O/c

adani

APSEZ/EnvCell/2017-18/038

Date: 22.11.2017

To

Additional Principal Chief Conservator of Forests (C),
Ministry of Environment, Forest and Climate Change,
Regional Office (WZ), E-5, Kendriya
Paryavaran Bhawan, Arera Colony,
Link Road No. – 3, Bhopal – 462 016.
E-mail: rowz.bpl-mef@nic.in

Sub : Half yearly Compliance report of Environment Clearance for the project namely "Development of Multipurpose berth (Terminal- 2) at Mundra Port, Dist. Kutch"

Ref : Environment clearance under CRZ notification granted to M/s Adani Ports & SEZ Limited vide letter dated 5th February, 2007 bearing no. 11-84/2006- IA.III

Dear Sir,

Please refer to the above cited reference for the said subject matter. In connection to the same, it is to state that copy of the compliance report for the Environmental and CRZ Clearance for the period of April – 2017 to September – 2017 is enclosed here for your records. The stated information is also provided in form of a CD (soft copy).

Thank you,
Yours Faithfully,
For, **M/s Adani Ports and Special Economic Zone Limited**

Ennarasu Karunesan
Chief Executive Officer
Mundra & Tuna Port

Encl: As above

Copy to:

1) The Director (IA Division), Ministry of Environment, Forests & Climate Change, Indira Paryavaran Bhawan, Jor Bagh Road, New Delhi-110003
2) Zonal Officer, Regional Office, CPCB – Western Region, Parivesh Bhawan, Opp. VMC Ward Office No. 10, Subhanpura, Vadodara – 390 023
3) Member Secretary, GPCB – Head Office, Paryavaran Bhavan, Sector 10 A, Gandhi Nagar – 382 010
4) Deputy Secretary, Forests & Environment Department, Block – 14, 8th floor, Sachivalaya, Gandhi Nagar – 382 010
5) Regional Officer, Regional Office GPCB (Kutch-East), Gandhidham, 370201

OFFICE
कार्यालय पर्यावरण एवं वन मंत्रालय (केन्द्रीय)
Ministry of Environment & Forests
क्षेत्रीय कार्यालय
Regional Office
भोपाल (म.प्र.)

Adani Ports and Special Economic Zone Ltd
Adani House
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Mundra, Kutch 370 421
Gujarat, India

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Environmental Clearance
Compliance Report

of

Multipurpose Berth
(Terminal -2)
at
Mundra Port,
Dist. Kutch, Gujarat

of

Adani Ports and SEZ Limited

Period:
April-2017 to September-2017

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Compliance Report

Half yearly Compliance report of Environment and CRZ Clearance for the project namely "Development of Multipurpose berth (Terminal – 2) at Mundra Port, Dist. Kutch" issued vide MoEF letter no. 11-84/2006-IA.III dated 5th February 2007

Sr. No.	Conditions	Compliance Status as on 30-09-2017
A. Specific Condition		
(i)	All the conditions stipulated by Forests Environment Department, Government of Gujarat vide their letter no. ENV-10-2005-222-P dated 12/10/2006 should be strictly implemented.	Complied. Point wise compliance report of CRZ recommendations issued vide letter No. ENV-10-2005-222-P dated 12/10/2006 is enclosed as **Annexure – A.**
(ii)	No Objection Certificate from Gujarat State Pollution Control Board should be obtained before initiating the project.	Complied. APSEZL had obtained No Objection Certificate vide GPCB letter No. GPCB/Unit-1/FT-139/11944 dated 27th April 2005. The project is in operation phase and have been granted Consent to Operate (CC&A) vide GPCB letter No. AWH-83561 valid till 20th November, 2021. Renewed CC&A copy was submitted along with last compliance report Oct-16 to March-17. Consent to Operate (CtO) is obtained and renewed/amended from time to time as per the progress of the project activity. CtO-Amendment obtained vide Order No. WH-88317 dated 03.10.2017 valid up to 20.11.2021. This consent order is processed for necessary correction from state pollution control board. Copy of the same is attached as **Annexure – 1**.
(iii)	The proposed project should not handle any hazardous goods and cargo.	Complied. During the compliance period, no hazardous cargo / goods are handled at the Multi-Purpose Berth (Terminal – 2).
(iv)	Quarantine condition should be provided for keeping the hazardous containers if they are accidentally received.	Complied. During the compliance period, no hazardous cargo / goods are handled at the Multi-Purpose Berth (Terminal – 2).
(v)	Green belt area should be developed along the project and budget earmarked.	Complied. During the course of development of the project, green belt was developed in 4.3 ha of land. Approx. 5988 trees were planted within the port premises.

Sr. No.	Conditions	Compliance Status as on 30-09-2017
		In addition to this, various green belt development and mangrove plantation activities are being carried out on regular basis by our horticulture department. Total expenditures of the horticulture dept. for the period of Apr to Sep- 2017 was INR 554 lakh. It may be noted that to enhance the marine biodiversity, till date APSEZ has carried out mangrove afforestation in more than 2800 ha. area across the coast of Gujarat. Total expenditure for the same till date is INR 782 lakh. So, far APSEZ have developed more than 400 ha. area as greenbelt with plantation more than 8.0 Lacs saplings within the APSEZ area. Details on mangroves afforestation & Green belt development carried out by APSEZ till date is annexed as **Annexure – 2**.
(vi)	A disaster management plan covering emergency evacuation mechanisms etc. to deal with natural disaster event should be prepared and furnished to the ministry.	Complied. Disaster Management plan to deal with natural disasters such as cyclone, earthquake, flood/heavy rain and tsunami is in place and will be implemented in the such events. Copy of the same was submitted to MoEF & CC along with half yearly compliance report for the period from Apr – 2016 to Sep – 2016.
(vii)	The company must take up and earmark adequate funds for the socio-economic development and for welfare measures in the area including drinking water supply, vocational training, fishery related development programmes (like cold storages)	Complied. APSEZ is actively working with local community around the project area and provides required support for their livelihood and other concerns through the CSR arm – Adani Foundation. Brief information about activities in the main five persuasions are mentioned below. Please refer **Annexure – 3** for full details of CSR activities carried out by Adani Foundation in the Mundra region.

Area	Activity
Community Health	• During this six month, total **13077** patients were provided with free Health Care Services by Mobile Dispensaries at 26 villages and 6 Fisher folk settlements. **15993** patients benefitted by the medical services at Rural Clinics at 11 locations. • During the month, total **4787** transactions were done out of **7487** card holders by beneficiaries Sr. Citizens of **65** Villages Mundra Taluka and they received cash less medical services under this project.
Sustainable Livelihood –	• Average **130** KL of water was supplied to 983 households from different settlements on a daily basis

<table>
<tr><th>Sr. No.</th><th>Conditions</th><th>Compliance Status as on 30-09-2017</th></tr>
<tr><td></td><td></td><td>
<table>
<tr><td>Fisher folk</td><td>under Machhimar Shudhh Jal Yojana.
• Computer Training: 30 Fisherman Youth
• Sewing Training: 60 Women
• Mangrove Plantation: 4000 Man-days
• Painting Labour: 3800 Man-days</td></tr>
<tr><td>Education</td><td>• Praveshotsav Kit is ready for 106 schools of Mundra Taluka, 6 Schools of Mandvi Taluka and 8 Schools of Anjar Taluka. Total 2200 kit distributed.
• Education Material support to 67 Students of Juna Bandar, Zarpara, Navinal, Bhadreshwar & Vandi of Standard 9th and 10th.</td></tr>
<tr><td>Rural Infrastructure</td><td>Work Completed
• Mota Bhadiya and Bhujpur- Pond deepening work
• Bhadreshwar- Prayer shed in School
• Kandagara – Garden work in matang temple
• Zarapara – Canal repairing work
• Shekhadia- Pagadiya fisherman road repair
• Shekhadia- construction of Bhunga Pagadiya fisherman
• Kutdi bander- construction of cricket pitch
• ASDC- civil works completed.
• Kandagara - Repairing of Checkdam and river widening
• Mundra- crematorium development
• Ragha - Prayer shed in primary school
• Shekhadiya – Const. of house of fisherman</td></tr>
<tr><td>Skill Development</td><td>• Soft skill training – 206 Nos.
• Technical Training – 400 Nos.</td></tr>
</table>

Budget for CSR Activity for the FY 2017-18 is to the tune of INR 1187 lakh. Out of which, Approx. INR 427 lakh are spent during this compliance period.</td></tr>
<tr><td>(viii)</td><td>The fishing activities by the fishermen living in the settlement along the creek should not be hindered and a mechanism may be evolved for the movement of fishing boats vis-a-vis shipping activities.</td><td>Complied.

No commercial fisheries are prevailing in this area except Pagadia and fishermen with small boats. Unhindered access is provided to the fishing boats.

During project proposal, APSEZ proposed to provide four (4) dedicated accesses at Juna Bandar, Luni, Bavdi Bandar and Zarpara for the fishermen to approach the sea for fishing activity. However, during construction as well as operation, through fishermen consultative process, APSEZ has provided seven (7) access roads. Total length of all the approach roads is approx. 23 Kms and expenditure involved is Rs. 637 Lacs. There is no hindrance to the movement of fisherman boats.
Communication mechanisms have been developed for the smooth movement of fishing boats vis-à-vis shipping activities. Please refer point no. vii above for further details regarding CSR activities being carried out by</td></tr>
</table>

Sr. No.	Conditions	Compliance Status as on 30-09-2017
		Adani Foundation.
(ix)	The relocation of the fishermen and local community if any, in the area should be done strictly in accordance with the norms prescribed by the State Government. The relocated communities should be provided with all facilities including health care, education, sanitation and livelihood.	Complied. The project was conceptualized in such a way that there are no fishermen or local community settlements in the project proposal. APSEZ performs a large scale socio-economic upliftment program in consultation with FOKIA (Federation of Kutch Industries Association) chaired by District Collector quarterly. APSEZL have provided necessary facilities including health care, education, sanitation, livelihood, drinking water & other infrastructural support to fisher folk community in the region. Please refer point no. vii above for further details regarding CSR activities being carried out by Adani Foundation.
(x)	The project proponent should not undertake any destruction of mangroves during construction and operation of the project.	Complied. Construction phase is already completed and the project is in operation phase. All developments are carried out as per permissions granted. As per EIA of 1998 carried out by NIO, mangrove status was: *"The total mangrove cover in the Navinal – Bocha – Baradi Mata – Kotadi Creeks complex is estimated at 1800 ha. with about 60% area covered with dense mangroves."* As per EIA of 2008 carried out by NIO, 1254 ha area has been identified as potential area for mangrove conservation. Same has been preserved and protected. CRZ map of CESS 2011 and satellite image confirmed the presence of more than 1800 ha mangrove area. A monitoring report was prepared by GUIDE for the mangrove conservation area at Mundra and the copy of the same is attached as **Annexure-8.** A progress report of a detailed study being carried out by NCSCM in Mundra region confirms the presence of 2265 ha of area is covered with mangroves. A copy of the said report is attached as **Annexure – 4**.
(xi)	Sewage arising in the port area should be disposed	Complied. Sewage generated from port premises is being treated in

<table>
<tr><th>Sr. No.</th><th>Conditions</th><th>Compliance Status as on 30-09-2017</th></tr>
<tr><td></td><td>off through septic tank – soak pit system or should be treated along with the industrial effluent to conform to the standards stipulated by Gujarat Pollution Control Board and should be utilized / recycled for gardening, plantation and irrigation.</td><td>designated treatment plants and treated sewage is used for horticulture purpose.
<table>
<tr><th>Location</th><th>Capacity</th><th>Quantity of Wastewater</th><th>Type of ETP / STP</th></tr>
<tr><td>Liquid Terminal</td><td>265 KLD</td><td>150 KLD</td><td>Activated Sludge</td></tr>
</table>
Third party analysis of the treated water is being carried out twice in a month by NABL and MoEF&CC accredited agency namely M/s. Pollucon Laboratories Pvt. Ltd. Summary of the same for duration from Apr-17 to Sep-17 is mentioned below.
<table>
<tr><th>Parameter</th><th>Unit</th><th>Max</th><th>Min</th><th>Perm. Limit$</th></tr>
<tr><td>Residual Chlorine</td><td>ppm</td><td>0.8</td><td>0.5</td><td>> 0.5</td></tr>
<tr><td>pH</td><td>--</td><td>7.55</td><td>5.48</td><td>6.5 – 8.5</td></tr>
<tr><td>TSS</td><td>mg/L</td><td>62</td><td>22</td><td>30</td></tr>
<tr><td>BOD (3 Days @ 27 °C)</td><td>mg/L</td><td>32</td><td>8</td><td>20</td></tr>
</table>
$ as per CC&A granted by GPCB
Please refer Annexure – 5 for detailed analysis reports. Approx. INR 12 Lakh is spent for all environmental monitoring activities during the F.Y. 2017-18 (till Sept' 17) periods.</td></tr>
<tr><td>(xii)</td><td>Project proponent should prepare and regularly update the disaster management plan from time to time.</td><td>Complied.
Disaster Management plan to deal with natural disasters such as cyclone, earthquake, flood/heavy rain and tsunami is in place and will be implemented in such events. Copy of the same was submitted to MoEF & CC along with half yearly compliance report for the period from Apr – 2016 to Sep – 2016.</td></tr>
<tr><td>(xiii)</td><td>There should be no withdrawal of ground water in CRZ area, for this project. The proponent should ensure that as a result of the proposed constructions, ingress of saline water into ground water does not take place. Piezometers should be installed for regular</td><td>Complied.

There is no withdrawal of ground water in CRZ area, for this project. Entire water requirement is sourced from Narmada water and desalination plant of APSEZ.

To monitor the ground water quality, bore wells are provided at various location in the port and SEZ areas. Third party analysis of the ground water is being carried out twice a year by NABL and MoEF&CC accredited agency namely M/s. Pollucon Laboratories Pvt. Ltd.</td></tr>
</table>

<table>
<tr><th>Sr. No.</th><th>Conditions</th><th>Compliance Status as on 30-09-2017</th></tr>
<tr><td></td><td>monitoring for this purpose at appropriate locations on the project site.</td><td>Summary of the same for duration from Apr'17 to Sep'17 is mentioned below. Monitoring Reports are attached as Annexure – 1 for the same.
<table>
<tr><th>Parameter</th><th>Unit</th><th>Min.</th><th>Max.</th></tr>
<tr><td>pH</td><td>-</td><td>7.43</td><td>7.68</td></tr>
<tr><td>Salinity</td><td>mg/L</td><td>0.55</td><td>12.73</td></tr>
<tr><td>Oil & Grease</td><td>mg/L</td><td>1.2</td><td>5.3</td></tr>
<tr><td>Hydrocarbon</td><td>mg/L</td><td>BDL</td><td>BDL</td></tr>
<tr><td>Lead as Pb</td><td>mg/L</td><td>0.06</td><td>0.53</td></tr>
<tr><td>Arsenic as As</td><td>mg/L</td><td>BDL</td><td>BDL</td></tr>
<tr><td>Nickel as Ni</td><td>mg/L</td><td>0.2</td><td>0.2</td></tr>
<tr><td>Total Cromium as Cr</td><td>mg/L</td><td>0.004</td><td>0.008</td></tr>
<tr><td>Cadmium as Cd</td><td>mg/L</td><td>0.008</td><td>0.13</td></tr>
<tr><td>Mercury as Hg</td><td>mg/L</td><td>BDL</td><td>BDL</td></tr>
<tr><td>Zinc as Zn</td><td>mg/L</td><td>0.043</td><td>1.81</td></tr>
<tr><td>Copper as Cu</td><td>mg/L</td><td>0.04</td><td>0.755</td></tr>
<tr><td>Iron as Fe</td><td>mg/L</td><td>0.67</td><td>17.05</td></tr>
<tr><td>Insecticides/Pesticides</td><td>mg/L</td><td>BDL</td><td>BDL</td></tr>
</table>
*BDL = Below Detectable Limit</td></tr>
<tr><td>(xiv)</td><td>The project should not be commissioned till the requisite water supply and electricity to the project are provided by PWD/ Electricity Department.</td><td>Complied.
Construction activity is already completed and the project is in operation phase. Necessary agreement for supply of Water & Electricity is done with MPSEZ Utilities Pvt. Ltd. (MUPL). Copies of agreements were submitted to MoEF&CC along with half yearly compliance report for the period from Apr – 2016 to Sep – 2016.</td></tr>
<tr><td>(xv)</td><td>Specific arrangements for rainwater harvesting should be made in the project design and the rain water so harvested should be optimally utilized. Details in this regard should be furnished to this Ministry's Regional Office at Bhopal within 3 months.</td><td>Complied.
Groundwater recharge cannot be done at the project site since the entire project is in the intertidal / sub tidal areas. Rain water within project area is managed through storm water drainage. However, APSEZL has carried out rainwater harvesting activities in the nearby villages for benefit of the locals. Following measures are taken for the same during the year 2011 – 13 and the same have benefited to the local farmers.
1. Pond deepening activities at villages
2. 18 check dams were constructed under the 'Sardar Patel Sahbhagi Jalsanchay Yojna'
Total cost of these efforts was approx. INR 320 lakh.

Pond deepening work is carried out in Mota Bhadiya and Bhujpur villages during the compliance period. The total cost incurred for this work was INR 16.7 Lakhs.</td></tr>
<tr><td>(xvi)</td><td>The facilities to be constructed in the CRZ</td><td>Complied.
Construction activities are completed in accordance</td></tr>
</table>

Sr. No.	Conditions	Compliance Status as on 30-09-2017
	area as part of this project should be strictly in conformity with the provisions of the CRZ Notification, 1991 as amended subsequently.	with the prevailing laws.
(xvii)	No product other than those permissible in the coastal Regulation Zone Notification, 1991 should be stored in the Coastal Regulation Zone area.	Complied. APSEZ store only those product / cargo within CRZ area, which are permissible as per Coastal Regulation Zone Notification, 1991.
B. General Condition		
(i)	Construction of the proposed structures should be undertaken meticulously confirming to the existing Central / local rules and regulations including Coastal Regulation Zone Notification 1991 and its amendments. All the construction designs / drawings relating to the proposed construction activities must have approvals of the concerned State Government Department / Agencies.	Complied. All construction activities are carried out confirming to the existing rules and regulation and as per the CRZ notification. Required details on No Objection Certificate from Gujarat State Pollution Control Board and applicable consent are as provided in Specific Condition No. 2 above.
(ii)	Adequate provisions for infrastructure facilities such as water supply, fuel, sanitation, etc. should be ensured for construction workers during the construction phase of the project so as to avoid felling of trees / mangroves and pollution of water and the surroundings.	Complied. Construction activity is completed and the project is in operation phase. No construction camps were located in CRZ area. Most workers came from nearby villages however, for others; construction camps were located outside CRZ area. All necessary infrastructure and facilities like mobile toilets, safe drinking water, medical health care etc. were provided.

<table>
<tr><th>Sr. No.</th><th>Conditions</th><th>Compliance Status as on 30-09-2017</th></tr>
<tr><td>(iii)</td><td>The project authorities must make necessary arrangements for disposal of solid wastes and for the treatment of effluents by providing a proper waste water treatment plant outside the CRZ area. The quality of treated effluents, solid wastes and noise levels etc. must conform to the standards laid down by the competent authorities including the Central / State Pollution Control Board and the Union Ministry of Environment and Forest under The Environment Protection Act, 1986, whichever are more stringent.</td><td rowspan="2">Complied.

<u>Liquid Effluent & Sewage</u> - It is being treated at ETP/STP plants outside the CRZ area, treated water from ETP/STP is being used for horticulture purposes. Please refer point no xi of the specific conditions above for further details.

All attributes of environment viz. air; water; soil and noise are being regularly analyzed by NABL and MoEF&CC accredited agency M/s Pollucon Laboratory Pvt. Ltd. Please refer Annexure – 5 for detailed analysis report.

<u>Solid Waste Management</u>:
APSEZL adopted 5R concept for environmentally sound management of different types of solid & liquid waste. The following table summarizes the waste management practice (for April'17 toSep'17) for different types of wastes at Mundra:
<table>
<tr><th>Waste</th><th>Quantity in MT</th><th>Disposal method</th></tr>
<tr><td colspan="3">Hazardous Waste</td></tr>
<tr><td>ETP Sludge</td><td>1.04</td><td>Landfilling at TSDF Site</td></tr>
<tr><td>Pig Waste</td><td>3.52</td><td>Co-processing at cement industries</td></tr>
<tr><td>Tank Bottom Sludge</td><td>1.73</td><td>Co-processing at cement industries</td></tr>
<tr><td>Oily Cotton waste</td><td>29.23</td><td>Co-processing at Cement Industries</td></tr>
<tr><td>Used / Spent Oil</td><td>41.41</td><td>Sell to registered recycler</td></tr>
<tr><td>Discarded Containers</td><td>4.18</td><td>Sell to registered recycler</td></tr>
<tr><td colspan="3">Municipal Solid Waste</td></tr>
<tr><td>Dry Waste</td><td>115</td><td>After recovery sent for recycling</td></tr>
<tr><td>Food Waste</td><td>98</td><td>Converted to Manure for Horticulture use</td></tr>
</table>
<u>Municipal Solid Waste</u>
A well-established system for segregation of dry & wet waste is in place, by which all wet waste (Organic waste) is being segregated & utilized for compost manufacturing; compost is further used by in house horticulture team for green belt development.
<u>Dry Recyclable Waste</u> - is being sorted out in various categories & finally being sent for recycling.
<u>E- Waste & Used Batteries</u> - is being sold to registered</td></tr>
<tr><td>(iv)</td><td>The proponents should provide for a regular monitoring mechanism so as to ensure that the treated effluents conform to the prescribed standards. The records of analysis reports must be properly maintained and made available for inspection to the concerned state /central officials during their visits.</td></tr>
</table>

Sr. No.	Conditions	Compliance Status as on 30-09-2017
		recycler. Solid Hazardous Waste - is being disposed through common facility i.e. CHWIF and / or co-processing at cement industries. Used/Waste Oil - It is being sold to authorized recycler/reprocesser. Downgrade Chemicals - It is being sold to authorized solvent recover. Slop Oil – Slop oil from vessels are received and water and oil particles from the same are separated in Oil Water Separator system. Separated oil from the same is being sold to authorized recycler /reprocessor.
(v)	In order to carry out the environmental monitoring during the operational phase of the project, the project authorities should provide an environmental laboratory well equipped with standard equipment and facilities and qualified manpower to carry out the testing of various environmental parameters.	Complied. Ambient Air Quality (twice in a week) and Noise (once in a month) monitoring are being carried out by NABL and MoEF&CC accredited agency namely M/s. Pollucon Laboratories Pvt. Ltd. Summary of the same for duration from April-17 to Sep-17 is mentioned below. **Total Sampling Locations: 03 Nos.**

Parameter	Unit	Max	Min	Perm. Limit$
PM_{10}	$\mu g/m^3$	96.62	37.59	100
$PM_{2.5}$	$\mu g/m^3$	55.40	15.39	60
SO_2	$\mu g/m^3$	27.56	5.26	80
NO_2	$\mu g/m^3$	45.40	14.25	80
Noise	**Unit**	**Avg. Value**		**Perm. Limit**
Day Time	dB(A)	65.9		75
Night Time	dB(A)	63.8		70

$ as per NAAQ standards, 2009

Please refer **Annexure – 5** for detailed analysis reports. M/s. Pollucon Laboratories Pvt. Ltd. has an environmental laboratory well equipped with standard equipment and facilities and qualified manpower to carry out the testing of various environmental parameters. Approx. INR 12 Lakh is spent for all environmental monitoring activities during the F.Y. 20176-17 18 (till Sep-17) periods.

Sr. No.	Conditions	Compliance Status as on 30-09-2017
(vi)	The sand dunes and mangroves, if any, on the site should not be disturbed in any way.	Complied. There are no sand dunes within the project site. Nearby conservation area of mangroves is protected & its regular monitoring is being done through Gujarat Institute of Desert Ecology (GUIDE).

Sr. No.	Conditions	Compliance Status as on 30-09-2017
(vii)	A copy of the clearance letter will be marked to the concerned Panchayat / local NGO, if any, from whom any suggestion / representation has been received while processing the proposal.	Not applicable at present
(viii)	The Gujarat Pollution Control Board should display a copy of the clearance letter at the Regional Office, District Industries center and Collector’s Office / Tehsildar’s Office for 30 days.	Not Applicable This condition does not belong to project proponent.
(ix)	The funds earmarked for environment protection measures should be maintained in a separate account and there should be no diversion of these funds for any other purpose. A year wise expenditure on environmental safeguards should be reported to this Ministry's Regional Office at Bhopal and the State Pollution Control Board.	Complied. Separate budget for the Environment protection measures is earmarked every year. All environment and horticulture activities are considered at corporate level and budget allocation is done accordingly. No separate bank account is maintained for the same however, all the expenses are recorded in advanced accounting system of the organization. Budget for environmental management measures (including horticulture) for the FY 2017-18 is to the tune of INR 966 lakh. Out of which, Approx. INR 682 lakh are spent during this compliance period (Aprl’17 to Sep’17). Detailed breakup of the expenditures is attached as **Annexure – 6.**
(x)	Full support should be extended to the officers of this Ministry's Regional Office at Bhopal and the officers of the Central and State Pollution Control Board by the project proponents during their inspection for monitoring purposes, by furnishing full details and action plans including the action	Complied. APSEZL is always extending full support to the regulatory authorities during their visit to the project site. Last visit of Regional Office, GPCB was done on 20.07.2017 for Main port. APSEZL has submitted the reply to the site visit report vide letter dated 04.08.2017 incorporating details of action taken in respect of the observations of the GPCB representative. Copy of the letter is enclosed as **Annexure – 7.**

Sr. No.	Conditions	Compliance Status as on 30-09-2017
	taken reports in respect of mitigative measures and other environmental protection activities.	
(xi)	In case of deviation or alteration in the project including the implementing agency, a fresh reference should be made to this Ministry for modification in the clearance conditions or imposition of new one for ensuring environmental protection.	Complied. Construction phase is completed and the project is in operation phase. There is no deviation or alteration in project including implementing agency.
(xii)	This Ministry reserves the right to revoke this clearance, if any of the conditions stipulated are not complied with to the satisfaction of this Ministry.	Point noted.
(xiii)	This Ministry or any other competent authority may stipulate any other additional conditions subsequently, if deemed necessary, for environmental protection, which should be complied with.	Point noted.
(xiv)	The project proponent should advertise in at least in two local newspapers widely circulated in the region around the project, one of which should be in the vernacular language of the locality concerned informing that the project has been accorded environmental clearance and copies of clearance	Complied

Sr. No.	Conditions	Compliance Status as on 30-09-2017
	letter are available with the State Pollution Control Board and may also be seen at the website of the Ministry of Environment & Forests at http://www.envfor.nic.in. The advertisement should be made within seven days from the date of issue of the clearance letter and a copy of the same should be forwarded to the Regional office of this Ministry at Bhopal.	
(xv)	The projects proponents should inform regional Office at Bhopal as well as the Ministry, the date of financial closure and final approval of the project by the concerned authorities and the date of start of land development work.	Complied. The construction phase is complete and the project is in operation phase.

ANNEXURE – A

CRZ Recommendation Compliance Report of WFDP

adani	Adani Ports and SEZ Limited	From : April'17 To : September'17
Status of the conditions stipulated under CRZ Recommendation		

Half yearly Compliance report of CRZ recommendation for the project namely "Development of Multipurpose berth (Terminal- 2) at Mundra Port, Dist. Kutch" issued by DoEF, GOG vide letter no. ENV-10-2005-222-P dated 12th October, 2006

Sr. No.	Conditions	Compliance Status as on 30-09-2017
Specific Condition		
1	The provision of the CRZ notification of 1991 and subsequent amendments issued from time to time shall be strictly adhered to by the GAPL. No activity in contradiction to the provision of the CRZ Notification shall be carried out by the GAPL.	Complied. Construction activities are completed and the project is in operation phase. All stipulations with respect to the CRZ notification and its subsequent amendments are complied with.
2	All permissions from different Government Departments / agencies shall be obtained by the GAPL before commencing the expansion activities.	Complied. Construction activity is already completed and the project is in operation phase. APSEZL had obtained No Objection Certificate vide GPCB letter No. GPCB/Unit-1/FT-139/11944 dated 27th April 2005. The project is in operation phase and have been granted Consent to Operate (CC&A) No. AWH-83561 valid till 20th November, 2021 by GPCB. Renewed CC&A copy was submitted along with last compliance report Oct-16 to March-17.Consent to Operate (CtO) is obtained and renewed/amended from time to time as per the progress of the project activity. CtO-Amendment obtained vide Order No. WH-88317 dated 03.10.2017 valid up to 20.11.2021. This consent order is processed for necessary correction from state pollution control board. Copy of the same is attached as **Annexure – 1**.
3	No Dredging and /or reclamation activity shall be carried out in the CRZ area categorized as CRZ (i) and it shall have to be	Complied. No dredging or reclamation is carried out in CRZ (1) A area. Capital dredging is completed and only maintenance dredging is being carried out, A study for conservation and monitoring for natural mangrove stands at mundra is carried out by M/s. Gujarat Institute of Desert Ecology (GUIDE). The report of the same is attached as **Annexure – 8**.

Sr. No.	Conditions	Compliance Status as on 30-09-2017
	ensured that the mangrove habitats and other ecologically important and significant areas are not affected due to any of the project activities.	
4	The dredge material shall be disposed of into pre-designated areas duly identified and got approved through the Gujarat Coastal Zone Management Authority for which the company shall have to make separate application along with proper EIA indicating the exact location of the dredge material disposal area on the CRZ map of the region prepared by the Space Application Center, Ahmedabad, as there exists best mangrove area in and around Bocha and Navinal islands,	Complied. Construction and capital dredging activities are completed and the project is in operation phase. Impact assessment was done for the same and EIA report was submitted to GCZMA and MoEF&CC based on which the final Environmental and CRZ clearance was granted. Detail on study for conservation and monitoring for natural mangrove stands at mundra is as provided in condition no. 3 above. Apr'16 to Sep'16.

Sr. No.	Conditions	Compliance Status as on 30-09-2017
	which requires to be protected.	
5	Massive mangrove plantation activity in at least 1200 ha. Area shall be carried out within a time frame of 5 years commencing from July, 2006 without any delay whatsoever.	Complied. It may be noted that to enhance the marine biodiversity, till date APSEZ has carried out mangrove afforestation in more than 2800 ha. area across the coast of Gujarat. Total expenditure for the same till date is INR 782 lakh. A progress report of a detailed study being carried out by NCSCM in Mundra region confirms the presence of 2265 ha of area is covered with mangroves. A copy of the said report is attached as **Annexure – 4**. Details on mangroves afforestation & Green belt development carried out by APSEZ till date is annexed as **Annexure – 2**.
6	No effluent or sewage shall be discharged into the sea / creek or in the CRZ area and shall be treated to conform the norms prescribed by the Gujarat Pollution Control Board and would be reused/ recycled within the plant premises.	Complied. Entire quantity of sewage generated is being treated in designated STPs and treated sewage is used for gardening. (see table A below) Third party analysis of the treated water is being carried out twice in a month by NABL and MoEF&CC accredited agency namely M/s. Pollucon Laboratories Pvt. Ltd. Summary of the same for duration from April-17 to Sep-17 is mentioned below. (see table B below) $ as per CC&A granted by GPCB BDL – Below Decatable Limit Please refer **Annexure – 5** for detailed analysis reports. Approx. INR 12 Lakh is spent for all environmental monitoring activities during the F.Y. 2017-18 period (till Sep'17).
7	All the recommendation and suggestions given by the NIO in its	Complied. All the recommendation and suggestions for conservation / protection and betterment of environment given by the NIO in its comprehensive EIA have been implemented. Few examples are provided below.

