by ITPCL may not alter the overall marine environmental status except resulting in the possibility of the Vellar river mouth getting closed and the consequential need to keep it open by a system of continuous maintenance dredging so as to ensure free flow of sea water to the Pichavaram mangrove and drainage of storm water into the sea. Further, an efficient shore stabilization scheme has to be implemented to stabilize the shoreline on the northern side of the breakwater.

SCENARIO 1 (MARINE STUDIES)

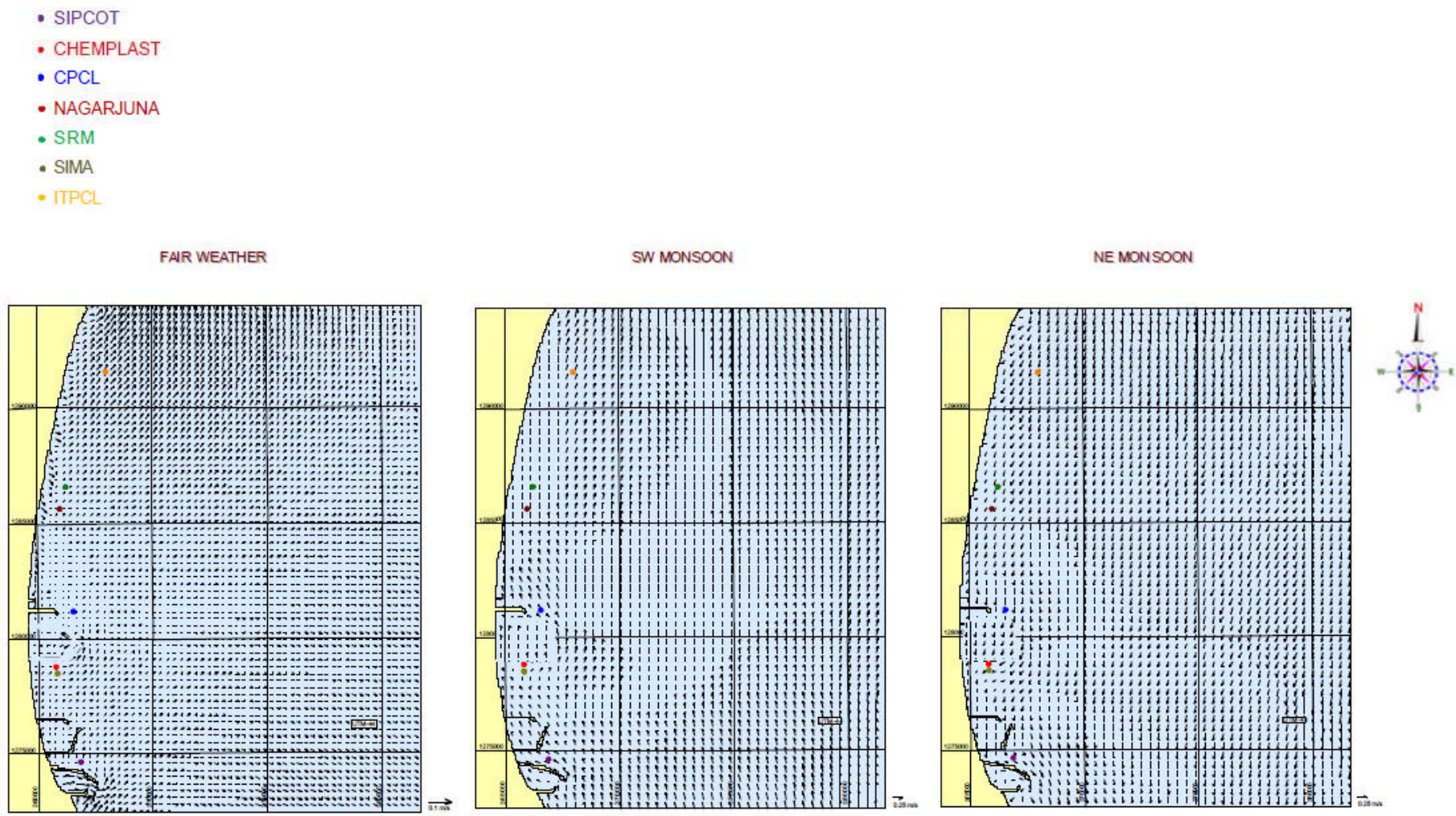


Figure. 19: Combined Scenario of Flow fields in 25 km radius

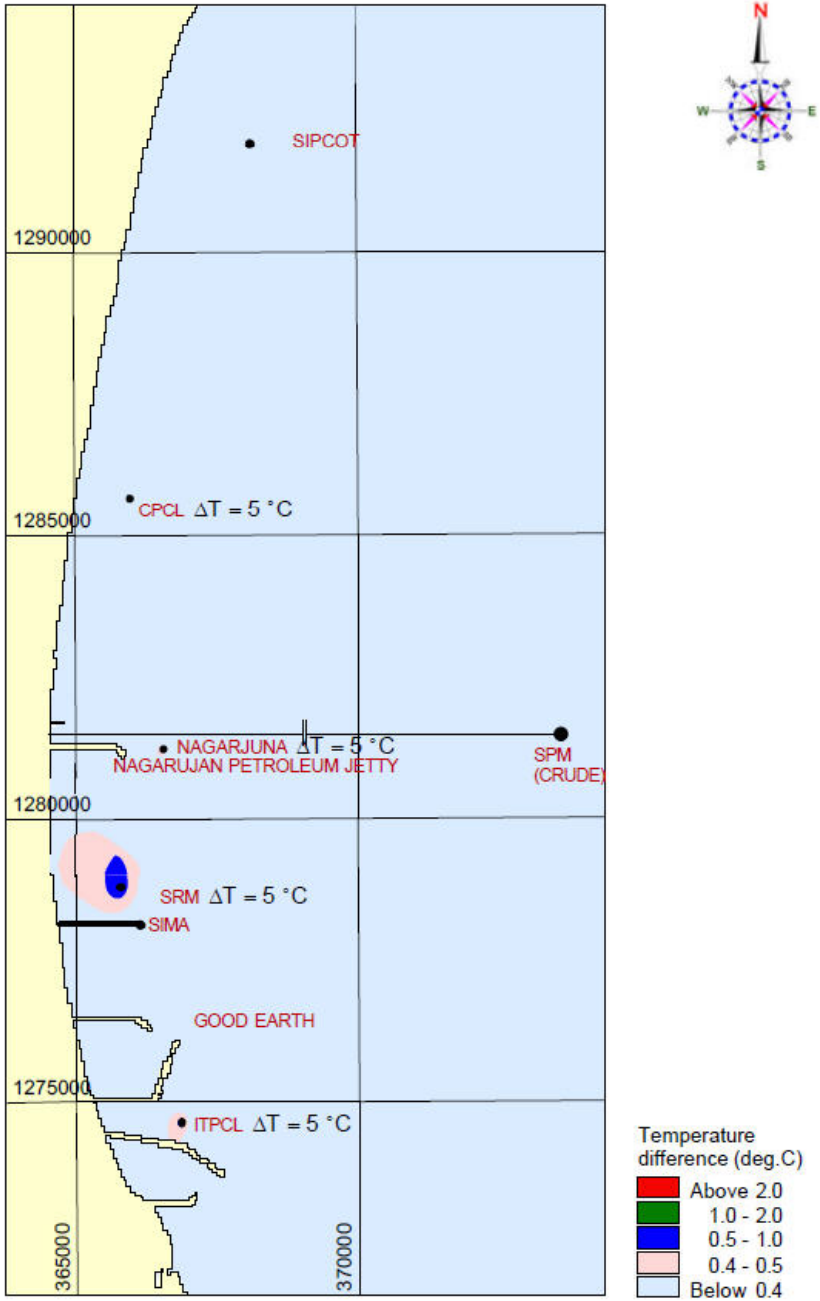


Figure. 20: Combined Scenario OF Various Discharges in 25 km Radius - warm water – fair weather

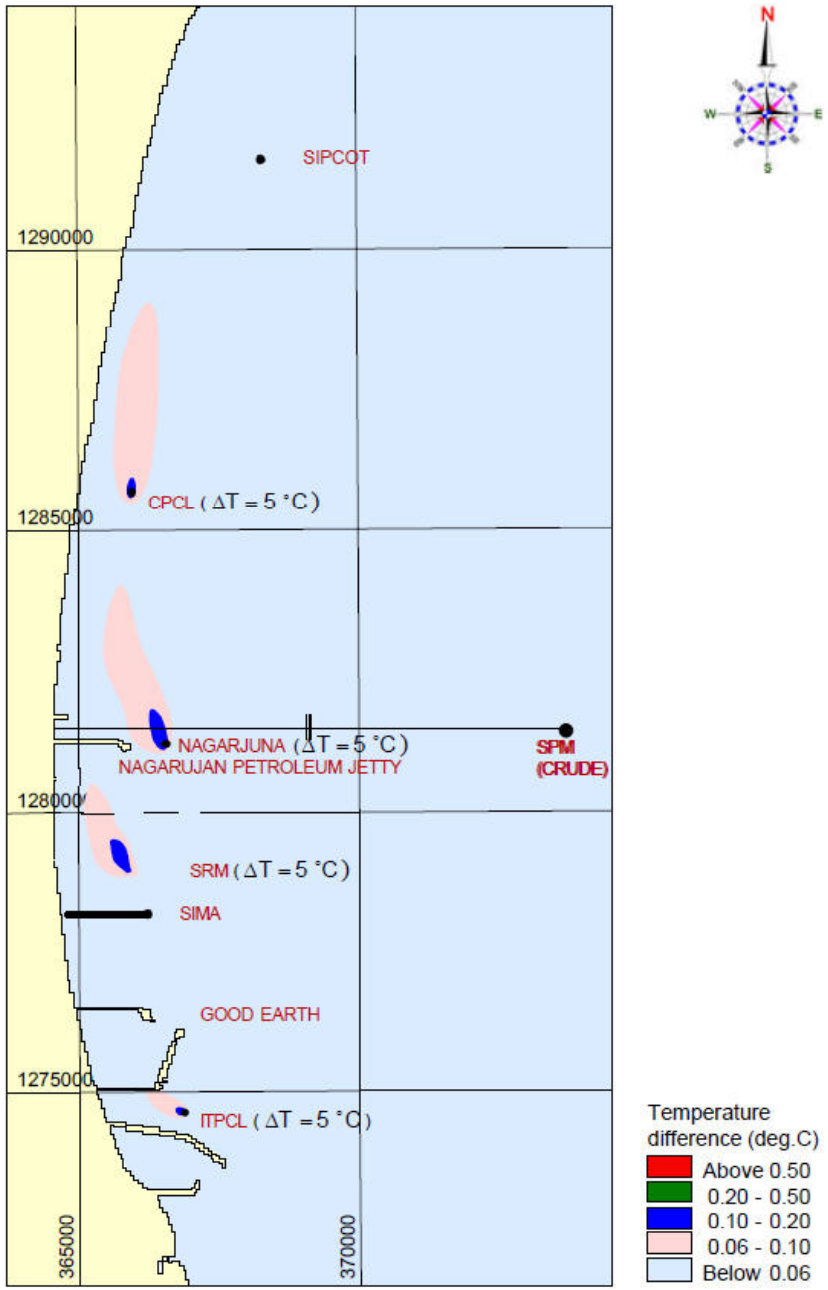


Figure. 21: Combined Scenario of various discharges in 25 km radius – warm water – SW monsoon

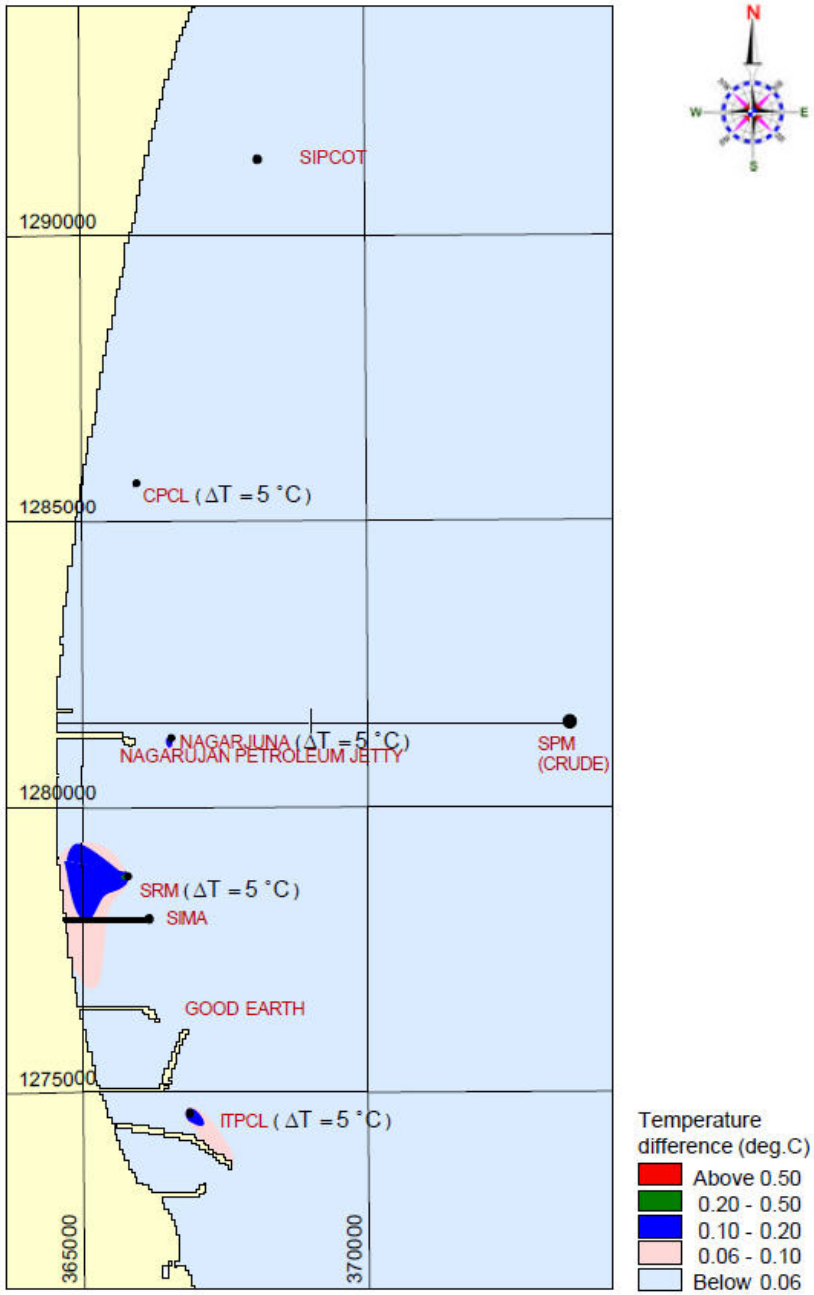


Figure. 22: Combined Scenario of various discharges in 25 km radius – warm water – NE monsoon

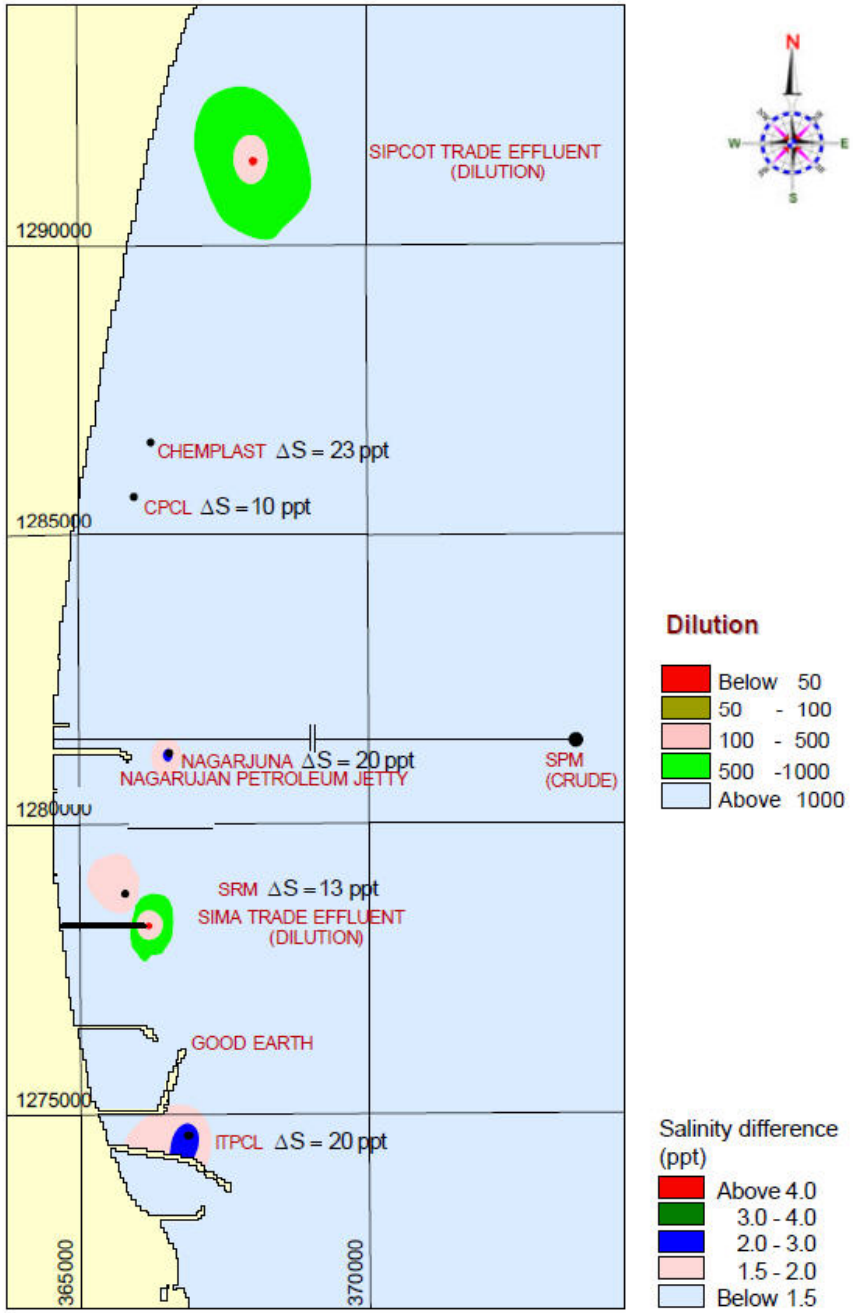


Figure. 23: Combined Scenario of various discharges in 25 km radius – brine – fair weather

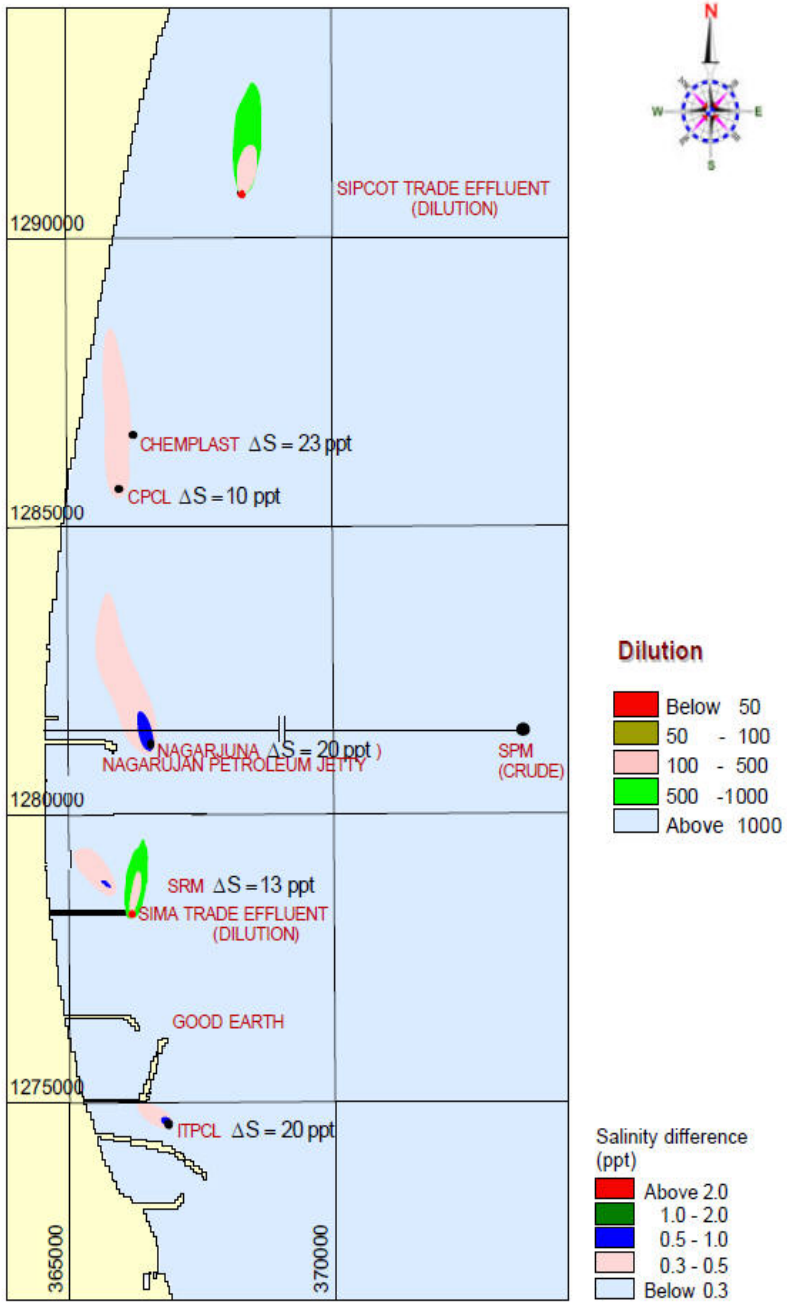


Figure 24: Combined Scenario of Various Discharges in 25 km Radius –Brine – SW Moonsoon