Table A:

Location	Capacity	Quantity of Wastewater	Type of ETP / STP
Liquid Terminal	265 KLD	150 KLD	Activated Sludge

Table B:

Parameter	Unit	Max	Min	Perm. Limit$
pH	--	7.55	6.78	6.5 – 8.5
TSS	mg/L	62	22	100
BOD (3 Days @ 27 °C)	mg/L	32	8	30

<table>
<tr><th>Sr. No.</th><th>Conditions</th><th colspan="2">Compliance Status as on 30-09-2017</th></tr>
<tr><td rowspan="5"></td><td rowspan="5">Comprehensive Environment Impact Assessment report for conservation / protection and betterment of environment shall be implemented strictly by the GAPL.</td><td colspan="2">Few Marine EIA recommendations:</td></tr>
<tr><td>Operational protocols and safety procedure should be printed and freely available to concerned staff. The employees must be adequately trained to inculcate a high level of competence not only in day to day operations but also during emergency situations. Periodic refresher courses must also be organized to maintain the level of their competence.</td><td>The company has written the operational protocols and safety procedures as a part of ISO 14001:2008, OHSAS 18001:2008 and ISO 9001:2008 certifications.
APSEZ has established training department to impart training to its employees.

IMO module course organized by Maritime Training Institute is conducted & 36 personnel have achieved IMO level 1 & 4 personnel have achieved IMO Level 2. Different training modules as Oil Spill, Oil Spill Equipment, Notification exercise, Incident are conducted at different frequency.</td></tr>
<tr><td>Temporary colonies of workforce should be located sufficiently away from the HTL with proper sanitation. Adequate arrangement of fuel supply to the workers should be made to discourage them from using mangroves for firewood.</td><td>Construction activity is already completed.
Most of the construction labours were residing in the nearby villages where all basic facilities are easily available. However, for those residing near the construction site, infrastructure facilities such as water supply, fuel, sanitation, first aid, ambulance etc. were provided by APSEZ.</td></tr>
<tr><td>Adequate vigilance is required to adherence of ships to Marpol protocol and related regulations.</td><td>During the vessel declaration compliances with respect to Air Pollution and Oil are monitored by the Port Authority. The ships are certified with international certification bodies only after complying with the Marpol protocol.</td></tr>
<tr><td>Manual Listing Procedure for conducting ship movement operations in the port area must be available to the concerned staff.</td><td>Berthing Policy & Tariff Structure is made available for conducting ship movement to the concerned staff and made available on web link www.adaniports.com/pdfs/PIB_06122013.pdf
Port Information Booklet is also made available on web link</td></tr>
</table>

Sr. No.	Conditions	Compliance Status as on 30-09-2017
		www.adaniports.com/Port_Operations_Port_Tariffs.aspx
8	The construction and operational activities shall be carried out in such a way that there is no negative impact on mangroves and other coastal / marine habitat. The construction activities and dredging shall be carried out only under the constant supervision of the NIO.	Complied. Construction and capital dredging activity is already completed. All operational activities are being carried out in such a way that there are no impacts on the nearby mangroves. Details on mangrove conservation and afforestation is provided against Specific Condition No. 5 above.
9	The GAPL shall strictly ensure that no creeks are blocked due to any activity at Mundra Port and the mangrove habitats are neither disturbed nor destroyed due to any activity.	Complied. As per Marine EIA carried out by NIO in 2008, prominent creek system (main creeks and small branches of creeks) in the study region are: (1) Kotdi (2) Baradimata (3) Navinal (4) Bocha (5) Mundra (Oldest port (Juna Bandar) leading to Bhukhi river) All above creeks are in existence allowing free flow of water and there is no filling or reclamation of any creek area. APSEZL has so far constructed 19 culverts having total length of approx. 1100 m with total cost of INR 20 Crores. Three RCC Bridges have been constructed over Kotdi creek with total length of 230 m and cost of INR 10 Crores. Photographs of the same are attached as Annexure -
10	The GAPL shall contribute financially for any common study or project proposed that may be proposed by this Department for environmental	Being complied Following studies were proposed by the FED and MOEF&CC. • Bathymetry & Topography study of Mundra is being carried out by National Center for Sustainable Coastal Management (NCSCM), Chennai. The study being carried out by NCSCM covers preparation of plan for protection of creeks/ mangrove area including buffer zone, mapping of co-ordinates, running length, HTL, CRZ boundary. The cost of the study as per the NCSCM proposal is 315.5 Lakh and 90% of the payment against the same is already made as an advance.

Sr. No.	Conditions	Compliance Status as on 30-09-2017
	management / conservation / improvement for the Gulf of Kutch.	• A Regional Impact Assessment study to identify the regional impacts of all the existing as well as proposed project activities is being carried out by NABET accredited consultant namely MS Cholamandamam. The cost of the study is 130 Lakh and majority of the payment for the same is also done.
11	The construction debris and/or any other type of waste shall not be disposed of into the sea, creek or in the CRZ areas. The debris shall be removed from the construction site immediately after the construction is over.	Complied. Construction activity is already completed. Project is in operation phase.
12	The construction camp shall be located outside the CRZ area and the construction labour shall be provided the necessary amenities, including sanitation, water supply & fuel and it shall be ensured that the environmental conditions are not deteriorated by the construction labours.	Complied. The construction activity of said project is already completed. Project is in operation phase. No construction camps were located in CRZ area. Most workers came from nearby villages however, for others; construction camps were located outside CRZ area. All necessary infrastructure and facilities like mobile toilets, safe drinking water, medical health care etc. were provided.
13	The GAPL shall prepare and regularly update their local Oil Spill	Complied. Oil spill contingency plan is in place to handle Tier 1 level oil spills considering different accident scenarios, and the vulnerable areas are identified and mitigation plan is prepared. OSCRP updated on 29.08.2017

Sr. No.	Conditions	Compliance Status as on 30-09-2017
	Contingency and Disaster Management Plan in for their all activities in Mundra Port consonance with the National Oil Spill and Disaster Contingency Plan and shall submit the same to this department after having it vetted through Indian Coast Guard.	is in place and implemented. An acknowledgement letter on updates in OSCRP by coast guard along with a copy of the updated plan is attached as **Annexure -09.** Disaster Management Plan is updated regularly and the updated DMP was submitted to the MoEF & CC along with half yearly compliance report Apr – 2016 to Sep – 2016. For responding to oil spill, the Indian Coast Guard has developed the National Oil Spill Disaster Contingency Plan NOSDCP which has the approval of the Committee of Secretaries and has been in operation since 1996. Oil Spill Contingency Response Plan (OSCRP) prepared by APSEZ is in accordance with the NOSDCP.
14	The Gujarat Maritime Board shall expedite for the Vessel Traffic Management System for the Gulf of Kutch and would work out the modus operandi for cost sharing by the different players in the Gulf indicating the GAPL. The GAPL shall contribute for the same as may be decided by the Gujarat Marine Board or any other competent authority for this purpose.	Point noted. APSEZ is practicing well defined traffic control procedure. A VTS service for Gulf of Kutch is provided by the VTS Gulf of Kutch, operated by Directorate General of Lighthouses and Lightships (DGLL), Govt. of India. Marine Control of APSEZ provides traffic update to vessels in Mundra Port Limit on VHF Channel- 77. Arrival and departure information before arrival and departure respectively in Gulf of Kutch is provided to VTS information cell through agent or by directly sending mail to vtsmanagergulfofkutch@yahoo.com and vtsgok@yahoo.com
15	The GAPL shall bear the cost of	Being complied Following studies were proposed by the FED and MOEF&CC.

Sr. No.	Conditions	Compliance Status as on 30-09-2017
	the external agency that may be appointed by this Department for supervision / monitoring of proposed activities and the environmental impacts of the proposed activities.	• Bathymetry & Topography study of Mundra is being carried out by National Center for Sustainable Coastal Management (NCSCM), Chennai. The study being carried out by NCSCM covers preparation of plan for protection of creeks/ mangrove area including buffer zone, mapping of co-ordinates, running length, HTL, CRZ boundary. The cost of the study as per the NCSCM proposal is 315.5 Lakh and 90% of the payment against the same is already made as an advance. • A Regional Impact Assessment study to identify the regional impacts of all the existing as well as proposed project activities is being carried out by NABET accredited consultant namely MS Cholamandamam. The cost of the study is 130 Lakh and majority of the payment for the same is also done.
General Condition		
16	The ground water shall not be tapped by the GAPL to meet with the water requirement in any case.	Complied. APSEZ does not draw any ground water for the water requirement. Present source of water for various project activities is desalination plant of APSEZ and/or Narmada water through Gujarat Water Infrastructure Limited. Average water consumption for entire APSEZ area is 5.6 MLD out of which 2.8 MLD is obtained from Desalination plant whereas remaining 2.8 MLD is obtained from GWIL.
17	The GAPL shall take up massive greenbelt development activities in consultation with Forest and Environment Department.	Complied. APSEZ has consulted Gujarat Institute of Desert Ecology (GUIDE) as they are one of the authorized agencies of Dept. of Forest & Env., Govt. of Gujarat for carrying out mangrove afforestation. Total 5988 trees are planted at the density of 1370 trees per ha. covering 4.37 hectare of land at Terminal – 2. In addition to this, various green belt development and mangrove plantation activities are being carried out on regular basis by the horticulture department. Total expenditures of the horticulture dept. for the period of Apr to Sep- 2017 was INR 554 lakh. So, far APSEZ have developed more than 400 ha. area as greenbelt with plantation of more than 8.0 Lacs saplings within the APSEZ area. Details on mangroves afforestation & Green belt development carried out by APSEZ till date is annexed as **Annexure – 2**.
18	The GAPL shall have to	Complied. APSEZ performs a large scale socio-economic upliftment program and

Sr. No.	Conditions	Compliance Status as on 30-09-2017
	contribute financially for taking up the socio-economic upliftment activities in this region in consultation with the Forests and Environment Department and the District Collector / District Development officer.	shares with FOKIA (Federation of Kutch Industries Association) chaired by District Collector quarterly. APSEZL have provided necessary facilities including health care, education, sanitation, livelihood, drinking water & other infrastructural support to Local community in the region. For further information related to the CRS activities being carried out by Adani Foundation in mundra region, please refer to specific condition no. 7 of the EC and CRZ clearance above.
19	A separate budget shall be earmarked for the purpose of socio-economic upliftment activities and details thereof shall be furnished to this department as well as the MoEF&CC, GOI from time to time. The details with respect to the expenditure from this budget head shall also be furnished on annual basis.	
20	A separate environment management cell with qualified personnel shall be created for environmental	Complied. M/s APSEZL has a well structured Environment Management Cell, staffed with qualified manpower for implementation of the Environment Management Plan. The Environment Management Cell is headed by Sr. Executive who directly reports to the top management. The organogram of Environment Cell is attached as **Annexure - 10**.

<table>
<tr><th>Sr. No.</th><th>Conditions</th><th>Compliance Status as on 30-09-2017</th></tr>
<tr><td></td><td>monitoring and management during construction and operational phases of the project.</td><td></td></tr>
<tr><td>21</td><td>Environmental Post Project Monitoring report indicating the changes, if any, with respect to the baseline environmental quality in the coastal and marine environment shall be submitted every year by the GAPL to this department as well as to the MoEF&CC, GOI.</td><td>Complied.

The quality of treated effluent, emission and noise level is being monitored regularly by a MoEF&CC/NABL accredited agency namely M/s. Pollucon Laboratories Pvt. Ltd. Monitoring results are confirming to the applicable norms.

Marine monitoring is being carried out once in a month. Summary of the same for duration from April'17 to Sep'17 is mentioned below.

Total Sampling Locations: 09 Nos.
<table>
<tr><th rowspan="2">Parameter</th><th rowspan="2">Unit</th><th colspan="2">Surface</th><th colspan="2">Bottom</th><th>Baseline (EIA, 2004)</th><th>Baseline (EIA, 2004)</th></tr>
<tr><th>Max</th><th>Min</th><th>Max</th><th>Surface</th><th>Surface</th><th>Bottom</th></tr>
<tr><td>pH</td><td>--</td><td>8.28</td><td>7.55</td><td>8.38</td><td>7.27</td><td>7.7- 8.3</td><td>8.1-8.3</td></tr>
<tr><td>TDS</td><td>mg/L</td><td>53670</td><td>30830</td><td>54820</td><td>32620</td><td></td><td></td></tr>
<tr><td>TSS</td><td>mg/L</td><td>30</td><td>12</td><td>40</td><td>16</td><td></td><td></td></tr>
<tr><td>BOD (3 Days @ 27 °C)</td><td>mg/L</td><td>8</td><td>3</td><td>9</td><td>4</td><td>0.1-4.4</td><td><0.1-3.8</td></tr>
<tr><td>DO</td><td>mg/L</td><td>6</td><td>4.8</td><td>5.4</td><td>4.4</td><td>1.8-5.7</td><td>1.8-5.7</td></tr>
<tr><td>Salinity</td><td>ppt</td><td>48.45</td><td>31.4</td><td>49</td><td>32.3</td><td>35.9-39.0</td><td>36.0-39.0</td></tr>
</table>
Please refer Annexure – 5 for detailed analysis reports. Approx. INR 12 Lakh is spent for all environmental monitoring activities during the F.Y. 2017-18 period (till Sep'17).</td></tr>
<tr><td>22</td><td>The GAPL shall have to contribute financially to support the National Green Corps Scheme being implemented in</td><td>Complied.
Necessary support will be provided on hearing from GEER foundation to support NGC scheme.</td></tr>
</table>

Sr. No.	Conditions	Compliance Status as on 30-09-2017
	Gujarat by the GEER foundation, Gandhinagar in consultation with Forests and Environment Department.	
23	A six monthly report of compliance of the conditions mentioned in this letter shall have to be furnished by the GAPL on a regular basis to this department without fail.	Complied. Six Monthly environment clearance compliance report is being submitted regularly to the concerned authorities. Last half yearly environmental clearance compliance report was submitted on 23.05.2017 in soft as well as hard copy.
24	Any other condition that may be stipulated by this department from time to time for environment protection / management purpose shall also have to be complied with by the GAPL.	Complied. Any other condition stipulated for environment protection / management purpose will be complied by APSEZ.

Annexure – 1

GPCB

GUJARAT POLLUTION CONTROL BOARD

PARYAVARAN BHAVAN
Sector-10-A, Gandhinagar 382 010
Phone : (079) 23222425
(079) 23232152
Fax : (079) 23232156
Website : www.gpcb.gov.in

By R.P.A.D.

AMENDMENT OF CONSOLIDATED CONSENT AND AUTHORIZATION (C C & A)

GPCB/CCA-Kutch (39 (4)/ ID-17739/ 424578 Date 27.9.2017
03/10/17

To,
M/s. Adani Ports & Special Economic zone Limited,
Plot No: 169/P
At Navinal Island, Taluka: Mundra,
Dist: Kutch – 370 421

Sub: - Amendment of Consolidated Consent and Authorization (CC& A) of this Board under the provision the Water (Prevention and Control of Pollution) Act-1981, the air Prevention and Control of Pollution) 1981 and the Hazardous Waste (Management, Handling & Transboundary Movement) Rules 2008 framed under the Environmental (Protection) Act-1986.

Ref: -

1. Consent Renewal Order No: AWH-83561 dated 9.1.2017 validity up to 20.11.2021 issued vide letter No: GPCB/CCA-Kutch-39 (4)/ID-17739/403658 dated 9.2.2017
2. Your CCA- Amendment application Inward no-124026 dated 12.7.2017

The Board has granted Consolidated Consent (CC & A) vide order No: AWH-83561 dated 9.1.2017 validity up to 20.11.2021 issued vide letter No: GPCB/CCA-Kutch-39 (4)/ID-17739/403658 dated 9.2.2017 is amended as under:

1. The above referred CC&A order is amended as order **No: WH-88317** and issued dated 12.7.2017 and validity period i.e. up to 20.11.2021 & shall remains unchanged.
2. The Products mentioned at Condition No: 2 of the above said CCA order is amended as under:

No.	Name Of Product	Existing Quantity	Proposed Quantity	TOTAL Quantity
1.	General Cargo	4.0 Lac MT/Month	------	4.0 Lac MT/Month
2.	Liquid Cargo (Chemical/Poc Products	2.65 Lac MT/Month	--------	2.65 Lac MT/Month
3.	Storage And Distribution Of Bitumen	26,400 MT/Month	------	26,400 MT/Month
4.	Dry Cargo Handling	9 MMT/Month	------	9 MMT/Month
5.	Container Terminal Handling Operation	4.5 Million TEUs/Annum	-----	4.5 Million TEUs/Annum
6.	Waste destruction system for decomposition/destruction of municipal solid waste	3.5 Cubic Meter (MSW Destruction Capacity @ 500 Kg/day)	-----	3.5 Cubic Meter (MSW Destruction Capacity @ 500 Kg/day)
7.	Oil water separate (Flame Proof) to remove –Oil portion from slope oil received from Vessels/Ships	25 M^3/Hr	---	25 M^3/Hr
8.	Import, Storage And Distribution Of Edible Oil	1.25 Lac MT/Month	0.6 Lac MT/ Month	1.85 Lac MT/Month

1

Clean Gujarat Green Gujarat

ISO-9001-2008 & ISO-14001 - 2004 Certified Organisation

4.0 The condition No: 4.1 is amended as under:

4.1 The following shall be used as fuel in addition to Existing.

	FUEL DETAILS	Existing	Proposed	Total after expansion
1.	Furnace oil/LDO/HSD	860 Liter/Hour	115	975 Liter/Hour
2.	HSD	100 Liter/Hour	-------	100 Ltr/ Hr

4.2 The condition No: 4.2 for flue gas emissions shall, confirm to the following standards as under:

Sr. no.	Stack attached to	Stack height in meters, Mtr	Parameter	Permissible limit
1.	Hot Water Generator --1	35	PM	150 mg/Nm^3
2.	Hot Water Generator ---2	35	SO_2	100 ppm
3.	Fuel Heater (Thermic) (2 Nos)	35	NOx	50 ppm
4.	D.G. Set – 9 Nos (500 KVA) (Stand By)	9 Meter Each		
5.	D.G. Set – 3 Nos (1250 KVA) (Stand By)	30 Meter common		
6.	D.G. Set – 6 Nos (1500 KVA) (Stand By)	30 Meter Each		

5.2 Condition NO 5.2 shall be amended for addition to existing waste as under, in accordance with the Hazardous Waste (Management, Handling & Transboundary Movement) Rules, 2016 as under:

Sr. No.	Waste	Existing Quantity	Proposed Quantity	Total Quantity	Cat.	Facility
1.	Used oil m	300 T/ Year	60 T/ year	360 T/ year	5.1	Collection, storage, Transportation,, Disposal by reuse within premises and / or selling out to registered recyclers/ /reprocessers
2	Contaminated cotton rags or other cleaning material	100 T/ Year	5 T/ Year	105 T/ Year	33.2	Collection, storage, Transportation, Disposal by Co-processing at cement Industries and / or incineration at CHWIF site.

3. Remaining all other conditions of Consolidated Consent (CC&A) vides order No: AWH-83561 dated 9.1.2017 validity up to 20.11.2021 issued vide letter No: GPCB/CCA-Kutch-39 (4)/ID-17739/403658 dated 9.2.2017 shall remains unchanged.

For and on behalf of
Gujarat Pollution Control Board

Vachhani

(P.J. Vachhani)
Sr. Environmental Engineer

Annexure – 2

Details of Greenbelt development at APSEZ, Mundra

LOCATION	**Total Green Zone Detail**				
	Area (In Ha.)	**Trees (Nos.)**	**Palm (Nos.)**	**Shrubs (SQM)**	**Lawn (SQM)**
SV COLONY	65.34	30051.00	6965.00	51138.00	80069.00
PORT & NON SEZ	77.52	131942.00	18613.00	68166.78	58455.18
SEZ	99.52	227135.00	15924.00	220449.60	27462.03
MITAP	2.48	8168.00	33.00	1670.00	4036.00
WEST PORT	83.20	182118.00	50221.00	24112.00	22854.15
AGRO- PARK	7.52	17244.00	1332.00	5400.00	2121.44
SOUTH PORT	14.08	25150.00	3430.00	3882.00	4826.97
Samudra Township	38.67	28252.00	11818.00	19978.07	35071.67
Productive Farming	15.69	19336.00	0.00	0.00	0.00
TOTAL (APSEZL)	**404.02**	**669396.00**	**108336.00**	**394796.45**	**234896.44**
		7,77,732			

<u>Details of Mangrove Afforstation done by APSEZ</u>

Sl. no.	Location	Area (ha)	Duration	Species	Implementation agency
1	Mundra Port	24.0	-	Avicennia marina	Dr. Maity, Mangrove consultant of India
2	Mundra Port	25.0	-	Avicennia marina	Dr. Maity, Mangrove consultant of India
3	Luni/Hamirmora (Mundra, Kutch)	160.8	2007 - 2015	Avicennia marina, Rhizophora mucronata, Ceriops tagal	GUIDE, Bhuj
4	Kukadsar (Mundra, Kutch)	66.5	2012 - 2014	Avicennia marina	GUIDE, Bhuj
5	Forest Area (Mundra)	298.0	2011 - 2013	Avicennia marina	-
6	Jangi Village (Bhachau, Kutch)	50.0	2012 - 2014	Avicennia marina	GUIDE, Bhuj
7	Jakhau Village (Abdasa, Kutch)	310.6	2007-08 & 2011-13	Avicennia marina, Rhizophora mucronata, Ceriops tagal	GUIDE, Bhuj
8	Sat Saida Bet (Kutch)	255.0	2014-15 & 2016-17	Avicennia marina & Bio diversity	GUIDE, Bhuj
9	Dandi Village (Navsari)	800.0	2006 - 2011	Avicennia marina, Rhizophora mucronata, Ceriops tagal	SAVE, Ahmedabad
10	Talaza Village (Bhavnagar)	50.0	2011-12	Avicennia marina	SAVE, Ahmedabad
11	Narmada Village (Bhavnagar)	250.0	2014 - 2015	Avicennia marina	SAVE, Ahmedabad
12	Malpur Village (Bharuch)	200.0	2012-14	Avicennia marina	SAVE, Ahmedabad
13	Kantiyajal Village (Bharuch)	50.0	2014-15	Avicennia marina	SAVE, Ahmedabad
14	Devla Village (Bharuch)	150.0	210-16	Avicennia marina	SAVE, Ahmedabad
15	Village Tala Talav (Khambhat, Anand)	100.0	2015 - 2016	Avicennia marina	SAVE, Ahmedabad
16	Village Tala Talav (Khambhat, Anand)	38.0	2015 - 2016	Avicennia marina	GEC, Gandhinagar
	Total Mangrove Plantation:	**2827.90 Ha**			

A. Green Development at APSEZL,Mundra (Till Nov.2017) as per EC

Green Belt Developed as per EC Condition

Sr No.	Symbol	EC	Ec Details	Locations	Green Belt (ha.)	Trees (No.)	Avarage Tree Density (ha.)
GB1		23.Au.1995	Handling facility of General cargo/LPG/Chemical and their storage terminal at Navinal island	Navinal island, Liquid area	15.15	51605	3406
GB2		20.Sept..2000	Port Expantion project including dry/bulk/breck bulk cargo/container terminal ,Rly Link , related ancillary and back up	Inside port,Avenue, Fire station,Rly.building, CT2 area,etc	13.66	18074	1323
GB3		21.july 2004	SPM,COT and connected pipeline at mundra port	IOCL/HPCL /HMPL area	6.1853	7607	1230
GB4		05.Feb.2007	Development of Multipurpose berth(T2).Mundra	Terminal 2	4.37	5988	1370
GB5		12.Jan.2009	Waterfront development project at mundra	Waterfront area (Adani hou and nearer area,South and west basin,APL Road,etc)	122.36	281819	2303
GB6		20.Feb.2010	Eslablisment of CETP (17MLD) capacity at survey no.141(part),mundra	CETP area and treated water utilization area	16.98	31083	1831
GB7		20 Feb 2010	Township and area Development project at survey no.141(Part),Mundra	Samudra township , Adani hospital,Perifery of Bhukhi river bank,etc	43.55	59166	1359
(A.)Total					**222.26**	**455342**	**2049**

Additional Green Belt Developed

B. Additional Green Development at APSEZL,Mundra (Till Nov.2017)

Sr No.		Area Details	Green Belt (ha.)	Trees(No.)	Tree Density (ha.)
GB8		Shantiwan colony ,Adani School,Temple,Guest houses,Mundra	65.34	40554	621
GB9		Mitap and nearer area	2.4	8168	3403
GB10		Agripark area	7.52	17244	2293
GB11		Airstrip and airstrip road ,Along road from Rly Gate 24 to 25,North gate & other SEZ area	88.79	243059	2737
GB12		New Development (area 1 to 13 ,A,B)	26.03	38625	1484
(B.)Total			**190.08**	**347650.00**	**1828.97**

Total Green Development at APSEZL,Mundra (Till Nov.2017)

Sr No.	Area Details	Green Belt (ha.)	Trees (No.)	Tree Density (ha.)
	A+B	**412.34**	**802992.00**	**1947.42**

Mangrove Afforestation Till Nov.-2017

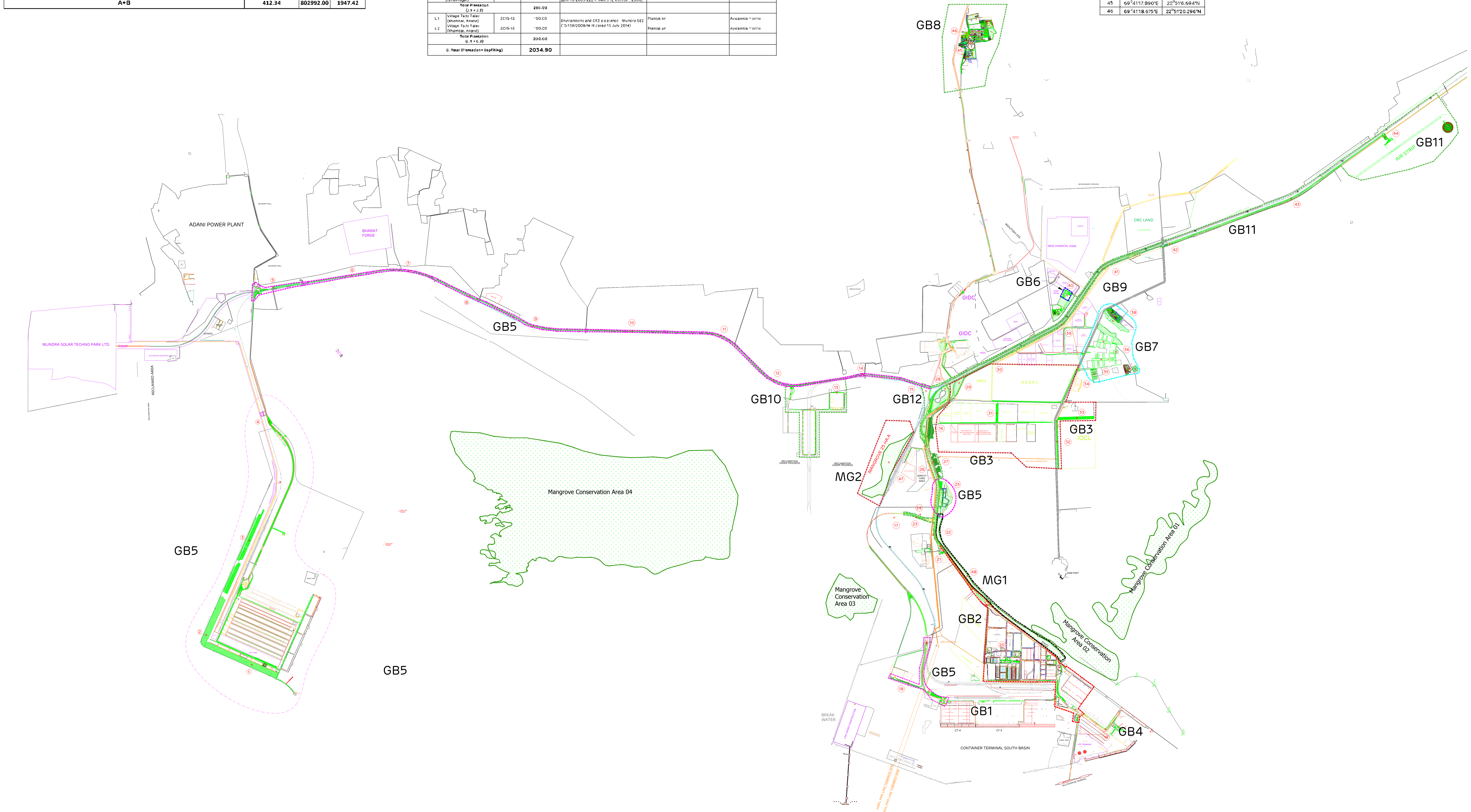
S. NO.	Location	FY	Area (Hectare)	Clearance Reference	Plantation/Gap Filling	Species
A.1	Mundra Port Area (Mundra, Kutch)		24.00	Environment Clearace - Mundra (J-16011/13/95- A. II dated 25 August 1995)	Plantation	Avicennia marina
	Total Plantation		**24.00**			
B.1	Mundra Port Area (Mundra, Kutch)		25.00	Environment Clearace - Mundra (J-16011/30/2003-IA. II dated 21 July 2004)	Plantation	Avicennia marina
	Total Plantation		**25.00**			
C.1	Luni/Hamiramora (Mundra, Kutch)	2007-08	40.00	CRZ Recommendation - Mundra 1200 ha mangrove to be plantaed (Env-10-2005-222-P dated 12 October, 2006)	Plantation	Avicennia marina Rhizophora mucronata Ceriops tagal
C.2		2009-10	10.00		Gap Filling Work	
C.3		2010-11	10.00		Gap Filling Work	
C.4		2011-12	95.40		Plantation	
C.5		2012-13	25.40		Plantation	
C.6		2013-14-15	70.00		Gap Filling Work	
	Total Plantation (C.1+C.4+C.5)		**160.80**			
D.1	Kukadsar (Mundra, Kutch)	2012-13	66.50	CRZ Recommendation - Mundra (Env-10-2005-222-P dated 12 October, 2006)	Plantation	Avicennia marina
D.2		2013-14	10.00		Gap Filling Work	Avicennia marina
	Total Plantation (D.1)		**66.50**			
E.1	Forest Area (Mundra)	2011-12	50.00	Forest Clearance - Mundra (F.No. 8-2/1999-FC (pt) dated 27 February 2009)	Plantation	Avicennia marina
E.2		2012-13	248.00		Plantation	Avicennia marina
	Total Plantation (E.1+E.2)		**298.00**			
S. NO.	**Location**	**FY**	**Area (Hectare)**	**Clearance Reference**	**Plantation/Gap Filling**	**Species**
F.1	Jangi village (Bhachau, Kutch)	2012-13	50.00	CRZ Recommendation - Mundra (Env 10 2005 222 P dated 12 October, 2006)	Plantation	Avicennia marina
F.2		2013-14	20.00		Gap Filling Work	Avicennia marina
	Total Plantation (F.1)		**50.00**			
G.1	Jakhau Village (Abdasa, Kutch)	2007-08	40.10	CRZ Recommendation - Mundra (Env-10-2005-222-P dated 12 October, 2006)	Plantation	Avicennia marina Rhizophora mucronata Ceriops tagal **Note :** We are doing the Conservation of mangroves in 1254 Ha area as per MoEF guidelines at Mundra and naerby port vicinity
G.2		2008-09	10.00		Gap Filling Work	
G.3		2009-10	10.00		Gap Filling Work	
G.5		2013-14	20.00		Gap Filling Work	
G.6		2012-13	30.00		Gap Filling Work	
G.7		2012-13	20.50	CRZ Recommendation - Mundra (Env-10-2005-222-P dated 12 October, 2006)	Plantation	
G.8		2012-13	200.00	Environment Clearance - Mundra (10-47/2008-IA.III dtd. 12th Jan.2009)	Plantation	
G.9		2013-14-15	50.00		Gap Filling Work	
	Total Plantation (G.1 + G.4 + G.7 + G.8)		**260.60**			
S. NO.	**Location**	**FY**	**Area (Hectare)**	**Clearance Reference**	**Plantation/Gap Filling**	**Species**
1	Village Dandi (Navsari)	2006-07	200.00	CRZ Recommendation - Mundra (Env-10-2005-222-P dated 12 October, 2006)	Plantation	Avicennia marina Rhizophora mucronata Ceriops tagal
I.2		2007-08	100.00		Plantation	
I.4		2008-09	200.00	CRZ Recommendation - Mundra (Env-10-2005-222-P dated 12 October, 2006)	Plantation	
I.5		2010-11	200.00		Plantation	
	Total Plantation (I.1 + I.2 + I.3 + I.4 + I.5)		**700.00**			
J.2	Village Narmada (Bhavnagar)	2014-2015	250.00	CRZ Recommendation - Mundra (Env-10-2005-222-P dated 12 October, 2006)	Plantation	Avicennia marina
	Total Plantation (J.1 + J.2)		**250.00**			
L.1	Village Tada Talav (Khambhat, Anand)	2015-16	100.00	Environment and CRZ clearance - Mundra SEZ (10-138/2008/IA III dated 15 July 2014)	Plantation	Avicennia marina
L.2	Village Tada Talav (Khambat, Anand)	2015-16	100.00		Plantation	Avicennia marina
	Total Plantation (L.1 + L.2)		**200.00**			
	G. Total (Plantation+Gapfilling)		**2034.90**			

Lat Long Of Green Belt Area

Sr. No.	Latitude	Longitude
1	69°33'29.798"E	22°44'58.842"N
2	69°33'2.398"E	22°45'14.365"N
3	69°33'32.735"E	22°46'17.109"N
4	69°33'44.520"E	22°47'20.650"N
5	69°33'41.090"E	22°48'43.306"N
6	69°34'31.981"E	22°48'50.120"N
7	69°35'11.003"E	22°48'54.268"N
8	69°35'58.337"E	22°48'36.557"N
9	69°36'38.620"E	22°48'19.674"N
10	69°37'44.608"E	22°48'16.751"N
11	69°38'35.659"E	22°48'14.104"N
12	69°39'12.518"E	22°47'46.137"N
13	69°39'51.720"E	22°47'39.717"N
14	69°40'10.522"E	22°47'50.513"N
15	69°40'48.508"E	22°47'40.312"N
16	69°40'47.610"E	22°47'18.746"N
17	69°40'28.982"E	22°46'29.237"N
18	69°40'38.406"E	22°44'44.679"N
19	69°42'43.751"E	22°44'17.492"N
20	69°40'47.412"E	22°44'57.528"N
21	69°40'56.317"E	22°46'6.039"N
22	69°40'53.035"E	22°46'13.077"N
23	69°40'42.589"E	22°46'28.874"N
24	69°40'43.374"E	22°46'32.176"N
25	69°41'0.640"E	22°46'38.096"N
26	69°40'50.601"E	22°46'53.156"N
27	69°40'54.883"E	22°47'3.674"N
28	69°40'57.778"E	22°47'36.690"N
29	69°41'9.996"E	22°47'44.044"N
30	69°41'30.201"E	22°47'57.091"N
31	69°41'34.576"E	22°47'26.535"N
32	69°42'13.593"E	22°47'8.318"N
33	69°42'26.888"E	22°47'23.693"N
34	69°42'37.345"E	22°47'50.499"N
35	69°42'42.020"E	22°47'58.785"N
36	69°42'51.726"E	22°48'3.073"N
37	69°42'43.597"E	22°48'9.573"N
38	69°42'50.969"E	22°48'21.573"N
39	69°42'14.688"E	22°48'18.784"N
40	69°42'19.806"E	22°48'37.682"N
41	69°42'43.190"E	22°48'52.628"N
42	69°43'26.341"E	22°49'8.778"N
43	69°44'49.105"E	22°49'36.665"N
44	69°45'48.623"E	22°50'8.344"N
45	69°41'17.890"E	22°51'6.694"N
46	69°41'18.675"E	22°51'20.296"N

Lat Long Of Mangrove Area

Sr. No.	Latitude	Longitude
47	69°40'22.704"E	22°46'59.824"N
48	69°41'12.855"E	22°45'49.811"N



DRG NO. HORTI/APSEZL

Implemented Green Zone Development In APSEZL Area
(Mangrove afforestation and Conservation, Green Zone area & Additional Green Belt Development)

DRG. TITLE:

Landscape Drawing

SCALE :- N.T.S.

DATE : 14.11.2017

adani

DEPT.OF HORTICULTURE
ADANI PORTS & SPECIAL ECONOMIC ZONE LIMITED, MUNDRA .

Annexure – 3

Adani Foundation Mundra

DEDICATED EFFORTS FOR HOLISTIC DEVELOPMENT

Contents

Mission AF : "Save Girl Child" & "Greet Girl Child"

Education

Adani Vidya Mandir, Bhadreshwar

Community Health

G.K.G.S, Bhuj

Fisherman Amenities

Agriculture Initiatives

Rural Infrastructure Development

Adani Skill Development Centre

Media Corner







EDUCATION PROJECTS
1. Balvadi at Fisherfolk settlements
2. Other Education Project

Education :

- **Praveshotsav Kit is ready for 106 schools of Mundra Taluka, 6 Schools of Mandvi Taluka and 8 Schools of Anjar Taluka. Total 2200 kit distributed.**
- **Initiated Same concept at Sharda Mandir Govt Primary school Mundra (School is situated between worker/labour Vasahats. Students are not able to cope up with basic subjects (Maths, Science and Gujarati). Our objective is to strengthen their base and increase their minimum level.**
- **Total more than 80 students benefitted, minimum level exams taken. Students are distributed as per their levels after minimum level test. Course material is designed for all level. Not only study we do over all personality development and personnel meeting with each students.**
- **Education : Fisherman**
- **Children are of age 2.5 to 5 years are learning in Balwadi and they also teach each other. Children are learning rhythms, best out of waste, balvarta display on LCD and other activities of education with fun. Total Number of students : 1st year – 64 and 2nd Year – 81 Total : 145 students are studying in Balvadi**
- **Education Material support to 67 Students of Juna Bandar, Zarpara, Navinal, Bhadreshwar & Vandi of Standard 9th and 10th.**
- **Vehicle Support is planned for 106 students of Juna Bandar, Luni Bandar, Bavadi Bandar and Luni Village. Entertainment through Games like Snakes and Leaders.**
- **As Education initiative for children at Balwadi are able to read write and speak A B C , numeric 1-50 very well. Moreover they are also teaching other fellow students.**

Adani Vidya Mandir : Success in Gujrat Board Examination

AVMB Std.-10 First Batch Result 2016/17			
No.	Grade	Students	Pass
1	Upto 70%	2	Pass
2	Upto 60%	5	Pass
3	Upto 50%	11	Pass
4	Upto 45%	3	Pass
	Total	23	21
	Percentage	90%	

AVMB Std.-10 First Batch Result 2016-17

Adani Vidya Mandir Bhadreshwar achievement in Gujrat Board Standard 10th Examination Result 91% (21 students have passed the examination out of 23). Adani Foundation will take all responsibility of further study of students with respect to their interest.

Community Health : Mundra

Mobilevan OPD April to Sep-2016							
Month	Apr-17	May-17	Jun-17	Jul-17	Aug-17	Sep-17	Total
OPD	2758	2460	2157	1751	2024	1927	13077

Rural Clinic OPD April to Sep-2016							
Month	Apr-17	May-17	Jun-17	Jul-17	Aug-17	Sep-17	Total
OPD	2999	2811	3034	2275	2390	2484	15993

Sr.No	Name CFS	Total HCP	Submit Cards	submit Files
1	All Cargo	10	5	10
2	Sea Bird	20	14	20
3	Maruti Nandan	78	22	66
3	Saurastra CFS	90	90	90
4	other all CFS	227	67	66
	Total	**425**	**198**	**252**

Senior Citizen Scheme	
Month	**OPD**
April	710
May	796
June	787
July	804
Aug,	758
Sep.	932
Total	**4787**

Poor Patients Support
698 Patients had been supported for treatment of illness.

- **Mobile Dispensaries & Rural Clinics**

During this six month, total **13077** patients were provided with free Health Care Services by Mobile Dispensaries at 26 villages and 6 Fisherfolk settlements . **15993** patients benefitted by the medical services at Rural Clinics at 11 locations.

- **Health Cards to Senior Citizens**

During the month, total 4787 transactions were done out of 7487 card holders by beneficiaries Sr. Citizens of 65 Villages Mundra Taluka and they received cash less medical services Under this project. We have entered into third phase of the project.

Dialysis Data April -17 To Sept-17								
Sr.No.	Patient Name	17-Apr	17-May	17-Jun	17-Jul	17-Aug	17-Sep	Total
1	Ramjan Adam	8	10	10	7	8	7	**50**
2	Narshi Samecha	5	-	-	0	0	0	**5**
3	Karim Theba	10	10	11	11	8	7	**57**
4	Budhiya Juma	8	7	9	5	0	0	**29**
	Total.	**31**	**27**	**30**	**23**	**16**	**14**	**141**

Community Health All Project Data at Adani Hospital - Total OPD & IPD for April to September-2017

Community Health Project OPD & IPD Data April -17 to Sep-17																					
Projects	Apr-17			May-17			June-17			July-17			Aug-17			Sep-17			Total		
	OPD	IPD	Total	OPD	IPD	Total	OPD	IPD	Total	OPD	IPD	Total	OPD	IPD	Total	OPD	IPD	Total	OPD	IPD	Total
Sr.Citizen	710	0	710	796	0	796	787	0	787	804	0	804	758	0	758	932	0	932	**4,787**	**0**	**4,787**
Medical Supports	120	3	123	127	5	132	115	3	118	82	1	83	115	0	115	126	1	127	**685**	**13**	**698**
Physio Camp	0	0	0	0	0	0	23	0	23	23	0	23	7	0	7	14	0	14	**67**	**0**	**67**
Dialysis	31	0	31	25	0	25	30	0	30	23	0	23	16	0	16	14	0	14	**139**	**0**	**139**
CFS Drives HCP	0	0	0	0	0	0	0	0	0	162	0	162	175	0	175	86	0	86	**423**	**0**	**423**
Total	**861**	**3**	**864**	**948**	**5**	**953**	**955**	**3**	**958**	**1094**	**1**	**1095**	**1071**	**0**	**1071**	**1172**	**1**	**1173**	**6101**	**13**	**6114**

Overview: "Suposhan Project"

- **To curb malnutrition amongst Children, Adolescent girls and Women in our CSR villages**
- To reduce malnutrition and anaemia amongst adolescent girls and pregnant & lactating women by 70% in three years
- To create awareness about the issue of malnutrition and anaemia and related factors amongst all stakeholders and role they may play in curbing the issue
- To create a pool of resources to be utilised for combating the issue of Malnutrition and Anaemia
- To support efforts in reducing IMR and MMR

Strategy: "Suposhan Project"

- Community based intervention with Community Health Workers from local communities. (Sangini)
- Each child and especially malnourished will be mapped with growth chart
- Regular inputs of THR, RUTF and other micronutrients treatment when necessary facilitated via Govt. Schemes and if necessary through AF
- FDGs with mothers and adolescent girls
- Village meeting one in a month at every village
- Health camp every month
- Awareness campaigns
- Cross Functional, across locations learnings

Outcome: "Suposhan Project"

- Reduction in occurrence of malnutrition amongst Children by 95 % in three years
- Reduction in malnutrition and anaemia amongst adolescent girls and pregnant & lactating women by 70% in three years
- Create awareness about the issue of malnutrition and anaemia and related factors amongst all stakeholders and role they may play in curbing the issue
- Create a pool of resources to be utilised for combating the issue of Malnutrition and Anaemia
- Support efforts in reducing IMR and MMR

Overview: "Suposhan Project"

Community Engagement and other Activities		Sept-17
Sr.No	Activity	Progress
1	No of Sangini	40
2	Total Village Cover	56
3	Total Anghanvadi Cover	99
4	Total PRA	9
5	SAM to MAM Monitoring Progress	28
6	MAM to Normal Monitoring Progress	13
7	SAM/MAM Child Camp	3
8	Focus Group Discussion	1003
9	Family Based Counselling	174
10	Village level Events	390
11	Formation of women's groups	242
12	Formation of adolescent's Groups	219
13	No of SAM children referred to CMTC	18
14	No of SAM children provided with RUTF	58
15	Total HB screening - RPA	2172
16	Total HB screening - Adolescent girls	3774
17	Women in RPA provided with IFA Tablets	161
18	Adolescent girls provided with IFA Tablets	239
19	Anthromatry Study (0 to 5)	7202
20	Sangini Meeting	17
21	Sangini Training	9

Community Health : Overview


Rural Clinic


Dead Body Van

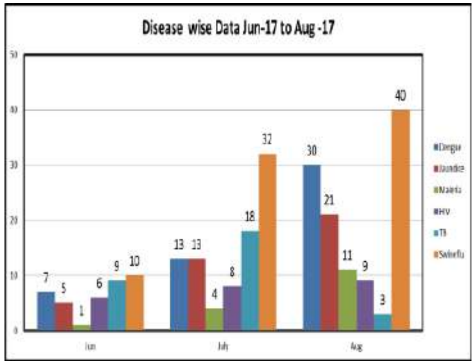

Sangini Training


Mobile Van


Physiotherapy Camp

GAIMS : Health is Wealth ....

- **Total 5547 Patients received Special Care and Coordination upto Sep 17 at GKGH regarding Hospital, Lab, OPD Department, Ward and Pharmacy Service.**
- **During six months Different 125 Village Level Meetings Organised with Sarpanch, Leader, Women Groups and other Stakeholders .**
- **We have Started School Health Check Up Under the "Safe child Project" in this six months Total 11 Schools Covered and 2263 Students has been benefited in camp.**
- **In this six months Total 363 dead bodies were shifted to different villages in Kutch District.**



Safe Child Project/ School Health Checkup			
No of School	Covered	No.of Student	Covered
	11		2263

Sr No.	Month	AF Van	Death in GKGH
1	April	57	65
2	May	63	78
3	Jun	52	58
4	July	49	55
5	Aug	75	92
6	Sep	67	120
	Total	**363**	**468**

Death Body Van and Hospital Death Data

Fisherfolk Amenities

Computer training : 30 Fisherman Youth

- Regular Meetings at bander with fishermen, fisheries department and coast guard
- to create awareness about fisheries scheme and cooperate during mock drill and Vessel approach
- Meeting at Kutdi regarding street light drinking water and approach.

Sewing training : 60 Women (Zarpara/Juna Bandar)

- Meeting and site visit with Luni fishermen leader & Kutch Jilla Machhimar Association Pramukh to provide potable water at Bavadi, Randh and Luni fishermen vasahat with collaboration of gram panchayat and GWIL(Gujarat water infra structure limited).
- Survey and meeting with fishermen regarding use of "Ma- Amrutam Yojna" and RSBY card.

- We have applied for Model cage unit in fisheries department for juna bandar(shekhdiya) fishermen in consultation with CMFRI.
- Cage culture project the total production may be 120 kg and we have plan for harvesting In next month. Community operated projects and taken care by community.

Mangroves plantation : 4000 Man-days

- With the help of I Khedut portal We can apply online for different agricultural(fisheries)department scheme.
- We have create awareness of this portal by Luni and Juna Bandar computer training center

Painting Labour : 3800 Man-days

Sustainable Livelihood Programme

Fodder Demonstration

Demonstration for NB 21 extended with 42 farmers for get better results for fodder cultivation. In this project, Parjanya Ecology was our implementing partner and Krishi Vigyan Kendra was our guide for the project. Total 14 acre land has been covered under this demo production in first phase 1.12 Lac Kg.

"Saheli Mahila Gruh Udyog"

Till date "Saheli Mahila Gruh Udyog "has annual turn over of more than Rs. 5.00 Lacs.
After one year of Pilot phase, Saheli Mahila Gruh Udyog includes 70 women. We are planning to convert "Saheli Mahila Gruh Udyog" into Producer company. Planning for 1. Production of Hygiene Products 2. Edible products and 3. Handicraft items capacity building women group

"Beti Vadhavo"

Beti Vadhavo Abhiyan" initiative has been taken by Adani Foundation in order to change the mindset of our society and think positively towards the girl child since four years. We are greeting each girl child born in Mundra Taluka with Kit including (one pair cloth, soap, shampoo, powder, mosquito net, bed sheet and nutritious food for mother). Joint efforts of Taluka Health Office, ICDS and Adani foundation greeted 121 daughters at Tunda, Siracha, Vadala, Goersama, Navinal and Gundala Village.

"Support to Handicapped, widows and senior citizen by Govt Schemes"

- **We are playing the role of facilitator in case of tie up with Government Scheme for Widows, Senior Citizens and Handicapped people. The identity cards are issued to two persons for the handicapped in coordination with Bhuj Samaj Suraksha Khata for regular visit and follow up.**
- **During the period , 8 widows and 204 handicapped - total 212 members got benefitted by different schemes of Government. The financial benefit of the senior citizen Yojana is Rs. 400 per month and the widow scheme is of Rs. 900 per month.**

Rural Infrastructure Development : Building Block of the Society

Adani Foundation has designed, planned and built a strong infrastructure for bettering education, community health, agriculture and living standards, all according as per official requests and demands of people of the community and the Gram Panchayat.

Work completed :

- **Mota Bhadiya and Bhujpur- Pond deepening work**
- **Bhadreshwar- Prayer shed in School**
- **Kandagara – Garden work in matang temple**
- **Zarapara – canal repairing work**
- **Shekhadia- Pagadiya fisherman road repair**
- **Shekhadia- construction of Bhunga Pagadiya fisherman**
- **Kutdi bander- construction of cricket pitch**
- **ASDC- civil works completed.**
- **Kandagara - Repairing of Checkdam and river widening**
- **Mundra- crematorium development**
- **Ragha - Prayer shed in primary school**
- **Shekhadiya – Const. of house of fisherman**




Adani Skill Development Center: Mundra

Along with computer related trainings, Stitching and Bagging training, Beauty Parlor and Mobile Repairing Training are also in full fledge at Gundala, Adani Ports, Navinal and Mundra

Soft Skill training					
Sr. No.	**Course Name**	**Location**	**Male**	**Female**	**No.of students**
1	Beautification training.	Mundra	0	20	20
2	Advance Excel training	Adani house	20	0	20
3	IT Basic Computer training	Navinal	13	7	20
4	IT Basic Computer training	ASDC	2	4	6
5	IT Basic computer-CRTG student training	ASDC	7	0	7
6	Wedding Mehnadi training	Gundala	0	16	16
7	Thread work training	Gundala	0	20	20
8	IT Basic computer-CRTG student training	ASDC	7	0	7
9	Spoken English	ASDC	13	3	16
10	IT Basic Computer training	Adani house	20	0	20
11	IT Basic Computer training	ASDC	0	7	7
12	IT Basic computer-CRTG student training	ASDC	7	0	7
13	Thread work training	Luni	0	14	14
14	Computer Excel training	Adani house	19	0	19
15	IT Basic Computer training	ASDC	7	0	7
		Total - A	**115**	**91**	**206**

Adani Skill Development Center: Mundra

Technical Training					
1	Checker cum RTG crane operator training	APSEZ	21	0	21
2	Tailoring training	Borana	0	30	30
3	Tailoring training	ASDC	0	14	14
4	Tailoring training	Mundra	0	41	41
5	Vocational training	Zarpara	38	7	45
		Total - B	**59**	**92**	**151**
Carier Guidance and Knowlage bage training					
1	Personality Devlopment training	ASDC	23	4	27
2	Personality Devlopment training	ASDC	13	3	16
		Total - C	**36**	**7**	**43**
		Grand Total A + B+C =	**210**	**190**	**400**



Important Events


Adani Cricket tournament final match between Navinal and Kathada team was organized at Shantivan cricket ground . The Final match was very thrilling and after all king of Navinal team won. we invited fishermen leader from different villages and officers from Gujrat Fisheries board, Forest and Sport department. on this occasion Mr. Mukesh Saxena (COO,APSEZ) were present to motivate players and promised to support them for coaching for their better future in cricket. The trophy and prize of- 25000 INR and 15000 INR awarded to winner and runners up team. Total 58 team & 609 Youth participated in tournament and We distributed cricket kit to all participated teams. **The best player is selected for training at Rajkot (Yusuf Bamaniya Academy) for his bright future.**

Shikshan Manthan Shibir

Background : Kutchh District is very poor in case of Education. Educational Standards of Govt. School is considerably depraved. It leads to pathetic situation for students. It continuously destroys our young generation in absence of proper direction and base. That's why we have planned for workshop for school teachers on innovative teaching.

Objective : It will be one of the many initiatives taken by AF to changing the teaching patterns being practised and how to simplify it.

Outcome : This would be extremely beneficial for the teachers and would help them get equipped with new teaching techniques and broaden up their notions in the domain of education

Impact : This kind of workshops can have a long term impact on the development of teachers and enhance their soft skills. First Workshop arranged on 1st Aug 2017 Guest : Mr. Jargela – DPEO

Beneficiaries : Principles of all 106 primary schools of Mundra

Trainers : Mr. Daxa Rajgor and Mr. Sanjay Thaker (District Institute of Education Training)

Seminar on " Qualities of an effective teacher: This module has given answers to some focussed questions on Qualities of an effective teacher like How, why and what works best in a classroom? Child psychology, Where to start to improve in teaching learning styles? What makes an effective teacher?

Important Events

Adani Foundation believes that, "The children of today will shape the future of tomorrow" and "We should always give a chance and support to educate girl child". To make bright future of children of fisherman Adani foundation has provided fee support to 174 Students at SMJ High School Luni.

Adani Foundation plays role of facilitator between government and community for Government Schemes for divyang, widows and senior citizens. Till date we were supporting divyang by schemes of state government. Tri-cycles were distributed among 142 differently able persons of Mundra and surrounding areas, at a function held at Mundra Taluka Health Office on Wednesday. AF, Mundra coordinated the entire process of issuance of tri-cycles to the beneficiaries with concerned authorities in Govt. of India and facilitated the distribution jointly with local Health dept. authorities.

Public hearing Copper Plant Adani Foundation Mundra has organized "Sneh Milan" Programme on 27th April 2017 Thursday. Total 155 local people participated including Sarpanch, village leaders and NGO working for welfare of community and media as well. Main Objective of Sneh Milan Programme was to brief about upcoming "Adani Copper Project". Mr. Surya Rao (VP, Adani Copper) had presented information about copper plant. Mr. Mukesh Saxena had warmly welcomed community leaders and obliged for their strong support in journey of development.

Stake holder Engagement

Women Participation in income generation activities through self help groups has created a positive impact on the life pattern of women and that has empowered them at various levels not only as individuals but also as members of the community and the society as whole. Adani Foundation has developed 7 SHG Groups consists of 97 members (Saving 2.5 Lacs for 18 months). Apart from savings, this women are associated with Saheli Mahila Gruh Udyog – preparing household items i.e. washing powder, phynayle, dish wash liquid etc. The groups are empowered to market their products themselves. The profits drawn from their rural enterprises are now being used for their essential family requirements and education of their children.

Regular meetings with Fisherman Community at Vasahats are conducted regularly. Main topics are covered about safety in sea, importance of savings, health and hygiene, various schemes of fisheries department, women empowerment, training and development of Adani skill development center etc. This type of interaction create trust and transparency towards community. Direct contact will increase rapport also. AF Team is also part of community function as well as personnel functions of the community. The youth engagement initiatives i.e. fisherman cricket match, cycle marathon etc. are also necessary.

Biogas is a clean, non-polluting and low cost fuel. It contains about 55 to 75 percent methane, which is inflammable. Bio gas can be produced from cattle dung, human waste and other organic matter by a process called "Anaerobic digestion" which takes place in a biogas plant. The digested effluent, which comes out of the plant, is enriched manure.

The Multiple benefits of the biogas have changed many lives in rural areas. During the last year 11 plants have been constructed and process for 10 more plants is going on. We are providing support addition to Government support to the beneficiary. (Under bio-gas scheme of government, the total cost is Rs.33, 500 out of which Rs.15, 000 will be granted by the government and out of the pending amount of Rs.18, 500 sum of Rs.10, 000 will be contributed by the Adani Foundation. The beneficiary will have to pay only Rs. 8, 500). Beneficiary women use the time, saved from cooking and fuelwood collection, to take up an additional economic activities.

During the non-fishing months, the fishermen under usual circumstances were benefit of any other alternate economic activity to sustain them. Under such cases due to the scarcity of their available funds and resources, it became extremely difficult for a majority of them to survive. Looking at the miseries the Foundation introduced 'mangrove plantation' and "Mangroves Algae Removal" in the area as a means of alternate income generating activity for the fisher folk community during the non-fishing months. Both men and women from the communities received trainings on Cheriya Plantation, moss cleaning etc. required for mangrove plantation. The program again was developed holistically, where focus was not only given on income generation but this initiative was seen as an important means to ensure environment sustainability. At the moment total 110 fisher folks from Luni, Shekhadia and Bhadreshwar are working for mangroves plantation and cleaning and getting income upto Rs. 300 per day.

Kitchen Garden

We have motivated adolescent girls and their mothers to develop kitchen garden at the back of their house. We have selected three different beneficiaries having biogas at their vadi. Kitchen garden and bio gas plant combination brings worth results for "Suposhan" in Adolescent girls.

All the vegetables grown at the garden are consumed by their own house. This is a model developed to motivate local people to develop a small kitchen garden in their home to get access to nutritional vegetables.

Bhujpur, a village 20 kilometres from Mundra has agriculture as its main occupation. The people of Kutch have to face the water related problems due to the geographical location of Kutch and the salinity of sea water here. Bhujpur has two inter connected ponds. Once the Sarpanch of the village Meghraj Gadhvi thought of deepening the pond and this he put forward in form of a request to the Head of the Adani foundation in coordination with the village heads, school teachers and the various members of women organizations. This participatory approach brought matter of great amazement when the village offered their services of three tractors. The villagers were happy to acknowledge that if the ponds keep on getting filled up year after year, it would help in increasing the level of ground water. It would also decrease the salinity of water and increase the agricultural production.

"Spreading Smiles"

A Large portion of the rain fed areas in Kutchh are characterized by low productivity, high risk and uncertainty. This leads to degradation of natural resources. Part of watershed management programmes, Check dam strengthening by de silting and repairing at Kandagara village is initiated. Work is completed before monsoon and village community is with Adani Foundation team since beginning of the project. Main objective is to control damaging runoff and degradation and thereby conservation of soil and water

Kamila ben Sheda owns 11 milch cows and two bulls. She was spending almost 40% money she earned from selling milk – on feeding his cattle. This squeezed his profits. Adani Foundation in coordination with Krishi Vigyan Kendra/Parjanya Ecology started demonstration of NB-21 (Type of Fodder which grows fast with less water)
Impact : She adopted this technique and also ensures that cattle will get proper balance food. This has reduce her cost of cattle feed considerably. She demonstrated the technique in 0.75 Acres of land and production in first cutting is total 8000 kg. She is our proud as she is the first lady farmer who adopted NB-21 technique and got good results.

Journey towards dignity

It is our moral responsibility as a Foundation to take the responsibility of flood relief work in Tharad taluka which is badly affected by flood. With based on suggestions of district administration, AF Mundra has started march with 12 members team and AF Ahmedabad has started with 8 members team on 30th July 2017.
The flag off done by SDM Mundra and Mamlatdar Mundra. Entire teams are fully charged up to severe affected villages as per need given by Govt and based on survey of our team members who went earlier to get details.

"Disaster Management"
Building Relations Over Troubled Water : Banaskantha District

Due to the recent heavy rains, many villages in the Banaskatha region of Gujarat have become flooded.

Many villages in Banaskantha district continue to remain cut off because the bridges and roads in route have been washed away. Number of villages affected by flood and faced large damage of lives, animals and goods.

Adani Foundation Mundra decided to start relief work after taking a preliminary survey of the flood affected areas. Mr. Karsan Gadhavi and Mr. Ishvar Parmar started their journey towards Banaskantha on 28th July 2017. They visited Dhanera, Tharad and Vav District . First they meet SDM and Mamlatdar of Tharad and Dhanera. With help of Govt dignitaries they received list of most affected villages of Tharad district. As a second step, they visited all suggested villages and did survey about issues i.e. ration, drinking water, approaches, cattle fatality, damages in schools and other govt. properties. Ishvar bhai and Karsanbhai was stationed there for four days.

Based on requirements of district administration and feedback of our team members, AF Mundra team had decided to march on 3rd Aug 2017 early morning with big flood rescue team.

"Disaster Management"
Building Relations Over Troubled Water : Banaskantha District

Flood Relief Work at Tharad Taluka (Banaskantha - Gujarat)							
Sr. No	Village	Details of Supported Items					
		Food Packet (Rasan Kit)	Tarpaulin with rope	Fodder	Blanket	Water (Pouch)	Requirement (2nd Layer Flood Relief)
1	Nani Pavad	150	60	25	60	1000	Fodder for cattle and Health Service
2	Datiya	285	100	30	100	1000	R.O. Plant as drinking water is too bad quality, Education Kit
3	Vadadar	250	250	25	500	1000	Bore well for clean drinking water
4	Pepar	50	50	19	100	500	Fodder, Education Kit and Health services
5	Kesargam	50	50	6	100	500	Fodder and Health services
6	Vantadau	350	300	55	0	1500	R.O. Plant and Health services
7	Mahadevpura	175	180	0	100	1000	R.O. Plant and Education Kit Health services
8	Khanpur	50	0	0	0	500	Still some part of village is submerged Cleaning required, Road repairing work and fodder, Education Kit
9	Bhachar	400	0	0	0	2000	Health camps
10	Bhadodar	100	100	0	0	1000	Health services
11	Benap	80	80	0	0		
12	Other	60	30	0	40		
	Total	**2000**	**1200**	**160**	**1000**	**10000**	

"Thanks Letter"

ધી ભડોદર દૂધ ઉત્પાદક સહકારી મંડળી લી.

મુ. ભડોદર, તા. થરાદ, જિ. બનાસકાંઠા.

તા. 3/8/2019

પ્રતિ શ્રી
અદાણી ગ્રુપ
મુંદ્રા (કચ્છ)

વિષય - આભાર પત્ર

વજાદર ગ્રામ પંચાયત

મુ.પો. વજાદર, તા. થરાદ, જિ. બનાસકાંઠા.

સરપંચશ્રી

ચૌહાણ રાઠોરભાઈ જોવારસિંહ

Mo. 99256 18446

આભાર પત્ર

"Thanks Letter"

કેશરગામ ગ્રુપ ગ્રામ પંચાયત

મુ. કેશરગામ, તા. થરાદ, જિ. બનાસકાંઠા.

સરપંચશ્રી

ચૌહાણ દેશાભાઈ જબ્બરસિંહ

Mo. 99098 39192

અભિનંદન પત્ર

ઈઢાટા ગ્રુપ ગ્રામ પંચાયત

આભાર પત્ર

"Thanks Letter"

ભાચર ગ્રામ પંચાયત

મુ. ભાચર, તા. થરાદ, જિ. બનાસકાંઠા.

સરપંચશ્રી

આંબાભાઈ સવદાસભાઈ પટેલ

Mo. 97275 31613

આભાર પત્ર

નાનીપાવડ ગ્રામ પંચાયત

મુ. નાનીપાવડ, તા. થરાદ, જિ. બનાસકાંઠા.

પ્રતિ શ્રી
અદાણી કંપની
મુન્દ્રા કચ્છ

(વિષય:- આભાર પત્ર)

Media Notes

અદાણી ફાઉન્ડેશનનો આર્થિક સહયોગ

ભુજમાં 110 વર્ષના વૃદ્ધાના થાપાનો ગોળો બદલાવાયો

જી.કે. જનરલ હોસ્પિટલમાં કરાયું સફળ ઓપરેશન

ભાસ્કર ન્યૂઝ.ભુજ

સામાન્ય રીતે વરિષ્ઠોની શસ્ત્રક્રિયા તબીબો માટે પડકારરૂપ બની રહે છે, તેવામાં ભુજની જનરલ હોસ્પિટલમાં 110 વર્ષના વૃદ્ધાના

થાપામાં ગોળો બેસાડવાનું ઓપરેશન સફળતાપૂર્વક પાર પાડવામાં આવ્યું હતું. અદાણી ફાઉન્ડેશનના આર્થિક સહયોગથી કરાયેલી આ શસ્ત્રક્રિયામાં વયોવૃદ્ધ દર્દીને લોહી ચડાવવાની કે આઈસીયુમાં રાખવાની જરૂર પણ પડી ન હતી.