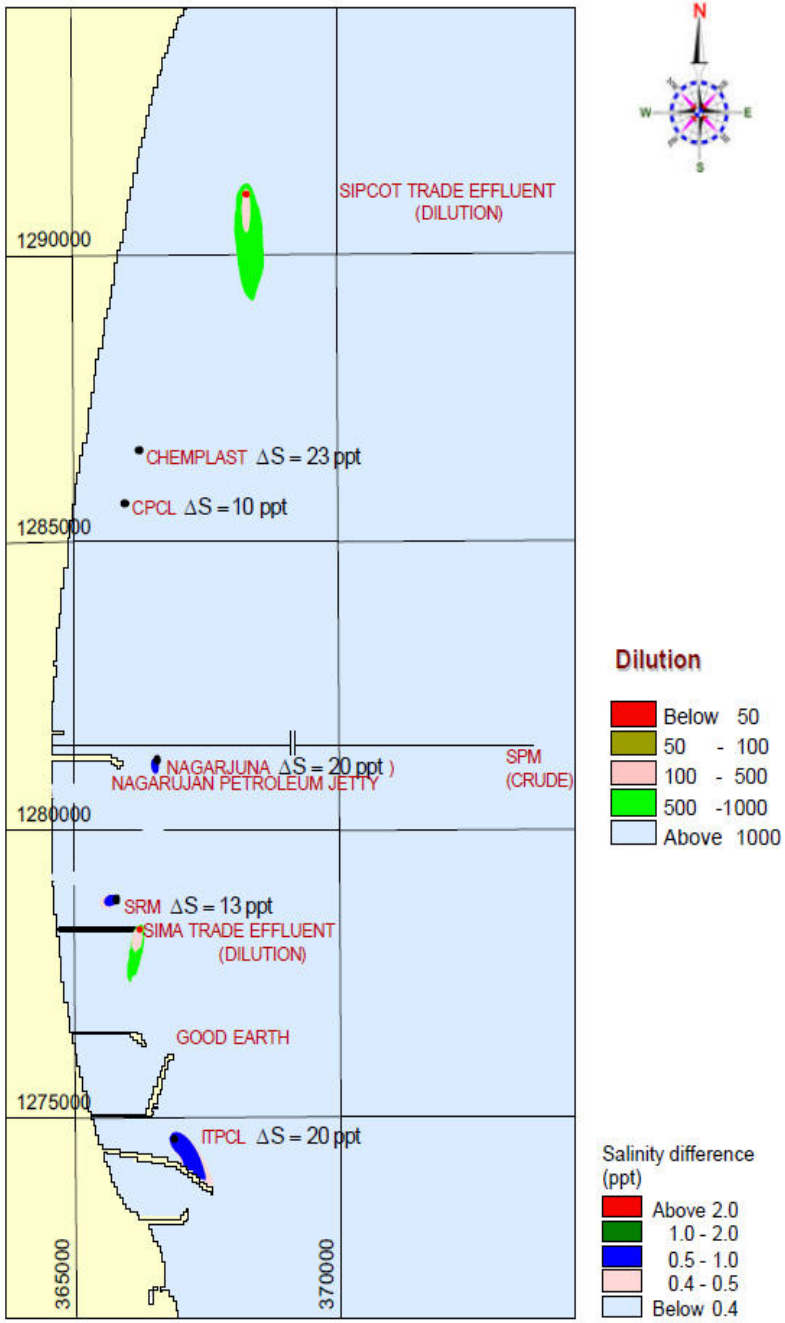


Figure 25: Combined Scenario of Various Discharges in 25 km Radius –Brine – NE Moonsoon

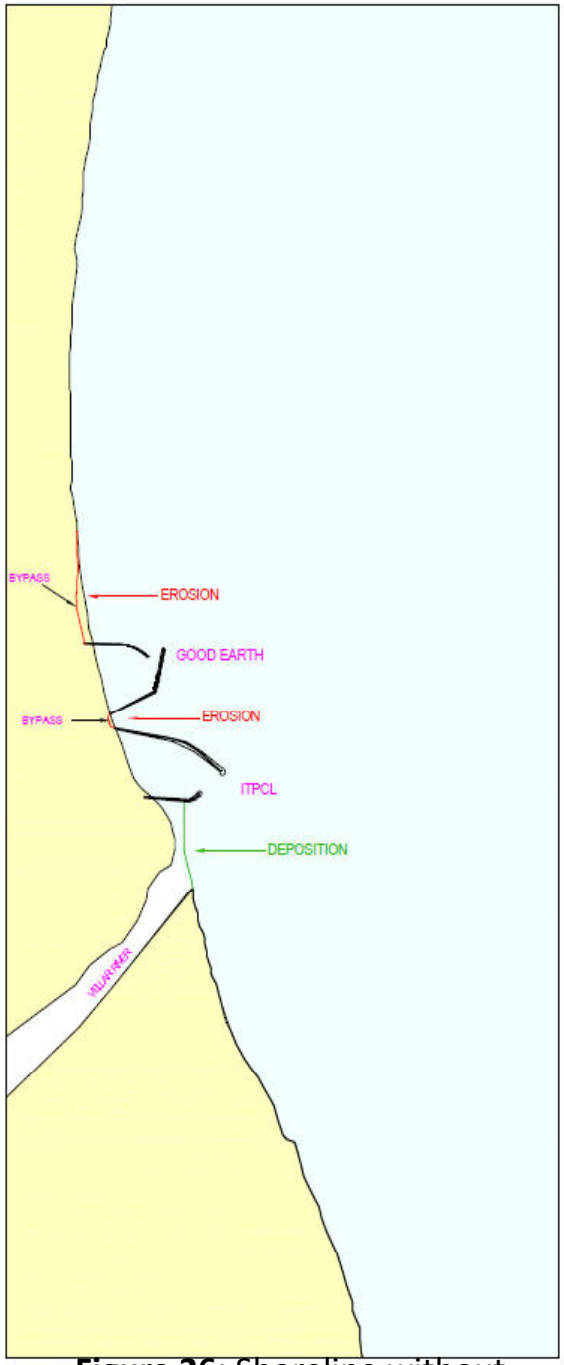


Figure 26: Shoreline without Bypassing

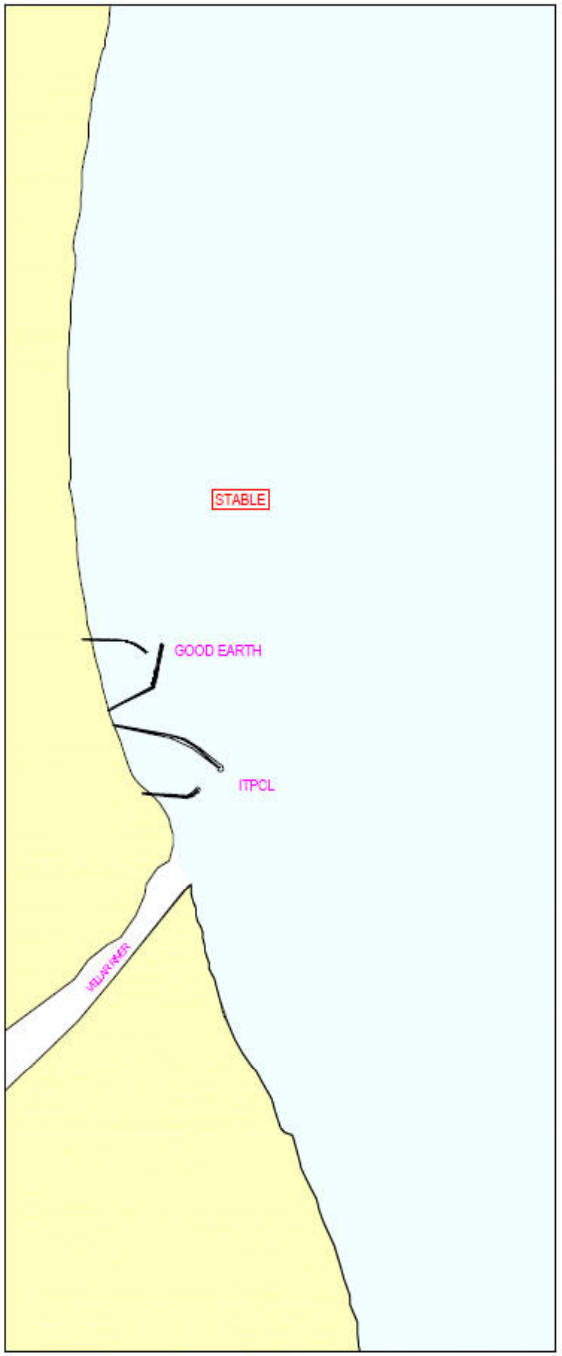


Figure 27: Shoreline after Bypassing

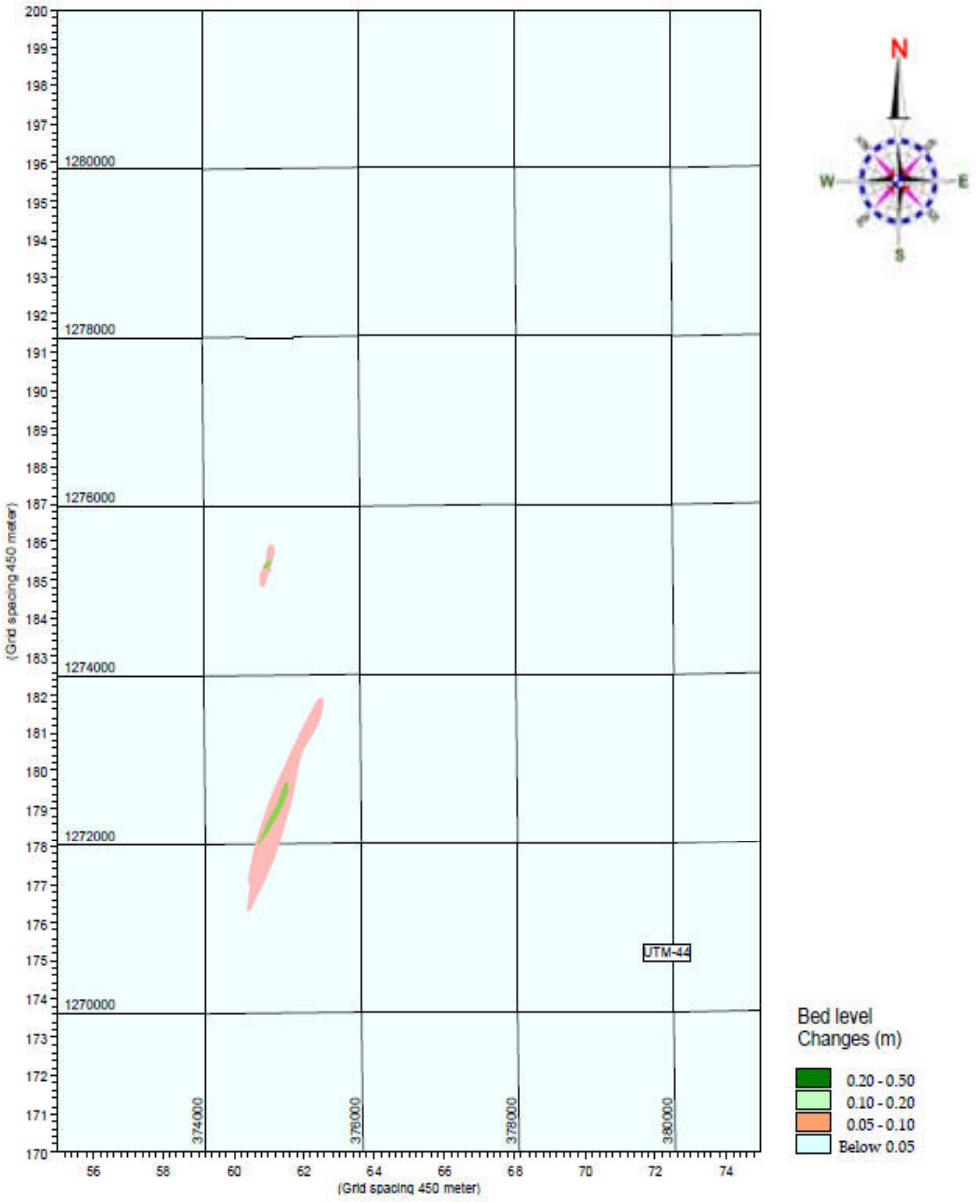


Figure 28: Change in Bed Level in 12 Months

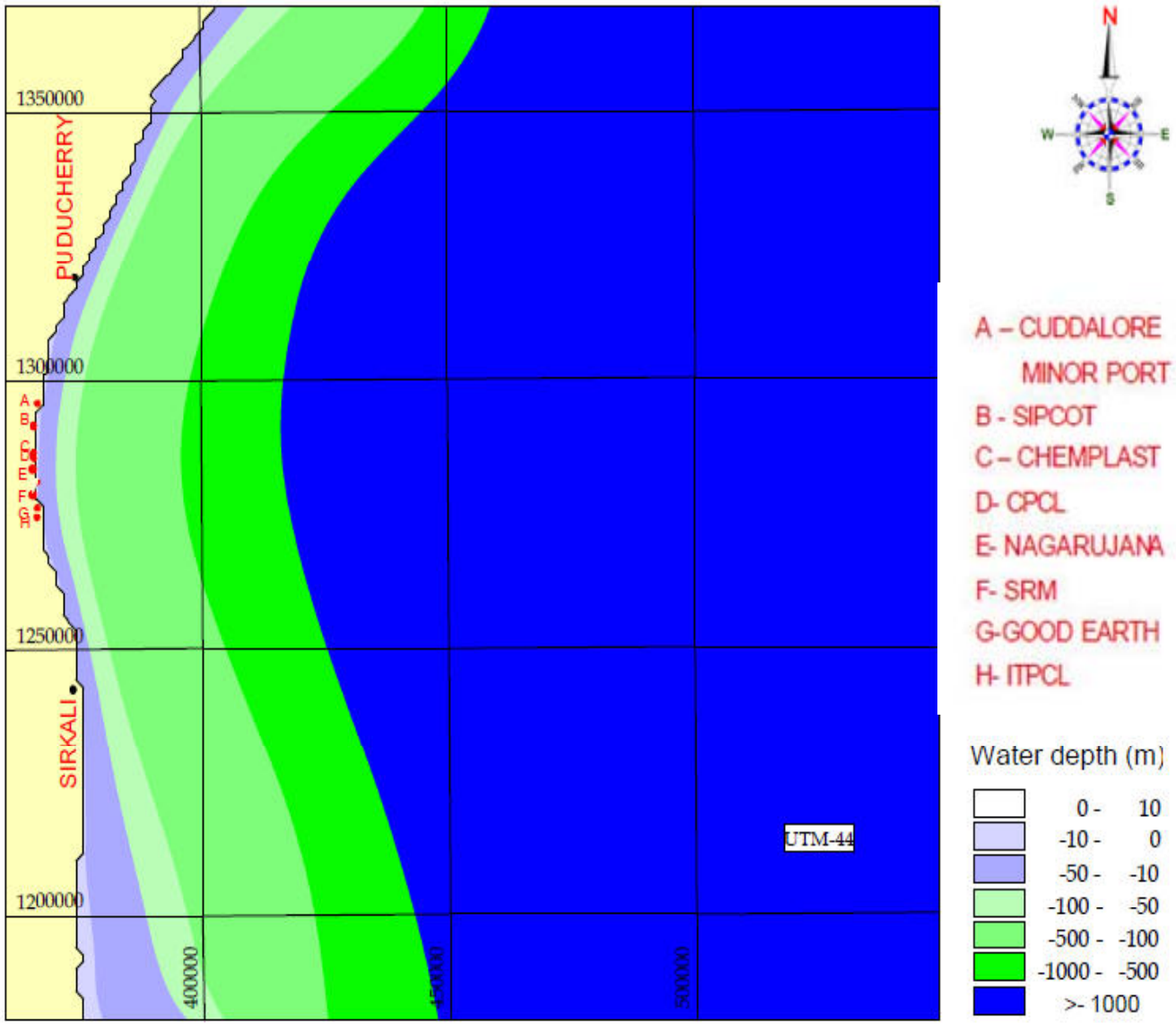


Figure 29: Bathymetry

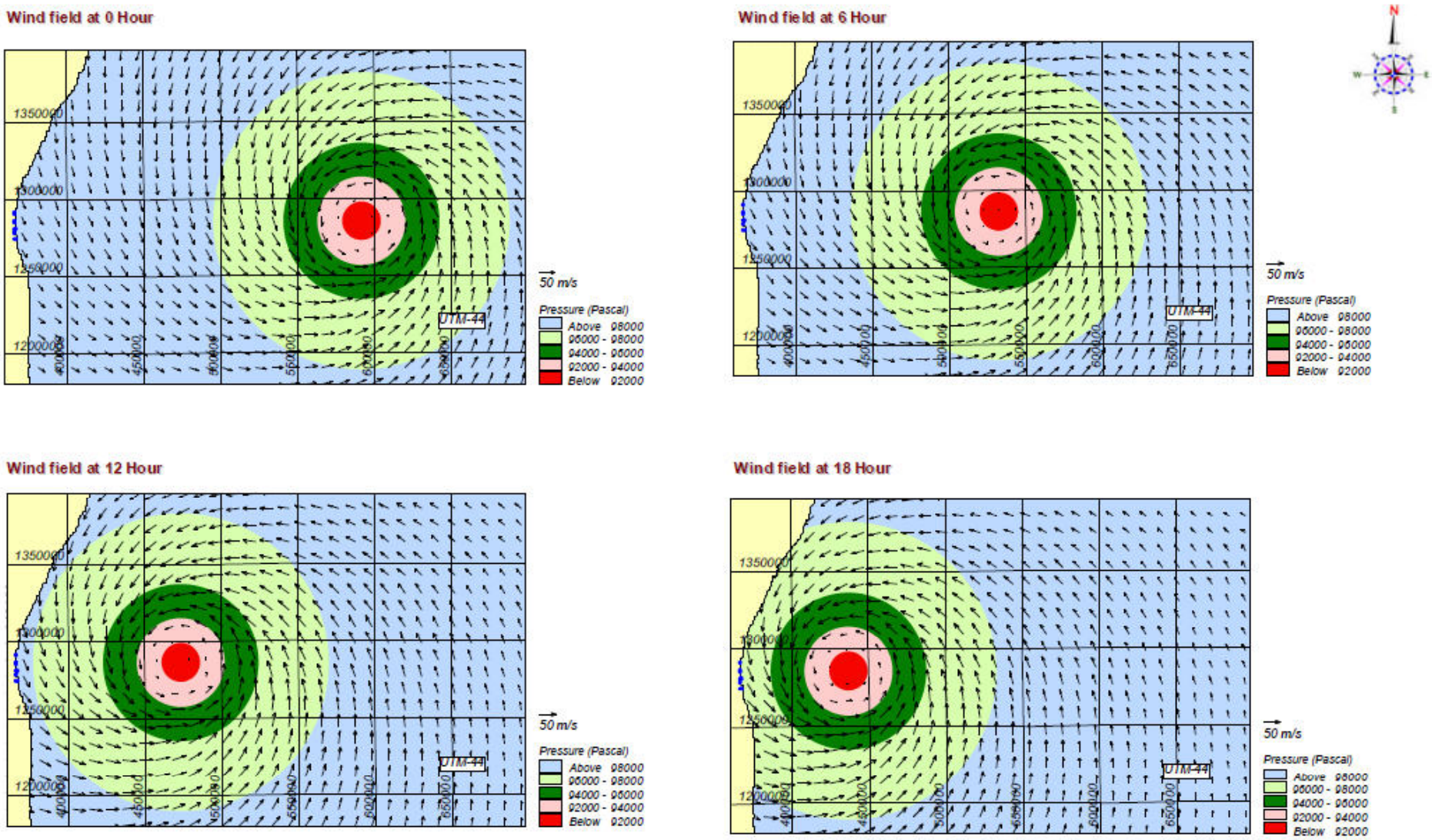


Figure 30: Moving of cyclone with intensity 180Km /hr

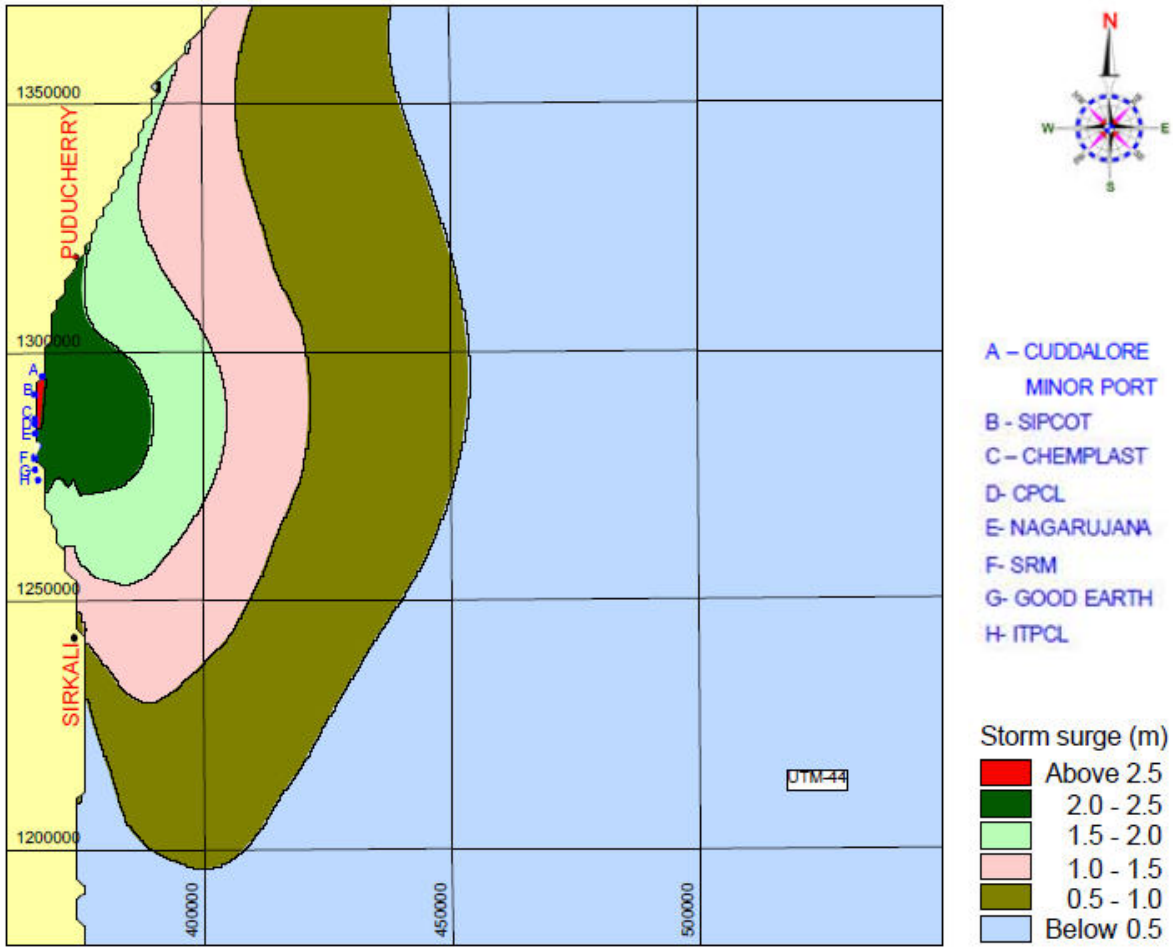


Figure 31: Storm Surge for Wind Speed of 50 m/s (180km/hr)

SCENARIO 2 (MARINE STUDIES)

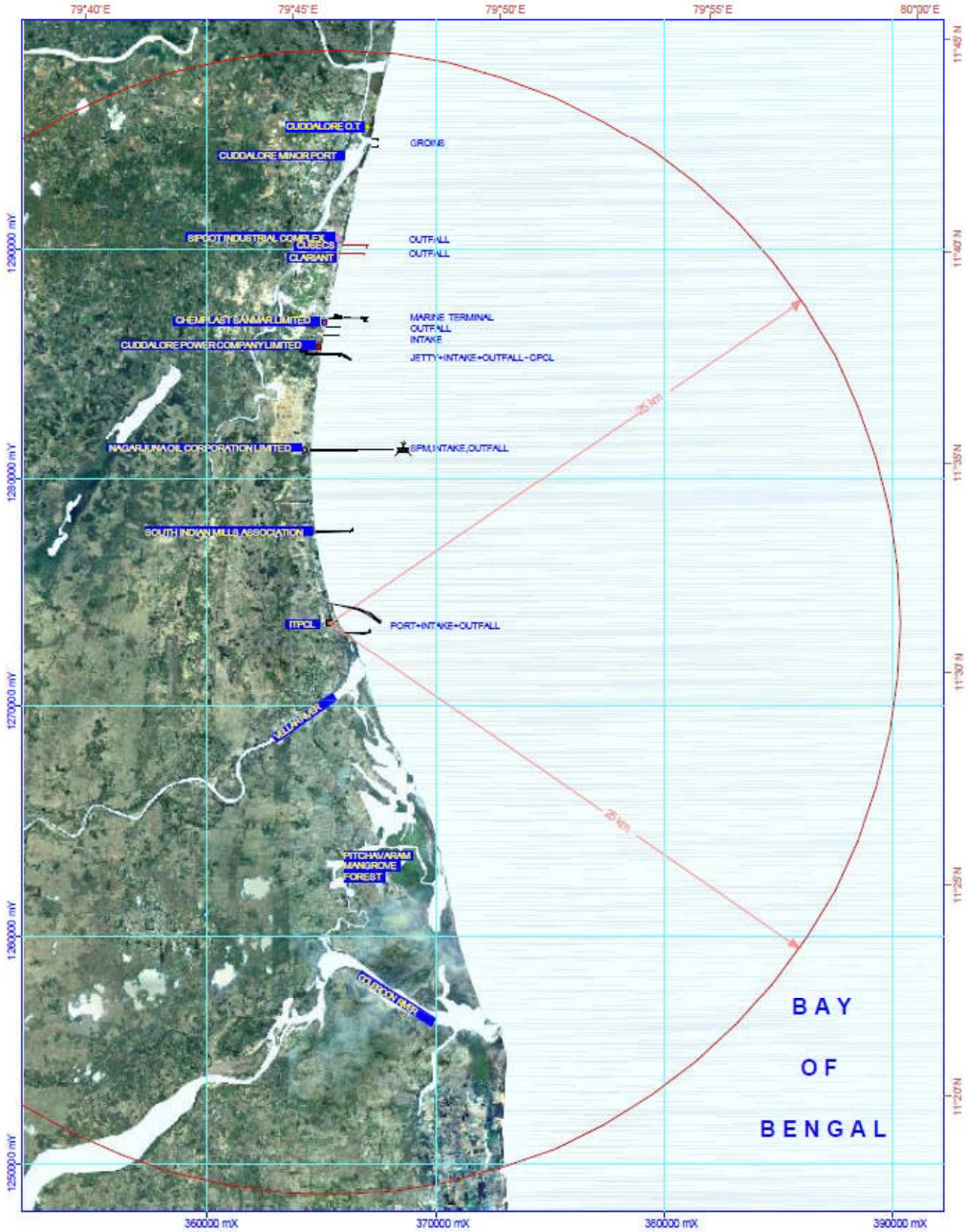


Figure 15: Industrial Units and Port Locations within 25 km radius

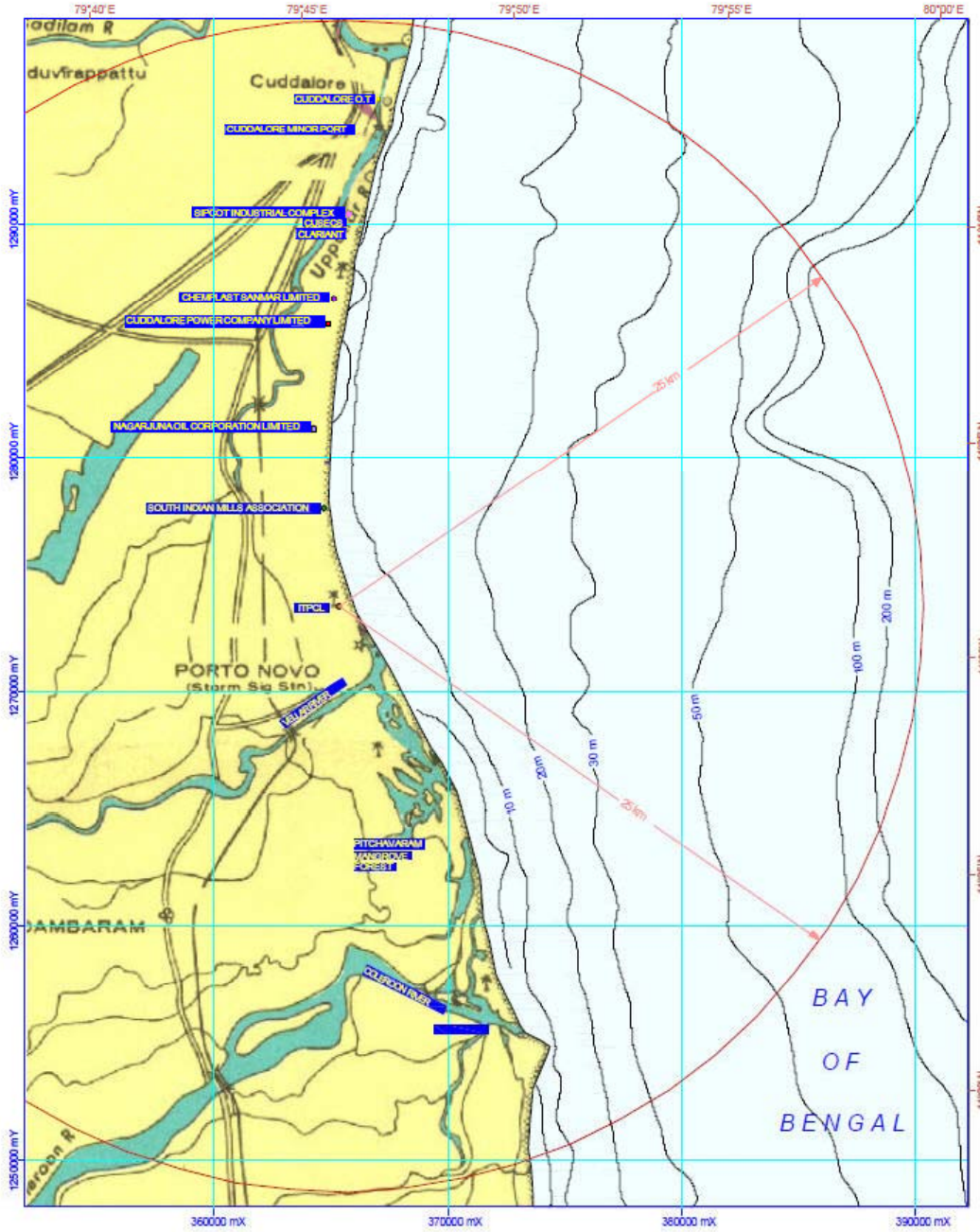


Figure 16: Bathymetry off Cuddalore Region

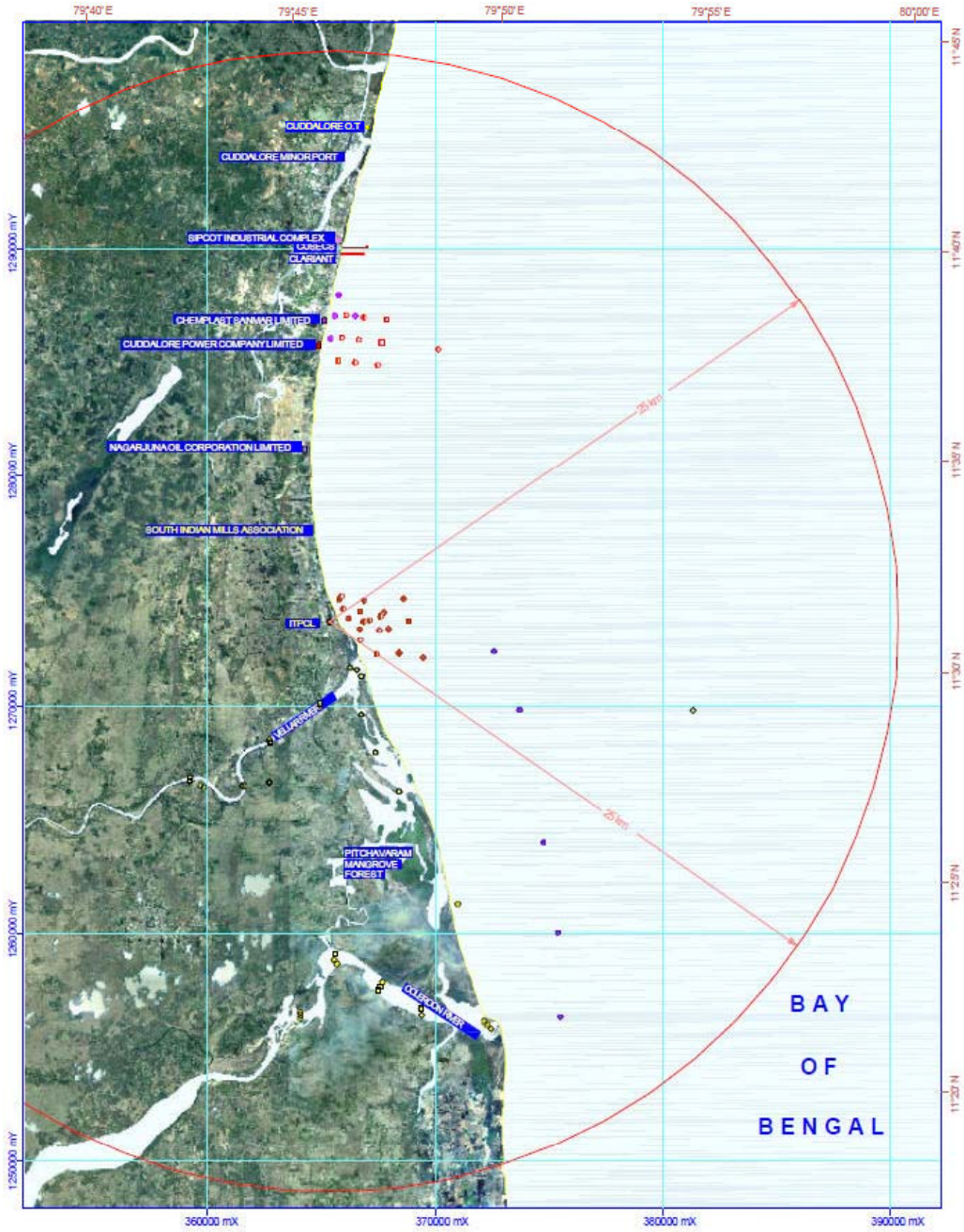


Figure 17: Locations of Environmental Data Collected under Different Projects

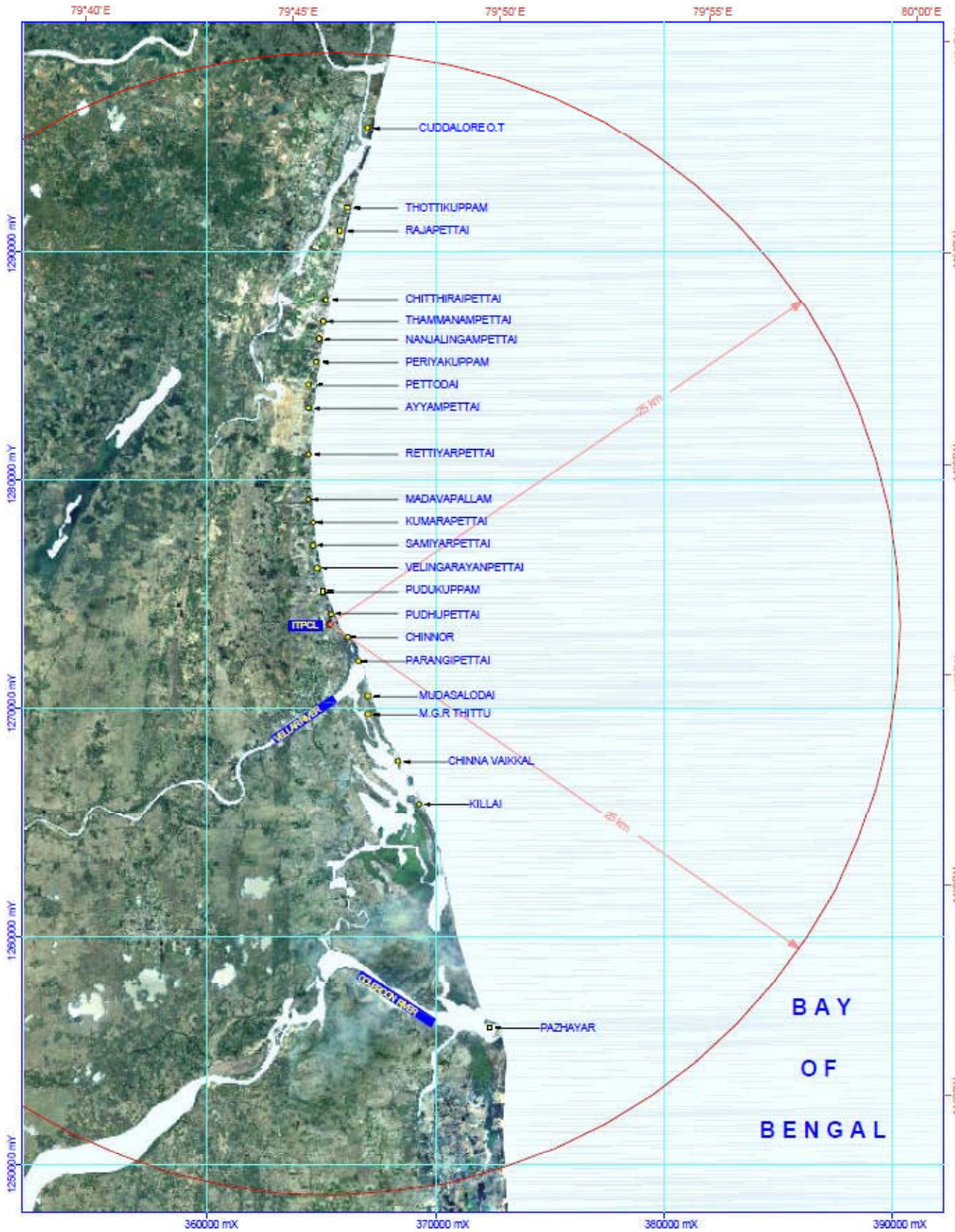


Figure 18: Villages within 25 km Radius (approximate)