મૂળ ગાગોદરના હાલે હમીપર કુભારામ આશ્રમમાં રહેતાં લાછીબેન મહાદેવ પ્રજાપતિ થોડા મહિના પહેલાં લપસી પડતાં તેમના થાપાના ભાગમાં ગંભીર ઈજાઓ થઈ હતી. તેમના પુત્ર કરસનભાઈએ સ્થાનિકે કરાવેલી સારવાર કારગત ન નીવડતાં તેમજ કેટલાક નિષ્ણાત તબીબોએ ઉંમરની દૃષ્ટિએ જોખમી જણાતા ઓપરેશનનો ઈન્કાર કરી દેતાં ભુજની અદાણી સંચાલિત જનરલ હોસ્પિટલમાં લાવ્યા હતા.

હાડકા વિભાગના ડો. પારસ મોટવાની, ડો. સંગીન ભુડિયા, ડો. ગૌરવ કાલરિયા, ડો. નવીન ગાગલ, ડો. સત્યજીત બારડ, ડો. આનંદ હિરાણીની ટીમે ઉંમરના હિસાબે જોખમી કહી શકાય તેવું થાપાનો ગોળો બદલવાનું ઓપરેશન સફળતા સાથે કર્યું હતું. તબીબોના જણાવ્યા મુજબ દર્દીએ ત્રીજા દિવસથી પથારીમાં હલન-ચલન શરૂ કર્યું હતું. અદાણી ફાઉન્ડેશનના આર્થિક સહયોગ માટે કિશોર ચાવડાએ ચાવીરૂપ ભૂમિકા ભજવી હતી.

જી.કે.માં ૧૫૦ પથારીવાળો કોર્પોરેટ વોર્ડ

ત્રણ કરોડના ખર્ચે નિર્મિત આગવી હોસ્પિટલ સમા વોર્ડને ધારાસભ્યએ ખુલ્લો મૂક્યો

૮૦૦ ગ્રામ વજનવાળા નવજાત શિશુને મોતના મુખેથી બચાવાયો

અદાણી-જી.કે. જનરલ હોસ્પિટલના

'મોનરા' તિથિ

મહિલાઓ સ્તન કેન્સર બાબતે જાગૃત બને

ભુજ - સોમવાર, તા. ૧૫-૦૫-૨૦૧૭

વાહન ચલાવતી વેળાએ જાગૃતિ અને તકેદારી રાખવાથી માર્ગ અકસ્માત થતા નિવારી શકાય

કચ્છ નાયક

અદાણી ફાઉન્ડેશન દ્વારા માછીમાર સમુદાયના યુવા માટે અદાણી પ્રિમિયર લીગ ક્રિકેટ ટુર્નામેન્ટનું આયોજ

માછીમાર સમુદાયની અદાણી પ્રીમિયર લીગમાં કિંગ ઓફ નવીનાળ ટીમ વિજેતા

અદાણી ફાઉન્ડેશન આયોજિત સ્પર્ધામાં ૫૮ ટીમોના ૬૯૬

નિ:શુલ્ક હેલ્થ કેમ્પ : અદાણી ફાઉન્ડેશન ભુજ તથા સ્વામી વિવેકાનંદ યુવક મંડળ પાનધ્રોના સહયોગથી લખપત તાલુકાના (પાનધ્રો) વર્માનગર ખાતે નિ:શુલ્ક જનરલ મેડિકલ હેલ્થ કેમ્પનું આયોજન કરવામાં આવ્યું હતું. આ કેમ્પમાં ૨૫૦ લાભાર્થીઓએ આ આરોગ્યસેવાનો લાભ લીધો.

વાહનચાલકો માટે તબીબી કેમ્પ : ...

માંડવીમાં પોલીસની 'ચાલકમિત્ર' યોજના દ્વારા મેડિકલ તપાસ યોજાઇ

૮૦૦ ગ્રામ વજન ધરાવતા નવજાત શિશુને અદાણી જી.કે.જનરલ હોસ્પિટલ માં મોતના મુખેથી બચાવાયું.

સામાન્ય રીતે બાળકનુ જન્મ થતા તેનુ વજન ૨.૫ થી ૩ કિ.ગ્રા હોવુ જોઈએ તેવા બાળકને શારીરિક રીતે સ્વસ્થ માનવા માં આવે છે. ભુજ ની અદાણી જી.કે.જનરલ હોસ્પીટલ મા માત્ર ૮૦૦ ગ્રામ વજન ધરાવતા બાળકનુ બાળ રોગના નિષ્ણાંત ડો. હરદાસ ચાવડા અને એન.આઈ.સી.યુ વિભાગના ઈનચાર્જ ડો. હસમુખ ચૌહાણ અને સ્ટાફ ખુબ જ કાળજી પુર્વક સારવાર આપવામા આવી હતી જેથી બાળક ગંભીર બીમારીઓથી બહાર આવી ગયું

ભીંજાયલા હૈયાની નહી, ભંગાયલા દિલની આ વાત
ક્યારેય નહીં ને આજે મજબુરીએ લંબાયલા હાથની આ વાત
કુદરતે આપેલ કે લઇ લીધેલ ! કેવા પ્રકોપની આ વાત
રહેમ કે જીંદાદીલી જે કહો તે બનાસની આપ વીતીની આ વાત

Adani Foundation -Mundra
Executive Summary of Budget Utilization - April to September 2017
F.Y. 2017-'18

(Rs. In Lacs)

Sr. No.	Budget Line Item	Budget F.Y.2017-18	Budget Plan upto Sept-2017	Expenditure up to Sept.17	% of total Utilization against Planned budget	% of utilization from FY 2017-18 budget	Remarks
	Admin Expense	152.05	76.03	56.65	74.51%	37.26%	
A.	Education	59.70	29.85	16.33	54.70%	27.35%	
B.	Community Health	214.49	107.25	68.89	64.23%	32.12%	
C.	Sustainable Livelihood Development	215.00	107.50	149.91	139.45%	69.72%	
D.	Rural Infrastructure Development	374.70	187.35	63.82	34.07%	17.03%	
TOTAL AF CSR Budget :		**1015.94**	**507.97**	**355.59**	**70.00%**	**35.00%**	
+	Adani Vidya Mandir-Bhadreshwar	142.08	71.04	48.82	68.73%	34.36%	
TOTAL - AF & AVMB Approved Budget :		**1158.02**	**579.01**	**404.42**	**69.85%**	**34.92%**	
+	Additional Approved Works	29.20	14.60	22.38	153.29%	76.64%	
GRAND TOTAL		**1187.22**	**593.61**	**426.80**	**71.90%**	**35.95%**	

Adani Foundation -Mundra
HR & Admin Budget Utilization - April to September 2017
F.Y 2017-18

(Rs. In Lacs)

Sr. No.	Budget Line Item	Budget F.Y. 2017-18	Budget Plan upto Sept.-2017	Expenditure up to Sept..17	% of total Utilization against Planned budget	% of utilization from FY 2017-18 budget	Remarks
A	**Salary**						
1	*Present Staff Salary*	91.50	45.75	47.33	103.46%	51.73%	
2	*New Staff Salary*	9.00	4.50	0.00	0.00%	0.00%	
3	HR Expenses	2.00	1.00	0.00	0.00%	0.00%	
	Total HR Expenses	**102.50**	**51.25**	**47.33**	**92.35%**	**46.18%**	
B	**Office Admin expenses**						
1	Office Printing and stationery	0.40	0.20	0.00	0.00%	0.00%	
2	*Travel and conveyance - Staff*	5.00	2.50	1.65	66.19%	33.10%	
3	Legal and professional fees (Lump sum)	0.05	0.03	0.00	0.00%	0.00%	
4	Office equipments and Maintenance	0.20	0.10	0.00	0.00%	0.00%	
5	*Mobile/Internet & Electricity Bill*	2.32	1.16	0.75	64.59%	32.29%	
6	Refreshment/ Guest Entertainment exp.	0.50	0.25	0.00	0.00%	0.00%	
7	Staff meetings / Trainings	0.20	0.10	0.00	0.00%	0.00%	
8	Field office / Training center rent & Field office other Expenses	1.44	0.72	0.09	13.10%	6.55%	
9	*Staff welfare activities*	4.75	2.38	0.00	0.00%	0.00%	
10	Insurance - vehicles	0.25	0.13	0.00	0.00%	0.00%	
11	Four wheel vehicle rent	12.00	6.00	3.09	51.58%	25.79%	
12	*Vehicle maintenance and fuel*	1.30	0.65	0.26	40.58%	20.29%	
13	Staff Capacity building, Training, Appreciation & Exposure visits	2.00	1.00	1.20	120.01%	60.01%	
14	Misc. Office & Admin Expense	0.24	0.12	0.00	0.00%	0.00%	
	Sub Total	***30.65***	***15.33***	***7.06***	**46.05%**	**23.02%**	
C	**Other exp.**						
1	Add. Misc. & Documentation Expenses	3.50	1.75	0.50	28.71%	14.36%	
3	***Staff SV Teachers Colony Exp***	**15.40**	**7.70**	**1.76**	22.83%	11.41%	
3.1	*Colony Maintanance Exp.*	15.00	7.50	4.54	60.50%	30.25%	
3.2	*Parking Shed in Shantivan Teacher Colony*	10.00	5.00	0.00	0.00%	0.00%	
Less:	*House Rent Recovery*	9.60	4.80	2.78	57.92%	28.96%	
	Sub Total	**18.90**	**9.45**	**2.26**	**23.92%**	**11.96%**	
	GRAND TOTAL (BUDGETED) :	**152.05**	**76.03**	**56.65**	**74.51%**	**37.26%**	

Adani Foundation -Mundra
Education Budget Utilization - April to September 2017
F.Y. 2017-'18

(Rs. In Lacs)

Sr. No.	Budget Line Item	Budget F.Y. 2017-18	Budget Plan upto Sept.2017	Expenditure up to Sept.17	% of total Utilization against Planned budget	% of utilization from FY 2017-18 budget	Remarks
1	**Support to Government / Private Educational Institutes**						
1.1	Educational Support at various Govt. schools	8.00	4.00	3.55	88.79%	44.40%	
1.2	Support to ITI	2.00	1.00	0.00	0.00%	0.00%	
	Sub Total	**10.00**	**5.00**	**3.55**	**71.03%**	**35.52%**	
2	**Adani Shaikshanik Vikas Kendra (Strenghening Primary Education)**	**5.90**	**2.95**	**1.87**	**63.55%**	**31.78%**	
2.1	Coaching & project staff Exp.	4.60	2.30	1.75	76.09%	38.04%	
2.2	Housekeeping Exp.	0.60	0.30	0.00	0.00%	0.00%	
2.3	Teaching & Learning Material Exp.	0.50	0.25	0.07	27.20%	13.60%	
2.4	Other Administrative Exp.	0.20	0.10	0.06	56.77%	28.39%	
3	**Training and Development (Strenghening Teachers of High School)**	**0.95**	**0.48**	**0.17**	**36.33%**	**18.17%**	
3.1	Seminar on " Qualities of an effective teacher" (Quarterly)	0.50	0.25	0.17	69.04%	34.52%	
3.2	Workshop 1 : "Continuous and comprehensive evaluation"	0.15	0.08	0.00	0.00%	0.00%	
3.3	Workshop 2 : "Effective Lesson Planning"	0.15	0.08	0.00	0.00%	0.00%	
3.4	Workshop 3: " Effective Administrative Skills" for Principles	0.15	0.08	0.00	0.00%	0.00%	
4	**Educational Support to Migrated Labour Children**	**10.00**	**5.00**	**0.00**	**0.00%**	**0.00%**	
5	**Support for Higher secondary students of AVMB**	**3.75**	**1.88**	**1.03**	**54.79%**	**27.40%**	
6	**Education Project Staff Salary & TA (1 CM)**	**3.10**	**1.55**	**1.25**	**80.48%**	**40.24%**	
7	**Education for Fisher folk**						
9.1	Education Initiative for children at vasahat	22.00	11.00	7.56	68.73%	34.36%	
9.2	Exposure tour, Fee & Other Edu. Support to poor students and cycle support to Fishermen Students	4.00	2.00	0.89	44.67%	22.34%	
	SUB TOTAL :	**26.00**	**13.00**	**8.45**	**65.03%**	**32.51%**	
	GRAND TOTAL (BUDGETED) :	**59.70**	**29.85**	**16.33**	**54.70%**	**27.35%**	

Adani Foundation -Mundra
Community Health Budget Utilization - April to September 2017
F.Y. 2017-'18

(Rs. In Lacs)

Sr. No.	Budget Line Item	Budget F.Y. 2017-18	Budget Plan upto Sept.2017	Expenditure up to Sept.17	% of total Utilization against Planned budget	% of utilization from FY 2017-18 budget	Remarks
B1. Community health programme - on going							
1	Medical mobile units	8.15	4.08	1.58	38.68%	19.34%	
2	Medicines for rural clinics - 12	8.75	4.38	1.65	37.82%	18.91%	
3	Medical support to very needy and poor patients	25.00	12.50	8.49	67.91%	33.95%	
	Sub Total	**41.90**	**20.95**	**11.72**	**55.94%**	**27.97%**	
B2. "Dialysis Support"							
1	Financial support for dialysis	10.00	5.00	2.27	45.37%	22.69%	
	Sub Total	**10.00**	**5.00**	**2.27**	**45.37%**	**22.69%**	
B3 Health card to Senior citizens *							
1	Health card services	90.00	45.00	28.20	62.68%	31.34%	
	Sub Total	**90.00**	**45.00**	**28.20**	**62.68%**	**31.34%**	
B4.Addressing Disability		**3.00**	1.50	0.49	32.75%	16.38%	
B5.Health Camps and Awareness programes							
1	General Health Camp for truckers	12.00	6.00	3.26	54.27%	27.13%	
	Sub Total	**12.00**	**6.00**	**3.26**	**54.27%**	**27.13%**	
Project Staff for Mundra Health Initiative		**8.59**	4.30	2.63	61.17%	30.59%	
	Grand total for Mundra Health Initiative :	**165.49**	**82.75**	**48.57**	**58.70%**	**29.35%**	
B6. Community Health Initiative from GKGH/GAIMS							
1	Medical Support to Poor Patients -GKGH	20.00	10.00	8.25	82.48%	41.24%	
2	Dignity to death - Dead body carrier vehicle support	7.00	3.50	4.22	120.63%	60.32%	
3	**Health Camps and Awareness programes**	**2.50**	**1.25**	**0.67**	**53.66%**	**26.83%**	
3.1	General Health Camp	1.00	0.50	0.27	54.75%	27.38%	
3.2	Safe Child Health Project - NEW	0.50	0.25	0.05	21.38%	10.69%	
3.3	Health Check Up Camping New	0.50	0.25	0.34	137.44%	68.72%	
3.4	GMDC Mining Labor Welfare Programme New	0.50	0.25	0.00	0.00%	0.00%	
4	Collaborative Actions in Lowering Maternity Encounters Death(CALMED)	1.50	0.75	0.01	1.35%	0.67%	
5	Medical Mobile Unit	2.00	1.00	0.61	61.12%	30.56%	
6	Project Staff & Administrative Exp.-GKGH	10.00	5.00	4.21	84.17%	42.09%	
7	Vehicle Hiring Charges	6.00	3.00	2.35	78.29%	39.15%	
	Sub Total - GKGH :	**49.00**	**24.50**	**20.32**	**82.94%**	**41.47%**	
	GRAND TOTAL :	**214.49**	**107.25**	**68.89**	**64.23%**	**32.12%**	

Adani Foundation -Mundra
Sustainable Livelihood Development Budget Utilization - April to September 2017
F.Y. 2017-'18

(Rs. In Lacs)

Sr. No.	Budget Line Item	Budget F.Y.2017-18	Budget Plan upto Sept.17	Expenditure up to Sept.17	% of total Utilization against Planned budget	% of utilization from FY 2017-18 budget	Remarks
Fisher Folk							
A	**Sustainable livelihood for Fisher folk**						
1	Community Engagement Activities	8.00	4.00	5.41	135.21%	67.61%	
2	Livelihood promotion - Income Generation to individual	5.00	2.50	1.57	62.85%	31.43%	
3	Awareness generation and capacity building	2.00	1.00	0.62	62.48%	31.24%	
4	Potable Water to Fisher Folk at vasahat	18.00	9.00	7.85	87.24%	43.62%	
5	Mangroves plantation and maintenance & Vasahat Cleaning	11.00	5.50	9.66	175.62%	87.81%	
6	Cage farming Asian Sea bass & Lobster	1.00	0.50	0.00	0.00%	0.00%	
	Fisher Folk Budget : Total	**45.00**	**22.50**	**25.12**	**111.62%**	**55.81%**	
Sustainable Livelihood							
B	**Women Empowerment**						
1	Women Empowerment	20.00	10.00	1.17	11.67%	5.83%	
	Sub Total	**20.00**	**10.00**	**1.17**	**11.67%**	**5.83%**	
C	**Agriculture**						
1	Fodder Support -	140.00	70.00	121.19	173.13%	86.57%	
2	Agriculture Initiatives and Support	10.00	5.00	2.43	48.66%	24.33%	
	Sub Total	**150.00**	**75.00**	**123.63**	**164.83%**	**82.42%**	
	TOTAL (APPROVED BUDGETED) :	**215.00**	**107.50**	**149.91**	**139.45%**	**69.72%**	
	Additional Approved Works :						
1	Cage farming Asian Sea bass & Lobster	3.00	1.50	0.00	0.00%	0.00%	
2	Polyculture	1.60	0.80	0.00	0.00%	0.00%	
3	Technical Expert for New Projects	3.60	1.80	1.51	83.92%	41.96%	
4	Flood Relief Work	21.00	10.50	20.87	198.76%	99.38%	
	Total	**29.20**	**14.60**	**22.38**	**153.29%**	**76.64%**	
	GRAND TOTAL	**244.20**	**122.10**	**172.29**	**141.10%**	**70.55%**	

Adani Foundation -Mundra
Rural Infrastructure Development Budget Utilization - April to September 2017
F.Y. 2017-'18

(Rs. In Lacs)

Sr. No.	Budget Line Item	Budget F.Y. 2017-18	Budget Plan upto Sept.17	Expenditure up to Sept.17	% of total Utilization against Planned budget	% of utilization from FY 2017-18 budget	Remarks
[1]	**Water Conservation and Ground Water Recharge**						
1.1	Pond deepening work	20.00	10.00	16.69	166.88%	83.44%	
	Sub Total	**20.00**	**10.00**	**16.69**	**166.88%**	**83.44%**	
[3]	**Education Related**						
3.1	Prayer shed in vaghervas school,bhadreshwar	5.00	2.50	0.97	38.82%	19.41%	
	Sub Total	**5.00**	**2.50**	**0.97**	**38.82%**	**19.41%**	
[4]	**Health Related**						
4.1	Sanitation block for girls in school, Sadau	3.00	1.50	1.66	110.44%	55.22%	
	Sub Total	**3.00**	**1.50**	**1.66**	**110.44%**	**55.22%**	
[5]	**Other Projects - Corporate Related**						
5.1	Drainage maintenance and JCB hiring	15.00	7.50	6.70	89.36%	44.68%	
5.2	Tuna Port Related CSR Projects	15.00	7.50	0.00	0.00%	0.00%	
5.3	Crematorium development, mundra	5.00	2.50	4.49	179.77%	89.88%	
5.4	Boundry wall and repair of iddgah, tragadi	6.50	3.25	0.00	0.00%	0.00%	
5.5	Garden work in matang temple, kandagara	4.00	2.00	3.09	154.69%	77.35%	
5.6	Basic infra. Facility in Labour Colony	20.00	10.00	0.00	0.00%	0.00%	
5.7	Infrastructure Development for HMV Drivers at North Gate	50.00	25.00	0.00	0.00%	0.00%	
5.8	Study for Mundra Town plan	5.00	2.50	0.00	0.00%	0.00%	
5.9	Development work in Zarpara & Mundra	30.00	15.00	2.84	18.91%	9.45%	
5.10	**Augmentation Of Check Dams budget** Construciton of Toilets in Bhuj taluka 2016-17 Repairing of Checkdam and river widening, kandagara 2017-18	6.00	3.00	4.38	145.88%	72.94%	
5.11	Prayer shed in school, Ragha-Luni	5.00	2.50	0.00	0.00%	0.00%	
5.12	Fisherman Shelter-house Repering-Shekhadiya	50.40	25.20	10.63	42.20%	21.10%	
	Sub Total	**211.90**	**105.95**	**32.14**	**30.33%**	**15.17%**	
[6]	**Fisherman Amenities :** **Infrastructure Support at different Bandar**	**54.80**	**27.40**	**12.37**	**45.15%**	**22.57%**	
[7]	**Startvision Projects**						
7.1	Participatory Ground Water Management	45.00	22.50	0.00	0.00%	0.00%	
	Sub Total	**45.00**	**22.50**	**0.00**	**0.00%**	**0.00%**	
[8]	**Spill Over Projects**						
8.1	Cricket Ground - Siracha	5.00	2.50	0.00	0.00%	0.00%	
	Sub Total	**5.00**	**2.50**	**0.00**	**0.00%**	**0.00%**	
[9]	**Retention Money**	30.00	15.00	0.00	0.00%	0.00%	
	GRAND TOTAL (BUDGETED) (A):	**374.70**	**187.35**	**63.82**	**34.07%**	**17.03%**	

Adani Vidya Mandir-Bhadreshwar
Budget Utilization - April to September 2017
F.Y. 2017-18

(Rs. In Lacs)

Sr. No.	Budget Line Item	Budget F.Y. 2017-18	Budget Plan upto Sept.2017	Expenditure up to Sept.17	% of total Utilization against Planned budget	% of utilization from FY 2017-18 budget	Remarks
A	**Salary Expenses**						
1	Staff Salary	51.15	25.58	19.16	74.94%	37.47%	
2	New Teachers Salary						
3	Non Teaching Staff Exp.	11.20	5.60	4.19	74.78%	37.39%	
	Sub Total	**62.35**	**31.18**	**23.35**	**74.91%**	**37.45%**	
B	**Student Expenses**						
1	Student Uniform Expense	4.42	2.21	3.20	144.62%	72.31%	
2	Food Expenses	50.30	25.15	16.04	63.78%	31.89%	
3	Text books, Notebooks and Work books Expenses	3.03	1.52	2.33	154.12%	77.06%	
4	Co-Curricular Activities	0.25	0.13	0.00	0.00%	0.00%	
5	Extra Curricular Activities Expenses	1.00	0.50	0.09	18.88%	9.44%	
6	Seminar/Conference/workshop/ Teachers Training	0.20	0.10	0.00	0.00%	0.00%	
7	Exposure Tour for Students & Staff	1.00	0.50	0.03	5.88%	2.94%	
8	Exam Fee for Board Examination	0.25	0.13	0.00	0.00%	0.00%	
9	Education Medical Expense, Student & Staff	0.20	0.10	0.00	4.60%	2.30%	
	Sub Total	**60.65**	**30.33**	**21.70**	**71.56%**	**35.78%**	
C	**Other Expenses**						
1	Mobile & Telephone bills/ Fax Expenses/Internet Charges	0.20	0.10	0.07	65.29%	32.65%	
2	Electricity Charges	2.40	1.20	1.03	85.77%	42.89%	
3	Postage & Courier Expenses	0.03	0.02	0.00	1.00%	0.50%	
4	Uniform for Peons-2, Security-2, Aaya-2,Sweeper-2	0.10	0.05	0.00	0.00%	0.00%	
5	Staff Welfare Expenses	0.15	0.08	0.00	0.00%	0.00%	
6	Misc. Expenses	1.00	0.50	0.04	8.35%	4.18%	
7	Travelling/Conveyance Expenses	0.20	0.10	0.05	47.87%	23.94%	
8	Printing & Stationary Expenses	1.50	0.75	0.51	67.49%	33.74%	
9	Newspapers & Periodical Expenses	0.10	0.05	0.01	12.80%	6.40%	
11	Vehicle Hire Charges	0.20	0.10	0.11	112.50%	56.25%	
12	House keeping	0.55	0.28	0.21	78.00%	39.00%	

Adani Vidya Mandir-Bhadreshwar
Budget Utilization - April to September 2017
F.Y. 2017-18

(Rs. In Lacs)

Sr. No.	Budget Line Item	Budget F.Y. 2017-18	Budget Plan upto Sept.2017	Expenditure up to Sept.17	% of total Utilization against Planned budget	% of utilization from FY 2017-18 budget	Remarks
13	Bike Expenses (Petrol & Maintenance)	0.20	0.10	0.10	96.39%	48.20%	
14	Vehicle Maintenance & Fuel Expenses (Transportation facilty for Science faculty)	2.85	1.43	0.15	10.72%	5.36%	
15	Water Tank Charges	0.50	0.25	0.48	192.37%	96.19%	
16	Computer Maintenance Charges (Old Computer) & UPS	0.50	0.25	0.01	4.00%	2.00%	
	Sub total	**10.48**	**5.24**	**2.76**	**52.75%**	**26.37%**	
D	**Building & Equipment related Expenses**						
1	Property Tax & Revenue Tax	0.50	0.25	0.00	0.00%	0.00%	
2	Insurance Premium						
3	School Building & Equipment Maintenance Expense + School classroom painting-2017-18	4.70	2.35	0.88	37.43%	18.72%	
	Sub Total	**5.20**	**2.60**	**0.88**	**33.83%**	**16.92%**	
	Total, Recurring expenses	**138.68**	**69.34**	**48.70**	**70.23%**	**35.11%**	
	E. Non-recurring expenses						
1	Library Books	0.30	0.15	0.00	0.00%	0.00%	
2	Smart Class	0.80	0.40	0.00	0.00%	0.00%	
3	Sport Equipment	0.20	0.10	0.00	0.00%	0.00%	
3	Kitchen Expenses	0.10	0.05	0.00	0.00%	0.00%	
4	Furniture & Fixture	0.30	0.15	0.00	0.00%	0.00%	
6	Cultural Dresses	0.20	0.10	0.00	0.00%	0.00%	
7	New CC TV Camera & Maintenance of old Camera	0.75	0.38	0.13	34.04%	17.02%	
8	New one Two wheeler	0.75	0.38	0.00	0.00%	0.00%	
	Total, Non-recurring expenses	**3.40**	**1.70**	**0.13**	**7.51%**	**3.75%**	
	Grand Total	**142.08**	**71.04**	**48.82**	**68.73%**	**34.36%**	

Annexure – 4

Prof. Dr. R. Ramesh
PhD (JNU) PhD (McGill)
Director

No. NCSCM/APSEZ/1/2017 Date: 21st November 2017

Dear Shri Shalin Shah

Kindly refer to the Service order No PURC/F/012 dt 29.8.2017 awarding consultancy to NCSCM on Preparation of comprehensive and integrated conservation plan for the APSEZ area including detailed bathymetry study and protection of creeks/mangrove area including buffer zone, mapping of co-ordinates, running length, HTL and CRZ boundary.

A progress report indicating status under the above consultancy project up to October, 2017 is enclosed. We have already sent you the hard copies of bathymetry charts of creeks. Kindly acknowledge the receipt of this report.

Best regards,

R. Ramesh 21/11/2017

R. Ramesh

Encl: as above

To
Shri Shalin Shah
Head (Environment)
Adani Ports and Special Economic Zone Limited
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Progress report on APSEZ consultancy on Integrated Management plan for mangroves and creeks in and around the APSEZ Mundra

1. Background

The Ministry of Environment and Forests have accorded Environmental Clearance (EC) vide Letter No. F.No.10-138/2008-IA.III dt. 15th July, 2014 to M/s Adani Ports and Special Economic Zone Ltd (APSEZ) to set up a multi-product SEZ at Mundra, Kachchh, Gujarat (Fig.1). The project involves development of SEZ in a notified SEZ area of 6641.2784 ha for which Environmental and CRZ clearance has been given. The activities proposed in the SEZ include:

- Processing zones
- Non-processing zones
- Warehousing zones
- Road network (trunk as well as internal)
- Bridges or culverts over natural drains
- Rail and IT communication networks
- Effluent collection network
- Water supply through freshwater sources and desalination
- Conservation & drainage network
- Effluent collection network
- Social infrastructure
- Existing airstrip
- Municipal solid waste disposal site
- Utilities & supporting infrastructure
- Disposal of treated sewage, effluents and brine from desalination plant

The SEZ covers both inland and water front areas. Industrial plots will be made by APSEZ and shall be given to the firms that would be setting up individual industries of any type who need to obtain EC before initiating their projects. The industries envisage to utilize the services of Adani port for transport of imported and exported goods. While according EC to the project, the MoEFCC have stipulated General and Specific conditions in its letter F.No.10-138/2008-IA.III dt 15 July 2014 in (viii) and (ix) of para 11 A (Specific conditions). The details of the ones relevant to NCSCM are:

- The Project Proponent (PP) shall get detailed bathymetry done for all the creeks and rivers within Port and SEZ areas along with mapping of co-ordinates, running length, HTL, CRZ boundary, mangrove area including buffer zone through NCSCM/NIOT.

- PP shall also get prepared a detailed action plan for conservation and protection of creeks, mangrove area etc. through NCSCM/NIOT and submit the same to GCZMA for their examination and recommendation. GCZMA will submit its recommendations to MoEFCC for approval.

Further in its order F.No.10-47/2008-IA.III dt 18 Sept. 2015, it gave following directions relevant to NCSCM:

A Comprehensive and integrated conservation plan including detailed bathymetry study and protection of creeks/mangrove area including buffer zone, mapping of co-ordinates, running length, HTL, CRZ boundary will be put in place. The plan will take note of all the conditions of approvals granted to all project proponents in this area, e.g., the reported case of disappearance of mangroves near Navinal creek. The preservation of entire area to maintain fragile ecological condition will be a part of the plan in relation to the creeks, mangrove conservation and conservation of Bocha island up to Baradimata and others.

NCSCM will prepare the plan in consultation with NIOT, PP and GCZMA. In recognition of the fact that the existing legal provisions under the E(P) Act 1986 do not provide for any authority to impose ERF by the Government, the plan will be financed by the PP. The implementation will be carried out by GCZMA. The monitoring of the implementation will be carried by NCSCM.

2. Compliance to the EC conditions

Accordingly Adani Ports and Special Economic Zone Limited (APSEZ) has requested the National Centre for Sustainable Coastal Management (NCSCM) to conduct bathymetry survey in creeks that are present in and around APSEZ area and for preparation of an integrated conservation plan for mangroves and creeks. Terms of Reference (ToR) were prepared and agreed upon with the following major components

a. Detailed bathymetry of creeks including the ones distributed on the seawater side, along with mapping of co-ordinates, running length, HTL, CRZ boundary in and around APSEZ area

b. Mapping of mangroves distributed in and around APSEZ area including their seaward side with buffer zones and
c. Preparation of Comprehensive and Integrated plan for preservation and conservation of mangroves and associated creeks

3. Description of Methodology

Bathymetry survey involves measurement of depth of creeks and major branch channels originating from the creeks. The method used to measure the depth is based on echosounder for depth > 0.5 m and tide pole for locations < 0.5 m. A dual beam echosounder was used to measure the depth in deeper areas and a graduated tide pole is used in shallow areas (<0.5 m of depth). Bathymetry measurements were made during high tide and tide corrections were made to account for tide induced water depth. For this purpose, tide gauges calibrated tide poles were placed at regular intervals to obtain water levels during different time period of bathymetry measurement. The data collected was processed in HYPACK software which has programmes for tide correction of bathymetry data. In dry channel branches of main creeks, Real Time Kinematic GPS is used to determine bottom levels with respect to adjoining ground to estimate depth. All the bathymetry data collected are presented in a chart with reference to Chart Datum.