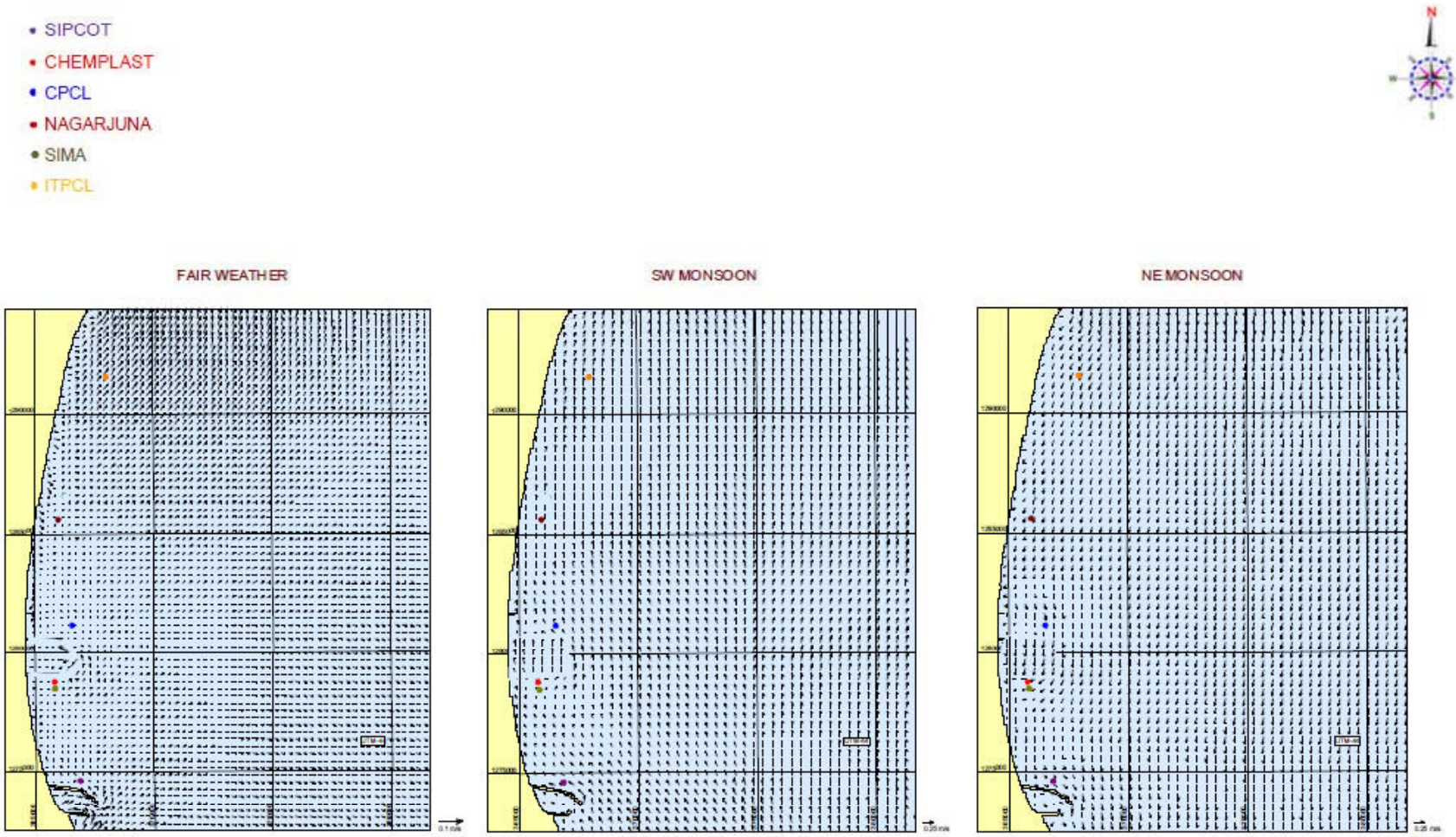


Figure 19: Combined Scenario of Flow Fields in 25 km Radius

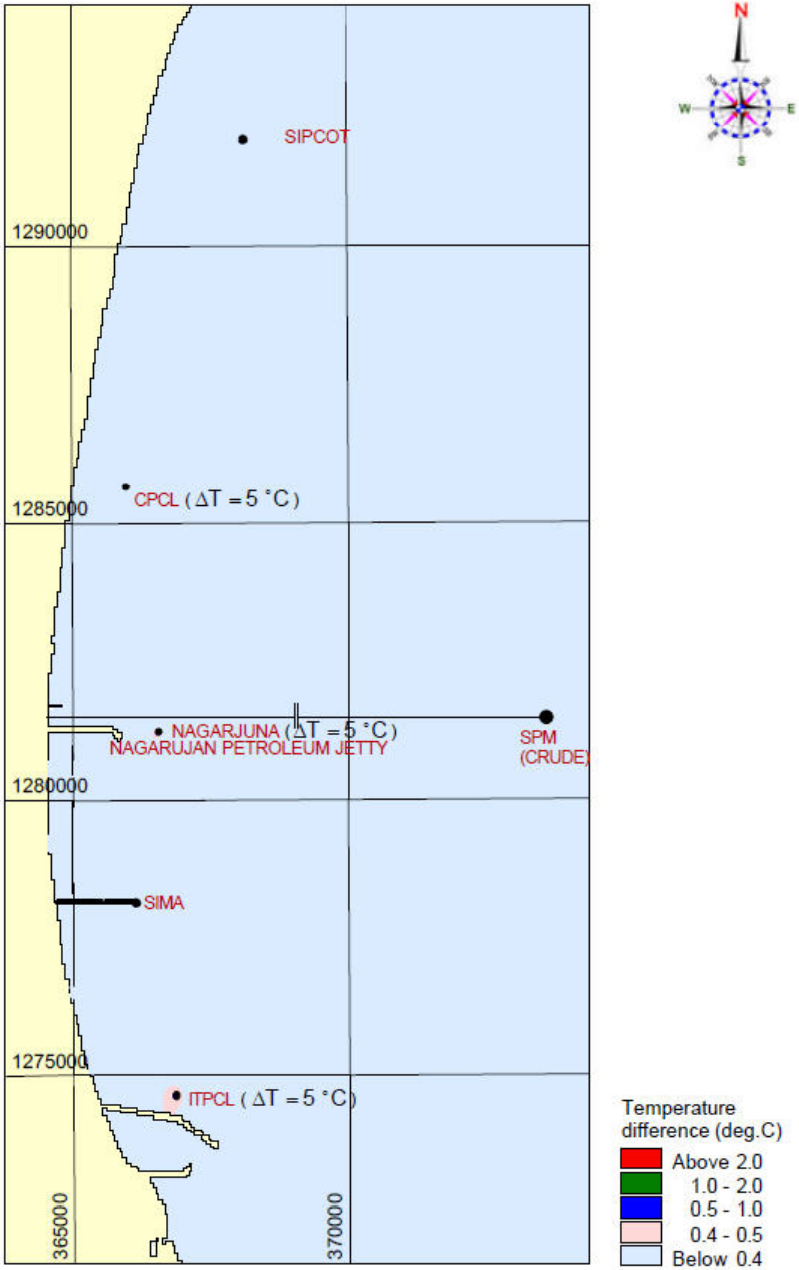


Figure 20: Combined Scenario of Various Discharges in 25 km radius – Warm Water – Fair Weather

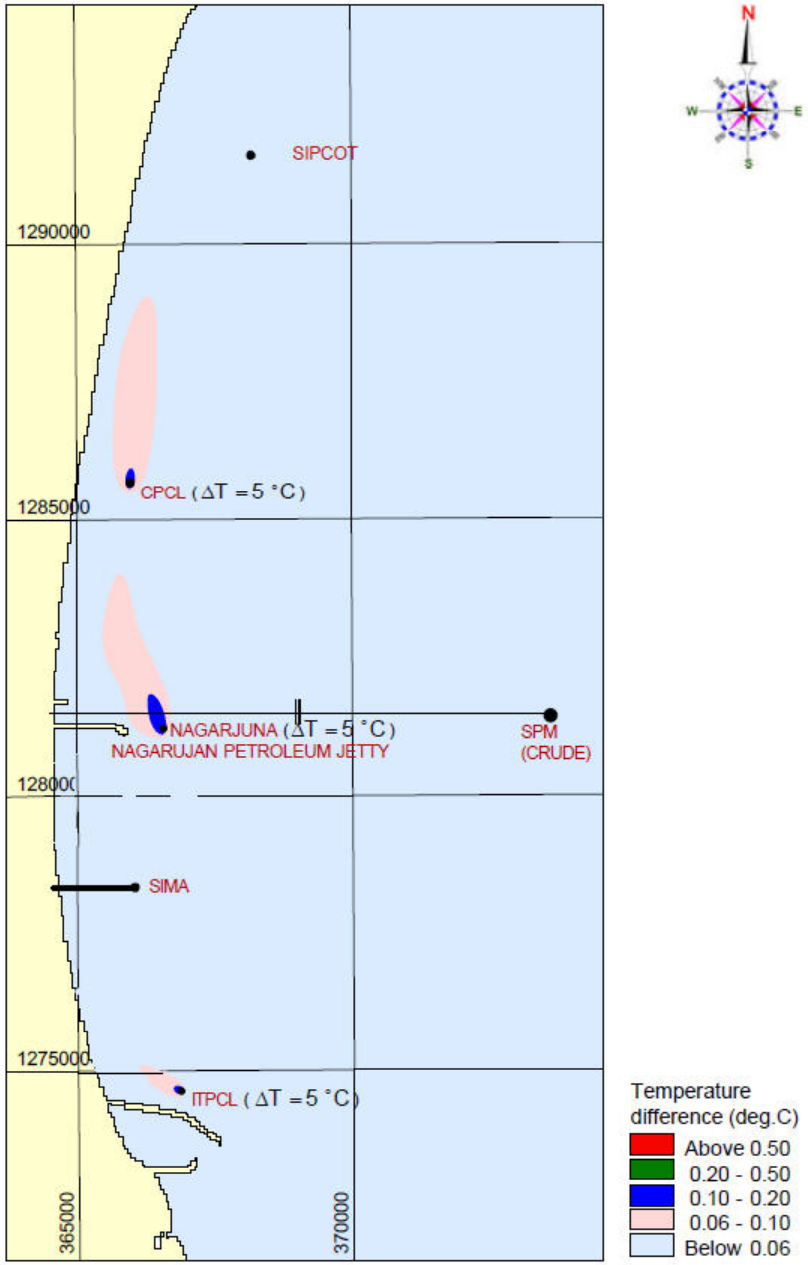


Figure 21: Combined Scenario of Various Discharges in 25 km Radius - Warm Water – SW Monsoon

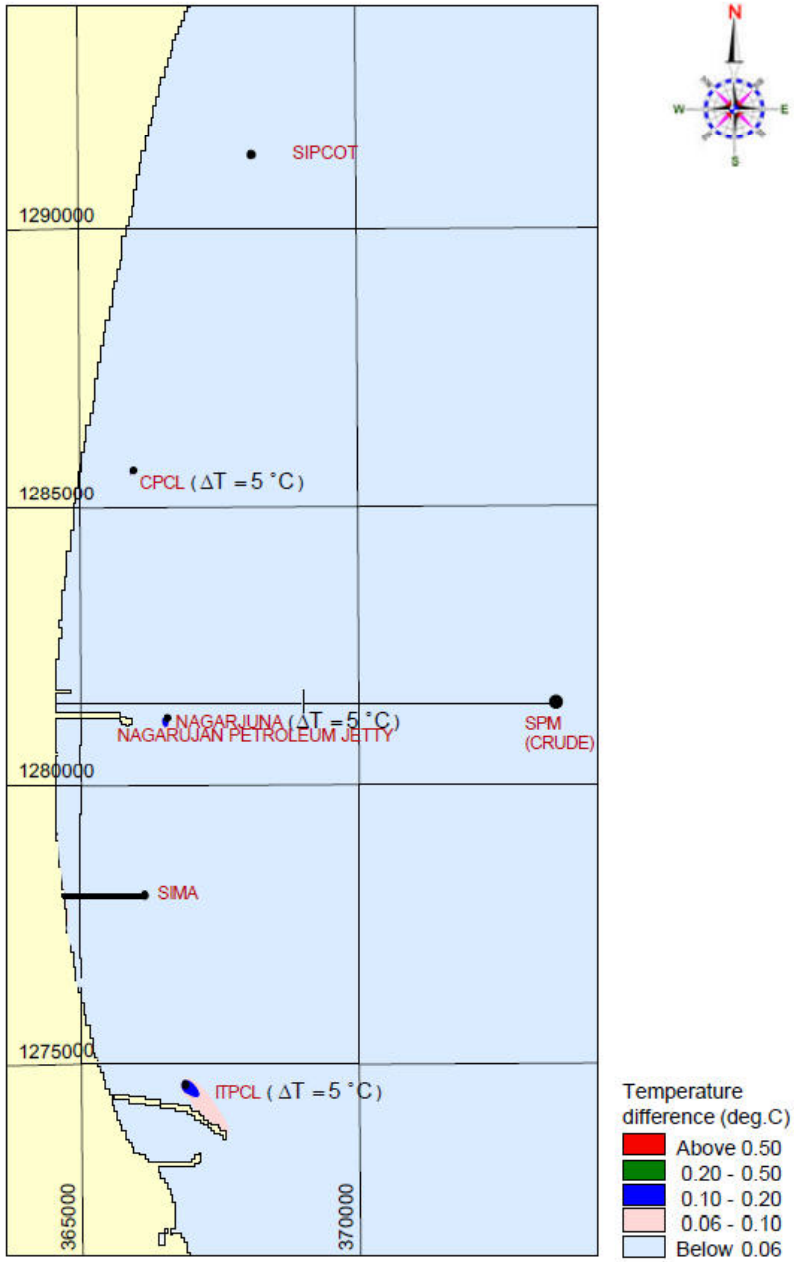


Figure 22: Combined Scenario of Various Discharges in 25 km Radius - Warm Water – NE Monsoon

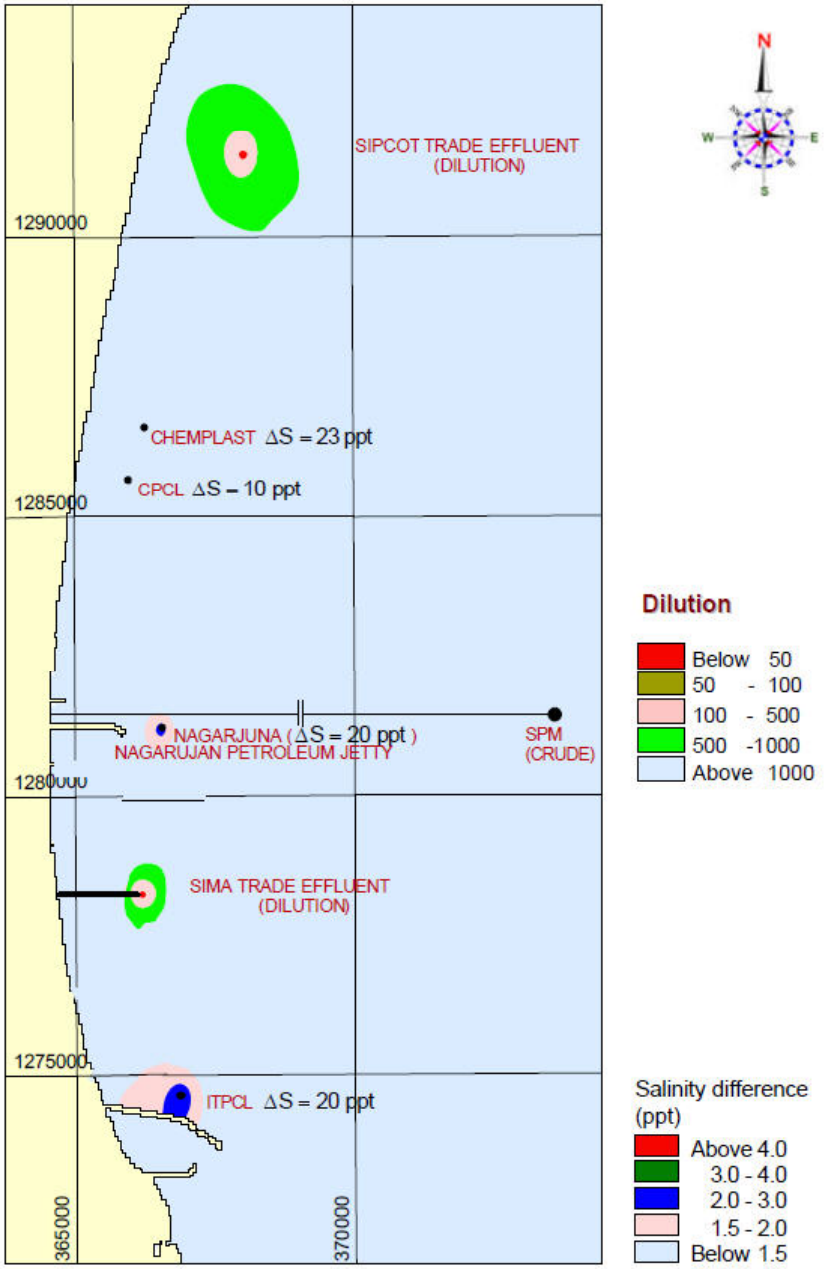


Figure 23: Combined Scenario of Various Discharges in 25 km Radius - Warm Water – Brine Weather

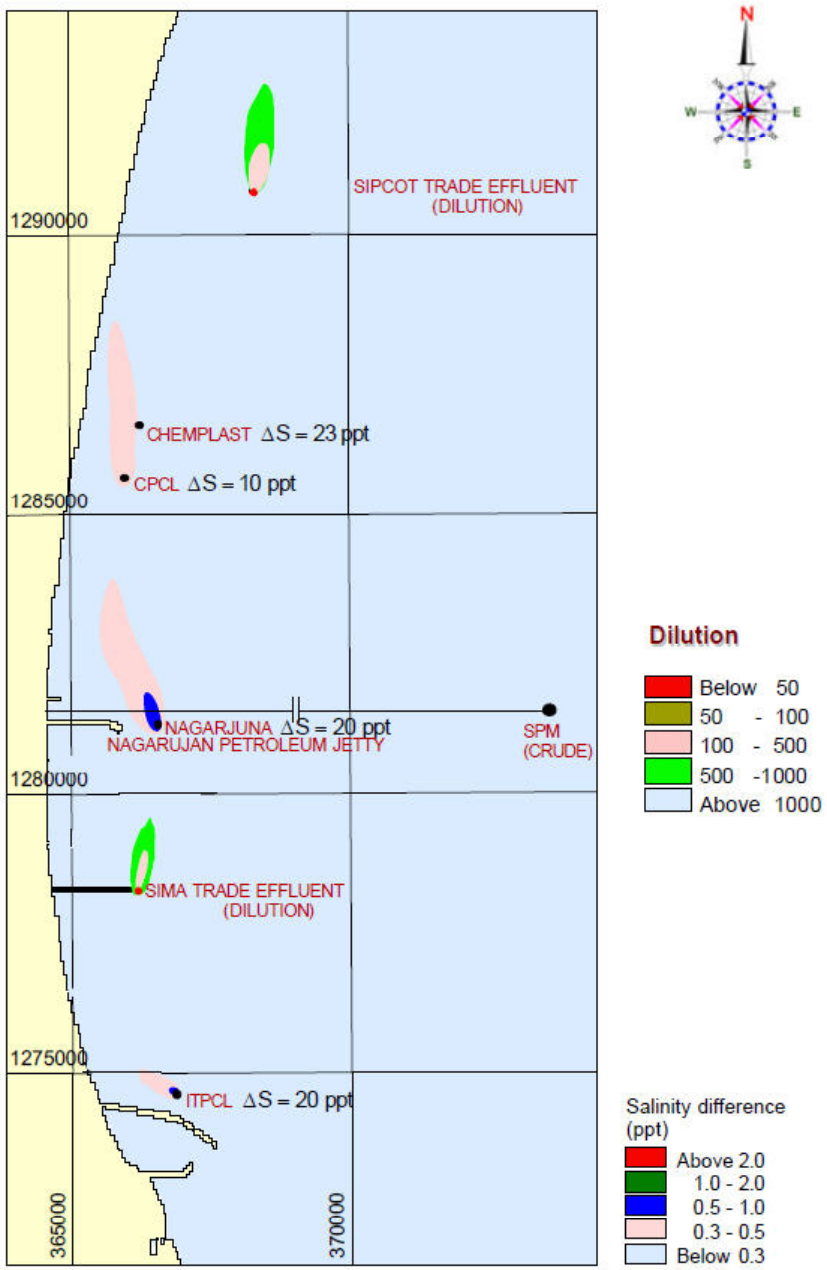


Figure 24: Combined Scenario of Various Discharges in 25 km Radius - Brine – SW Monsoon

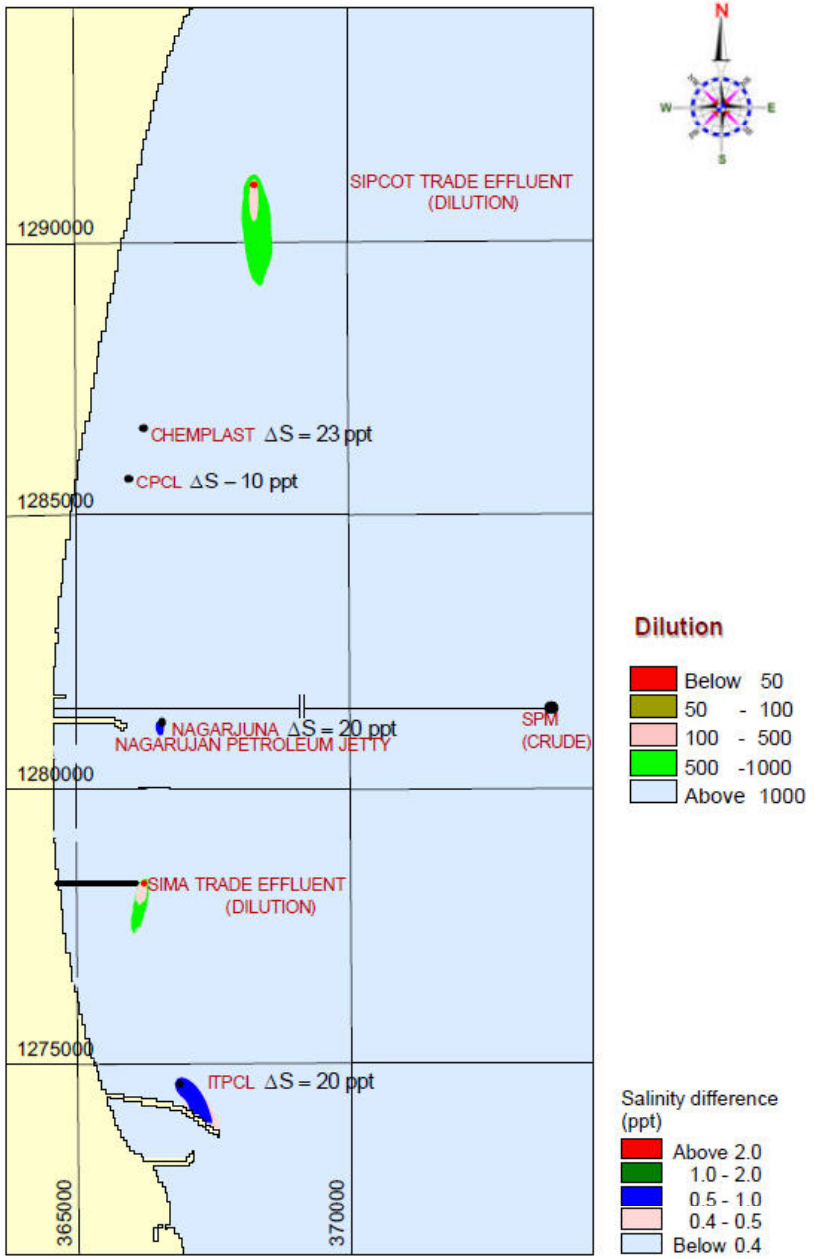


Figure 25: Combined Scenario of Various Discharges in 25 km Radius - Brine – NE Monsoon

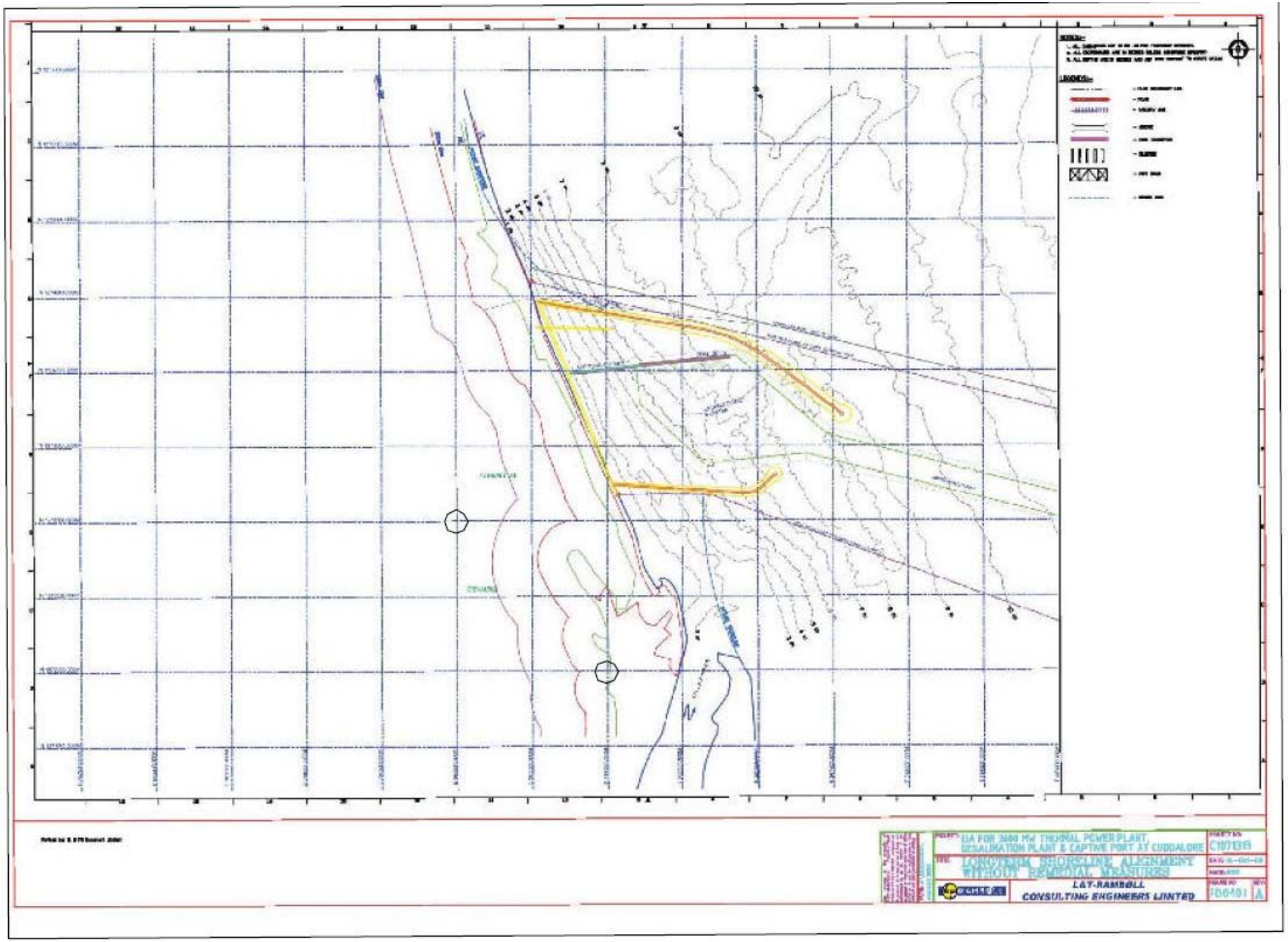


Figure 26: Shoreline changes

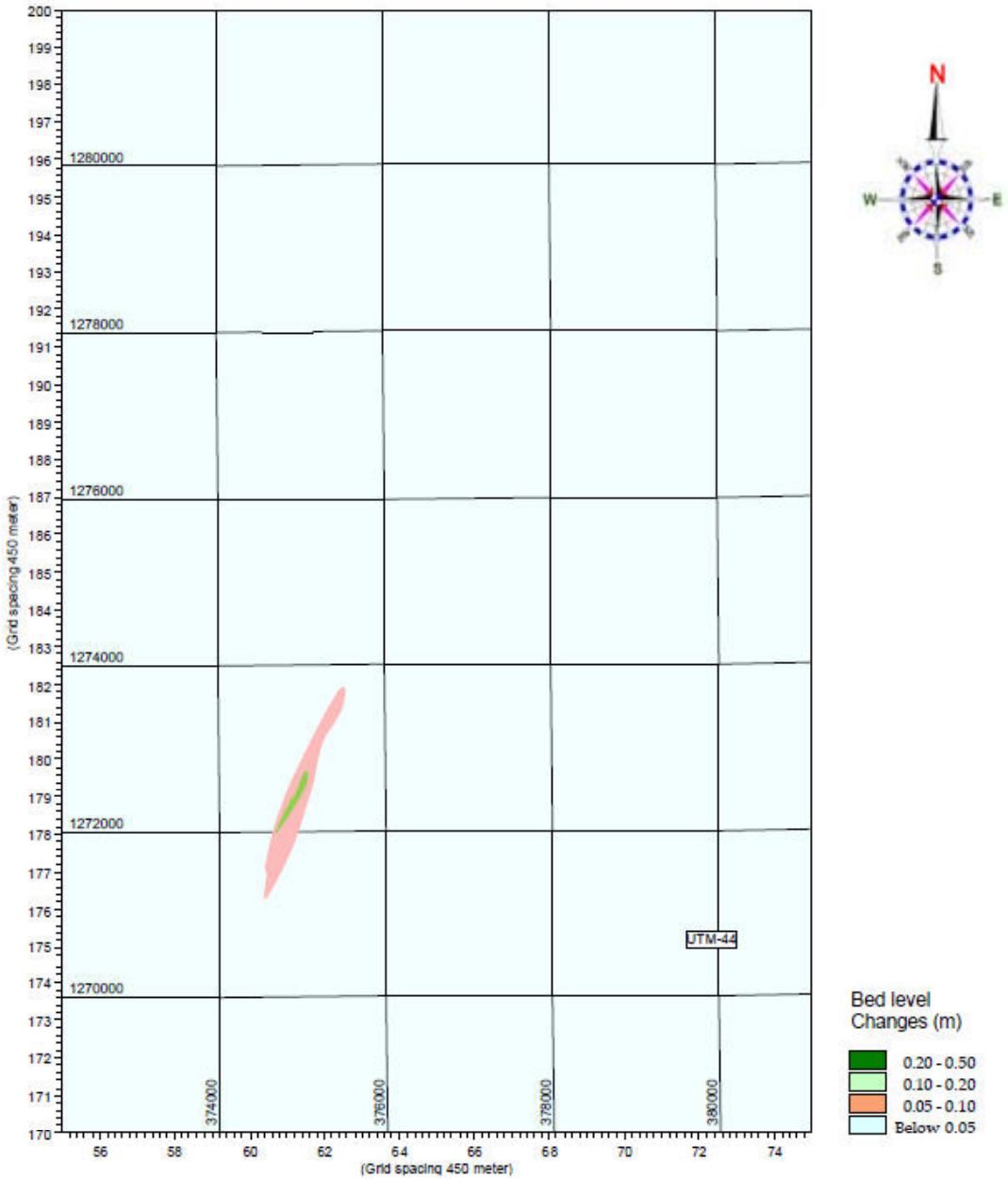


Figure 27: Change in Bed Level in 12 Months

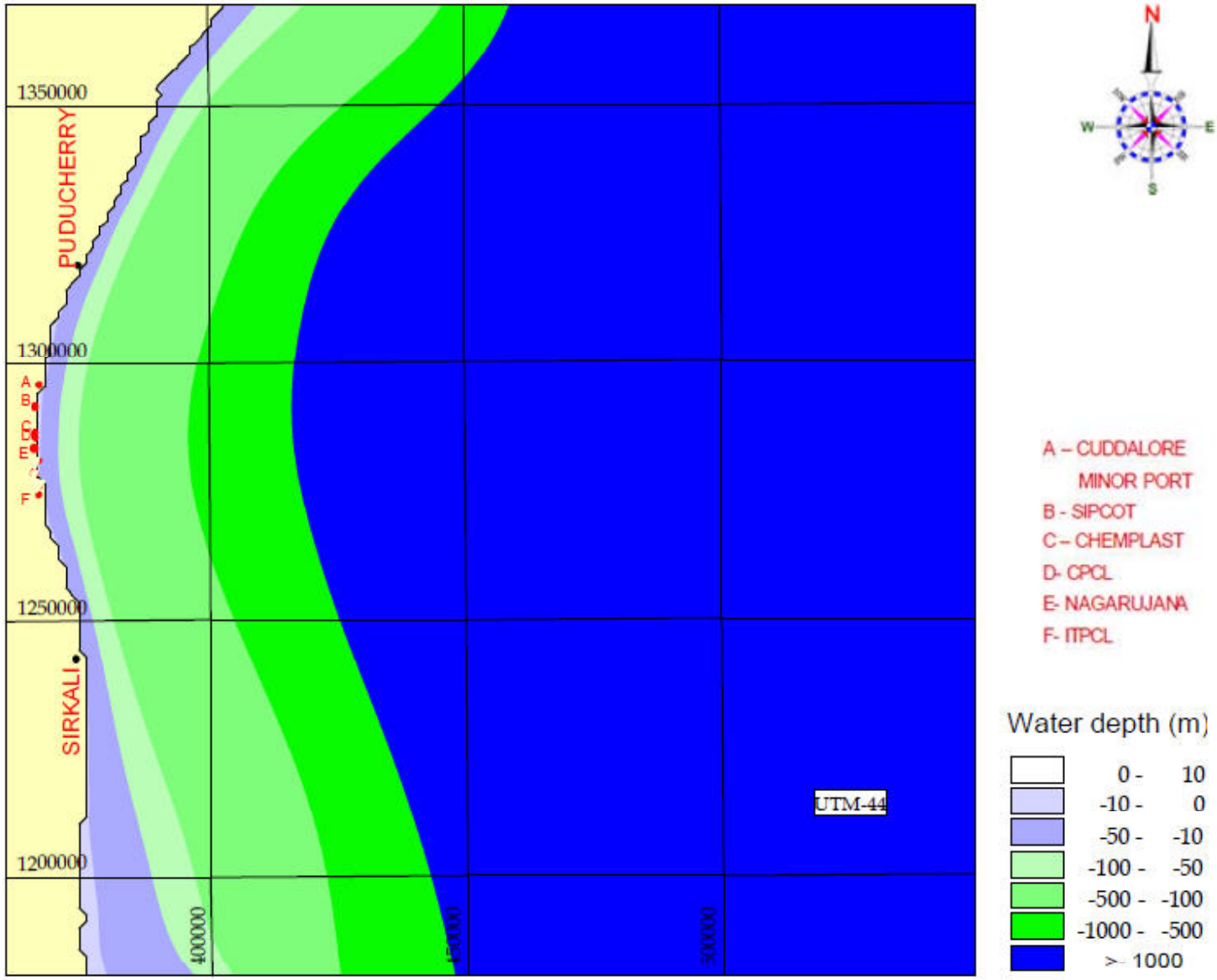


Figure 28: Bathymetry

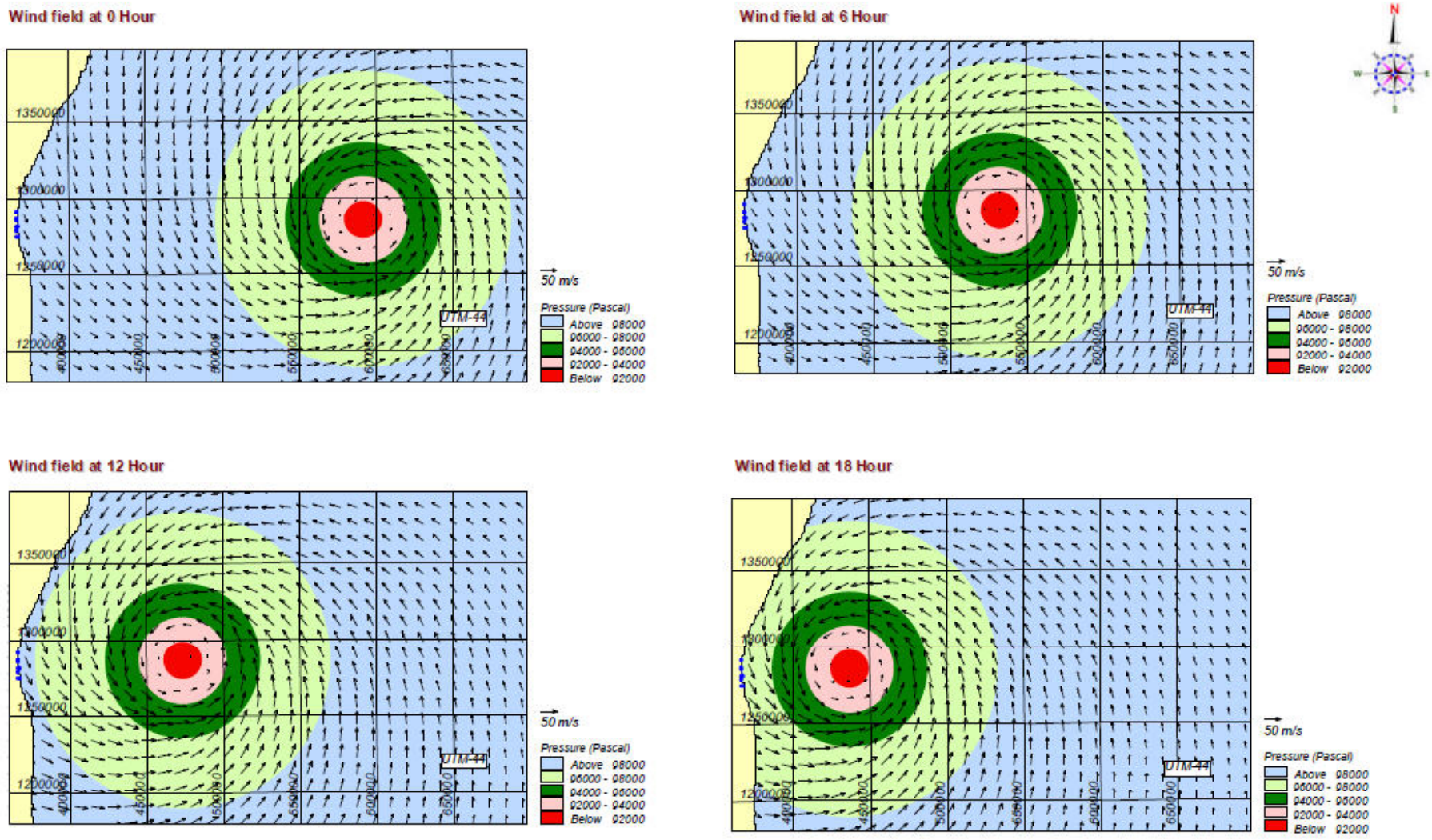


Figure 29: Moving of cyclone with intensity 180Km/hr

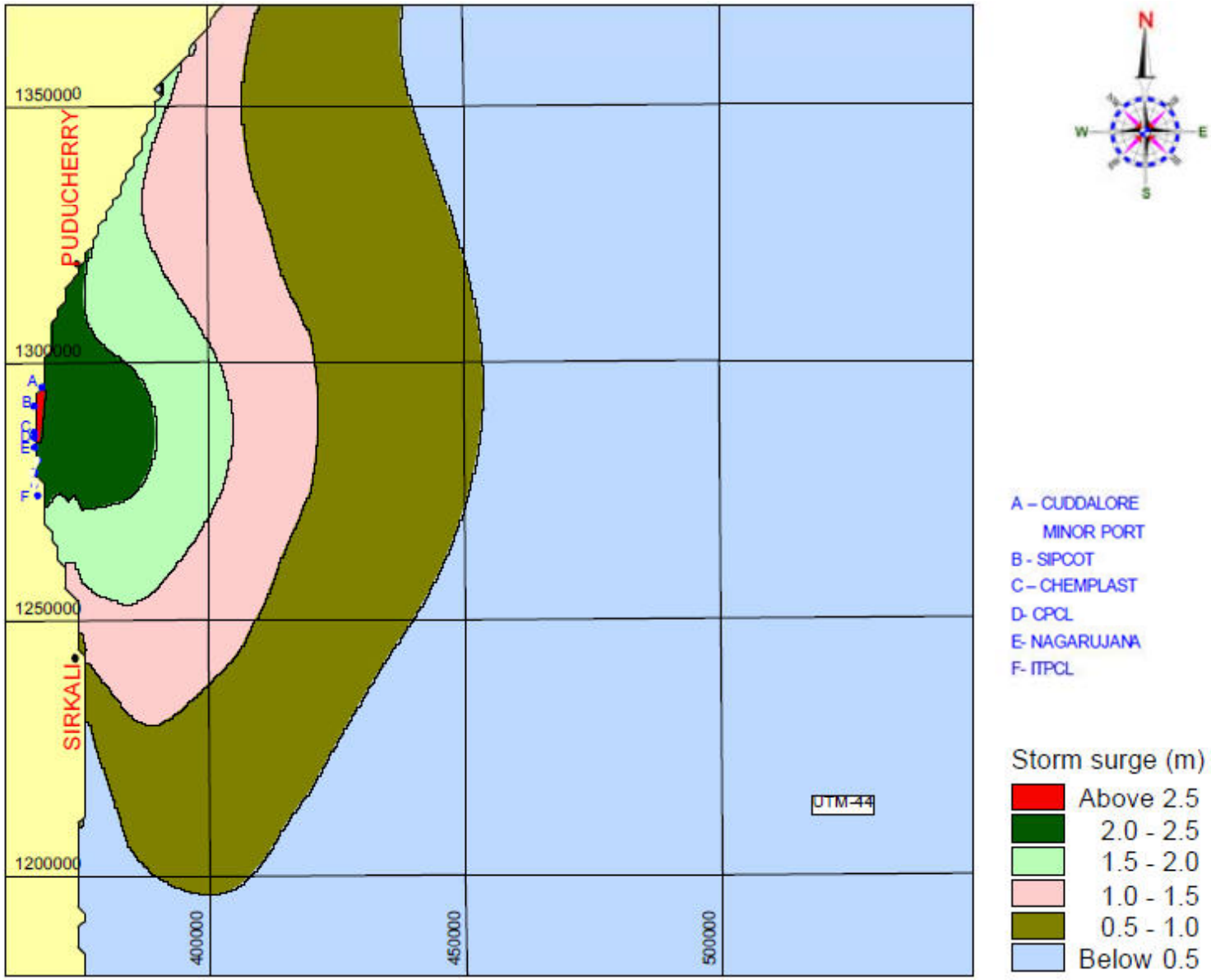


Figure 30: Storm Surge for Wind Speed of 50 m/s (180km/hr)

CHAPTER 7:
CONCLUSIONS

7 Conclusion

The mathematical modelling and assessment of the cumulative marine environmental impact indicates that all the marine impacts from the marine infrastructure and marine wastewater discharges in the study area of 25 km radius around the ITPCL project site cause only localised impacts and likely to minimally affect the overall marine environmental status.