4. Progress made so far:

4.1. Bathymetry of creeks

The area in and around APSEZ has five major creeks namely (i) Kotdi creek originating from Daneshwari River with two branches, (ii) Baradimatha creek originating from Nagavati river with two branches, (iii) Navinal creek adjoining main Adani Port (iv) Bocha creek and (v) Khari creek originating from Phot and Bhuki rivers. The bathymetry survey of above-mentioned 5 creeks (with branches) was initiated in April 2017 in association with M/s Indomer Coastal Hydraulics, Chennai which is specialized in bathymetry measurements. The measurements were carried out using Ceeducer PRO Echosounder/ Garmin Echosounder supported by Trimble DSM 232 DGPS Beacon Receiver (to co-record position for every depth measurement), HYPACK MAX Data collection and processing software.

The survey was carried out using low draft survey vessel equipped with safety gears. The echosounder transducer was mounted by positioning below the water surface. The DGPS receiver antenna was mounted on the mast vertically in line with the transducer, so that it represents the exact coordinates of the location where the depth is simultaneously measured by the transducer. The necessary inputs were given in HYPACK data collection software before the commencement of the survey.

The planned track lines were displayed on the monitor at the wheel for navigation. Watch guards were positioned at bow, transducer/antenna and heave compensator at rear end. The data was continuously collected in the onboard PC along each transect. After each day of data collection, the entire data was downloaded to external hard disc and stored. The recorded data will include: date, time, latitude, longitude, X coordinate, Y coordinate and heave. The depth data was recorded at 0.2 sec interval.

Bathymetry measurements have been completed in all the 5 creeks and the surveyed areas are indicated in Fig.1. In smaller channels with depths <0.5 m and adjoining mud flats, collection of topographic data has been completed. The entire data collected has been processed using HYPACK software with corrections on tidal variation and transducer draught and the depth values will be presented in maps with contour intervals.

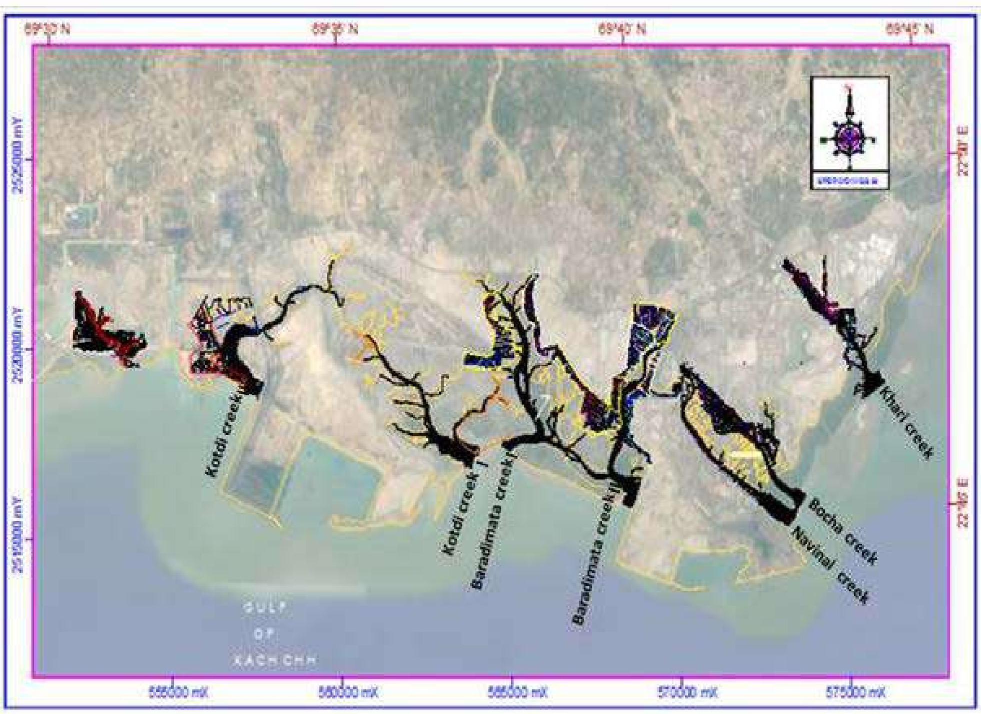

Fig.1: Bathymetry Survey – Completed areas indicated in black colour

The bathymetry charts of the creeks are placed in Figs. 2-6. The depth values are indicated with reference to Chart datum (which is presumably Lowest low tide level) and the depth may increase during high tide conditions, depending on the tidal range prevalent at a location Table 1. The green colours in the chart are inter-tidal areas with respect to mean highest high water spring. Areas beyond inter-tidal areas (elevated areas) have been indicated in yellow colour.

NCSCM in association with its consultant M/s Indomer Coastal Hydradulics, Chennai has completed the bathymetry of creeks in and around APSEZ area. The highlight of bathymetry of the creeks and running length of the creeks with water parts are indicated in Table 1.

Table 1. Depth ranges and running length of creeks in and around APSEZ area

Name of the creek	Depth range (m) w.r.t CD*	Running Length of water part of the creek during High Tide (Km)*	Running Length of the Creek (Km) including water and dry parts of the creek*
Kotdi creek I	0.1-1m	5.00	5.00
Kotdi creek II	0.1-1.8m	7.57	8.38
Baradimata creek I	0.1-5.0 m	6.15	6.29
Inter-connecting channel	Inter-tidal	2.25	2.25
Baradimata creek II	0.1-5.6m	5.59	5.94
Navinal Creek	0.1-16.8m	4.69	4.80
Bocha creek	0.1-12.2m	3.95	4.42
Khari Creek	0.9-8.9 m	3.80	4.22

* Source: Bathymetry charts at Figs 2-6.

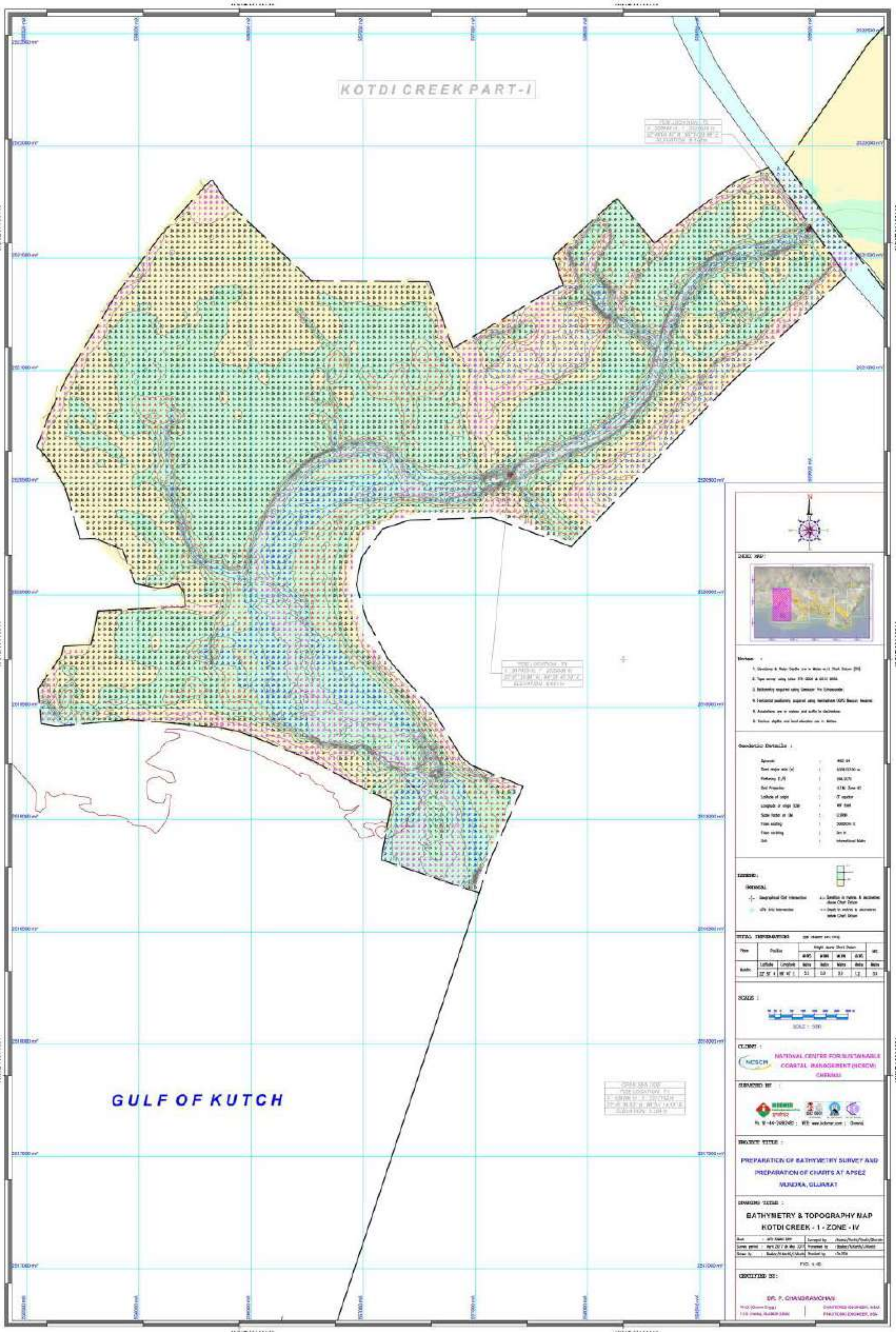

Fig 2 Bathymetry of Kotdi creek I and elevation (numbers with underscore mark) in adjoining mangrove areas

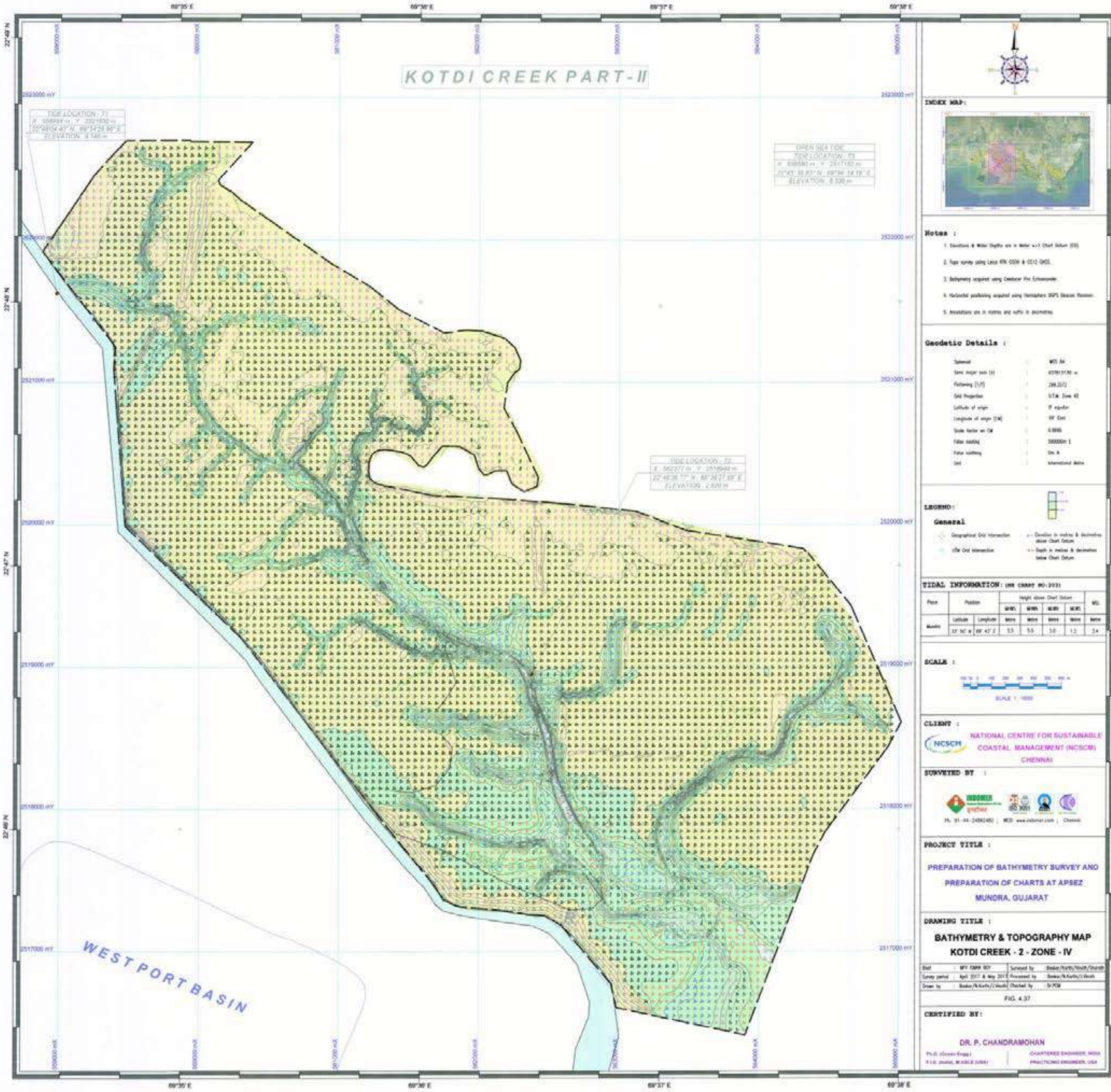

Fig 3 Bathymetry of Kotdi creek II and elevation (numbers with underscore mark) in adjoining mangrove areas

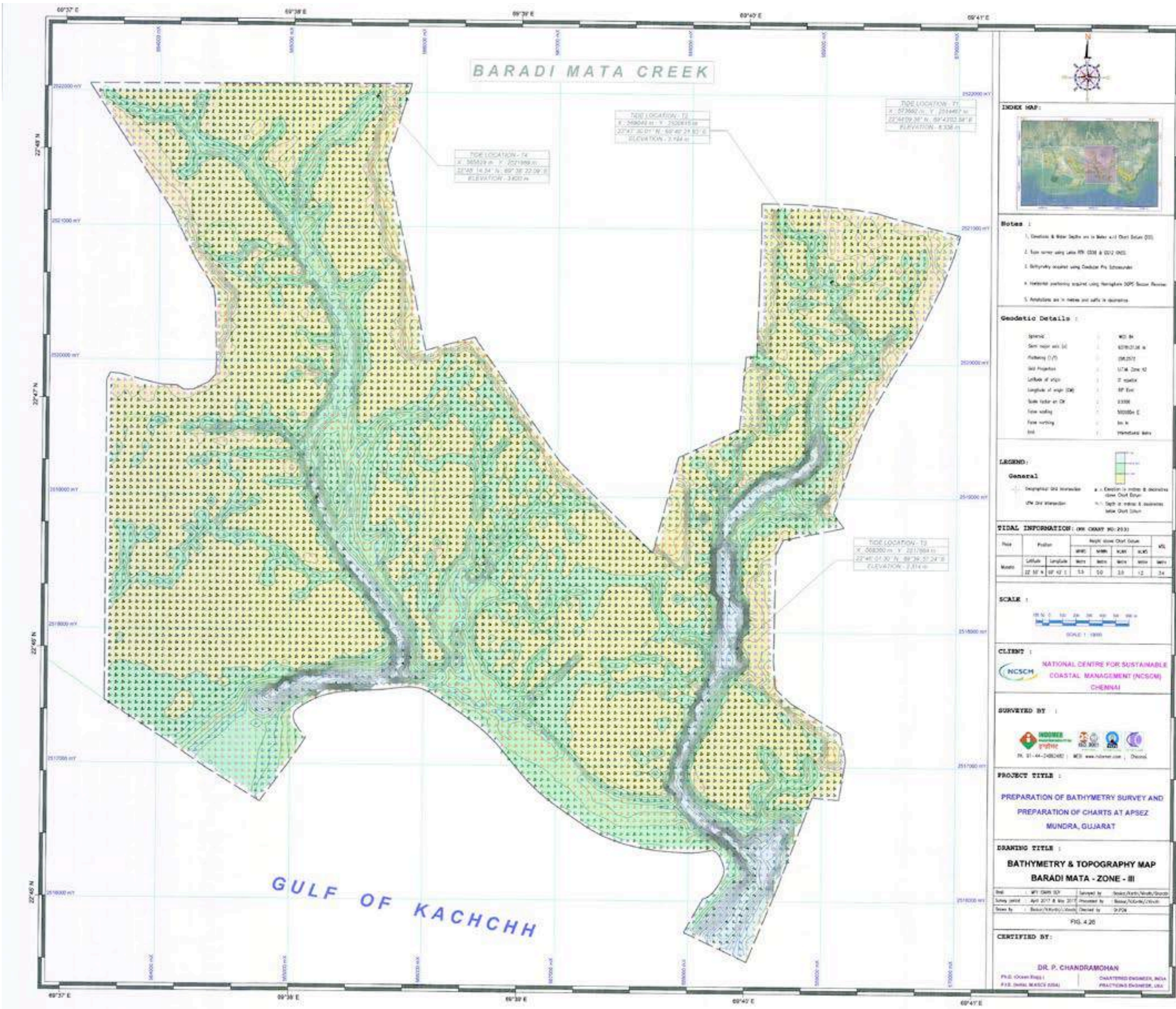

Fig.4. Bathymetry of Baradimata creeks and elevation (numbers with underscore mark) in adjoining mangrove areas

Kotdi and Baradimata creeks: These creeks are shallow compared to Bocha, Navinal and Khari creeks. While Kotdi creeks exhibited least depths and mostly exposed during the low tide conditions, the mouth regions of Baradimata creek was fairly deeper compared to Kotdi creeks. (Figs.2-4)

Navinal: Navinal creek study indicates that at the mouth and port areas were deeper with depths ranging from 0.1-16.8 m. The depth decreases from 16.8m at the mouth to 0.1m beyond the port limit. The depth was shallow, as low as 0.13 m towards interior parts of the creek. most of the branches of main creek, the creeks were totally exposed during the low tide. (Fig.5)

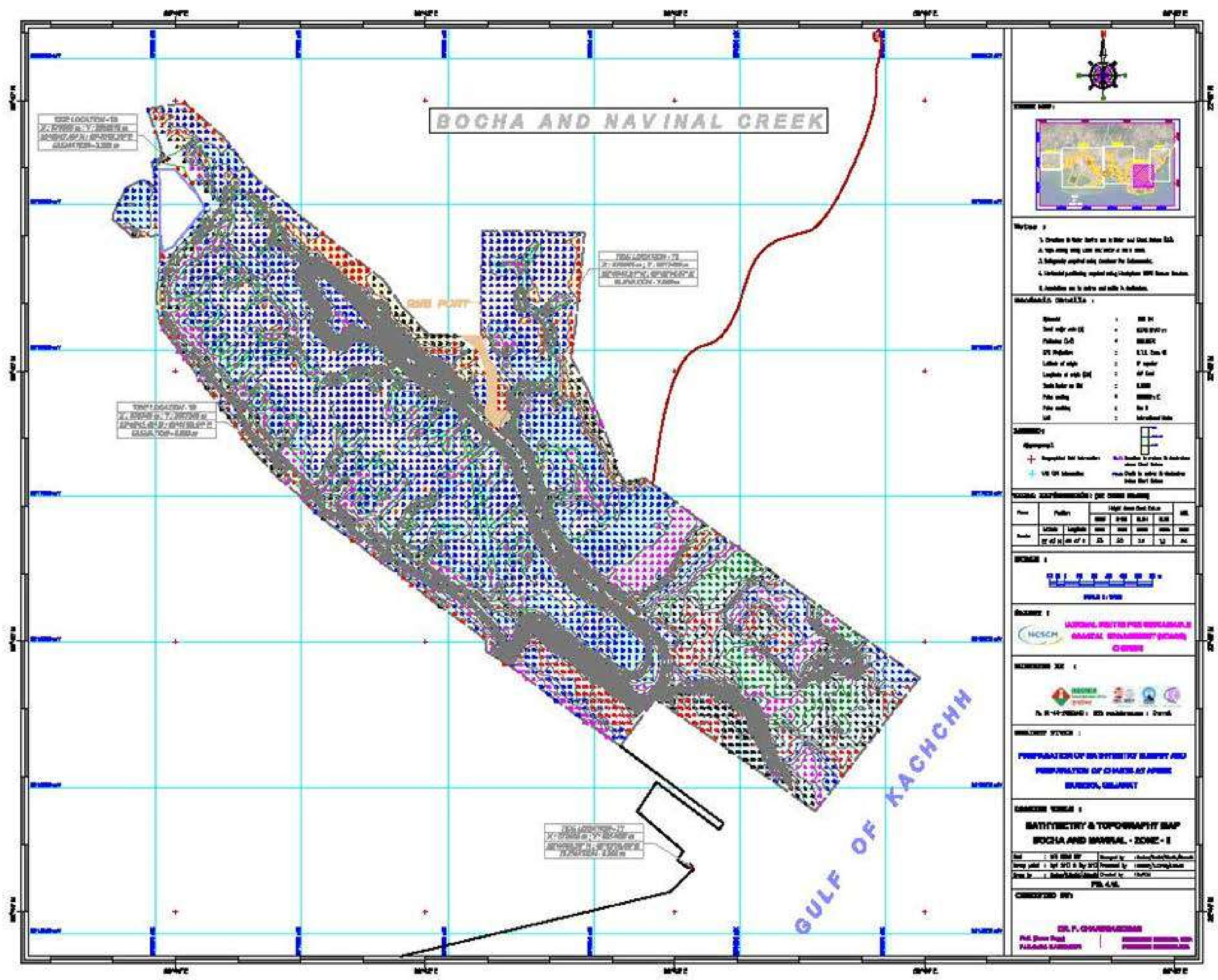

Fig.5 Bathymetry of Navinal and Bocha creeks and elevation (numbers with underscore mark) in Bocha Island

- **Bocha**: The water depth ranged from 0.3 to 12.2 m. (Fig.5) and increased from mouth to reach 12.2 m at middle of the creek. There after the depth became shallow and the creek and its branches were exposed during the low tide

- **Khari (Juna Bandar creek):** The shallow water depth of Khari creek at Junabandar with the depths ranging from 0.9 to 8.9 m and the deeper depths were noticed close to mouth areas (Fig.6)

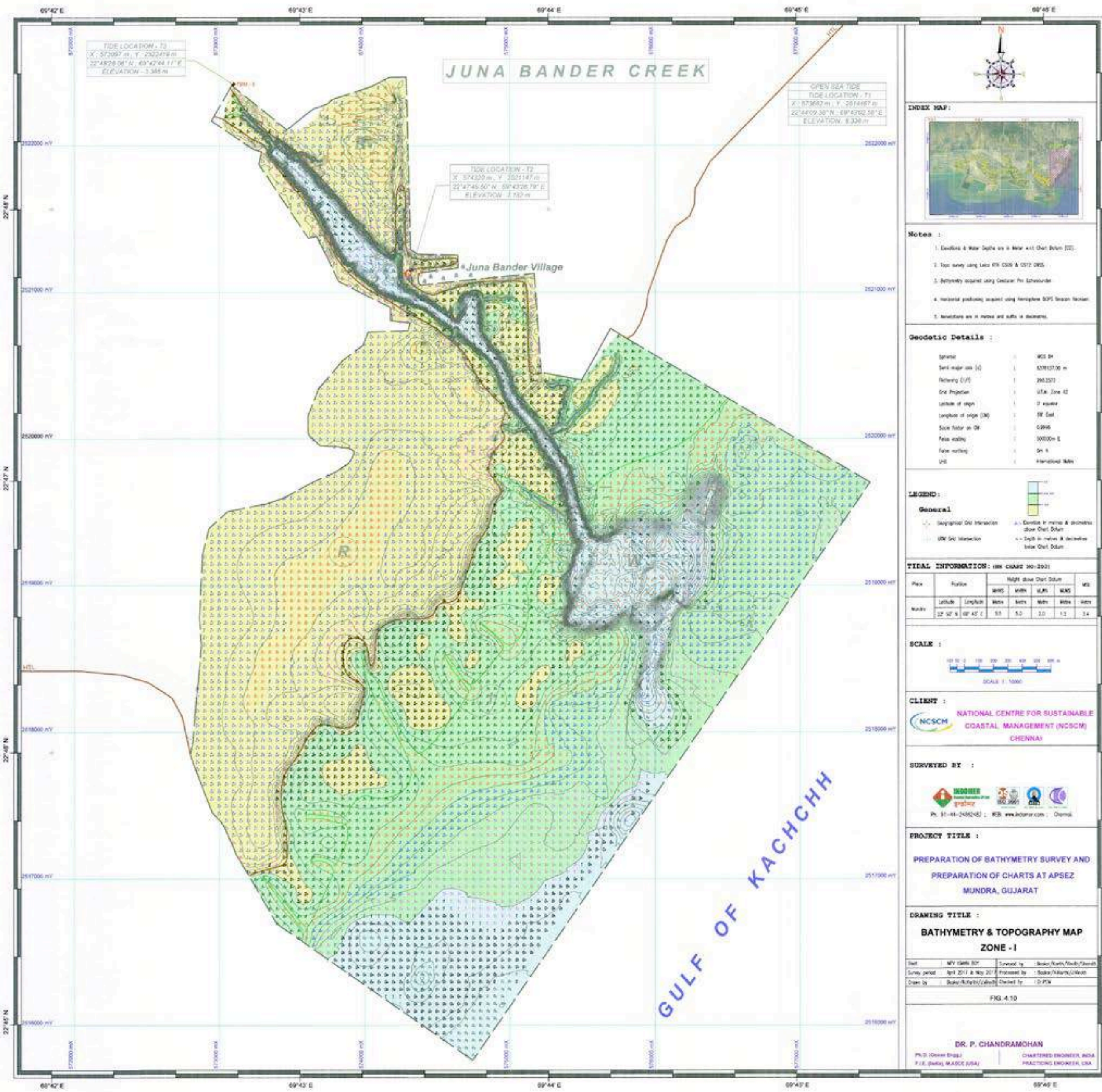

Fig.6. Bathymetry of Khari (Juna bundar) creek and elevation (numbers with underscore mark) of mangrove and mud flats around the creek

4.2. . Mapping and status of Mangroves

Maps of mangrove areas in and around APSEZ, namely Bocha island, along creeks of Bocha and Navinal, Baradimata creeks and Kotdi creeks using Google Earth pro image of 2016 for Mundra area have been prepared and field rectified. The field survey was conducted along the creeks in and around APSEZ area namely, Bocha (including island), Navinal, Kotdi, Baradimata (land mass also) and Khari between 9th and 14th of May, 2017, using Line Transect (LT) method (100m; triplicate; 50m interval). Quantitative data on mangrove vegetative structures were collected by laying quadrats (10 × 10 m) along the line transects. In each line transect, three quadrats were laid at 0, 50 and 100 m points. Within each plot, all mangroves were identified up to species level and counted according to maturity categories, such as seedling (≤1m) and tree (>1 m). Vegetation measurements such as, tree height (measured by a Distometer (Leica Disto D510)) and diameter at breast height (using a measuring tape) were made and the number of seedlings and saplings were counted species-wise in each quadrat. Further, the associated flora and fauna in each creek were identified and documented. While categorizing mangroves in terms of their density, they have been classified as dense, sparse (low height or shrubs with distance between patches less than 5 m) and scattered (shrubs and distance between patches is more than 5 m). Though the terminology of scattered is not used in mangrove literature, in order to explicitly indicate the mangrove patches are distributed far apart, this terminology has been used.

The status of the mangroves along the creeks and adjoining land/island are given in Table 2. Descriptions related to mangroves of creeks have been given in subsequent sections below.

Table 2. Summary of the structural characteristics of mangroves distributed along the study sites of APSEZ

Site Name	Area of dense mangroves (ha)*	Species Richness (*D*)	Density (No/Ha)	Basal Area (m^2/H)	Complexity Index	Diversity Indices		Recruitment (No/Ha)	Mean Girth (m ±SD)	Mean Height (m ± SD)
						H′	*S*			
Bocha island	332(571)	3	2700	39.48	22.7	0.48	0.71	5500	0.35 ± 0.24	1.97 ± 0.009
East side of Navinal Creek	Included in Bocha island	3	1566	56.58	60.74	0.17	0.93	16633	0.62 ± 0.25	2.96 ± 0.007
Khari Creek	190 (288)	2	1266	18.92	11.11	0	1	8500	0.43 ± 0.13	4.54 ± 0.002
Baradimata Creek	216 (1036)	3	1933	19	18.16	0.66	0.53	12500	0.32 ± 0.13	4.21 ± 0.018
Kotdi Creek	17 (370)	3	1733	22.72	21.90	0	1	13000	0.4 ± 0.03	5.37 ± 0.005

- Value refers only to dense part of the mangroves
- Basal area refers to cross-sectional area of a tree stem measured at breast height (1.4m)
- Complexity index of tree
- Girth indicates circumference or diameter of trunk of a tree

* values in parenthesis indicate total mangrove cover

4.2.1. Kotdi creek

Kotdi creek is located close to the West port area and adjacent to the Baradimata creek. This creek has many sub-creeks and it surrounds the West port, opening to the Arabian Sea on east and west sides of the port.

Distribution of mangroves along the creek and nearby land areas are indicated in Fig.7. It may be seen that the total mangrove cover was about 370 ha out of which dense mangroves occurred to the extent of only 17 ha, followed by sparse mangroves distributed in 181 ha. The scattered mangrove had coverage of 172 ha.

Fig.7. Mangroves of Kotdi – I and Kotdi – II creeks

a. Mangrove species composition

The mangrove species distributed in this creek includes *Avicennia marina*, *Ceriops tagal* and *Rhizophora mucronata*. The western side (northeast of West port) of the creek has dense and tall mangroves from the mouth towards the inside of creek upto≈1 km where *A. marina* dominates followed by a few *R. mucronata*. The mangroves are sparse and stunted, and beyond the *A. marina* zones, natural colonization of *C. tagal* was noticed. The eastern side of the creek is characterized by sparse, stunted, single stretched (2 m width) *A. marina* zonation followed by dense *Prosopis* sp. and sparse salt marsh towards the landward side. Plantation of *A. marina* by Gujarat Forest Department was witnessed here. In the middle of the creek (Opposite to Adani Power plant), dense and stunted (>1 m height) *A. marina* was observed; however, from this point up to the mouth (north side of the West port, where it mixes with Arabian Sea) mangroves are sparse and stunted (Fig. 8a & 8b).

Fig. 8 a Google image (2016) indicating location of sparse/stunted mangroves in Kotdi I creek (indicated as 36 - Lat.22^0 46′ 33″ Long 69^0 36′ 33″)

Fig. 8b. Photo of Stunted growth of mangrove in Kotdi I creek (Lat.22^0 46′ 33″ Long 69^0 36′ 33″)

Analysis with image of the 2004 at this location indicates that the sparse and scattered mangroves were earlier habited by mangrove vegetation of different density.

c. Associated flora and fauna

Dense distribution of *Arthrocnemum indicum* was found beyond the mangroves on the western side of the creek whereas, the eastern side has sparse vegetation. Mangrove crabs namely *Uca annulipes*, *Uca tetragonum* and *Metapograpsus messor* were observed here. Birds were represented by *Myceterialeuco cephala*, *Ardea purpurea*, *A. cinerea* and *Egretta gularis*.

d. Mangrove structure

The overall density of mangrove trees was found to be 1,733 individuals ha^{-1}. The basal area and complexity index estimated were 22.72 m^2 ha^{-1} and 21.90 respectively (Table 2). The diversity indices were found to be low (H' = 0, D = 1). In the case of recruitment of mangroves, 13,000 individuals ha^{-1}were recorded. The mean girth and height of mangrove trees were 0.4 ± 0.03 and 5.37 ± 0.01 respectively.

e. Issues

The major issue to the mangroves of both parts of the Kotdi creek include, higher elevation in scattered mangrove area to the extent of 0.1 to 2.4 m from High water level of that location (~5.5m), which prevents penetration of tidal water that is required for propagation of mangroves (Fig.2)

f. Mitigation measures

Hydrological correction is required for enhancing the frequency of tidal inundation to the sparse and scattered mangrove areas so that natural colonization can take place. This will be attempted in the Conservation plan of mangroves based on modeling studies which will provide extent of possibilities for increasing tidal flow in to the Kotdi creeks.

4.2.2. Baradimata creek

The Baradimata creek is located between the South port and West port and adjacent to the Kotdi creek (Fig.1). This creek is divided into two major creeks and many sub-creeks. Presence of distinct islets are witnessed inside the creek. Major creeks open into the Arabian Sea on the northern side and are interconnected close to the mouth.

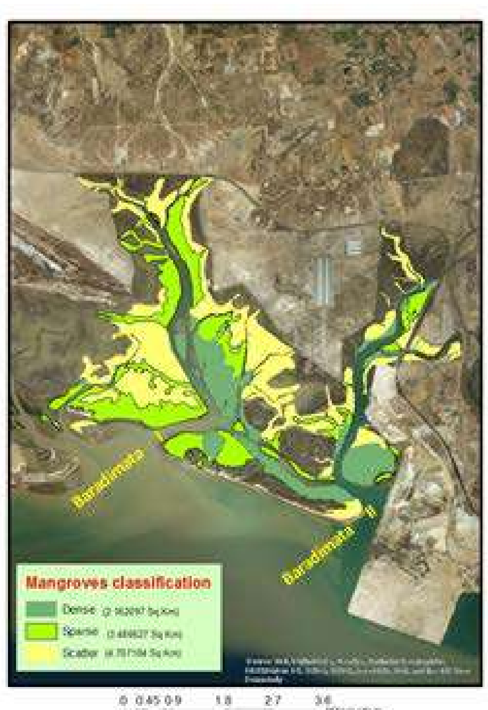

Fig. 9. Mangroves of Baradimata – I and Baradimata – II creeks

a. Mangrove species composition

Mangrove cover of the Baradimata land area was about 1036 ha (Fig.9). Out of this, scattered vegetation was found to be dominating with 45.5% (471 ha), followed by sparse vegetation with 33.7% (349 ha) and the least being dense vegetation with 20.8%.

(216 ha). The species present were *Avicennia marina*, *Ceriops tagal* and *Rhizophora mucronata*. Mangroves along the creek banks (periphery) were dense (≈10 m width) beyond which scanty distribution of salt marsh could be seen. The major creek on the eastern side has all the three species with a good dense patch of *R. mucronata* between the *A. marina*. In the case of the second major creek, the western side had a mono specific distribution of *A. marina* with stunted growth, whereas tall (≈6.5 m) and dense mangroves were distributed on the east side of the creek. The natural colonization of *A. marina* was witnessed along the northern side of the pit near to the mouth and the creeks were connected together. The island found on the seaward side has dense mangroves on the northern side and sparse mangroves on the southern side.

c. Associated flora and fauna

Sparse distribution of *Arthrocnemum indicum* was recorded behind the mangrove area towards landward side. Dense colonization by *Prosopis* sp. was observed just behind the mangrove zonation. Mangrove crabs, *Uca annulipes*, *Uca* sp. and *Metapograpsus messor* and swimming crab *Portunus pelagicus* were recorded here. Coastal birds namely *Casmerodius albus*, *Myceterialeuco cephala*, *Ardea purpurea*, *Egretta gularis*, *Platalealeu corodia* were observed in this creek.

d. Mangrove structure

The density of mangrove trees in the Baradimata creek is 1,933 individuals per hectare (Table 2). The basal cover of mangrove trees was recorded to be 19 m^2 ha^{-1}. The estimated complexity index was 18.16 (Table 2). The diversity indices were found to be low (H'= 0.66, D = 0.53). The recruitment of juveniles recorded was 12,500 individuals ha^{-1}. The mean girth and height is calculated to be 0.32 ± 0.13 and 4.21 ± 0.02 respectively.

e. Observation and recommendation

The sparse and scattered mangrove areas have been remaining in the similar conditions over the years as evidenced when Satellite images of 2016 and pre 2005 were compared. Hence it is suggested that the area should remain as per present condition without undertaking any developmental activities. No dredge spoil should be dumped off the mouth which may affect the tidal flow and also may cause erosion of banks of creeks resulting in loss of mangrove vegetation.

4.2.3. Bocha island and creek

The Bocha island is situated between Navinal and Bocha creeks. Mouth of the Navinal creek is used as Port basin. The total mangrove cover of the island is about 571 ha including banks of Navinal and Bocha creeks (Fig.10) with dense mangroves contributing to the highest percentage of 58% (332 ha), followed by scattered as 24 % (135 ha) and sparse 18% (104 ha).

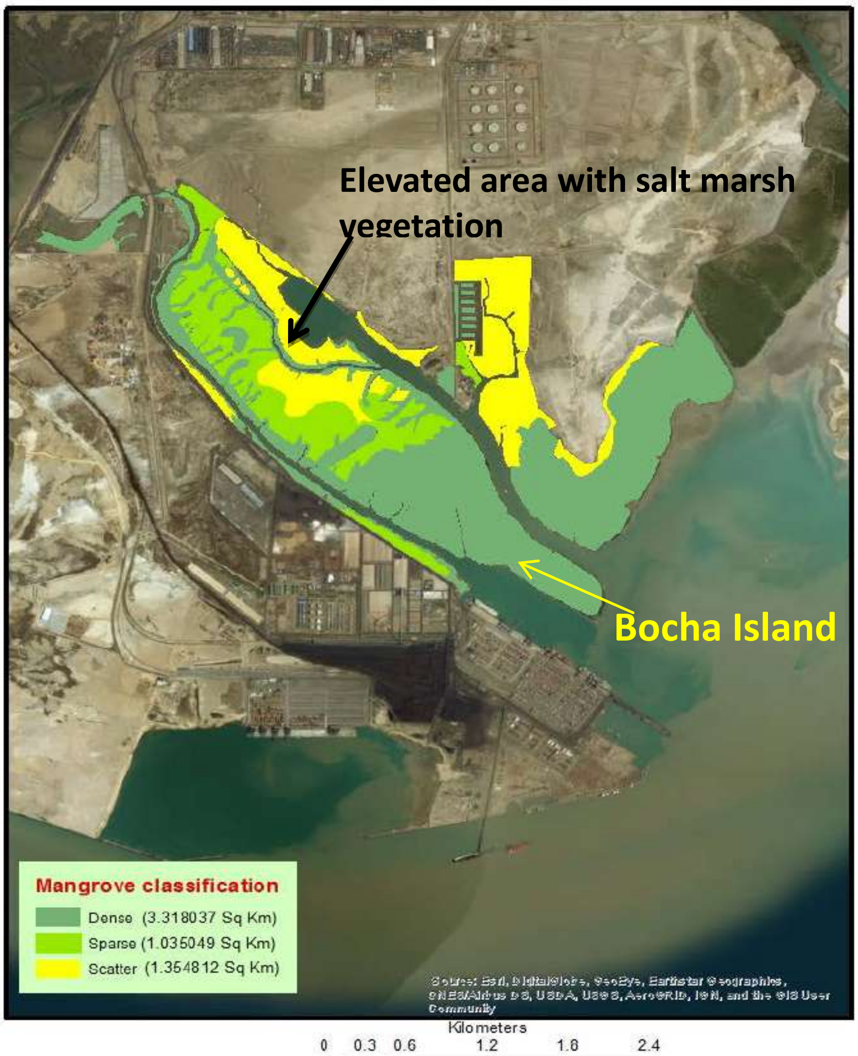

Fig. 10. Distribution of mangrove vegetation in Bocha island

a. Mangrove species composition

There were three mangrove species distributed along the Bocha creek *viz*., *Avicennia marina, Ceriops tagal* and *Rhizophora mucronata* (Figs. 11 a-c). A major mono specific expansion of *A. marina* was recorded along the creeks except at the mouth where *C. tagal* and *R. mucronata* were found to be mixed. In general, tall mangroves were found either near the creek mouth or along the banks up to the middle. In other places, the mangroves had stunted growth and towards the northen side at elevated locations (~0.1-1.6 from spring high water level = ~5.5m), sparse distribution of salt marsh species was noticed (Fig.10)

(a)

(b)

(c)

Figs 11 a-c. Mangrove species recorded at creeks in and around APSEZ(a) ***Avicennia marina*** **(b)** ***Ceriops tagal*** **(c)** ***Rhizophora mucronata***

c. Associated flora and fauna

Sparse and scattered distribution of salt marsh species, *Arthrocnemum indicum* and *Suaeda fruticosa* were recorded towards the landward side. Mangrove crabs were represented by *Uca annulipes*, *Metapograpsus mesor*, *Grapsusalb olineatus* and *Metaplax indica* (Fig.12). Birds such as *Threskiornis melanocephalus*, *Casmerodius albus*, *Myceteria leucocephala, Sterna aurantia and Vanellus indicus* were observed during the survey. Occurrence of crabs like *Uca* sp indicates that the existing mangrove ecosystem is healthy in terms of associated biodiversity.

Grapsusalbo lineatus

Uca sp

Fig.12. Associated fauna

d. Mangrove structure

The overall tree density for Bocha creek is 2700 individuals ha^{-1}. The basal cover and complexity index was found to be 39.48 m^2ha^{-1} and 22.7 respectively (Table 2). The Shannon-Wiener diversity (*H'*) and Simpson Dominance (*S*) was found to be low (0.48, 0.71). The recruitment of mangrove juveniles was found to be 5500 individuals ha^{-1}. The mean girth and height was estimated to be 0.35 ± 0.24 m and 1.97 ± 0.009 m respectively.

e. Issues

The major issues observed along the Bocha Island are given below:

(i) Despite the high tidal amplitude, there is less frequency of tidal inundation at north central part of the creek which is due to elevated topography (Example Location indicated in Fig.10 with elevation of 0.5 m more than spring high tide and photo in Fig. 13).

(ii) Erosion along the banks of the creek and tip of the Bocha island causing damage/loss of mangroves and sea facing mud flats (Fig.14).

Fig.13. Elevated north part of the Bocha island with growth of salt marsh vegetation (Lat. 22°46′06.31 N and Long. 69°41′35.06)

Fig. 14. Erosion of banks of Bocha island in the Bocha creek side with mangrove vegetation

f. Mitigation measures

The issue of no tidal inundation in elevated part of the island and erosion of banks are being analysed. Mathematical model simulating the existing topographic conditions with prevalent tidal range for such areas in the mangrove region in and around APSEZ is being developed to explore the possibility of reaching the tidal water in the area so that formation of mangrove vegetation will commence after appropriate interventions. Regarding the erosion at the tip of the island facing Gulf of Kachchh which has led to loss of mangroves and mud flats compared to the previous years, it is understood that the cause of erosion might be alteration of the coastal processes prevailing in the nearshore waters. Therefore it is suggested that no further developmental and other activities that disturb/alter the coastal processes should be undertaken in the sea around the tip of the island and also along both Navinal and Bocha creeks adjoining the Bocha Island. This will avoid further loss of mangroves and mud flats by way of increased erosion. Remedial measures to prevent erosion of tip of island will be suggested after conclusion of modelling studies.

4.2.4. Navinal Creek

a. Creek location

This creek is situated on the western side of the Bocha Island and it dissects the Island and the existing Port of APSEZ (Fig.1). Several small sub-creeks/ branches are present, of which one connects the Bocha creek on the northern side.

b. Mangrove species composition

Three mangroves species namely *Avicennia marina*, *Ceriops tagal* and *Rhizophora mucronata* were recorded on the Bocha island banks of this creek. Like Bocha creek side of Bocha island, the species richness is heterospecific near the mouth and thereafter monospecific represented by *A. marina* up to the end of the creek on the eastern side. The mangroves along the banks are distinctly tall (≈5.5 m) but occupy only a 10 m wide stretch on the periphery followed by stunted mangroves inwards. The western side of the creek was covered with *A. marina* as a single stretch of ≈7 m width. The creek banks of Bocha island side were highly eroded near the creek mouth (Fig.15). New recruitment of *A. marina* (seedlings and established saplings) was found along the creek banks indicating commencement of natural regeneration of mangroves.

Fig. 15. Erosion of banks of Bocha island along the Navinal creek

c. Mangrove structure

The density of trees found here is 1566 individuals ha^{-1}. The basal cover and complexity index was estimated as 56.58 m^2ha^{-1} and 60.74 respectively (Table 2). Low diversity indices were recorded (*H'*, 0.17; *D*, 0.93). The recruitment of *A. marina* colonizing along the waterfront areas of the creek was calculated as 16,633 juveniles per hectare. The mean girth and height recorded were 0.62 ± 0.25 and 2.96 ± 0.007 respectively.

c. Associated flora and fauna

Sparse distribution of *Arthrocnemum indicum* was observed within this creek. The distribution of mangrove crabs such as *Metapograpsus messor*, *Metaplax indica*, *Uca annulipes*, *Grapsusalbo lineatus* were observed. Birds such as *Egretta gularis*, *Himantopus himantopus*, *Vanellus indicus* and *Casmerodius albus* were found foraging on the exposed banks.

d. Issues

The major issue was erosion of creek banks of Bocha island near the mouth of Navinal creek resulting in loss of frontline mangrove vegetation of Bocha Island (Fig.16)

Fig.16. Erosion of banks of Bocha island along Navinal creek

e. Mitigation measures

Recommendations for stabilisaton of banks of Navinal creek through appropriate interventions will be made after conducting mathematical modelling studies.

4.2.5. Khari creek

a. Creek location

Khari creek is ≈3.5 km in length and branched with two major and many small sub-creeks, located near Juna bander (Fishermen settlement) (Fig.1)

b. Mangrove species composition

The mangrove cover of the creek area is about 288 ha. The order of distribution of dense, sparse and scattered mangroves were 190 ha (66%), 40 ha (14%) and 56 ha (20%) as shown in Fig 17. A mono specific expansion of *Avicennia marina* is observed in the Khari creek along with very few *Rhizophora mucronata* species. Stunted and sparse distribution of *A. marina* was observed along the creek banks except the mouth, where the mangroves are tall (≈4.5 m) and moderately dense. The creek mouth possesses a wide mudflat with the natural colonization of *A. marina*.

Fig.17 Mangrove cover of Khari creek

c. Associated flora and fauna

Salt marsh *Suaeda* sp. is moderately distributed in this creek. Mangrove crabs *Uca tetragonum*, *Uca* sp and *Metapograpsus messor* were recorded from this creek. Birds were represented by *Egretta gularis*, *Ardea cinerea*, *Platalealeu corodia*, *Myceterialeuco cephala*, *Corvus splendens* and *Himantopus himantopus*.

d. Mangrove structure

The tree density of the Khari creek was found to be 1,266 individuals per hectare. The basal cover and complexity index was estimated as 18.92 m^2 ha^{-1} and 11.11 respectively (Table 2). Due to the monospecies distribution of *A. marina*, the diversity indices were low (H'= 0; D = 1). Natural recruitment of *A. marina* was recorded as 8,500 juveniles per hectare. The mean girth and height of *A. marina* is 0.43 ± 0.13 and 4.54 ± 0.002 respectively.

e. Issues

The major issue observed in the Khari creek was cutting of Mangrove trees by human as evident from Photo at Fig 18, which may cause erosion of banks of Khari creek posing a threat to existence of mangrove vegetation.

Fig. 18. Erosion on the banks of Khari creek and cutting of mangrove vegetation

f. Mitigation measures

- The mangrove felling by human needs to be analysed and a suitable solution through stakeholder consultation to prevent such felling is necessary

4.3. Mangrove Health

a. Basal cover

Basal area is an indicator to measure the forest stand development and to understand species population, biomass and productivity in response to stress factors. The pristine mangrove forests with slight impacts will have a basal area of >25 m^2 ha^{-1}; secondary forest is found to have around 15 m^2 ha^{-1}; and disturbed forests havebasal areas of <10 m^2 ha^{-1}. Thus, results indicate that low stand of basal area recorded at Khari, Baradimata and Kotdi creeks are due to low structural development. In most of the creeks, *Avicennia marina* had better basal area coverage in comparison to other reported species. **The mangroves at Bocha and Navinal creeks can be classified as pristine mangroves.**

b. Complexity index

The complexity index is an integrative measure that combines a quantitative description of the floral and structural characteristics of mangrove vegetation. However, the mono species dominance causes the reduction in structural complexity and ecosystem services. Our findings revealed that Bocha island has the largest complexity index (60.74) owing to taller canopy and larger basal areas when compared with the mangroves documented along the other creeks. The low tree density and basal cover is an indication of the reduced structural complexity with disturbed conditions. For example, in Andaman mangrove forests, the complexity index ranged between 87.14-268.74 and 6.69-14.18 in undisturbed and disturbed forests respectively.

c. Regeneration potential

The quality of crop and productivity of forest stands determined by population growth, and is thus chiefly determined by seedling recruitment and survivorship. The evaluation of the regeneration potential involves assessment of seedling and sapling density, composition, sizes and the possibility of recruitment into the adult canopy. For adequate natural regeneration potential of a stand, the following criteria are required:

- ✓ a minimum of 2500 well distributed seedlings per hectare
- ✓ the total number of seedlings and saplings are > 50% of the number of mature trees per hectare

Field surveys by NCSCM revealed that all the mangrove stands in the creeks of Port and SEZ have adequate natural regeneration potential either as***'potential regeneration'*** (juvenile measuring <30 cm) or '***established regeneration'*** (30 cm to 1 m). However, erosion along the creek banks makes the seedlings starved, where the juveniles regenerate. Generally, seedling density is high outside the canopy cover since it requires regular inundation and sun light. Field observation exhibited that the regeneration potential was significant in *Avicennia marina* compared to *Rhizophora mucronata* or *Ceriops tagal* due to the monospecific expansion of *A. marina*. In mixed stands, regeneration potential is almost equal.

Due to the deeper depth at the mouth of the Baradimata creek , the natural colonization of mangroves along the front line areas is well established. However, the mouth should be regularly monitored otherwise there is a chance of closing of mouth due to accretion/ sedimentation.

d. Species diversity

There are only three mangrove species *viz.*, *Avicennia marina*, *Rhizophora mucronata* and *Ceriops tagal* present in the creeks. *A. marina* is predominantly present in the creeks. Absence of a clear mangrove zonation pattern is witnessed in the creeks of Port and SEZ.

4.4. Associated species

Occurrence of wide range of associated fauna especially *Uca* sp indicates that associated faunal diversity around the dense mangrove environment is healthy.

5. Mitigation measures

5.1. Hydrology

The mangroves are highly sensitive to minor alterations in the hydrology of an area. Generally, regeneration takes place when the normal tidal hydrology is restored in elevated areas (for e.g., central part of Bocha creek, as indicated in Fig. 7) and the supply of seeds or propagules from adjacent stands is re-established. Mangroves can be established (restored in some areas) through meticulous hydrological corrections which will be suggested after completion of modelling studies.

6. Completion of remaining tasks

The tasks remaining are following

1. **Bathymetry maps with HTL and CRZ areas**
   The HTL data from satellite image will be plotted on the bathymetry map and verified with field HTL data collected at the time of bathymetry survey. The CRZ areas will also be mapped.
2. Finalising buffer in mangrove maps
3. **Preparation of integrated plan for conservation of mangroves and the creeks**

Using the mangrove maps prepared and elevation data obtained over sparse and scatter mangroves, based on field observations and mathematical modeling results, measures will be suggested to facilitate inflow of seawater to set a condition for growth of mangroves. The task of modeling is in progress.

As a part of the conservation plan, the extent of dependence on mangrove plants for fuel and fodder will be determined from the communities living around mangrove areas of APSEZ through Focus Group Discussion. The data will be used to suggest use of alternate methods against mangrove vegetation.

Annexure – 5

"HALF YEARLY ENVIRONMENTAL MONITORING REPORT"

FOR

adani

ADANI PORTS AND SPECIAL ECONOMIC ZONE LIMITED
TAL: MUNDRA, KUTCH, MUNDRA – 370 421

MONITORING PERIOD:
APRIL 2017 TO SEPTEMBER 2017

PREPARED BY:

Pollucon

POLLUCON LABORATORIES PVT.LTD.

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TC - 5945 ISO 9001:2008 ISO 14001:2004 OHSAS 18001:2007

MARINE WATER MONITORING SUMMARY REPORT

RESULTS OF MARINE WATER [M1 LEFT SIDE OF BOCHA CREEK - N 22°45'183" E 069°43'241"]

SR. NO.	TEST PARAMETERS	UNIT	APRIL 2017		MAY 2017		JUNE 2017		JULY 2017		AUGUST 2017		SEPTEMBER 2017		TEST METHOD
			SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	
1	pH	--	7.96	8.04	8.02	8	8.08	8.19	8.14	8.18	8.11	8.23	7.96	8.04	IS3025(P11)83Re.02
2	Temperature	ºC	28	29	29	30	29	30	28	29	28	29	29	30	IS3025(P9)84Re.02
3	Total Suspended Solids	mg/L	18	20	14	20	24	18	16	22	18	24	16	22	IS3025(P17)84Re.02
4	BOD (3 Days @ 27 ºC)	mg/L	BDL*	BDL*	BDL*	BDL*	7	10	3	4	BDL*	4	BDL*	BDL*	IS 3025 (P44)1993Re.03Edition2.1
5	Dissolved Oxygen	mg/L	5.60	5.20	5.6	4.6	5.6	5	5	4.6	5.2	4.8	5.8	5.4	IS3025(P38)89Re.99
6	Salinity	ppt	41.40	41.80	41.2	42.8	40.54	41.17	38.21	39	34.6	35.8	31.4	32.8	APHA (22ndEdi) 2550 B
7	Oil & Grease	mg/L	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	APHA(22ndEdi)5520 D
8	Nitrate as NO_3	mg/L	0.500	0.730	0.532	0.598	0.673	0.734	0.63	0.72	0.54	0.7	0.6	0.69	IS3025(P34)88
9	Nitrite as NO_2	mg/L	0.022	0.035	0.03	0.047	0.06	0.072	0.058	0.069	0.06	0.067	0.021	0.033	IS3025(P34)88 NEDA
10	Ammonical Nitrogen as NH_3	mg/L	0.980	1.130	0.924	1.1	0.721	0.887	0.8	0.99	0.74	0.89	0.85	1.16	IS3025(P34)88Cla.2.3
11	Phosphates as PO_4	mg/L	0.048	0.100	1.03	1.215	0.636	0.781	0.75	0.83	0.46	0.64	0.044	0.98	APHA(22ndEdi) 4500 C
12	Total Nitrogen	mg/L	1.600	1.910	1.486	1.745	1.454	1.693	1.47	1.77	1.34	1.657	1.471	1.883	IS3025(P34)88
13	Petroleum Hydrocarbon	mg/L	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	PLPL-TPH
14	Total Dissolved Solids	mg/L	46980	47860	48593	48878	49870	50560	47580	48670	37580	38670	36980	37860	IS3025(P16)84Re.02
15	COD	mg/L	19	24	19	28	29	38	9	19	10	20	15	24	APHA(22ndEdi) 5520-D Open Reflux
16	Oxidisable Particular Organic Carbon	%	0.530	0.470	0.6	0.44	0.68	0.48	0.44	0.38	0.5	0.42	0.48	0.37	SOP – PLPL – 07
A	**Flora and Fauna**														
17	Primary productivity	mgC/L /day	2.700	1.350	1.125	0.338	2.02	0.9	1.91	0.428	2.21	0.522	2.7	1.46	APHA (22nd Edi) 10200-J
B	**Phytoplankton**														
18.1	Chlorophyll	mg/m^3	2.670	0.908	1.28	0.267	1.816	0.427	2.18	0.534	2.76	0.504	2.67	0.9	APHA (22ndEdi) 10200-H

H. T. Shah Lab Manager	POLLUCON LABORATORIES PVT. LTD. SURAT-3	Dr. ArunBajpai Lab Manager (Q)

18.2	Phaeophytin	mg/m^3	1.290	3.017	0.98	1.39	0.072	1.348	0.203	1.727	0.198	1.62	BDL*	1.03	APHA (22nd Edi) 10200-H
18.3	Cell Count	Unit x 10^3/L	250.0	314.0	147	52	186	45	232	54	178	52	252	110	APHA (22nd Edi) 10200-H
18.4	Name of Group Number and name of group species of each group	--	Bacillariophyceae Coscinodiscus sp. Pinnularia sp. synendra sp. Navicula sp. Pleurosigma sp. Green algae Volvox sp. Chlorella sp. Ulothrix sp. Cyanophyceae Oscillatoria sp. Nostoc sp.	Bacillariophyceae Fragillaria sp. Navicula sp. Pinnularia sp. Melosira sp. Green algae Spirogyra sp. Spirogyra sp. Cyanophyceae Oscillatoria sp.	Bacillariophyceae Nitzschia sp. Rhizosolenia sp. Navicula sp. Asterionella sp. Cymbella sp. Synedra sp. Green Algae Pandorina sp. Pediastrum sp. Ulothrix sp. Cyanophyceae Oscillatoria sp. --	Bacillariophyceae Navicula sp. Fragillaria sp. Pinnularia sp. Biddulphia sp. Green Algae Ulothrix sp. Cyanophyceae Oscillatoria sp. Spirulina sp. -- -- -- --	Bacillariophyceae Asterioello.sp Navicula sp. Nitzschia sp. Coscinodiscus sp. Pinnularia sp. Rhizosolenia sp. Amphora sp. Cyanophyceae Chlorella sp. Volvox sp. Hydrodictyon sp. Hydrodictyon sp. --	Bacillariophyceae Asterionella sp. Cyclotella sp. Fragillaria sp. Coscinodiscus sp. -- -- Cyanophyceae Oscillatoria sp. Spirulina sp. Green Algae Chlorella sp. Spirogyra sp. --	Bacillariophyceae Biddulphia sp. Fragillaria sp. Gomphonema sp. Rhizosolenia sp. Cymbella sp. Thallasiosira sp. Cyanophyceae Anabaena sp. Oscillatoria sp. Nostoc sp. Green Algae Chlorella sp. Hydrodictyon sp.	Bacillariophyceae Gomphonema sp. Nitzschia sp. Synedra sp. Fragillaria sp. Cyanophyceae Spirulina sp. Oscillatoria sp. Green Algae Chlorella sp. Hydrodictyon sp. -- -- --	Bacillariophyceae Biddulphia sp. Fragillaria sp. Gomphonema sp. Rhizosolenia sp. Cymbella sp. Thallasiosira sp. Cyanophyceae Anabaena sp. Oscillatoria sp. Nostoc sp. Green Algae Hydrodictyon sp. Pediastrum sp.	Bacillariophyceae Fragillaria sp. Synedra sp. Nitzschia sp. Gomphonema sp. Cyanophyceae Spirulina sp. Green Algae Chlorella sp. Hydrodictyon sp. -- -- -- --	Bacillariophyceae Coscinodiscus sp. Gomphonema sp. Gyrosigma sp. Pleurosigma sp. Navicula sp. Synedra sp. Pinnularia sp. Cyanophyceae Oscillatoria sp. Nostoc sp. Anabaena sp. Green Algae Ankistrodesmus sp Chlorella sp. Pandorina sp. Ulothrix sp.	Bacillariophyceae Coscinodiscus sp Nitzschia sp. Gomphonema sp. Skeletonema sp. Thallasionema sp. Cyanophyceae Microcystis sp. Oscillatoria sp. Green Algae Chlorella sp. Pandorina sp. Pediastrum sp. -- -- -- --	APHA (22nd Edi) 10200-H
C	**Zooplanktons**														
19.1	Abundance (Population)	no/m^2	313	38	280	60	275	100	240	80	250	78	425	150	APHA (22nd Edi) 10200-G

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19.2	Name of Group Number and name of group species of each group	--	copepods Fish egg Cyclops Gastropods	Copepods Cyclops Daphnia	Gastropods Isopods Decapods Krill Namatodes Molluscans Copepods	Copepods Polychaete worms Crustaceans -- --	Crustaceans Cyclops Decapods Copepods Gastropods Rotifers --	Copepods Crustaceans Platinelminths -- -- -- --	Copepods Decapods Ostracods Crustaceans Krill Barnades	Polychaetes Worms Crustaceans Gastropods -- -- --	Copepods Decapods Ostracods Crustaceans Krill Barnades	Polychaete worms Crustaceans Gastropods -- -- --	Copepods Decapods Gastropods Polychaete worms Cyclops	Echinoderms -- --	APHA (22nd Edi) 10200-G
19.3	Total Biomass	ml/100 m^3	225	4	38	23	91	18	87.8	8.4	77.3	8.2	76.3	12.1	APHA (22nd Edi) 10200-G
D	**Microbiological Parameters**														
20.1	Total Bacterial Count	CFU/ml	1780	1520	1130	870	1840	1580	1480	1020	1680	1160	1780	1520	IS 5402:2002
20.2	Total Coliform	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	APHA(22ndEdi)9221-D
20.3	Ecoli	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS:1622:1981Edi.2.4 (2003-05)
20.4	Enterococcus	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 15186 :2002
20.5	Salmonella	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 5887 (P-3)
20.6	Shigella	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 1887 (P-7)
20.7	Vibrio	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 5887 (P-5)

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RESULTS OF SEDIMENT ANALYSIS [M1 LEFT SIDE OF BOCHA CREEK - N 22°45'183" E 069°43'241"]

SR. NO.	TEST PARAMETERS	UNIT	APRIL 2017	MAY 2017	JUNE 2017	JULY 2017	AUGUST 2017	SEPTEMBER 2017	TEST METHOD
			SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	
1	Organic Matter	%	0.48	0.352	0.622	0.5	0.45	0.47	FCO:2007
2	Phosphorus as P	µg/kg	140	146	144	127	133	138	APHA(22ndEdi) 4500 C
3	Texture	--	Sandy loam	Sandy Loam	Sandy Loam	Sandy loam	Sandy Loam	Sandy Loam	--
4	Petroleum Hydrocarbon	mg/kg	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	PLPL-TPH
5	**Heavy Metals**								
5.1	Aluminum as Al	%	5.05	4.99	5.59	4.85	5.86	4.92	AAS APHA 3111 B
5.2	Total Chromium as Cr^{+3}	µg/kg	189	189	188	200	198	210	AAS 3111B
5.3	Manganese as Mn	µg/kg	709	789	860	689	884	722	AAS APHA 3111 B
5.4	Iron as Fe	%	3.95	2.61	2.12	4.07	2.06	4.02	AAS APHA(22ndEdi)3111 B
5.5	Nickel as Ni	µg/kg	52.29	57.96	50	51.96	51.89	54.4	AAS APHA(22ndEdi)3111 B
5.6	Copper as Cu	µg/kg	39.13	37.99	32	37.96	36.12	34.42	AAS APHA(22ndEdi)3111 B
5.7	Zinc as Zn	µg/kg	137	143	139	143	140	148	AAS APHA(22ndEdi)3111 B
5.8	Lead as Pb	µg/kg	1.63	1.13	1.18	1.54	1.66	1.28	AAS APHA(22ndEdi)3111 B
5.9	Mercury as Hg	µg/kg	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	AAS APHA- 3112 B
6	**Benthic Organisms**								
6.1	Macrobenthos	--	Polychaete Worms Echinoderms Mysids	Crabs Anthozoans Isopods Decapods	polychaete worms isopods Decapods mysids	Polychaete worms Mysids Decapods	Polychaete worms Mysids Decapods	Polychaete worms Hydrozoa Nematodes Isopods	APHA (22nd Edi) 10500-C
6.2	MeioBenthos	--	Isopods Nematodes Hydrozans	Copepods Foraminiferans --	Copepods ostracodes --	Foraminiferans Nematodes Ciliates	Foraminiferans Nematodes Ciliates	Mysids Echinoderms	APHA (22nd Edi) 10500-C
6.3	Population	no/m2	503	288	440	357	399	470	APHA (22nd Edi) 10500-C

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Lab Manager

POLLUCON LABORATORIES PVT. LTD. SURAT-3

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RESULTS OF MARINE WATER [M2 MOUTH OF BOCHA & NAVINAL CREEK - N 22°44'239" E 069°43'757"]