The cumulative air quality impact modelling and assessment indicate that NAAQS 2009/2005 standards are met for PM10, PM2.5, NOx at all 30 receptor locations and at 4 locations the predicted SO_2 concentration exceeds the 24 hour average value by about 10 % only for less than 2% of the modelled period of 3 months, which is in line with the NAAQS 2009 standards.

Based on the mathematical modelling the cumulative air and marine environmental impacts on the Pichavaram Mangroves is expected to be minimal.

The infusion of investment into the area by various projects is expected to provide additional jobs and opportunities for the local populace and is likely to enhance the infrastructure, social and economic fabric of the area. Also, the committed CSR programs by various industries, with special focus on the vulnerable sections including women, fishermen, etc. the infusion of funds is likely to bring about major economic changes in the area.

ANNEXURE 1:
FLORA AND FAUNA SURVEY

ANNEXURE I - FLORA & FAUNA SURVEY

Table-1 List of plant species collected from the project site and its surroundings up to 25 km radius. Mangroves and associates are listed separately. The species found in the core area (ITPCL Project Site) are indicated by *

Family	Scientific name	Remarks
Amaranthaceae	*Alternanthera philoxeroides*	Aquatic
Amaranthaceae	*Alternanthera pungens*	Aquatic
Amaranthaceae	*Alternanthera sessilis* *	Aquatic
Amaranthaceae	*Alternanthera tenella*	Aquatic
Aponogetonaceae	*Aponogeton natans*	Aquatic
Pontederiaceae	*Eichhornia crassipes*	Aquatic
Hydrocharitaceae	*Hydrilla verticillata*	Aquatic
Acanthaceae	*Hygrophila salicifolia*	Aquatic
Convolvulaceae	*Ipomoea aquatica*	Aquatic
Juncaceae	*Juncus effusus*	Aquatic
Lemnaceae	*Lemna gibba*	Aquatic
Scrophulariaceae	*Limnophila heterophylla*	Aquatic
Scrophulariaceae	*Limnophila indica*	Aquatic
Hydrocharitaceae	*Nechamandra alternifolia*	Aquatic
Nelumbonaceae	*Nelumbo nucifera*	Aquatic
Nymphaeaceae	*Nymphaea nouchali*	Aquatic
Nymphaeaceae	*Nymphaea pubescens*	Aquatic
Nymphaeaceae	*Nymphaea rubra*	Aquatic
Hydrocharitaceae	*Ottelia alismoides*	Aquatic
Araceae	*Pistia stratiotes*	Aquatic
Potamogetonaceae	*Potamogeton nodosus*	Aquatic
Alismataceae	*Sagittaria sagittifolia.*	Aquatic
Typhaceae	*Typha angustifolia* *	Aquatic
Hydrocharitaceae	*Vallisneria natans*	Aquatic
Lemnaceae	*Wolffia globosa*	Aquatic
Caesalpiniaceae	*Cassia grandis*	Avenue tree
Caesalpiniaceae	*Cassia siamea*	Avenue tree
Caesalpiniaceae	*Cassia spectabilis*	Avenue tree
Annonaceae	*Polyalthia pendula*	Avenue tree
Annonaceae	*Polyalthia longifolia*	Avenue tree
Fabaceae	*Abrus precatorius* *	Climber
Vitaceae	*Ampelocissus indica*	Climber
Polygonaceae	*Antigonon leptopus*	Climber
Asparagaceae	*Asparagus racemosus*	Climber
Basellaceae	*Basella rubra*	Climber
Cucurbitaceae	*Benincasa hispida*	Climber
Sapindaceae	*Cardiospermum halicacabum* *	Climber
Lauraceae	*Cassytha filiformis*	Climber
Vitaceae	*Cissus quadrangularis* *	Climber
Vitaceae	*Cissus repanda*	Climber
Vitaceae	*Cissus repens*	Climber
Vitaceae	*Cissus vitiginea*	Climber
Cucurbitaceae	*Citrullus colocynthis* *	Climber
Ranunculaceae	*Clematis gouriana*	Climber
Fabaceae	*Clitoria ternatea* *	Climber
Cucurbitaceae	*Coccinia grandis*	Climber

Table-1 List of plant species collected from the project site and its surroundings up to 25 km radius. Mangroves and associates are listed separately. The species found in the core area (ITPCL Project Site) are indicated by *		
Family	**Scientific name**	**Remarks**
Cucurbitaceae	*Cucumis melo*	Climber
Cucurbitaceae	*Cucumis sativus*	Climber
Cucurbitaceae	*Cucurbita maxima* .	Climber
Cucurbitaceae	*Cucurbita pepo*	Climber
Periplocaceae	*Decalepis hamiltonii* *	Climber
Dioscoreaceae	*Dioscorea pentaphylla* *	Climber
Colchicaceae	*Gloriosa superba*	Climber
Periplocaceae	*Hemidesmus indicus* *	Climber
Convolvulaceae	*Ipomoea batatus*	Climber
Convolvulaceae	*Ipomoea cairica*	Climber
Convolvulaceae	*Ipomoea nil*	Climber
Convolvulaceae	*Ipomoea obscura*	Climber
Asclepiadaceae	*Leptadenia reticulata* *	Climber
Cucurbitaceae	*Luffa acutangula*	Climber
Cucurbitaceae	*Luffa cylindrica* .	Climber
Cucurbitaceae	*Momordica charantia*	Climber
Fabaceae	*Mucuna pruriens*	Climber
Passifloraceae	*Passiflora edulis*	Climber
Passifloraceae	*Passiflora foetida*	Climber
Asclepiadaceae	*Pergularia daemia* *	Climber
Solanaceae	*Physalis minima* *	Climber
Piperaceae	*Piper betle*	Climber
Piperaceae	*Piper longum*	Climber
Piperaceae	*Piper nigrum*	Climber
Araceae	*Pothos scandens*	Climber
Combretaceae	*Quisqualis indica*	Climber
Combretaceae	*Quisqualis malabarica*	Climber
Fabaceae	*Rhynchosia minima* *	Climber
Fabaceae	*Rhynchosia rothii*	Climber
Fabaceae	*Rhynchosia suaveolens* *	Climber
Smilacaceae	*Smilax zeylanica*	Climber
Asclepiadaceae	*Tylophora indica* *	Climber
Orchidaceae	*Vanilla planifolia*	Climber
Asclepiadaceae	*Wattakaka volubilis* *	Climber
Orobanchaceae	*Orobanche cernua*	Complete root parasite
Orchidaceae	*Vanda testaceae*	Epiphyte
Orchidaceae	*Vanda wightii*	Epiphyte
Annonaceae	*Annona reticulata*	Fruit tree
Annonaceae	*Annona squamosa*	Fruit tree
Rutaceae	*Citrus aurantium*	Fruit tree
Rutaceae	*Citrus limon*	Fruit tree
Rutaceae	*Citrus maxima*	Fruit tree
Rutaceae	*Citrus medica*	Fruit tree
Rutaceae	*Limonia acidissima*	Fruit tree
Magnoliaceae	*Michelia champaca*	Grown as ornamental
Malvaceae	*Abelmoschus esculentus*	Herb
Malvaceae	*Abelmoschus moschatus* *	Herb
Malvaceae	*Abutilon crispum*	Herb

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Family	**Scientific name**	**Remarks**
Malvaceae	*Abutilon hirtum*	Herb
Malvaceae	*Abutilon indicum* *	Herb
Malvaceae	*Abutilon ramosum*	Herb
Malvaceae	*Abutilon striatum*	Herb
Euphorbiaceae	*Acalypha indica* *.	Herb
Amaranthaceae	*Achyranthes aspera* *	Herb
Amaranthaceae	*Aerva lanata* *	Herb
Fabaceae	*Aeschynomene aspera* *	Herb
Fabaceae	*Aeschynomene indica* *	Herb
Compositae	*Ageratum conyzoides**	Herb
Alliaceae	*Allium cepa*	Herb
Alliaceae	*Allium sativum*	Herb
Fabaceae	*Alysicarpus monilifer* *	Herb
Fabaceae	*Alysicarpus ovalifolius*	Herb
Amaranthaceae	*Amaranthus caudatus*	Herb
Amaranthaceae	*Amaranthus hybridus*	Herb
Amaranthaceae	*Amaranthus spinosus* *	Herb
Amaranthaceae	*Amaranthus tricolor*	Herb
Amaranthaceae	*Amaranthus viridis* *	herb
Lythraceae	*Ammania baccifera* *	Herb
Acanthaceae	*Andrographis echioides* *	Herb
Acanthaceae	*Andrographis neesiana*	Herb
Acanthaceae	*Andrographis paniculata* *	Herb
Fabaceae	*Arachis hypogaea*	Herb
Papaveraceae	*Argemone mexicana* *	Herb
Aristolochiaceae	*Aristolochia indica*	herb
Acanthaceae	*Asystasia gangetica*	Herb
Scrophulariaceae	*Bacopa monnieri* *	Herb
Oxalidaceae	*Biophytum sensitivum* *	Herb
Acanthaceae	*Blepharis repens*	Herb
Compositae	*Blumea hieracifolia*	Herb
Nyctaginaceae	*Boerhavia diffusa* *	herb
Nyctaginaceae	*Boerhavia erecta* *	Herb
Brassicaceae	*Brassica juncea* *	Herb
Brassicaceae	*Brassica nigra*	Herb
Brassicaceae	*Brassica oleracea*	Herb
Compositae	*Calendula officinalis*	Herb
Cannaceae	*Canna indica*	Herb
Solanaceae	*Capsicum annuum*	Herb
Solanaceae	*Capsicum frutescens*	Herb
Amaranthaceae	*Celosia argentea* *	Herb
Amaranthaceae	*Celosia cristata* *	Herb
Anthericaceae	*Chlorophytum tuberosum*	Herb
Euphorbiaceae	*Chrozophora prostrate**	Herb
Euphorbiaceae	*Chrozophora rottleri* *	Herb
Fabaceae	*Cicer arietinum*	Herb
Capparidaceae	*Cleome aspera* *	Herb
Capparidaceae	*Cleome monophylla* *	Herb

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Family	**Scientific name**	**Remarks**
Capparidaceae	*Cleome viscosa* *	Herb
Commelinaceae	*Commelina benghalensis* *	Herb
Commelinaceae	*Commelina erecta* *	herb
Convolvulaceae	*Convolvulus arvensis* *	Herb
Convolvulaceae	*Convolvulus flavus*	Herb
Convolvulaceae	*Convolvulus rottlerianus*	Herb
Compositae	*Conyza stricta* *	Herb
Tiliaceae	*Corchorus aestuans* *	Herb
Tiliaceae	*Corchorus capsularis* *	Herb
Tiliaceae	*Corchorus fascicularis*	Herb
Tiliaceae	*Corchorus trilocularis*	Herb
Convolvulaceae	*Cressa cretica* *	Herb
Amaryllidaceae	*Crinum asiaticum*	Herb
Acanthaceae	*Crossandra infundibuliformis*	Herb
Fabaceae	*Crotalaria evolvuloides* *	Herb
Fabaceae	*Crotalaria fysonii*	Herb
Fabaceae	*Crotalaria heyneana*	Herb
Fabaceae	*Crotalaria hirta* *	Herb
Fabaceae	*Crotalaria juncea* .	Herb
Fabaceae	*Crotalaria linifolia* *.	Herb
Fabaceae	*Crotalaria medicaginea*	Herb
Fabaceae	*Crotalaria obtecta*	Herb
Fabaceae	*Crotalaria pallida*	Herb
Fabaceae	*Crotalaria paniculata* *	Herb
Fabaceae	*Crotalaria peduncularis*	Herb
Fabaceae	*Crotalaria prostrata* *	Herb
Fabaceae	*Crotalaria ramosissima* *	Herb
Fabaceae	*Crotalaria retusa*	Herb
Fabaceae	*Crotalaria verrucosa* *	Herb
Euphorbiaceae	*Croton bonplandianum* *	Herb
Zingiberaceae	*Curcuma longa*	Herb
Fabaceae	*Cyamopsis tetragonoloba*	Herb
Commelinaceae	*Cyanotis adscendens**	Herb
Commelinaceae	*Cyanotis axillaris**	Herb
Commelinaceae	*Cyanotis cristata* *	Herb
Commelinaceae	*Cyanotis tuberosa*	Herb
Solanaceae	*Datura innoxia* *	Herb
Solanaceae	*Datura metal* *	Herb
Fabaceae	*Desmodium ferrugineum*	Herb
Fabaceae	*Desmodium gangeticum* *	Herb
Fabaceae	*Desmodium heterocarpon*	Herb
Fabaceae	*Desmodium triflorum* *.	Herb
Fabaceae	*Desmodium triquetrum*	Herb
Amaranthaceae	*Digera muricata* *	Herb
Scrophulariaceae	*Digitalis purpurea* *	Herb
Compositae	*Eclipta prostrata* *	Herb
Compositae	*Emilia sonchifolia* *.	Herb
Compositae	*Emilia zeylanica*	Herb

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Family	**Scientific name**	**Remarks**
Compositae	*Eupatorium repandum*	Herb
Euphorbiaceae	*Euphorbia chamaesyce* *	Herb
Euphorbiaceae	*Euphorbia hirta* L*	Herb
Euphorbiaceae	*Euphorbia pulcherrima*	Herb
Euphorbiaceae	*Euphorbia serpens* *	Herb
Euphorbiaceae	*Euphorbia thymifolia* *	Herb
Convolvulaceae	*Evolvulus alsinoides* *	Herb
Convolvulaceae	*Evolvulus nummularius*	Herb
Fabaceae	*Glycine max*	Herb
Amaranthaceae	*Gomphrena globosa* *	Herb
Amaranthaceae	*Gomphrena serrata*	Herb
Malvaceae	*Gossypium arboreum*	Herb
Malvaceae	*Gossypium barbadense*	Herb
Malvaceae	*Gossypium herbaceum*	Herb
Capparidaceae	*Gynandropsis gynandra* *	Herb
Compositae	*Helianthus annus*	Herb
Boraginaceae	*Heliotropium curassavicum* *	Herb
Boraginaceae	*Heliotropium indicum**	Herb
Boraginaceae	*Heliotropium marifolium* *	Herb
Boraginaceae	*Heliotropium peruvianum* *	Herb
Malvaceae	*Hibiscus micranthus* *	Herb
Malvaceae	*Hibiscus panduriformis*	Herb
Malvaceae	*Hibiscus platanifolius*	Herb
Malvaceae	*Hibiscus radiatus*	Herb
Balsaminaceae	*Impatiens balsamina*	Herb
Fabaceae	*Indigofera hirsuta* *	Herb
Fabaceae	*Indigofera linifolia* *	Herb
Fabaceae	*Indigofera linnaei* *	Herb
Fabaceae	*Indigofera prostrata* *	Herb
Fabaceae	*Indigofera tinctoria*	Herb
Fabaceae	*Indigofera trita* *	Herb
Convolvulaceae	*Ipomoea alba* *	Herb
Acanthaceae	*Justicia diffusa*	Herb
Acanthaceae	*Justicia procumbens* *	Herb
Acanthaceae	*Justicia prostrata* *	Herb
Acanthaceae	*Justicia simplex* *	Herb
Fabaceae	*Lablab purpureus*	Herb
Compositae	*Lactuca sativa*	Herb
Acanthaceae	*Lepidagathis cristata* *	Herb
Acanthaceae	*Lepidagathis spinosa* *	Herb
Labiatae	*Leucas aspera* *	Herb
Labiatae	*Leucas biflora*	Herb
Labiatae	*Leucas hirta* *	Herb
Labiatae	*Leucas indica*	Herb
Labiatae	*Leucas lamifolia*	Herb
Labiatae	*Leucas prostrata* *	Herb
Onagraceae	*Ludwigia perennis* *	Herb
Onagraceae	*Ludwigia peruviana*	Herb

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Family	**Scientific name**	**Remarks**
Onagraceae	*Ludwigia prostrasta*	Herb
Solanaceae	*Lycopersicon esculentum*	Herb
Malvaceae	*Malachra capitata* *	Herb
Malvaceae	*Malvastrum coromandelianum* *	Herb
Fabaceae	*Medicago sativa*	Herb
Mimosaceae	*Mimosa pudica* *	Herb
Mimosaceae	*Neptunia prostrata* *.	Herb
Mimosaceae	*Neptunia triquetra* *	Herb
Solanaceae	*Nicotiana tabacum*	Herb
Labiatae	*Ocimum americanum*	Herb
Labiatae	*Ocimum basilicum*	Herb
Labiatae	*Ocimum gratissimum* *	Herb
Oxalidaceae	*Oxalis acetosella* *	Herb
Oxalidaceae	*Oxalis corniculata* *	Herb
Oxalidaceae	*Oxalis corymbosa* *	Herb
Compositae	*Parthenium hysterophorus* *	Herb
Malvaceae	*Pavonia procumbens* *	Herb
Malvaceae	*Pavonia zeylanica* *	Herb
Pedaliaceae	*Pedalium murex* *	Herb
Acanthaceae	*Peristrophe paniculata* *	Herb
Fabaceae	*Phaseolus vulgaris*	Herb
Euphorbiaceae	*Phyllanthus amarus* *.	Herb
Urticaceae	*Pilea microphylla* *.	Herb
Fabaceae	*Pisum sativum*	Herb
Plumbaginaceae	*Plumbago zeylanica*	Herb
Caryophyllaceae	*Polycarpaea corymbosa* *	Herb
Polygalaceae	*Polygala arvensis* *	Herb
Polygalaceae	*Polygala chinensis* *	Herb
Polygalaceae	*Polygala elongata* *	Herb
Polygalaceae	*Polygala persicariifolia* *	Herb
Polygalaceae	*Polygala rosmarinifolia* *	Herb
Polygonaceae	*Polygonum dichotomum*	Herb
Polygonaceae	*Polygonum glabrum*	Herb
Portulacaceae	*Portulaca oleracea* *	Herb
Portulacaceae	*Portulaca pilosa* *	Herb
Portulacaceae	*Portulaca quadrifida* *	Herb
Urticaceae	*Pouzolzia bennettiana*	Herb
Brassicaceae	*Raphanus sativus*	Herb
Commelinaceae	*Rhoeo discolor*	Herb
Fabaceae	*Rothia indica* *	Herb
Acanthaceae	*Ruellia tuberosa* *	Herb
Polygonaceae	*Rumex acetosella*	Herb
Acanthaceae	*Rungia repens* *	Herb
Labiatae	*Salvia officinalis*	Herb
Labiatae	*Salvia splendens*	Herb
Dracaenaceae	*Sansevieria roxburghiana* *	Herb
Rubiaceae	*Saprosma corymbosum* *	Herb
Hyacinthaceae	*Scilla hyacinthina* *	Herb