SR. NO.	TEST PARAMETERS	UNIT	APRIL 2017		MAY 2017		JUNE 2017		JULY 2017		AUGUST 2017		SEPTEMBER 2017		TEST METHOD
			SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	
1	pH	--	7.96	8.04	8.02	8	8.08	8.19	8.14	8.18	8.11	8.23	7.96	8.04	IS3025(P11)83Re.02
2	Temperature	°C	28	29	29	30	29	30	28	29	28	29	29	30	IS3025(P9)84Re.02
3	Total Suspended Solids	mg/L	18	20	14	20	24	18	16	22	18	24	16	22	IS3025(P17)84Re.02
4	BOD (3 Days @ 27 °C)	mg/L	BDL*	BDL*	BDL*	BDL*	7	10	3	4	BDL*	4	BDL*	BDL*	IS 3025 (P44)1993Re.03 Edition2.1
5	Dissolved Oxygen	mg/L	5.6	5.2	5.6	4.6	5.6	5	5	4.6	5.2	4.8	5.8	5.4	IS3025(P38)89Re.99
6	Salinity	ppt	41.4	41.8	41.2	42.8	40.54	41.17	38.21	39	34.6	35.8	31.4	32.8	APHA (22ndEdi) 2550 B
7	Oil & Grease	mg/L	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	APHA(22ndEdi)5520D
8	Nitrate as NO_3	mg/L	0.5	0.73	0.532	0.598	0.673	0.734	0.63	0.72	0.54	0.7	0.6	0.69	IS3025(P34)88
9	Nitrite as NO_2	mg/L	0.022	0.035	0.03	0.047	0.06	0.072	0.058	0.069	0.06	0.067	0.021	0.033	IS3025(P34)88 NEDA
10	Ammonical Nitrogen as NH_3	mg/L	0.98	1.13	0.924	1.1	0.721	0.887	0.8	0.99	0.74	0.89	0.85	1.16	IS3025(P34)88Cla.2.3
11	Phosphates as PO_4	mg/L	0.048	0.1	1.03	1.215	0.636	0.781	0.75	0.83	0.46	0.64	0.044	0.98	APHA(22ndEdi) 4500 C
12	Total Nitrogen	mg/L	1.6	1.91	1.486	1.745	1.454	1.693	1.47	1.77	1.34	1.657	1.471	1.883	IS3025(P34)88
13	Petroleum Hydrocarbon	mg/L	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	PLPL-TPH
14	Total Dissolved Solids	mg/L	46980	47860	48593	48878	49870	50560	47580	48670	37580	38670	36980	37860	IS3025(P16)84Re.02
15	COD	mg/L	19	24	19	28	29	38	9	19	10	20	15	24	APHA(22ndEdi) 5520-D Open Reflux
16	Oxidisable Particular Organic Carbon	%	0.53	0.47	0.6	0.44	0.68	0.48	0.44	0.38	0.5	0.42	0.48	0.37	SOP – PLPL - 07
A	**Flora and Fauna**														
17	Primary productivity	mgC/L/day	2.7	1.35	1.125	0.338	2.02	0.9	1.91	0.428	2.21	0.522	2.7	1.46	APHA (22nd Edi) 10200-J
B	**Phytoplankton**														
18.1	Chlorophyll	mg/m^3	2.67	0.908	1.28	0.267	1.816	0.427	2.18	0.534	2.76	0.504	2.67	0.9	APHA (22ndEdi) 10200-H
18.2	Phaeophytin	mg/m^3	1.29	3.017	0.98	1.39	0.072	1.348	0.203	1.727	0.198	1.62	BDL*	1.03	APHA (22ndEdi) 10200-H
18.3	Cell Count	Unit x 10^3/L	250	314	147	52	186	45	232	54	178	52	252	110	APHA (22nd Edi) 10200-H

H. T. Shah
Lab Manager

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18.4	Name of Group Number and name of group species of each group	--	Bacillariop hyceae Coscinodi scus sp. Pinnularia sp. synendra sp. Navicula sp. Pleurosig ma sp. Green algae Volvox sp. Chlorella sp. Ulothrix sp. Cyanophy ceae Oscillatori a sp. Nostoc sp.	Bacillariop hyceae Fragillaria sp. Navicula sp. Pinnularia sp. Melosira sp. Green algae Spirogyra sp. Spirogyra sp. Cyanophy ceae Oscillatori a sp.	Bacillariop hyceae Nitzschia sp. Rhizosole nia sp. Navicula sp. Asterionel la sp. Cymbella sp. Synedra sp. Green Algae Pandorina sp. Pediastru m sp. Ulothrix sp. Cyanophy ceae Oscillatori a sp. --	Bacillariop hyceae Navicula sp. Fragillaria sp. Pinnularia sp. Biddulphi a sp. Green Algae Ulothrix sp. Cyanophy ceae Oscillatori a sp. Spirulina sp. -- -- -- --	Bacillariop hyceae Asterioell o.sp Navicula sp. Nitzschia sp. Coscinodi scus sp. Pinnularia sp. Rhizosole nia sp. Amphora sp. Cyanophy ceae Chlorella sp. Volvox sp. Hydrodict yon sp. Hydrodict yon sp. --	Bacillariop hyceae Asterionel la sp. Cyclotella sp. Fragillaria sp. Coscinodi scus sp. -- Cyanophy ceae Oscillatori a sp. Spirulina sp. Green Algae Chlorella sp. Spirogyra sp. --	Bacillariop hyceae Biddulphi a sp. Fragillaria sp. Gomphon ema sp. Rhizosole nia sp. Cymbella sp. Thallasios ira sp. Cyanophy ceae Anabaena sp. Oscillatori a sp. Nostoc sp. Green Algae Chlorella sp. Hydrodict yon sp.	Bacillariop hyceae Gomphon ema sp. Nitzschia sp. Synedra sp. Fragillaria sp. Cyanophy ceae Spirulina sp. Oscillatori a sp. Green Algae Chlorella sp. Hydrodict yon sp. --	Bacillariop hyceae Biddulphi a sp. Fragillaria sp. Gomphon ema sp. Rhizosole nia sp. Cymbella sp. Thallasios ira sp. Cyanophy ceae Anabaena sp. Oscillatori a sp. Nostoc sp. Green Algae Hydrodict yon sp. Pediastru m sp.	Bacillariop hyceae Fragillaria sp. Synedra sp. Nitzschia sp. Gomphone ma sp. Cyanophyc eae Spirulina sp. Green Algae Chlorella sp. Hydrodicty on sp. -- -- -- --	Bacillariop hyceae Coscinodi scus sp. Gomphon ema sp. Gyrosigm a sp. Pleurosig ma sp. Navicula sp. Synedra sp. Pinnularia sp. Cyanophy ceae Oscillatori a sp. Nostoc sp. Anabaena sp. Green Algae Ankistrod esmus sp Chlorella sp. Pandorina sp. Ulothrix sp.	Bacillariop hyceae Coscinodi scus sp Nitzschia sp. Gomphon ema sp. Skeletone ma sp. Thallasion ema sp. Cyanophy ceae Microcysti s sp. Oscillatori a sp. Green Algae Chlorella sp. Pandorina sp. Pediastru m sp. -- -- -- --	APHA (22nd Edi) 10200-H
C								Zooplanktons							
19.1	Abundance (Population)	no/m2	313	38	280	60	275	100	240	80	250	78	425	150	APHA (22nd Edi) 10200-G

H. T. Shah
Lab Manager

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19.2	Name of Group Number and name of group species of each group	--	copepods Fish egg Cyclops Gastropods	Copepods Cyclops Daphnia	Gastropods Isopods Decapods Krill Namatodes Molluscans Copepods	Copepods Polychaete worms Crustaceans -- --	Crustaceans Cyclops Decapods Copepods Gastropods Rotifers	Copepods Crustaceans Platinelminths -- -- --	Copepods Decapods Ostracods Crustaceans Krill Barnades	Polychaetes Worms Crustaceans Gastropods -- -- --	Copepods Decapods Ostracods Crustaceans Krill Barnades	Polychaete worms Crustaceans Gastropods -- -- --	Copepods Decapods Gastropods Polychaete worms Cyclops	Echinoderms -- -- -- --	APHA (22nd Edi) 10200-G
19.3	Total Biomass	ml/100 m^3	225	4	38	23	91	18	87.8	8.4	77.3	8.2	76.3	12.1	APHA (22nd Edi) 10200-G
D	**Microbiological Parameters**														
20.1	Total Bacterial Count	CFU/ml	1780	1520	1130	870	1840	1580	1480	1020	1680	1160	1780	1520	IS 5402:2002
20.2	Total Coliform	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	APHA(22ndEdi)9221-D
20.3	Ecoli	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS:1622:1981Ed i.2.4(2003-05)
20.4	Enterococcus	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 15186 :2002
20.5	Salmonella	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 5887 (P-3)
20.6	Shigella	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 1887 (P-7)
20.7	Vibrio	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 5887 (P-5)

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RESULTS OF SEDIMENT ANALYSIS [M2 MOUTH OF BOCHA & NAVINAL CREEK – N 22°44'239" E 069°43'757"]

SR. NO.	TEST PARAMETERS	UNIT	APRIL 2017	MAY 2017	JUNE 2017	JULY 2017	AUGUST 2017	SEPTEMBER 2017	TEST METHOD
			SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	
1	Organic Matter	%	0.68	--	--	--	--	--	FCO:2007
2	Phosphorus as P	µg/kg	159	--	--	--	--	--	APHA(22nd Edi) 4500 C
3	Texture	--	Sandy loam	--	--	--	--	--	--
4	Petroleum Hydrocarbon	mg/kg	BDL*	--	--	--	--	--	PLPL-TPH
5	**Heavy Metals**								
5.1	Aluminum as Al	%	5.22	--	--	--	--	--	AAS APHA 3111 B
5.2	Total Chromium as Cr+3	µg/kg	146	--	--	--	--	--	AAS 3111B
5.3	Manganese as Mn	µg/kg	808	--	--	--	--	--	AAS APHA 3111 B
5.4	Iron as Fe	%	2.06	--	--	--	--	--	AAS APHA(22nd Edi)3111 B
5.5	Nickel as Ni	µg/kg	36.61	--	--	--	--	--	AAS APHA(22nd Edi)3111 B
5.6	Copper as Cu	µg/kg	80.88	--	--	--	--	--	AAS APHA(22nd Edi)3111 B
5.7	Zinc as Zn	µg/kg	120	--	--	--	--	--	AAS APHA(22nd Edi)3111 B
5.8	Lead as Pb	µg/kg	1.12	--	--	--	--	--	AAS APHA(22nd Edi)3111 B
5.9	Mercury as Hg	µg/kg	BDL*	--	--	--	--	--	AAS APHA- 3112 B
6	**Benthic Organisms**								
6.1	Macrobenthos	--	Isopods Decapods Echonodems	--	--	--	--	--	APHA (22nd Edi) 10500-C
6.2	MeioBenthos	--	Nematodes isopods ciliats	--	--	--	--	--	APHA (22nd Edi) 10500-C
6.3	Population	no/m^2	314	--	--	--	--	--	APHA (22nd Edi) 10500-C

H. T. Shah
Lab Manager

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Lab Manager (Q)

RESULTS OF MARINE WATER [M3 EAST OF BOCHAISLAND - N 22°46'530" E 069°41'690"]

SR. NO.	TEST PARAMETERS	UNIT	APRIL 2017		MAY 2017		JUNE 2017		JULY 2017		AUGUST 2017		SEPTEMBER 2017		TEST METHOD
			SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	
1	pH	--	7.84	8.19	7.62	8.08	7.55	7.92	7.86	8.09	7.77	8.18	7.83	8.2	IS3025(P11)83Re.02
2	Temperature	^{o}C	29	30	29	30	29	30	30	31	28	29	28	29	IS3025(P9)84Re.02
3	Total Suspended Solids	mg/L	22	26	22	25	30	38	24	28	20	24	20	24	IS3025(P17)84Re.02
4	BOD (3 Days @ 27^{o}C)	mg/L	5	9.0	BDL*	BDL*	4	5	5	6	4	8	6	10	IS 3025 (P44)1993Re.03Edition2.1
5	Dissolved Oxygen	mg/L	5.60	4.50	5.4	4.6	5.6	4.8	5.4	4.6	5.2	4.8	5.4	4.6	IS3025(P38)89Re.99
6	Salinity	ppt	41.60	42.80	42.8	43.02	41.66	42.92	37.84	38.33	32.6	33.6	41.6	42.5	APHA (22ndEdi) 2550 B
7	Oil & Grease	mg/L	BDL*	BDL*	0.2	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	APHA(22ndEdi)5520D
8	Nitrate as NO_3	mg/L	0.370	0.450	0.3	0.42	0.28	0.36	0.3	0.4	0.32	0.43	0.41	0.49	IS3025(P34)88
9	Nitrite as NO_2	mg/L	0.013	0.023	0.019	0.028	0.02	0.026	0.018	0.023	0.016	0.025	0.017	0.026	IS3025(P34)88 NEDA
10	Ammonical Nitrogen as NH_3	mg/L	0.580	0.687	0.8	0.9	0.7	0.8	0.63	0.7	0.6	0.69	0.48	0.51	IS3025(P34)88Cla.2.3
11	Phosphates as PO_4	mg/L	0.073	0.099	0.64	0.81	0.58	0.72	0.54	0.7	0.58/	0.73	BDL*	BDL*	APHA(22ndEdi) 4500 C
12	Total Nitrogen	mg/L	0.91	1.143	1.12	1.35	1.08	1.21	0.948	1.123	0.92	1.14	0.907	1.026	IS3025(P34)88
13	Petroleum Hydrocarbon	mg/L	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	PLPL-TPH
14	Total Dissolved Solids	mg/L	50900	51220	51288	51492	49920	51430	49380	50840	40890	41360	51500	51910	IS3025(P16)84Re.02
15	COD	mg/L	16	30	18	28	20	26	18	24	14	28	22	32	APHA(22ndEdi) 5520-D Open Reflux
16	Oxidisable Particular Organic Carbon	%	0.290	0.170	0.31	0.2	0.28	0.21	0.26	0.22	0.3	0.2	0.27	0.19	SOP – PLPL - 07
A	**Flora and Fauna**														
17	Primary productivity	mgC/L /day	2.295	0.450	2.25	0.225	1.46	0.113	2.08	0.526	1.77	0.319	2.13	0.675	APHA (22nd Edi) 10200-J
B	**Phytoplankton**														
18.1	Chlorophyll	mg/m^3	3.520	0.267	2.05	0.053	1.01	0.24	2.184	0.484	1.597	0.362	2.2	0.507	APHA (22ndEdi) 10200-H
18.2	Phaeophytin	mg/m^3	1.520	4.064	0.523	2.52	1.56	2.17	BDL*	1.628	BDL*	1.62	BDL*	1.5	APHA (22ndEdi) 10200-H

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18.3	Cell Count	Unit x 10^3/L	262.0		254	25	178	18	220	46	199	32	241	58	APHA (22nd Edi) 10200-H
18.4	Name of Group Number and name of group species of each group	--	Bacillariop hyceae Asterionel la sp. Gyrosigm a sp. Fragillaria sp. Rhizosole nia sp. Green algae Hydrodict yon sp. Ulothrix sp. Oedogoni um sp. Cyanophy ceae microcysti s sp. Nostoc sp.	Bacillariop hyceae Fragillaria sp. Melosira sp. Rhizosole nia sp. Green algae Scenedes mus sp. Cyanophy ceae Anabaena sp. Nostoc sp.	Bacillariop hyceae Synedra sp. Nitzschia sp. Rhizosole nia sp. Thallasios ira sp Coscinodi scus sp. Green Algae Scenedes mus sp. Chlorella sp. Spirogyra sp. Cyanophy ceae Nostoc sp. Oscillatori a sp. --	Bacillariop hyceae Nitzschia sp. Navicula sp. Gyro sigma sp. Green Algae Chlorella sp. Desmids Closteriu m sp. -- -- -- -- -- --	Bacillariop hyceae Cymbella sp. Pinnularia sp. Coscinodi scus sp. Rhizosole nia sp. Green Algae Chlorella sp. Oedogoni um sp. Oscillatori a sp. Anabaena sp. --	Bacillariop hyceae Fragillaria sp. Pinnularia sp. Navicula sp. Nitzschia sp. Gyrosigm a sp. Green Algae Chlorella sp. -- -- --	Bacillariop hyceae Tabellaria sp. Thallasios ira sp. Rhizosole nia sp. Fragillaria sp. Cyclotella sp. Cheatocer ous sp. Biddulphi a sp. Cyanophy ceae Spirulina sp. Nostoc sp. Microcysti s sp. Green Algae Pediastru m sp. Hydrodict yon sp. Chlorella sp.	Bacillariop hyceae Gyrosigm a sp. Melosira sp. Skeletone ma sp. Nitzschia sp. Cyclotella sp. Cyanophy ceae Oscillatori a sp. Green Algae Scenedes mus sp. Pandorina sp. --	Bacillariop hyceae Biddulphi a sp. Cheatocer ous sp. Cyclotella sp. Fragillaria sp. Rhizosole nia sp. Thallasios ira sp. Tabellaria sp. Cyanophy ceae Microcysti s sp. Nostoc sp. Spirulina sp. Green Algae Hydrodict yon sp. Pediastru m sp.	Bacillariop hyceae Cyclotella sp. Nitzschia sp. Skeletone ma sp. Melosira sp. Gyrosigm a sp. Cyanophy ceae Oscillatori a sp. Green Algae Pandorina sp. Scenedes mus sp. -- -- -- --	Bacillariop hyceae Tabellaria sp. Thallasios ira sp. Rhizosole nia sp. Fragillaria sp. Cyclotella sp. Cheatocer ous sp. Biddulphi a sp. Cyanophy ceae Microcysti s sp. Nostoc sp. Spirulina sp. Green Algae Chlorella sp. Hydrodict yon sp. Pediastru m sp.	Bacillario phyceae Gyrosigm a sp. Melosira sp. Skeleton ema sp. Nitzschia sp. Cyclotella sp. Cyanoph yceae Oscillator ia sp. Green Algae Scenedes mus sp. Pandorin a sp. -- -- -- --	APHA (22nd Edi) 10200-H
C	**Zooplanktons**														
19.1	Abundance (Population)	no/m^2	188	63	150	30	213	25	208	56	210	40	233	67	APHA (22nd Edi) 10200-G

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19.2	Name of Group Number and name of group species of each group	--	Copepods Crustaceans Ctenophores Ostracods	Crustaceans Polychaete worms Nematodes	Polychaete Worms Echinoderms Molluscans -- --	Gastropods Isopods -- -- --	Copepods Ostracods Crustaceans Krill Ctenophores -- --	Polychaetes Decapods Nauplius larvae -- -- -- --	Copepods Cyclops Krill Ctenophores Chaetognathes Ostracods Decapods	Polychaete worms Copepods -- -- -- -- --	Copepods Decapods Ostracods Chaetognathes Ctenophores Krill Cyclops	Polychaete worms Copepods -- -- -- --	Copepods Decapods Ostracods Chaetognathes Ctenophores Krill Cyclops	Copepods Polychaetes -- -- -- -- --	APHA (22nd Edi) 10200-G
19.3	Total Biomass	ml/100 m^3	225	5	46	7	54	9	90.6	8.4	96.5	8.9	93.55	8.65	APHA (22nd Edi) 10200-G
D	**Microbiological Parameters**														
20.1	Total Bacterial Count	CFU/ml	1590	1220	1840	1550	1680	1375	1850	1280	1640	1120	1560	1220	IS 5402:2002
20.2	Total Coliform	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	APHA(22ndEdi)922 1-D
20.3	Ecoli	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS:1622:1981Edi.2 .4(2003-05)
20.4	Enterococcus	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 15186 :2002
20.5	Salmonella	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 5887 (P-3)
20.6	Shigella	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 1887 (P-7)
20.7	Vibrio	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 5887 (P-5)

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RESULTS OF SEDIMENT ANALYSIS [M3 RIGHT SIDE OF BOCHA CREEK - N 22°46'530" E 069°41'690"]

SR. NO.	TEST PARAMETERS	UNIT	APRIL 2017	MAY 2017	JUNE 2017	JULY 2017	AUGUST 2017	SEPTEMBER 2017	TEST METHOD
			SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	
1	Organic Matter	%	0.59	0.52	--	0.54	0.6	0.57	FCO:2007
2	Phosphorus as P	µg/kg	142	150	--	140	146	140	APHA(22nd Edi) 4500 C
3	Texture	--	sandyloam	Sandy Loam	--	Sandy loam	Sandy Loam	Sandy Loam	--
4	Petroleum Hydrocarbon	mg/kg	BDL*	BDL*	--	BDL*	BDL*	BDL*	PLPL-TPH
5	**Heavy Metals**								
5.1	Aluminum as Al	%	4.78	5.4	--	5.6	5.2	5.4	AAS APHA 3111 B
5.2	Total Chromium as Cr^{+3}	µg/kg	182	140	--	180	160	168	AAS 3111B
5.3	Manganese as Mn	µg/kg	866	890	--	790	810	850	AAS APHA 3111 B
5.4	Iron as Fe	%	1.9	2.02	--	2.28	2.22	2.3	AAS APHA(22nd Edi)3111 B
5.5	Nickel as Ni	µg/kg	52	52	--	56	54	58	AAS APHA(22nd Edi)3111 B
5.6	Copper as Cu	µg/kg	36	36	--	32	34	32	AAS APHA(22nd Edi)3111 B
5.7	Zinc as Zn	µg/kg	142	138	--	140	136	130	AAS APHA(22nd Edi)3111 B
5.8	Lead as Pb	µg/kg	1.46	1.6	--	1.34	1.32	1.29	AAS APHA(22nd Edi)3111 B
5.9	Mercury as Hg	µg/kg	BDL*	BDL*	--	BDL*	BDL*	BDL*	AAS APHA- 3112 B
6	**Benthic Organisms**								
6.1	Macrobenthos	--	Bivalxes Echinoderms Decapods Amphipods	Polychaete Worms Bivalves Anthozoans --	--	Polychaete worms Isopods Echinoderms Decapods	Echinoderms Polychaete worms Isopods Decapods	Echinoderms Polychaetes Isopods Decapods	APHA (22nd Edi) 10500-C
6.2	MeioBenthos	--	Nematodes ostrucodes Gastrotriches	Foraminiferans Copepods --	--	Ostracods --	Ostracods	Ostracods	APHA (22nd Edi) 10500-C
6.3	Population	no/m^2	252	337	--	294	377	273	APHA (22nd Edi) 10500-C

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POLLUCON LABORATORIES PVT. LTD. SURAT-3

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Lab Manager (Q)

RESULTS OF MARINE WATER [M4 JUNA BANDAR N 22°47'577" E 069°43'620"]

SR. NO.	TEST PARAMETERS	UNIT	APRIL 2017		MAY 2017		JUNE 2017		JULY 2017		AUGUST 2017		SEPTEMBER 2017		TEST METHOD
			SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	
1	pH	--	8.03	8.13	8.02	8	7.98	8.13	7.98	8.14	8.01	8.12	7.69	8.17	IS3025(P11)83Re.02
2	Temperature	°C	29	30	29	30	29	30	29	30	29	30	28	29	IS3025(P9)84Re.02
3	Total Suspended Solids	mg/L	16	22	28	32	24	30	19	22	16	20	18	16	IS3025(P17)84Re.02
4	BOD (3 Days @ 27 °C)	mg/L	6	6	BDL*	BDL*	7	9	4	5	3	4	4	5	IS 3025 (P44)1993Re.03 Edition2.1
5	Dissolved Oxygen	mg/L	5	4.80	5.8	4.8	5.6	4.8	5.2	4.4	5.4	4.8	5.6	4.8	IS3025(P38)89Re.99
6	Salinity	ppt	42.40	43.80	38.4	39.1	39.82	40.54	34.52	38.41	32.4	33.2	42.2	43	APHA (22ndEdi) 2550 B
7	Oil & Grease	mg/L	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	APHA(22ndEdi)5520D
8	Nitrate as NO_3	mg/L	0.49	0.620	0.384	0.222	0.367	0.397	0.46	0.55	0.33	0.2	0.51	0.59	IS3025(P34)88
9	Nitrite as NO_2	mg/L	0.052	0.067	0.054	0.076	0.051	0.065	0.054	0.07	0.059	0.077	0.047	0.066	IS3025(P34)88 NEDA
10	Ammonical Nitrogen as NH_3	mg/L	0.720	0.840	1.01	1.29	0.702	0.776	0.74	0.82	0.91	1.15	0.69	0.74	IS3025(P34)88Cla.2.3
11	Phosphates as PO_4	mg/L	0.068	0.089	0.54	0.675	0.248	0.353	0.18	0.17	0.02	0.11	0.057	0.073	APHA(22ndEdi) 4500 C
12	Total Nitrogen	mg/L	1.262	1.467	1.448	1.588	1.12	1.238	1.254	1.44	1.3	1.42	1.247	1.396	IS3025(P34)88
13	Petroleum Hydrocarbon	mg/L	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	PLPL-TPH
14	Total Dissolved Solids	mg/L	52840	54110	45313	46173	46890	48030	53670	54820	32990	34280	52910	54310	IS3025(P16)84Re.02
15	COD	mg/L	14	19	14	24	24	28	14	18	14	19	16	20	APHA(22ndEdi) 5520-D Open Reflux
16	Oxidisable Particular Organic Carbon	%	0.840	0.380	0.5	0.46	0.82	0.46	0.82	0.38	0.8	0.43	0.8	0.36	SOP – PLPL - 07
A	Flora and Fauna														
17	Primary productivity	mgC/L/day	1.8	0.45	1.575	0.675	1.688	0.788	2.36	0.563	3.03	1.46	97	8.2	APHA (22nd Edi) 10200-J
B	Phytoplankton														
18.1	Chlorophyll	mg/m^3	3.040	0.801	1.89	0.16	1.789	0.587	1.816	0.721	2.48	0.69	2.148	0.654	APHA (22ndEdi) 10200-H
18.2	Phaeophytin	mg/m^3	2.480	3.420	0.067	1.69	0.23	1.207	0.24	1.03	BDL*	1.36	0.2	1.11	APHA (22ndEdi)

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Lab Manager (Q)

															10200-H
18.3	Cell Count	Unit x 10^3/L	302	30.0	162	33	189	41	214	68	326	82	264	75	APHA (22nd Edi) 10200-H
18.4	Name of Group Number and name of group species of each group	--	Bacillariophyceae Melosira sp. synendra sp. Tabellaria sp. Cheatocerous sp. Green algae Ulothrix sp. Pediastrum sp. Cyanophyceae Oscillatoria sp. Spirulina sp.	Bacillariophyceae synendra sp. Navicula sp. Nitzschia sp. Green algae Chlorella sp. Cyanophyceae Oscillatoria sp. Lyngbya sp.	Bacillariophyceae Asterionella sp. Coscinodiscus sp. Navicula sp. Nitzschia sp. Fragillaria sp. Surirella sp. Thallasionema sp. Green Algae Ankistrodesmus sp. Chlorella sp. Pandorina sp. Cyanophyceae Anabaena sp.	Bacillariophyceae Tabellaria sp. Navicula sp. Gyrosigma sp. Coscinodiscus sp. Asterionella sp. Cyanophyceae Oscillatoria sp. Nostoc sp. -- -- -- -- --	Bacillariophyceae Nitzschia sp. Coscinodiscus sp. Pleurosigma sp. Pinnularia sp. Cyanophyceae Oscillatoria sp. Spirulina sp. Green Algae Chlorella sp. Ulothrix sp. Ankistrodesmus sp. Volvox sp. -- --	Bacillariophyceae Pinnularia sp. Fragillaria sp. Nitzschia sp. Navicula sp. Cyanophyceae Anabaena sp. #VALUE! Green Algae Pandorina sp. Ankistrodesmus sp. -- -- --	Bacillariophyceae Asterionella sp. Biddulphia sp. Gomphonema sp. Rhizosolenia sp. Pinnularia sp. Skeletonema sp. Nitzschia sp. Navicula sp. Cocconeis sp. Cyanophyceae Oscillatoria sp. Anabaena sp. Green Algae Ankistrodesmus sp. Oedogonium sp. Pediastrum sp.	Bacillariophyceae Coscinodiscus sp. Pleurosigma sp. Nitzschia sp. Fragillaria sp. Navicula sp. Cyanophyceae Anabaena sp. Oscillatoria sp. Spirulina sp. Green Algae Oedogonium sp. Pediastrum sp. -- -- -- --	Bacillariophyceae Amphora sp. Asterionella sp. Coscinodiscus sp. Fragillaria sp. Gomphonema sp. Skeletonema sp. Cyclotella sp. Cyanophyceae Microcystis sp. Oscillatoria sp. Green Algae Ankistrodesmus sp. Chlorella sp. Pandorina sp. Scenedesmus sp.	Bacillariophyceae Cymbella sp. Fragillaria sp. Melosira sp. Nitzschia sp. Cyanophyceae Oscillatoria sp. Microcystis sp. Nostoc sp. Green Algae Chlorella sp. Hydrodictyon sp. Scenedesmus sp. Volvox sp.-- -- --	Bacillariophyceae Pleurosigma sp. Coscinodiscus sp. Nitzschia sp. Thallasiosira sp. Pinnularia sp. Cyanophyceae Oscillatoria sp. Spirulina sp. Green Algae Chlorella sp. Volvox sp. Ankistrodesmus sp. Ulothrix sp.	Bacillariophyceae Navicula sp. Nitzschia sp. Fragillaria sp. Pinnularia sp. Cyanophyceae Oscillatoria sp. Anabaena sp. Green Algae Ankistrodesmus sp. Pandorina sp. -- -- --	APHA (22nd Edi) 10200-H
C	**Zooplanktons**														
19.1	Abundance (Population)	no/m^2	213	25	267	133	350	75	275	50	300	160	312.5	62.5	APHA (22nd Edi) 10200-G

H. T. Shah
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Lab Manager (Q)

19.2	Name of Group Number and name of group species of each group	--	Chaetognaths Copepods Nematodes Nauplius larvae Cyclops	Cyclops Copepods Crustaceans	Gastropods Copepods Decapods Ostracods Krill Crustaceans Cyclops	Ctenophores Gastropods Krill Nematodes --	Copepods Chaetognathes Ctenophores Krill Cyclops Decapods Rotifiers	Copepods Decapods -- -- -- -- --	Ctenophores Ostracods Gastropods Decapods Polychaete worms	Copepods Decapods -- -- --	Copepods Polychaetes Crustaceans Nematodes Mysids Rotifers	Crustaceans Gastropods Nematodes -- -- --	Copepods Krill Decapods Chaetognathes Cyclops Rotifers Ctenophores	Copepods Decapods -- -- -- -- --	APHA (22nd Edi) 10200-G
19.3	Total Biomass	ml/100 m^3	194	5	75	15	97	8.2	97.4	7.8	62.4	7.4	79.9	7.6	APHA (22nd Edi) 10200-G
D	**Microbiological Parameters**														
20.1	Total Bacterial Count	CFU/ml	1750	1590	1850	1680	2130	1870	1560	1220	1700	1580	1610	1280	IS 5402:2002
20.2	Total Coliform	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	APHA(22ndEdi)9 221-D
20.3	Ecoli	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS:1622:1981Edi .2.4(2003-05)
20.4	Enterococcus	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 15186 :2002
20.5	Salmonella	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 5887 (P-3)
20.6	Shigella	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 1887 (P-7)
20.7	Vibrio	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 5887 (P-5)

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POLLUCON LABORATORIES PVT. LTD. SURAT-3

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Lab Manager (Q)

RESULTS OF SEDIMENT ANALYSIS [M4 JUNA BANDAR N 22°47'577" E 069°43'620"]