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Family	**Scientific name**	**Remarks**
Scrophulariaceae	*Scoparia dulcis* *	Herb
Compositae	*Senecio cineraria* *	Herb
Compositae	*Senecio tenuifolius*	Herb
Compositae	*Senecio vulgaris*	Herb
Caesalpiniaceae	*Senna alata*	Herb
Caesalpiniaceae	*Senna italica* *	Herb
Caesalpiniaceae	*Senna occidentalis* * (=*Cassia occidentalis)*	Herb
Caesalpiniaceae	*Senna tora* (=*Cassia tora*)	Herb
Pedaliaceae	*Sesamum alatum* *	Herb
Pedaliaceae	*Sesamum indicum*	Herb
Pedaliaceae	*Sesamum prostratum* *	Herb
Fabaceae	*Sesbania procumbens* *	Herb
Malvaceae	*Sida acuta* *	Herb
Malvaceae	*Sida cordata* *	Herb
Malvaceae	*Sida cordifolia* *	Herb
Malvaceae	*Sida rhombifolia* *	Herb
Malvaceae	*Sida spinosa*	Herb
Solanaceae	*Solanum melongena*	Herb
Compositae	*Solidago canadensis* *	Herb
Rubiaceae	*Spermacoce articularis*	Herb
Rubiaceae	*Spermacoce hispida* *	Herb
Compositae	*Sphaeranthus indicus* *	Herb
Fabaceae	*Stylosanthes fruticosa**	Herb
Compositae	*Tagetus erecta*	Herb
Compositae	*Taraxacum officinale* *	Herb
Fabaceae	*Tephrosia spinosa*	Herb
Fabaceae	*Tephrosia purpurea* *	Herb
Fabaceae	*Tephrosia villosa* *	Herb
Malvaceae	*Thespesia populnea*	Herb
Euphorbiaceae	*Tragia involucrata* *	Herb
Boraginaceae	*Trichodesma indicum* *	Herb
Compositae	*Tridax procumbens* *	Herb
Fabaceae	*Trigonella foenum-graecum*	Herb
Tiliaceae	*Triumfetta annua* *	Herb
Tiliaceae	*Triumfetta pentandra*	Herb
Tiliaceae	*Triumfetta pilosa*	Herb
Tiliaceae	*Triumfetta rhomboidea* *	Herb
Hyacinthaceae	*Urginea indica* *	Herb
Urticaceae	*Urtica parviflora*	Herb
Compositae	*Vernonia cinerea* *	Herb
Compositae	*Vernonia conyzoides* *	Herb
Compositae	*Vernonia indica*	Herb
Fabaceae	*Vigna aconitifolia*	Herb
Fabaceae	*Vigna mungo*	Herb
Fabaceae	*Vigna radiata*	Herb
Fabaceae	*Vigna trilobata* *	Herb
Sterculiaceae	*Waltheria indica* *	Herb

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Family	**Scientific name**	**Remarks**
Compositae	*Xanthium indicum*	Herb
Zingiberaceae	*Zingiber officinale*	Herb
Compositae	*Zinnia elegans*	Herb
Fabaceae	*Zornia diphylla* *	Herb
Fabaceae	*Zornia gibbosa* *	Herb
Lentibulariaceae	*Utricularia reticulata*	Insectivorous plant
Arecaceae	*Areca catechu*	Palm
Arecaceae	*Borassus flabellifer*	Palm
Arecaceae	*Caryota urens*	Palm
Arecaceae	*Cocos nucifera*	Palm
Arecaceae	*Livistona chinensis*	Palm
Arecaceae	*Phoenix loureirii*	Palm
Arecaceae	*Phoenix sylvestris*	Palm
Scrophulariaceae	*Striga asiatica* *	Partial root parasite
Scrophulariaceae	*Striga densiflora*	Partial root parasite
Convolvulaceae	*Cuscuta chinensis*	Partial stem parasite
Convolvulaceae	*Cuscuta reflexa*	Partial stem parasite
Loranthaceae	*Dendrophthoe falcata*	Partial stem parasite
Viscaceae	*Viscum articulatum*	Partial stem parasite
Caesalpiniaceae	*Saraca asoca*	Rarely grown
Convolvulaceae	*Ipomoea pes-tigridis* *	Runner
Convolvulaceae	*Ipomoea purpurea* *	Runner
Convolvulaceae	*Merremia emarginat*a*	Runner
Convolvulaceae	*Ipomoea pes-caprae* *	Sand binder
Agavaceae	*Agave americana*	Shrub
Agavaceae	*Agave angustifolia*	Shrub
Asphodelaceae	*Aloe vera*	Shrub
Labiatae	*Anisomeles indica* *	Shrub
Labiatae	*Anisomeles malabarica*	Shrub
Asclepiadaceae	*Asclepias curassavica*	Shrub
Rutaceae	*Atalantia monophylla*	Shrub
Salvadoraceae	*Azima tetracantha* *	Shrub
Acanthaceae	*Barleria cristata*	Shrub
Acanthaceae	*Barleria prionitis*	Shrub
Euphorbiaceae	*Breynia retusa* *	Shrub
Euphorbiaceae	*Breynia vitis-idaea**	Shrub
Caesalpiniaceae	*Caesalpinia bonduc*	Shrub
Caesalpiniaceae	*Caesalpinia pulcherrima*	Shrub
Fabaceae	*Cajanus cajan*	Shrub
Asclepiadaceae	*Calotropis gigantea* *	Shrub
Asclepiadaceae	*Calotropis procera* *	Shrub
Capparidaceae	*Capparis decidua* *	Shrub
Capparidaceae	*Capparis divaricata*	Shrub
Apocynaceae	*Carissa carandas*	Shrub
Apocynaceae	*Carissa spinarum**	Shrub
Celastraceae	*Celastrus paniculatus* *	Shrub
Solanaceae	*Cestrum nocturnum*	Shrub
Compositae	*Chromolaena odorata**	Shrub

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Family	**Scientific name**	**Remarks**
Verbenaceae	*Clerodendrum indicum*	Shrub
Verbenaceae	*Clerodendrum inerme*	Shrub
Verbenaceae	*Clerodendrum phlomidis*	Shrub
Ebenaceae	*Diospyros chloroxylon* *	Shrub
Ebenaceae	*Diospyros melanoxylon*	Shrub
Sapindaceae	*Dodonaea viscosa* *	Shrub
Verbenaceae	*Duranta erecta*	Shrub
Erythroxylaceae	*Erythroxylum monogynum*	Shrub
Euphorbiaceae	*Euphorbia antiquorum*	Shrub
Euphorbiaceae	*Euphorbia tirucalli*	Shrub
Tiliaceae	*Grewia hirsuta*	Shrub
Malvaceae	*Hibiscus rosa-sinensis*	Shrub
Convolvulaceae	*Ipomoea carnea* *	Shrub
Oleaceae	*Jasminum angustifolium*	Shrub
Oleaceae	*Jasminum sambac*	Shrub
Euphorbiaceae	*Jatropha curcas* *	Shrub
Euphorbiaceae	*Jatropha glandulifera* *	Shrub
Euphorbiaceae	*Jatropha gossypifolia* *	Shrub
Verbenaceae	*Lantana camara* *	Shrub
Celastraceae	*Maytenus emarginata* *	Shrub
Rubiaceae	*Morinda pubescens*	Shrub
Rutaceae	*Murraya koenigii*	Shrub
Rutaceae	*Murraya paniculata*	Shrub
Rubiaceae	*Mussaenda frondosa*	Shrub
Apocynaceae	*Nerium oleander*	Shrub
Rubiaceae	*Pavetta indica*	Shrub
Euphorbiaceae	*Phyllanthus reticulatus*	Shrub
Labiatae	*Plectranthus barbatus*	Shrub
Labiatae	*Plectranthus rotundifolius*	Shrub
Punicaceae	*Punica granatum*	Shrub
Apocynaceae	*Rauvolfia serpentina*	Shrub
Apocynaceae	*Rauvolfia tetraphylla*	Shrub
Rhamnaceae	*Rhamnus cathartica*	Shrub
Fabaceae	*Sesbania bispinosa*	Shrub
Solanaceae	*Solanum torvum* *	Shrub
Apocynaceae	*Tabernaemontana divaricata*	Shrub
Rubiaceae	*Tamilnadia ulginosa*	Shrub
Rubiaceae	*Tarenna asiatica*	Shrub
Verbenaceae	*Vitex negundo* *	Shrub
Verbenaceae	*Vitex trifolia*	Shrub
Solanaceae	*Withania somnifera*	Shrub
Apocynaceae	*Wrightia tinctoria*	Shrub
Agavaceae	*Yucca gloriosa*	Shrub
Rhamnaceae	*Ziziphus horrida* *	Shrub
Rhamnaceae	*Ziziphus mauritiana*	Shrub
Rhamnaceae	*Ziziphus nummularia*	Shrub
Rhamnaceae	*Ziziphus oenoplia*	Shrub
Rhamnaceae	*Ziziphus rugosa* *	Shrub

Table-1 List of plant species collected from the project site and its surroundings up to 25 km radius. Mangroves and associates are listed separately. The species found in the core area (ITPCL Project Site) are indicated by *		
Family	**Scientific name**	**Remarks**
Rhamnaceae	*Ziziphus xylopyrus*	Shrub
Bixaceae	*Bixa orellana*	Small tree
Cactaceae	*Cereus pterogonus*	Succulent
Cactaceae	*Opuntia elatior*	Succulent
Asclepiadaceae	*Caralluma adscendens*	Succulent herb
Asclepiadaceae	*Caralluma umbellata*	Succulent herb
Crassulaceae	*Kalanchoe grandiflora*	Succulent herb
Crassulaceae	*Kalanchoe lanceolata*	Succulent herb
Mimosaceae	*Acacia auriculiformis* .	Tree
Mimosaceae	*Acacia caesia*	Tree
Mimosaceae	*Acacia catechu*	Tree
Mimosaceae	*Acacia chundra*	Tree
Mimosaceae	*Acacia confusa*	Tree
Mimosaceae	*Acacia decurrens*	Tree
Mimosaceae	*Acacia eburnea*	Tree
Mimosaceae	*Acacia elata*	Tree
Mimosaceae	*Acacia farnesiana* .	Tree
Mimosaceae	*Acacia ferruginea*	Tree
Mimosaceae	*Acacia holosericea*	Tree
Mimosaceae	*Acacia horrida*	Tree
Mimosaceae	*Acacia leucophloea*.	Tree
Mimosaceae	*Acacia melanoxylon*	Tree
Mimosaceae	*Acacia nilotica*	Tree
Mimosaceae	*Acacia planifrons*	Tree
Mimosaceae	*Acacia tomentosa*	Tree
Mimosaceae	*Acacia torta*	Tree
Rutaceae	*Aegle marmelos*	Tree
Simaroubaceae	*Ailanthus excelsa*	Tree
Mimosaceae	*Albizia amara*	Tree
Mimosaceae	*Albizia lebbeck*	Tree
Mimosaceae	*Albizia odoratissima*	Tree
Mimosaceae	*Albizia procera*	Tree
Apocynaceae	*Alstonia scholaris*	Tree
Anacardiaceae	*Anacardium occidentale* *.	Tree
Moraceae	*Artocarpus heterophyllus*	Tree
Meliaceae	*Azadirachta indica*	Tree
Barringtoniaceae	*Barringtonia acutangula* *	Tree
Barringtoniaceae	*Barringtonia asiatica*	Tree
Barringtoniaceae	*Barringtonia racemosa*	Tree
Caesalpiniaceae	*Bauhinia purpurea*	Tree
Caesalpiniaceae	*Bauhinia racemosa*.	Tree
Bombacaceae	*Bombax ceiba*	Tree
Burseraceae	*Boswellia serrata*	Tree
Fabaceae	*Butea monosperma*	Tree
Myrtaceae	*Callistemon citrinus*	Tree
Clusiaceae	*Calophyllum inophyllum*	Tree
Capparidaceae	*Capparis grandis*	Tree
Caesalpiniaceae	*Cassia fistula*	Tree

Table-1 List of plant species collected from the project site and its surroundings up to 25 km radius. Mangroves and associates are listed separately. The species found in the core area (ITPCL Project Site) are indicated by *		
Family	**Scientific name**	**Remarks**
Caesalpiniaceae	*Cassia javanica*	Tree
Casuarinaceae	*Casuarina equisetifolia* *	Tree
Euphorbiaceae	*Cleistanthus collinus*	Tree
Boraginaceae	*Cordia domestica*	Tree
Lecythidaceae	*Couroupita guianensis*	Tree
Fabaceae	*Dalbergia melanoxylon*	Tree
Fabaceae	*Dalbergia sissoo*	Tree
Caesalpiniaceae	*Delonix elata*	Tree
Caesalpiniaceae	*Delonix regia*	Tree
Dilleniaceae	*Dillenia indica*	Tree
Dipterocarpaceae	*Dipterocarpus indicus*	Tree
Bignoniaceae	*Dolichandrone falcata*	Tree
Fabaceae	*Erythrina suberosa*	Tree
Fabaceae	*Erythrina variegata*	Tree
Myrtaceae	*Eucalyptus camaldulensis*	Tree
Myrtaceae	*Eucalyptus globulus*	Tree
Myrtaceae	*Eucalyptus grandis*	Tree
Myrtaceae	*Eucalyptus tereticornis*	Tree
Myrtaceae	*Eugenia indica*	Tree
Moraceae	*Ficus amplissima*	Tree
Moraceae	*Ficus arnottiana*	Tree
Moraceae	*Ficus benghalensis*	Tree
Moraceae	*Ficus carica*	Tree
Moraceae	*Ficus elastica*	Tree
Moraceae	*Ficus hispida*	Tree
Moraceae	*Ficus microcarpa*	Tree
Moraceae	*Ficus mollis*	Tree
Moraceae	*Ficus nervosa*	Tree
Moraceae	*Ficus racemosa*	Tree
Moraceae	*Ficus religiosa*	Tree
Fabaceae	*Gliricidia sepium* *	Tree
Verbenaceae	*Gmelina arborea*	Tree
Verbenaceae	*Gmelina asiatica*	Tree
Proteaceae	*Grevillea robusta*	Tree
Caesalpiniaceae	*Hardwickia binata*	Tree
Bignoniaceae	*Jacaranda mimosifolia*	Tree
Bignoniaceae	*Kigelia africana*	Tree
Lythraceae	*Lagerstroemia indica*	Tree
Lythraceae	*Lagerstroemia parviflora*	Tree
Mimosaceae	*Leucaena leucocephala*	Tree
Sapotaceae	*Madhuca indica*	Tree
Sapotaceae	*Madhuca longifolia*	Tree
Anacardiaceae	*Mangifera indica*	Tree
Sapotaceae	*Manilkara hexandra*	Tree
Sapotaceae	*Manilkara zapota*	Tree
Meliaceae	*Melia azedarach*	Tree
Melastomataceae	*Memecylon edule* *	Tree
Melastomataceae	*Memecylon heyneanum* *	Tree

Table-1 List of plant species collected from the project site and its surroundings up to 25 km radius. Mangroves and associates are listed separately. The species found in the core area (ITPCL Project Site) are indicated by *		
Family	**Scientific name**	**Remarks**
Melastomataceae	*Memecylon umbellatum* *	Tree
Bignoniaceae	*Millingtonia hortensis*	Tree
Sapotaceae	*Mimusops elengi*.	Tree
Moringaceae	*Moringa concanensis*	Tree
Moringaceae	*Moringa pterygosperma*	Tree
Moraceae	*Morus alba*	Tree
Tiliaceae	*Muntingia calabura*	Tree
Nyctanthaceae	*Nyctanthes arbor-tristis*	Tree
Caesalpiniaceae	*Parkinsonia aculeata*	Tree
Caesalpiniaceae	*Peltophorum pterocarpum*	Tree
Euphorbiaceae	*Phyllanthus emblica*	Tree
Mimosaceae	*Pithecellobium dulce* *	Tree
Apocynaceae	*Plumeria obtusa*	Tree
Apocynaceae	*Plumeria rubra*	Tree
Fabaceae	*Pongamia pinnata*	Tree
Mimosaceae	*Prosopis cineraria* *	Tree
Mimosaceae	*Prosopis juliflora* *	Tree
Myrtaceae	*Psidium guajava*	Tree
Salvadoraceae	*Salvadora persica**	Tree
Sapindaceae	*Sapindus emarginatus*	Tree
Sapindaceae	*Sapindus trifoliata*	Tree
Anacardiaceae	*Semecarpus anacardium*	Tree
Fabaceae	*Sesbania grandiflora*	Tree
Bignoniaceae	*Spathodea campanulata*	Tree
Sterculiaceae	*Sterculia urens*	Tree
Moraceae	*Streblus asper*	Tree
Moraceae	*Streblus taxoides*	Tree
Myrtaceae	*Syzygium cumini*	Tree
Caesalpiniaceae	*Tamarindus indica*	Tree
Tamaricaceae	*Tamarix aphylla* *	Tree
Tamaricaceae	*Tamarix indica*	Tree
Bignoniaceae	*Tecoma stans*	Tree
Verbenaceae	*Tectona grandis*	Tree
Combretaceae	*Terminalia bellirica*	Tree
Combretaceae	*Terminalia catappa*	Tree
Combretaceae	*Terminalia chebula*	Tree
Combretaceae	*Terminalia paniculata*	Tree
Caricaceae	*Carica papaya*	Tree like
Musaceae	*Musa parasidiaca*	Tree like
Pandanaceae	*Pandanus odoratissimus*	Tree like
Musaceae	*Ravenala madagascarensis*	Tree like
Convolvulaceae	*Merremia tridentate**	Twiner
Casuarinacae	*Casurina equiselifolia*	Tree
Anacardiacae	Anacardium occidentale	Tree
Malvacae	Hibiscus rosasinensis	Flowering Shrub
Bambusae	*Bambusa tulda*	Tree like
Asteracae	*Lantana camara*	Flowering shrub
Euphorbiacae	*Eupborbia antiquantum*	Shrub

Table-1 List of plant species collected from the project site and its surroundings up to 25 km radius. Mangroves and associates are listed separately. The species found in the core area (ITPCL Project Site) are indicated by *		
Family	**Scientific name**	**Remarks**
Caricacae	*Carica papaya*	Tree like
Malvacae	*Thespesia populnea*	Shrub
Apocynacae	Calotropis gigantea	Flowering Herb
Fabacae	*Bauhinia blakeana*	Flowering Tree
Fabacae	*Tamarindus indicus*	Tree
Apocynacae	*Nerium oleander*	Flowering Tree Like Shrub
Asteracae	*Tridax procumbans*	Flowering Herb
Myrtacae	*Pisidium guajava*	Fruit Tree
Rosacae	*Prunus dulcis*	Almond tree
Oleacae	*Jasminium sp*	Flowering plant
Euphorbiacae	*Jatropha indica*	Herb

Table-2 Checklist of graminoids found in the study area. They are found mainly in the buffer area. Those present in the core area (ITPCL Project Site) are indicated by *	
FAMILY	**SCIENTIFIC NAME**
Cyperaceae	*Bulbostylis barbata* *
Cyperaceae	*Bulbostylis densa*
Cyperaceae	*Carex longipes*
Cyperaceae	*Carex speciosa*
Cyperaceae	*Cyperus alopecuroides*
Cyperaceae	*Cyperus arenarius* *
Cyperaceae	*Cyperus articulatus* *
Cyperaceae	*Cyperus bulbosus* *
Cyperaceae	*Cyperus compressus* *
Cyperaceae	*Cyperus corymbosus* *
Cyperaceae	*Cyperus diffusus*
Cyperaceae	*Cyperus iria* *
Cyperaceae	*Cyperus pilosus*
Cyperaceae	*Cyperus rotundus*
Cyperaceae	*Cyperus stoloniferous* *
Cyperaceae	*Fimbristylis cymosa*
Cyperaceae	*Fimbristylis squarrosa* *
Cyperaceae	*Kylinga brevifolius*
Cyperaceae	*Kylinga bulbosa* *
Cyperaceae	*Schoenoplectus articulatus*
Cyperaceae	*Scirpus maritimus* *
Poaceae	*Aeluropus lagopoides* *
Poaceae	*Agrostis micrantha*
Poaceae	*Agrostis peninsularis*
Poaceae	*Agrostis stolonifera* *
Poaceae	*Apluda mutica*
Poaceae	*Aristida funiculata*
Poaceae	*Aristida hystrix*
Poaceae	*Aristida setacea*
Poaceae	*Arthraxon depressus*
Poaceae	*Arundinella ciliata* *
Poaceae	*Arundinella purpurea* *
Poaceae	*Arundo donax*
Poaceae	*Bothriochloa pertusa* *
Poaceae	*Brachiaria distachya*
Poaceae	*Brachiaria mutica*
Poaceae	*Brachiaria ramosa* *
Poaceae	*Brachiaria remota*
Poaceae	*Brachiaria reptans* *
Poaceae	*Cenchrus ciliaris* *
Poaceae	*Cenchrus setigerus* *
Poaceae	*Chloris barbata* *
Poaceae	*Chloris gayana* *
Poaceae	*Chrysopogon fulvus* *
Poaceae	*Cymbopogon caesius*
Poaceae	*Cymbopogon coloratus*
Poaceae	*Cymbopogon flexuosus*
Poaceae	*Cynodon dactylon* *
Poaceae	*Dactyloctenium aegyptium* *

Table-2 Checklist of graminoids found in the study area. They are found mainly in the buffer area. Those present in the core area (ITPCL Project Site) are indicated by *	
FAMILY	**SCIENTIFIC NAME**
Poaceae	*Dendrocalamus strictus*
Poaceae	*Dichanthium annulatum* *
Poaceae	*Digitaria ciliaris* *
Poaceae	*Dinebra retroflexa**
Poaceae	*Echinochloa colona* *
Poaceae	*Echinochloa crus - galli* *
Poaceae	*Eleusine coracana*
Poaceae	*Eleusine indica*
Poaceae	*Eragrostis ciliaris* *
Poaceae	*Eragrostis coarctata*
Poaceae	*Eragrostis maderaspatana*
Poaceae	*Eragrostis minor*
Poaceae	*Eragrostis tenella* *
Poaceae	*Eragrostis viscosa* *
Poaceae	*Eremopogon foveolatus*
Poaceae	*Heteropogon contortus*
Poaceae	*Imperata cylindrica* *
Poaceae	*Ischaemum indicum*
Poaceae	*Iseilema laxum* *
Poaceae	*Iseilema prostratum*
Poaceae	*Leptochloa chinensis* *
Poaceae	*Oryza sativa*
Poaceae	*Panicum antidotale*
Poaceae	*Panicum brevifolium*
Poaceae	*Panicum maximum*
Poaceae	*Panicum miliaceum*
Poaceae	*Panicum psilopodium* *
Poaceae	*Panicum repens*
Poaceae	*Panicum trypheron* *
Poaceae	*Paspalum scrobiculatum*
Poaceae	*Pennisetum purpureum*
Poaceae	*Pennisetum villosum*
Poaceae	*Perotis indica* *
Poaceae	*Phragmites karka*
Poaceae	*Saccharum officinarum*
Poaceae	*Saccharum spontaneum* *
Poaceae	*Sehima nervosum*
Poaceae	*Setaria italica*
Poaceae	*Spinifex littoreus.**
Poaceae	*Sporobolus indicus*
Poaceae	*Sporobolus maderaspatanus*
Poaceae	*Tragus roxburghii* *
Poaceae	*Urochloa panicoides* *
Poaceae	*Zea mays*

Table-3 Checklist of Mangroves and Halophytes found in the Study Area		
S.No	**Scientific name**	**Family**
1	*Acanthus ilicifolius*	Acanthaceae
2	*Aegiceras corniculatum*	Mrysinaceae
3	*Avicennia alba*	Avicenniaceae*
4	*Avicennia marina*	Avicenniaceae*
5	*Avicennia officinalis*	Avicenniaceae*
6	*Bruguiera cylindrica*	Rhizophoraceae*
7	*Bruguiera gymnorrhiza*	Rhizophoraceae*
8	*Ceriops decandra*	Rhizophoraceae*
9	*Ceriops tagal*	Rhizophoraceae*
10	*Dalbergia spinosa*	Fabaceae
11	*Excoecaria agallocha*	Euphorbiaceae*
12	*Heritiera littoralis*	Sterculiaceae
13	*Kandelia candel*	Rhizophoraceae*
14	*Lumnitzera racemosa*	Combretaceae
15	*Myriostachya wightiana*	Poaceae
16	*Rhizophora annamalayana*	Rhizophoraceae*
17	*Rhizophora apiculata*	Rhizophoraceae*
18	*Rhizophora mucronata*	Rhizophoraceae*
19	*Scyphiphora hydrophyllacea*	Rubiaceae
20	*Sonneratia apetala*	Sonneratiaceae*
21	*Xylocarpus granatum*	Meliaceae

*= True Mangroves

Table-4 Checklist of Amphibians recorded or reported from the study area			
Order	**Species**	**Common Name**	**Remarks**
Anura	Bufo fergusonii	Boulenger's Burrowing Toad	Common
Anura	Bufo melanosticus	Common Indian Toad	Common
Anura	Microhyla rubra	Red Microhylid	Common
Anura	Kaloula pulchra	Narrow- Mouthed Frogs	Common
Anura	Melanobatrachus indicus	Black Microhylid Frog	Common
Anura	Rana leithii	Boulenger's brown Frog	-
Anura	Tomopterna dobsonii	Dobson's Burrowing Frog	Common
Anura	Rana(Tomopterna) rolandae	Southern Burrowing Frog	Rare
Anura	Philautus elegans	Elegant bash Frog	Common
Anura	Polypedatus maculatus	Common Tree Frog	Common
Anura	*Euphlyctis cyanophlyctics*	Indian Skipper frog	none
Anura	*Tomopterma breviceps*	Tree frog	none
Anura	*Polypedates maculates*	Indian Tree frog	none
Anura	*Hoplobatrachus tigerinus*	Indian bull frog	none
Anura	*Hemidactylus leschenaultia*	House gecko	none

Table -5 Checklist of reptiles reported or recorded form the study area			
Order	**Species**	**Common Name**	**Remarks**
Squamata	*Cyrtodactylus nebulosus*	Andhra Rock Gecko	
Squamata	*Cyrtodactylus colleglensis*	South Indian Rock Gecko	Common
Squamata	*Hemidactylus leschenaulti*	Bark Gecko	Common
Squamata	*Hemidactylus brooki*	Brook's Gecko	Common
Squamata	*Hemidactylus frenatus*	Smooth House Gecko	Common
Squamata	*Hemidactylus giganteus*	Giant Tree Gecko	Common
Squamata	*Eublepharis hardwickii*	Common Fat tailed Gecko	-
Squamata	*Calotes versicolor*	Indian Garden Lizard	Very Common
Squamata	*Ophisops jerdoni*	Punjab snake eyed lacerta	Least Concern(LC)#
Squamata	*Ophisops beddomii*	Beddoms snake eyed lacerta	Least Concerned
Squamata	*Eryx conicus*	Common Sand Boa	Least Concerned
Squamata	*Eryx johni*	Red Sand Boa	Least Concerned
Squamata	*Lycodon aulicus*	Common Wolf Snake or Kattuvirian	Least Concerned
Squamata	*Lycodon striatus*	Shaw's Wolf snake	Least Concerned
Squamata	*Macropisthodon plumbicolor*	Pachai Nagam	Common
Squamata	*Liopeltis calamaria*	_	
Squamata	*Ptyas mucosus*	Common Rat snake	Least Concerned
Squamata	*Argyrogena fasciolatus*	Banded Racer	
Squamata	*Dendrelaphis tristis*	Bronze- back Tree Snake or Komberi mooken	Common
Squamata	*Chrysopelea ornata*	Flying Snake	
Squamata	*Psammophis condanarus*	Condanarous sandsnake	
Squamata	*Elaphe Helena*	Trinket Snake	Common
Squamata	*Boiga forsteni*	_	
Squamata	*Enhydris seiboldi*	_	
Squamata	*Bungarus caeruleus*	Krait or Kattu virian	Least Concerned
Squamata	*Calliophis melanurus*	_	
Squamata	*Naja naja naja*	Common Cobra or Naga pamboo	Very Common
Squamata	*Ophiophagus hannah*	Karunagam or King Cobra	Least Concerned
Testudina	*Geochelone elegans*	Star Tortoise	Least Concerned
Squamata	*Boiga dendrophila*	Cat snake	none
Squamata	*Nerodia piscator*	*Fresh water snake*	*Sch-III*

 # As per IUCN

Table-6 List of birds recorded or reported from the study area			
Order	**Species**	**Common Name**	**Remarks**
Passeriformes	*Passer domesticus*	House Sparrow	Common
Passeriformes	*Petronia xanthocollis*	Yellow throated Sparrow	Common
Passeriformes	*Corvus splendens*	House Crow	Common
Passeriformes	*Corvus macrorhynchos*	Jungle Crow	Common
Passeriformes	*Turdoides affinis*	White headed Babbler	Common
Passeriformes	*Copsychus saularis*	Oriental Robin	Common
Passeriformes	*Tersiphone paradisi*	Asian Paradise Flycatcher	LC[#]
Passeriformes	*Acrocephalus dumetorum*	Blyth's Reed Warbler	LC
Passeriformes	*Acrocephalus agricola*	Paddy Field Warbler	LC
Passeriformes	*Acrocephalus stentoreus*	Indian Great Reed Warbler	LC
Passeriformes	*Hippolais caligata*	Booted Warbler	LC
Passeriformes	*Cisticola juncidis*	Streaked Fantail- Warbler	LC
Passeriformes	*Prinia socialis*	Franklin's Prinia Warbler	LC
Passeriformes	*Phylloscopus collybita*	Greenish Leaf Warbler	LC
Passeriformes	*Coracina melanoptera sykesi*	Black- Headed Cuckoo Shrike	LC
Passeriformes	*Coracina macei*	Large Cuckoo-Shrike	
Passeriformes	*Dicrurus aeneus*	Southern Bronzed Drongo	Common
Passeriformes	*Dicrurus paradiseus*	Large Racket-Tailed Drongo	LC
Passeriformes	*Dicrurus leucophaeus*	Grey Drongo	Common
Passeriformes	*Dicrurus macrocercus*	Black Drongo	Common
Passeriformes	*Oriolus oriolus*	Golden Oriole	Common
Passeriformes	*Sturnus roseus*	Rose- coloured Starling	Common
Passeriformes	*Sturnus pagodarum*	Brahminy Starling	LC
Passeriformes	*Acridotheres tristiris*	Common Myna	Common
Passeriformes	*Ploceus philippinus*	Baya Weaver	Common
Passeriformes	*Ploceus manyar*	Streaked Weaver	LC
Passeriformes	*Lonchura punctulata*	Spotted Munia	LC
Passeriformes	*Lonchura malacca*	Black Headed Munia	LC
Passeriformes	*Lonchura malabarica*	White- throated Munia	LC
Passeriformes	*Lonchura striata*	White rumped Munia	LC
Passeriformes	*Hirundo rustica*	Common Swallow	Common
Passeriformes	*Hirundo daurica*	Striated Swallow	Common
Passeriformes	*Motacilla maderaspatensis*	Large pied Wagtail	Common
Passeriformes	*Motacilla flava*	Yellow Wagtail	LC
Passeriformes	*Motacilla citreola*	Yellow –Headed Wagtail	Common
Passeriformes	*Motacilla cinerea*	Grey Wagtail	LC
Passeriformes	*Anthus richardi*	Richard's Pipit	Common
Passeriformes	*Mirafra erythroptera*	Red-winged Bush Lark	LC
Passeriformes	*Ammomanes phoenicurus*	Rufous –tailed Finch Lark	LC
Apodiformes	*Hirundapus giganteus*	Spine tail Swift	LC
Apodiformes	*Hirundapus sylvatica*	White - rumped spinetail Swift	
Apodiformes	*Tachymarptis melba*	Alpine Swift	Common
Apodiformes	*Apus affinis*	Common Indian House Swift	Common
Apodiformes	*Cypsiurus balasiensis*	Asian Palm Swift	LC
Apodiformes	*Hemiprocne coronata*	Crested Tree Swift	LC
Caprimulgiformes	*Caprimulgus atripennis*	Jerdon's Nightjar	LC

Table-6 List of birds recorded or reported from the study area			
Order	**Species**	**Common Name**	**Remarks**
Caprimulgiformes	*Caprimulgus indicus*	Indian Jungle Nightjar	LC
Caprimulgiformes	*Caprimulgus asiaticus*	Common Indian Nightjar	Common
Trogoniformes	*Harpactes fasciatus*	Malabar Trogon	LC
Cuculiformes	*Cuculus micropterus*	Indian Cuckoo	Common
Cuculiformes	*Hierococcyx varius*	Brainfever Bird	Common
Cuculiformes	*Cacomantis merulinus*	Indian Plaintive Cuckoo	LC
Cuculiformes	*Cacomantis sonneratii*	Indian Bay Banded Cuckoo	LC
Cuculiformes	*Cacomantis passerinus*	Indian Plaintive Cuckoo	LC
Cuculiformes	*Surniculus lugubris*	Drongo Cuckoo	LC
Cuculiformes	*Eudynamys scolopacea*	Indian Koel	Common
Cuculiformes	*Centropus sinensis*	Greater Coucal	Common
Psittaciformes	*Psittacula eupatria*	Alexandrine Parakeet	Common
Psittaciformes	*Psittacula krameri*	Rose Ringed Parakeet	Common
Psittaciformes	*Psittacula cyanocephala*	Plum-Headed Parakeet	Common
Psittaciformes	*Psittacula columboides*	Blue Winged Parakeet	LC
Strigiformes	*Bubo nipalensis*	Forest Eagle Owl	Common
Strigiformes	*Tyto alba*	Barn Owl	Common
Strigiformes	*Otus scops rufipennis*	Southern Indian Scops Owl	LC
Strigiformes	*Ninox scutulata*	Brown hawk Owl	LC
Falconiformes	*Spilornis cheela*	Lesser Crested Serpent Eagle	LC
Falconiformes	*Haliastur indus*	Brahminy Kite	Common
Falconiformes	*Milvus migrans*	Common Kite or Pariah Kite	Very common
Falconiformes	*Accipiter virgatus*	Besra Sparrow Hawk	LC
Falconiformes	*Accipiter badius*	Shikra	LC
Galliformes	*Coturnix chinensis*	Blue Breasted Quail	LC
Galliformes	*Coturnix coturnix*	Common Quail	Common
Galliformes	*Coturnix coromandelica*	Rain Quill	LC
Galliformes	*Perdicula argoondah*	Rock Bush Quail	LC
Hemipodii	*Turnix suscitator*	Common Button Quail	Common
Hemipodii	*Turnix tanki*	Yellow-legged –Button Quail	LC
Columbiformes	*Columba livia*	Indian Blue Rock Pigeon	Common
Columbiformes	*Streptopelia chinensis*	Spotted Dove	Common
Columbiformes	*Streptopelia senegalensis*	Little Brown Dove	Common
Columbiformes	*Streptopelia decaocto*	Eurasian Collered -Dove	Common
Columbiformes	*Streptopelia tranquebarica*	Red collered- Dove	Common
Columbiformes	*Pterocles indicus*	Close-Barred or Painted Sand Grouse	LC[#]
Columbiformes	*Pterocles exustus*	Common Indian SandGrouse	Common
Passeriformes	Large grey babbler	*Turoides malcomii*	Least Concern
Coraciformes	Hoopoe	*Upupa epops*	Least Concern
Apodiformes	Wire tailed Swallow	*Hirundo smithii*	Least Concern
Falconiformes	Scavenger vulture	*Gyps sp.*	Common
Passeriformes	Tailor bird	*Orthomus sutorius*	Least Concern
Passeriformes	Common myna	*Acridotherus tristus*	Least Concern
Falconiformes	Black winged kite	*Elanus caerulus*	Least Concern
Columbiformes	Spotted dove	*Streptoptelius chinensis*	Least Concern

Table-6 List of birds recorded or reported from the study area			
Order	**Species**	**Common Name**	**Remarks**
Galliformes	*Quills contronix*	Grey quail	Sch-IV
Passeriformes	*Aegithina tiphia*	Iora	Sch-IV
Passeriformes	*Pycnonotus jokokus*	White browed Bulbul	Sch-IV
Passeriformes	*Saxicoloides fulicata*	Indian robin	Sch-IV
Passeriformes	*Columbus livia*	Rock Pigeon	Sch-IV
Passeriformes	*Tchitrea paradisi*	Paradise Flycatcher	Sch-IV
Passeriformes	*Tephrodornis pondiceraianus*	Common Wood shrike	Sch-IV
Passeriformes	*Lalage sykesi*	Black headed cuckoo Shrike	Sch-IV
Passeriformes	*Artamus fuscus*	Ashy Swallow Shrike	Sch-IV
Passeriformes	*Oriolus oriolus*	Indian Oriole	Sch-IV
Passeriformes	*Ploceus philippines*	Weaver bird	*Sch-IV*
Passeriformes	*Uroloncha striata*	*Spotted munia*	*Sch-IV*
Passeriformes	*Cinnyris asiatica*	*Purple Sunbird*	*Sch-IV*
piciformes	*Brachypternus bengalensis*	*Malabar Golden backed woodpecker*	*Sch-IV*
Cuculiformes	*Megalaima merulinus*	*Indian Cuckoo*	*Sch-IV*
Cuculiformes	*Hierococys varius*	*Common Hawk Cuckoo*	*Sch-IV*
Coraciformes	*Coracias benghalensis*	*Indian Roller*	*Sch-IV*
Coraciformes	*Merops orinetalis*	*Common Bee Eater*	*Sch-IV*
Coraciformes	*Alcedo atthis*	*Common Kingfisher*	*Sch-IV*
Passeriformes	*Caprimulgus asiaticus*	*Common Indian jar*	*Sch-IV*
Strigiformes	*Tylo alba*	*Barn Owl*	*Sch-IV*
Columbiformes	*Chalcophaps indica*	*Emerald Dove*	*Sch-IV*
Charadiformes	*Lobvanella indicus*	*Redwattled Lapwing*	*Sch-IV*
Charadiformes	*Lobpluvia malabaraica*	*Yellow wattled lapwing*	*Sch-IV*
	Anhinga melanogaster	*Darter*	*Sch-V*
Ciconiformes	*Egretta garzetta*	*Little Egret*	*Sch-IV*
Ciconiformes	*Bubulcus ibis*	*Cattle Egret*	*Sch-IV*
Ciconiformes	*Ardeola grayii*	*Pond Heron*	*Sch-IV*
	Sterna albifrons	*Indian River Tern*	*Sch-IV*
Passeriformes	*Galerida malabarica*	*Malabar Crested Lark*	*Sch-IV*

[#] *Least Concern As per IUCN*

Table -7 Checklist of mammals reported or recorded from the study area			
Order	**Species**	**Common Name**	**Remarks**
Insectivora	*Suncus murinus*	Grey Musk Shrew	LC[#]
Insectivora	*Suncus stoliczkanus*	Anderson Shrew	LC
Chiroptera	*Saccolaimus saccolaimus*	Pouch- bearing Bat	LC
Chiroptera	*Taphozous longimanus*	Long Winged Tomb Bat	LC
Chiroptera	*Megaderma lyra*	Indian False Vampire	Common
Chiroptera	*Rhinolophus luctus*	Eastern Woolly Horseshoe Bat	LC
Chiroptera	*Rhinolophus rouxii*	Peninsular Horseshoe Bat	LC
Chiroptera	*Hesperoptenus tickelli*	Tickell's Bat	LC
Chiroptera	*Scotophilus heathi*	Asiatic Greater Yellow Bat	LC
Chiroptera	*Chaerephon plicata*	Wrinkle- lipped Bat	Common
Primates	*Semnopithecus entellus*	Langur	Common
Carnivora	*Canis aureus*	Golden Jackal	LC
Carnivora	*Vulpes bengalensis*	Indian Fox	Common
Carnivora	*Herpestes edwardsii*	Indian grey Mongoose	LC
Carnivora	*Herpestes vitticollis*	Stripe-naked Mongoose	LC
Carnivora	*Viverricula indica*	Small Indian Civet	Schedule II
Carnivora	*Paradoxurus hermaphroditus*	Common Palm Civet	Schedule II
Artiodactyla	*Sus scrofa*	Wild Pig	Schedule III
Rodentia	*Petaurista petaurista*	Red Giant Flying Squirrel	Schedule II
Rodentia	*Funambulus tristriatus*	Jungle Striped Squirrel	LC
Rodentia	*Bandicota bengalensis*	Bandicoot Rat	LC
Rodentia	*Banticota indica*	Greater Bandicoot Rat	Common
Rodentia	*Golunda ellioti*	Indian Bush Rat	LC
Rodentia	*Rattus norvegicus*	Common Rat	Common
Rodentia	*Rattus rattus*	Black Rat	Very Common
Rodentia	*Mus booduga*	Common Indian Field Mouse	LC
Rodentia	*Mus cookii*	Ryley's Spiny Mouse	LC
Rodentia	*Mus musculus*	House Mouse	LC
Rodentia	*Mus saxicola*	Elliot's Spiny Mouse	LC
Rodentia	*Vandeleuria oleracea*	Palm Mouse	LC
Rodentia	*Hystrix indica*	Indian Crested Porcupine	LC
Lagomorpha	*Lepus nigricollis*	Indian Hare	Common

[#] *Least Concern As per IUCN*

Table -8 Checklist of Butterflies reported or recorded from the study area		
Species	**Common Name**	**Remarks**
Pachliopta hector	*Crimson rose*	-
Papilo demoleus	*Lime butterfly*	-
Graphium agamemnos	*Tailed jay*	-
Papilo polymnstor	*Blue mormon*	-
Junonia atlites	*Grey pansey*	-
Juninia almana	*Peacock pansey*	-
Neptis hylas	*Common sailor*	*Sch-IV*
Parantica aglea	*Glassy tiger*	*Sch-IV*