SR. NO.	TEST PARAMETERS	UNIT	APRIL 2017	MAY 2017	JUNE 2017	JULY 2017	AUGUST 2017	SEPTEMBER 2017	TEST METHOD
			SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	
1	Organic Matter	%	0.42	0.495	0.463	0.51	0.425	0.63	FCO:2007
2	Phosphorus as P	µg/kg	174	172	178	192	175	150	APHA(22nd Edi) 4500 C
3	Texture	--	Sandy loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	--
4	Petroleum Hydrocarbon	mg/kg	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	PLPL-TPH
5	**Heavy Metals**								
5.1	Aluminum as Al	%	5.42	5.21	5.19	5.08	5.41	5.62	AAS APHA 3111 B
5.2	Total Chromium as Cr^{+3}	µg/kg	118	127	165	146	119	129	AAS 3111B
5.3	Manganese as Mn	µg/kg	854	896	885	798	856	809	AAS APHA 3111 B
5.4	Iron as Fe	%	1.76	2.33	2.4	2.82	1.75	266	AAS APHA(22nd Edi)3111 B
5.5	Nickel as Ni	µg/kg	57.94	49.9	49.97	52	57.99	44.19	AAS APHA(22nd Edi)3111 B
5.6	Copper as Cu	µg/kg	43.9	45.9	43.97	48	43.98	40.22	AAS APHA(22nd Edi)3111 B
5.7	Zinc as Zn	µg/kg	162	179	166	190	160	189	AAS APHA(22nd Edi)3111 B
5.8	Lead as Pb	µg/kg	1.84	1.94	1.96	1.88	1.87	0.91	AAS APHA(22nd Edi)3111 B
5.9	Mercury as Hg	µg/kg	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	AAS APHA- 3112 B
6	**Benthic Organisms**								
6.1	Macrobenthos	--	Bivalves Decapods Lobsters	Polychaete worms Echinoderms Isopods Anthozoans	Echinoderms Decapods Isopods --	Polychaete worms Echinoderms Isopods	Echinoderms Isopods --	Echinoderms Polychaete worms Mysids	APHA (22nd Edi) 10500-C
6.2	MeioBenthos	--	Bryozoans Water bears Foraminiferans	Namatodes Foraminiferans Hydrozoa --	Nematodes Foraminiterams --	Nematodes Foraminiferans --	Nematodes Foraminiferans Hydrozoa	Nematodes Foraminiferans Ciliotes	APHA (22nd Edi) 10500-C
2	Population	no/m^2	440	440	314	314	433	481	APHA (22nd Edi) 10500-C

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Lab Manager

POLLUCON LABORATORIES PVT. LTD. SURAT-3

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Lab Manager (Q)

RESULTS OF MARINE WATER [M5 TOWARDS WESTERN SIDE OF EAST PORT – N 22°46'041" E 069°47'296"]

SR. NO.	TEST PARAMETERS	UNIT	APRIL 2017		MAY 2017		JUNE 2017		JULY 2017		AUGUST 2017		SEPTEMBER 2017		TEST METHOD
			SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	
1	pH	--	8.04	8.13	8.08	8.14	8.02	8.11	7.87	7.7	8.14	7.73	8.02	8.17	IS3025(P11)83Re.02
2	Temperature	°C	28	29	28	29	29	30	29	30	29	30	29	30	IS3025(P9)84Re.02
3	Total Suspended Solids	mg/L	14	18	26	30	24	32	18	24	18	24	28	20	IS3025(P17)84Re.02
4	BOD (3 Days @ 27 °C)	mg/L	3	4	BDL*	BDL*	4	5	BDL*	3	3	4	BDL*	BDL*	IS 3025 (P44)1993Re.03Edition2.1
5	Dissolved Oxygen	mg/L	5.60	5.40	5.4	4.6	5.8	4.6	48.45	4.6	5.9	4.6	5.8	5.2	IS3025(P38)89Re.99
6	Salinity	ppt	40.80	41.40	39.2	40.4	38.2	39.37	38.45	49	44.8	46.4	40.6	41.2	APHA (22nd Edi) 2550 B
7	Oil & Grease	mg/L	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	APHA(22nd Edi)5520D
8	Nitrate as NO_3	mg/L	0.640	0.690	0.518	0.607	0.627	0.704	0.61	0.67	0.916	0.6777	0.58	0.65	IS3025(P34)88
9	Nitrite as NO_2	mg/L	0.047	0.031	0.036	0.025	0.047	0.039	0.047	0.035	0.008	0.035	0.038	0.029	IS3025(P34)88 NEDA
10	Ammonical Nitrogen as NH_3	mg/L	0.320	0.440	0.48	0.619	0.277	0.397	0.37	0.44	0.6	0.44	0.29	0.38	IS3025(P34)88Cla.2.3
11	Phosphates as PO_4	mg/L	0.026	0.096	0.45	0.27	0.158	0.171	0.24	0.57	0.922	0.157	0.021	0.088	APHA(22nd Edi) 4500 C
12	Total Nitrogen	mg/L	1.000	1.120	1.034	1.251	0.951	1.14	1	1.1	1.041	1.155	0.908	1.059	IS3025(P34)88
13	Petroleum Hydrocarbon	mg/L	0.84	BDL*	0.42	BDL*	2	BDL*	0.8	BDL*	0.8	BDL*	0.6	BDL*	PLPL-TPH
14	Total Dissolved Solids	mg/L	44620	45130	45966	46874	47860	48320	46800	47300	42800	47300	44260	45590	IS3025(P16)84Re.02
15	COD	mg/L	9	14	9	24	14	19	5	14	9	14	9	19	APHA(22nd Edi) 5520-D Open Reflux
16	Oxidisable Particular Organic Carbon	%	0.540	0.420	0.5	0.42	0.58	0.46	0.56	0.42	0.56	0.42	0.58	0.46	SOP – PLPL - 07
A	**Flora and Fauna**														
17	Primary productivity	mgC/L /day	2.250	0.670	1.688	0.563	1.463	0.788	1.6	0.56	1.688	0.563	1.57	0.45	APHA (22nd Edi) 10200-J
B	**Phytoplankton**														
18.1	Chlorophyll	mg/m^3	2.770	0.960	1.362	0.294	1.922	0.721	1.8	0.61	ND*	0.614	2.08	0.9	APHA (22nd Edi) 10200-H
18.2	Phaeophytin	mg/m^3	2.793	3.300	0.806	0.959	0.134	0.737	0.61	1.27	5.3	1.274	0.179	0.98	APHA (22nd Edi) 10200-H

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18.3	Cell Count	Unit x 10^3/L	546	24.0	215	40	196	52	145	32	145	32	222	58	APHA (22^{nd} Edi) 10200-H
18.4	Name of Group Number and name of group species of each group	--	Bacillariophyceae Biddulphia sp. Cymbella sp. Navicula sp. sydra sp. pinnularia sp. Green algae Volvox sp. Pediastrum sp. Ulothrix sp. Cyanophyceae Lyngbya sp. Nostoc sp.	Bacillariophyceae Cocconeis sp. Fragillaria sp. Navicula sp. Green algae Chlorella sp. Pediastrum sp. Cyanophyceae Spirulina sp.	Bacillariophyceae Rhizosolenia sp. Synedra sp. Navicula sp. Coscinodiscus sp. Skeletonema sp. Green Algae Spirogyra sp. Pediastrum sp. Hydrodictyon sp. Desmids Cosmarium sp. --	Bacillariophyceae Nitzschia sp. Pinnularia sp. Fragillaria sp. Biddulphia sp. Cyanophyceae Anabaena sp. Nostoc sp. -- -- -- -- --	Bacillariophyceae Gomphonema sp. Pleurosigma sp. Nitzschia sp. Synedra sp. Rhizosolenia sp. Surirella sp. Tabellaria sp. Biddulphia sp. Cyanophyceae Microcystis sp. Oscillatoria sp. Green Algae Chlorella sp. Ulothrix sp. Scenedesmus sp. --	Bacillariophyceae Asterionella sp. Cyclotella sp. Cymbella sp. Gyrosigma sp. Pinnularia sp. Cocconeis sp. Green Algae Oedogonium sp. Hydrodictyon sp. Scenedesmus sp. -- -- -- -- -- --	Bacillariophyceae Cyclotella sp. Cocconeis sp. Pinnularia sp. Skeletonema sp. Pleurosigma sp. Biddulphia sp. Amphiprora sp. Cyanophyceae Anabaena sp. Oscillatoria sp. Green Algae Ankistrodesmus sp. Chlorella sp. Pediastrum sp. Volvox sp.	Bacillariophyceae Gomphonema sp. Pleurosigma sp. Navicula sp. Nitzschia sp. Coscinodiscus sp. Cyanophyceae Oscillatoria sp. Green Algae Pandorina sp. -- -- -- -- -- --	Bacillariophyceae Amphiprora sp.. Biddulphia sp. Pleurosigma sp. Skeletonema sp. Pinnularia sp. Cocconeis sp. Cyclotella sp. Cyanophyceae Anabaena sp. Oscillatoria sp. Spirulina sp. Green Algae Ankistrodesmus sp. Chlorella sp. Pediastrum sp. Volvox sp.	Bacillariophyceae Coscinodiscus sp. Nitzschia sp. Pleurosigma sp. Navicula sp. Gomphonema sp. Cyanophyceae Oscillatoria sp. Green Algae Pandorina sp. -- -- -- -- -- -- --	Bacillariophyceae Navicula sp. Synedra sp. Nitzschia sp. Coscinodiscus sp. Thallasionema sp. Pleurosigma sp. Cyclotella sp. Skeletonema sp. Cyanophyceae Anabaena sp. Nostoc sp. Oscillatoria sp. Green Algae Ankistrodesmus sp. Pandorina sp. Scenedesmus sp.	Bacillariophyceae Navicula sp. Fragillaria sp. Gomphonema sp. Pleurosigma sp. Coscinodiscus sp. Cyanophyceae Oscillatoria sp. Lyngbya sp. Green Algae Chlorella sp. Pediastrum sp. Pandorina sp. -- -- -- --	APHA (22^{nd} Edi) 10200-H
C	**Zooplanktons**														
19.1	Abundance (Population)	no/m^2	250	30	260	60	250	50	210	60	200	50	275	100	APHA (22^{nd} Edi) 10200-G

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19.2	Name of Group Number and name of group species of each group	--	Crustaceans Nematodes Nauplius larvae Gastropods	Bivalves Rotifers Nematodes	Copepods Cyclops Decapods Krill Polychaete worms	Copepods Polychaete worms Ostracods -- --	copepods krill Polychaete worms Siphonophores Rotifers Cyclops	Gastropods Polychaete worms -- -- -- --	Copepods Decapods Ostracods Gastropods Crustaceans	Polychaetes Gastropods Absent -- --	Copepods Decapods Ostracods Gastropods Crustaceans	Polychaete worms Gastropods -- -- --	Nematodes Gastropods Crustaceans Mysids	Copepods Cyclops Nematodes --	APHA (22nd Edi) 10200-G
19.3	Total Biomass	ml/100 m^3	189	7	69	11	75	15	72	13	85	0.7	45.2	7.4	APHA (22nd Edi) 10200-G
D	**Microbiological Parameters**														
20.1	Total Bacterial Count	CFU/ml	1640	1500	1830	1630	1650	1370	1740	1480	1740	1480	1620	1480	IS 5402:2002
20.2	Total Coliform	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	APHA(22ndEdi)9221-D
20.3	Ecoli	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS:1622:1981Edi. 2.4(2003-05)
20.4	Enterococcus	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 15186 :2002
20.5	Salmonella	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 5887 (P-3)
20.6	Shigella	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 1887 (P-7)
20.7	Vibrio	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 5887 (P-5)

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POLLUCON LABORATORIES PVT. LTD. SURAT-3

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Lab Manager (Q)

RESULTS OF SEDIMENT ANALYSIS [M5 TOWARDS WESTERN SIDE OF EAST PORT – N 22°46'041" E 069°47'296"]

SR. NO.	TEST PARAMETERS	UNIT	APRIL 2017	MAY 2017	JUNE 2017	JULY 2017	AUGUST 2017	SEPTEMBER 2017	TEST METHOD
			SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	
1	Organic Matter	%	0.62	0.546	0.701	0.64	0.58	0.6	FCO:2007
2	Phosphorus as P	μg/kg	182	148	189	180	166	162	APHA(22nd Edi) 4500 C
3	Texture	--	sandyloam	Sandy Loam	Sandy Loam	Sandy loam	Sandy Loam	SandyLoam	--
4	Petroleum Hydrocarbon	mg/kg	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	PLPL-TPH
5	**Heavy Metals**								
5.1	Aluminum as Al	%	5.66	5.39	5.6	5.79	5.82	5.61	AAS APHA 3111 B
5.2	Total Chromium as Cr^{+3}	μg/kg	120	131	120	119	132	121	AAS 3111B
5.3	Manganese as Mn	μg/kg	722	789	760	729	756	745	AAS APHA 3111 B
5.4	Iron as Fe	%	2.38	2.09	2.45	2.41	2.12	2.32	AAS APHA(22nd Edi)3111 B
5.5	Nickel as Ni	μg/kg	48.34	46.77	48.32	48.21	58.6	97.57	AAS APHA(22nd Edi)3111 B
5.6	Copper as Cu	μg/kg	52.48	36.39	52.52	54.52	44.48	49.82	AAS APHA(22nd Edi)3111 B
5.7	Zinc as Zn	μg/kg	176	161	166	179	182	167	AAS APHA(22nd Edi)3111 B
5.8	Lead as Pb	μg/kg	2.04	1.8	2.02	2.02	2.08	2.06	AAS APHA(22nd Edi)3111 B
5.9	Mercury as Hg	μg/kg	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	AAS APHA- 3112 B
6	**Benthic Organisms**								
6.1	Macrobenthos	--	Bivalxes Sponges Tubellaria	Crabs Polychaete worms Mysids Decapods Bivalves	Echinoderms Decapods Isopods Chaetognaths	Isopods Polychaete worms Echinoderms	Echinoderms Isopods Polychaete worms	Crabs Bivalves Echinoderms	APHA (22nd Edi) 10500-C
6.2	MeioBenthos	--	Copepodes Cilliates Decapods	Gastrotriches Ostracods --	Gadtrotriches Bryozoans Ostracods	Bryozoans Copepods --	Copepods Bryozoans	Hydrozoa Nematodes	APHA (22nd Edi) 10500-C
6.3	Population	no/m2	252	385	337	440	361	377	APHA (22nd Edi) 10500-C

H. T. Shah
Lab Manager

POLLUCON LABORATORIES PVT. LTD. SURAT-3

Dr. ArunBajpai
Lab Manager (Q)

RESULTS OF MARINE WATER [M7 EAST PORT N 22°47'120" E 069°47'110"]

SR. NO.	TEST PARAMETERS	UNIT	APRIL 2017		MAY 2017		JUNE 2017		JULY 2017		AUGUST 2017		SEPTEMBER 2017		TEST METHOD
			SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	
1	pH	--	8.06	8.17	8.1	8.18	7.94	8.08	7.86	7.99	7.89	7.66	8.02	8.13	IS3025(P11)83Re.02
2	Temperature	°C	28	29	29	30	29	30	29	30	30	31	28	29	IS3025(P9)84Re.02
3	Total Suspended Solids	mg/L	16	24	18	22	14	16	18	20	16	22	25	20	IS3025(P17)84Re.02
4	BOD (3 Days @ 27°C)	mg/L	8.0	6.0	BDL*	BDL*	6	4	7	6	8	7	6	4	IS 3025 (P44)1993Re.03Edition2.1
5	Dissolved Oxygen	mg/L	5.40	5.00	5.6	4.8	5.8	4.6	5.6	4.8	5.4	4.8	5.4	4.6	IS3025(P38)89Re.99
6	Salinity	ppt	38.50	39.12	38.1	39.2	39.37	40.18	38.19	39.3	35.2	36.4	38.42	39.26	APHA (22^{nd}Edi) 2550 B
7	Oil & Grease	mg/L	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	0.1	BDL*	APHA(22^{nd}Edi)5520D
8	Nitrate as NO_3	mg/L	0.520	0.780	0.681	0.784	0.616	0.857	0.42	0.7	0.17	0.162	0.52	0.81	IS3025(P34)88
9	Nitrite as NO_2	mg/L	0.057	0.049	0.063	0.05	0.067	0.053	0.024	0.022	0.026	0.021	0.037	0.52	IS3025(P34)88 NEDA
10	Ammonical Nitrogen as NH_3	mg/L	0.150	0.310	0.295	0.554	0.203	0.488	0.2	0.36	0.22	0.38	0.13	0.34	IS3025(P34)88Cla.2.3
11	Phosphates as PO_4	mg/L	0.190	0.170	0.54	0.585	0.545	0.492	0.16	0.15	0.17	0.162	0.21	0.22	APHA(22^{nd}Edi) 4500 C
12	Total Nitrogen	mg/L	0.710	1.590	1.039	1.189	0.886	1.399	0.644	1.082	0.707	1.15	0.687	1.67	IS3025(P34)88
13	Petroleum Hydrocarbon	mg/L	10.20	BDL*	1.4	BDL*	1.4	BDL*	2	BDL*	2.2	BDL*	1	BDL*	PLPL-TPH
14	Total Dissolved Solids	mg/L	47020	47530	43186	43828	44020	44680	44620	45600	46800	33500	46930	47460	IS3025(P16)84Re.02
15	COD	mg/L	24	18	24	28	24	14	26	22	28	24	24	15	APHA(22ndEdi) 5520-D Open Reflux
16	Oxidisable Particular Organic Carbon	%	0.700	0.500	0.82	0.58	0.48	0.39	0.66	0.56	0.76	0.58	0.82	0.52	SOP – PLPL - 07
A	**Flora and Fauna**														
17	Primary productivity	mgC/L /day	1.350	0.675	1.35	0.45	2.138	0.563	1.808	0.686	1.913	0.787	1.91	0.56	APHA (22nd Edi) 10200-J
B	**Phytoplankton**														
18.1	Chlorophyll	mg/m^3	3.097	0.748	1.682	0.107	2	0.507	2.18	0.808	2.296	0.988	1.2	0.26	APHA (22^{nd}Edi) 10200-H
18.2	Phaeophytin	mg/m^3	1.239	4.410	0.598	2.02	0.053	1.287	BDL*	0.8	BDL*	0.9	0.75	1.39	APHA (22^{nd}Edi) 10200-H

H. T. Shah
Lab Manager

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Dr. ArunBajpai
Lab Manager (Q)

18.3	Cell Count	Unit x 10^3/L	276	24.0	227	29	202	56	108	46	184	48	180	20	APHA (22nd Edi) 10200-H
18.4	Name of Group Number and name of group species of each group	--	Bacillariophyceae Cymbella sp. Navicula sp. Nitzschia sp. Surirella sp. Green algae Hydrodictyon sp. Scenedesmus sp. Cyanophyceae oscillatoria sp. Spirulina sp.	Bacillariophyceae Asterionella sp. Melosira sp. Nitzschia sp. Green algae Pandorina sp. Spirogyra sp. Cyanophyceae Nostoc sp.	Bacillariophyceae Nitzschia sp. Synedra sp. Coscinodiscus sp. Pleurosigma sp. Thallasiosira sp. Pinnularia sp. Green Algae Chlorella sp. Pandorina sp. Ulothrix sp. Desmids Closterium sp. --	Bacillariophyceae Navicula sp. Fragillaria sp. Cyclotella sp. Tabellaria sp. Cyanophyceae Oscillatoria sp. Nostoc sp. Green Algae Chlorella sp. -- -- -- --	Bacillariophyceae Navicula sp. Coscinodiscus sp. Fragillaria sp. Asterionella sp. Cymbella sp. Rhizosolenia sp. Skeletonema sp. Coscinodiscus sp. Biddulphia sp. Green Algae Ankistrodesmus sp. Chlorella sp. Pandorina sp. Desmids Cosmarium sp. Closterium sp.	Bacillariophyceae Fragillaria sp. Biddulphia sp. Pleurosigma sp. Thallasiosira sp. Pinnularia sp. Cyanophyceae Oscillatoria sp. Spirulina sp. Lyngbya sp. -- -- -- -- -- -- --	Bacillariophyceae Nitzschia sp. Fragillaria sp. Gyrosigma sp. Pinnularia sp. Cheatocerous sp. Cyanophyceae Pediastrum sp. Ankistrodesmus sp. Oscillatoria sp. Microcystis sp.	Bacillariophyceae Rhizosolenia sp. Cocconeis sp. Cheatocerous sp. Biddulphia sp. Achnanthes sp. Cyanophyceae Spirulina sp. Nostoc sp. Oscillatoria sp. Microcystis sp.	Bacillariophyceae Gyrosigma sp. Cheatocerous sp. Fragillaria sp. Pinnularia sp. Nitzschia sp. Pleurosigma sp. Cyanophyceae Microcystis sp. Oscillatoria sp. Spirulina sp. Green Algae Ankistrodesmus sp. Pediastrum sp.	Bacillariophyceae Achnanthes sp. Biddulphia sp. Cheatocerous sp. Cocconeis sp. Rhizosolenia sp. Cyanophyceae Microcystis sp. Oscillatoria sp. Nostoc sp. Green Algae Pandorina sp. Scenedesmus sp. --	Bacillariophyceae Asterionella sp. Navicula sp. Synedra sp. Rhizosolenia sp. Melosira sp. Skeletonema sp. Coscinodiscus sp. Cyanophyceae Oscillatoria sp. Nostoc sp. Green Algae Ankistrodesmus sp. Chlorella sp. Pandorina sp. Scenedesmus sp.	Bacillariophyceae Nitzschia sp. Fragillaria sp. Rhizosolenia sp. Coscinodiscus sp. Cyclotella sp. Cyanophyceae Oscillatoria sp. Nostoc sp. Green Algae Chlorella sp. Hydrodictyon sp. Pediastrum sp. Pandorina sp. -- --	APHA (22nd Edi) 10200-H
C	**Zooplanktons**														
19.1	Abundance (Population)	no/m^2	275	75	280	40	300	125	166	50	140	60	175	50	APHA (22nd Edi) 10200-G

H. T. Shah
Lab Manager

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Lab Manager (Q)

19.2	Name of Group Number and name of group species of each group	--	copepods ctenophor s molluscan s Rotifry	Cylons Nematod es Bivalves	Copepods Krill Decapods Crustacea ns Ostracods & Fish egg	Copepods Gastropo ds -- -- --	Copepods Crustacea ns Decapods Krill Ostracods Rotiferd	Polychaet es worms Chaetogn athes -- -- -- --	Gastropo ds Chaetogn athes Ostracods Decapods Copepods	Decapods Ostracods Polychaet es -- --	Copepods Decapods Ostracods Ctenopho res Gastropo ds Absent	Polychaet e worms Ostracods Decapods -- -- --	Echinoder ms Nematod es Decapods Gastropo ds	Bivalves Decapod s Nematod es --	APHA (22nd Edi) 10200-G
19.3	Total Biomass	ml/100 m^3	148	4	56	5	101	46	80.8	6.6	82.5	7.4	48.52	8.72	APHA (22nd Edi) 10200-G
D	**Microbiological Parameters**														
20.1	Total Bacterial Count	CFU/ml	1870	1610	1760	1580	1970	1680	1790	1380	1680	1260	1890	1600	IS 5402:2002
20.2	Total Coliform	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	APHA(22ndEdi)922 1-D
20.3	Ecoli	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS:1622:1981Edi.2 .4(2003-05)
20.4	Enterococcus	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 15186 :2002
20.5	Salmonella	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 5887 (P-3)
20.6	Shigella	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 1887 (P-7)
20.7	Vibrio	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 5887 (P-5)

H. T. Shah
Lab Manager

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Lab Manager (Q)

RESULTS OF MARINE WATER [M8 RIGHT SIDE OF BOCHA CREEK N 22°45'987" E 069°43'119"]

SR. NO.	TEST PARAMETERS	UNIT	APRIL 2017		MAY 2017		JUNE 2017		JULY 2017		AUGUST 2017		SEPTEMBER 2017		TEST METHOD
			SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	
1	pH	--	8.08	8.17	8.04	8	8.1	8.16	8.03	8.23	8.13	8.28	7.78	8.01	IS3025(P11)83Re .02
2	Temperature	°C	28	29	28	29	29	30	28	29	28	29	29	30	IS3025(P9)84Re. 02
3	Total Suspended Solids	mg/L	22	24	16	20	18	22	20	28	22	26	22	30	IS3025(P17)84Re .02
4	BOD (3 Days @ 27 °C)	mg/L	6.0	7	BDL*	BDL*	5	6	4	6	4	5	5	6	IS 3025 (P44)1993Re.03E dition2.1
5	Dissolved Oxygen	mg/L	5.40	4.80	5.4	4.6	5.6	4.8	5.6	4.8	5.8	4.6	5.4	4.6	IS3025(P38)89Re .99
6	Salinity	ppt	44.80	45.22	38.8	39.6	39.82	40.54	44.6	45.8	30.96	34.88	44.2	45.6	APHA (22nd Edi) 2550 B
7	Oil & Grease	mg/L	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	APHA(22nd Edi)552 0D
8	Nitrate as NO_3	mg/L	0.020	0.580	0.325	0.399	0.443	0.52	0.54	0.66	0.33	0.58	0.52	0.64	IS3025(P34)88
9	Nitrite as NO_2	mg/L	0.330	0.022	0.044	0.019	0.497	0.638	0.02	0.029	0.032	0.022	0.019	0.025	IS3025(P34)88 NEDA
10	Ammonical Nitrogen as NH_3	mg/L	0.032	0.520	0.554	0.591	0.684	0.748	0.62	0.7	0.59	0.52	0.6	0.68	IS3025(P34)88Cla .2.3
11	Phosphates as PO_4	mg/L	0.027	0.042	0.495	0.585	0.447	0.479	0.19	0.15	0.027	0.041	0.048	0.029	APHA(22nd Edi) 4500 C
12	Total Nitrogen	mg/L	0.952	1.12	0.923	1.009	1.624	1.906	1.18	1.389	0.96	1.13	1.1	1.4	IS3025(P34)88
13	Petroleum Hydrocarbon	mg/L	BDL*	BDL*	1.2	BDL*	0.4	BDL*	1	BDL*	0.88	BDL*	1.2	BDL*	PLPL-TPH
14	Total Dissolved Solids	mg/L	47250	47870	42750	43320	43460	45020	51990	53890	38830	39690	52090	54680	IS3025(P16)84Re .02
15	COD	mg/L	20	22.000	24	28	19	24	18	24	19	24	20	22	APHA(22nd Edi) 5520-D Open Reflux
16	Oxidisable Particular Organic Carbon	%	0.440	0.23	0.54	0.62	0.38	0.24	0.48	0.62	0.63	0.76	0.46	0.6	SOP – PLPL - 07
A							Flora and Fauna								
17	Primary productivity	mgC/L /day	1.350	0.450	1.463	0.113	1.193	0.45	1.35	0.338	1.12	0.033	78	22	APHA (22nd Edi) 10200-J
B							Phytoplankton								
18.1	Chlorophyll	mg/m^3	2.720	1.220	1.922	0.427	1.842	0.614	7.762	0.614	1.73	0.61	4.802	0.58	APHA (22nd Edi) 10200-H
18.2	Phaeophytin	mg/m^3	1.680	2.990	0.021	1.479	0.12	1.199	0.294	1.33	0.97	1.64	0.207	1.15	APHA (22nd Edi) 10200-H

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Lab Manager (Q)

18.3	Cell Count	Unit x 10^3/L	282	36.0	202	33	178	32	220	51	188	31	199	41.5	APHA (22nd Edi) 10200-H
18.4	Name of Group Number and name of group species of each group	--	Bacillariophyceae Asterionella sp. Gyrosigma sp. Melosira sp. Fragillaria sp. Green algae Scenedesmus sp. Ulothrix sp. Cyanophyceae Microcystis sp. Nostoc sp.	Bacillariophyceae Biddulphia sp. Cymbella sp. Navicula sp. Fragillaria sp. Green algae Oedogonium sp. Ulothrix sp. Spirogyra sp. Cyanophyceae Spirulina sp.	Bacillariophyceae Asterionella sp. Fragillaria sp. Navicula sp. Synedra sp. Coscinodiscus sp. Cymbella sp. Pleurosigma sp. Cyanophyceae Oscillatoria sp. Nostoc sp. Green Algae Chlorella sp. Pediastrum sp.	Bacillariophyceae Fragillaria sp. Navicula sp. Nitzschia sp. Gyrosigma sp. Cyanophyceae Oscillatoria sp. Desmids Closterium sp. -- -- -- -- --	Bacillariophyceae Cheatocerous sp. Pinnularia sp. Thallasiosira sp. Biddulphia sp. Asterionella sp. Cyanophyceae Spirulina sp. Microcystis sp. Anabaena sp. Green Algae Scenedesmus sp. -- --	Bacillariophyceae Cyclotella sp. Thallasiosira sp. Fragillaria sp. Pinnularia sp. Nitzschia sp. Green Algae Volvox sp. Ulothrix sp. Chlorella sp. Pandorina sp. -- -- --	Bacillariophyceae Asterionella sp. Gyrosigma sp. Pinnularia sp. Synedra sp. Tabellaria sp. Gomphonema sp. Cyanophyceae Oscillatoria sp. Oedogonium sp. Hydrodictyon sp. Pandorina sp. Pediastrum sp.	Bacillariophyceae Fragillaria sp. Gomphonema sp. Navicula sp. Nitzschia sp. Cyanophyceae Oscillatoria sp. Spirulina sp. Green Alage Pandorina sp. -- -- --	Bacillariophyceae Asterionella sp. Biddulphia sp. Nitzschia sp. Rhizosolenia sp. Thallasiosira sp. Skeletonema sp. Cyclotella sp. Cyanophyceae Anabaena sp. Oscillatoria sp. Nostoc sp. Green Algae Ankistrodesmus sp. Pandorina sp. Pediastrum sp. Ulothrix sp.	Bacillariophyceae Fragillaria sp. Nitzschia sp. Biddulphia sp. Navicula sp. Cyanophyceae Oscillatoria sp. Microcystis sp. Nostoc sp. Green Algae Chlorella sp. Hydrodictyon sp. Pandorina sp. -- -- -- --	Bacillariophyceae Biddulphia sp. Pinnularia sp. Thallasiosira sp. Cheatocerous sp. Asterionella sp. Cyanophyceae Anabaena sp. Microcystis sp. Spirogyra sp. Green Algae Scenedesmus sp.	Bacillariophyceae Nitzschia sp. Fragillaria sp. Pinnularia sp. Thallasiosira sp. Cyclotella sp. Green Algae Pandorina sp. Chlorella sp. Ulothrix sp. Volvox sp. --	APHA (22nd Edi) 10200-H
C							Zooplanktons								
19.1	Abundance (Population)	no/m^2	350	6	240	80	375	50	280	100	200	80	327.5	75	APHA (22nd Edi) 10200-G

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Lab Manager (Q)

19.2	Name of Group Number and name of group species of each group	--	Nauplius larvae Nematodes Daphnia Mysids	Ostracods Nematodes Polychaete worms	Nematodes Copepods Krill Molluscans	Polychaete worms Isopods -- --	Copepods Krill Decapods Isopods Crustaceans Chaetognathes Rotifers	Ostracods Decapods -- -- -- -- --	Copepods Decapods Ostracods	Copepods Decapods Isopods	Copepods Ostracods Krill Crustaceans Echinoderms	Decapods Krill	Copepods Krill Isopods Decapods Crustaceans Chaetognathes	Ostracods Decapods -- -- -- --	APHA (22nd Edi) 10200-G
19.3	Total Biomass	ml/100 m^3	243	6	61	9	78	22	83.8	5.7	68.9	9	80.9	13.8	APHA (22nd Edi) 10200-G
D	**Microbiological Parameters**														
20.1	Total Bacterial Count	CFU/ml	1700	1540	1470	1110	1540	1220	1860	1340	1690	1500	1750	1280	IS 5402:2002
20.2	Total Coliform	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	APHA(22ndEdi)9221-D
20.3	Ecoli	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS:1622:1981Edi. 2.4(2003-05)
20.4	Enterococcus	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 15186 :2002
20.5	Salmonella	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 5887 (P-3)
20.6	Shigella	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 1887 (P-7)
20.7	Vibrio	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 5887 (P-5)

H. T. Shah
Lab Manager

POLLUCON LABORATORIES PVT. LTD. SURAT-3

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Lab Manager (Q)

RESULTS OF SEDIMENT ANALYSIS [M8 RIGHT SIDE OF BOCHA CREEK – N 22°45'987" E 069°43'119"]

SR. NO.	TEST PARAMETERS	UNIT	APRIL 2017	MAY 2017	JUNE 2017	JULY 2017	AUGUST 2017	SEPTEMBER 2017	TEST METHOD
			SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	
1	Organic Matter	%	0.544	0.441	0.569	0.53	0.51	0.52	FCO:2007
2	Phosphorus as P	μg/kg	146	187	170	200	170	198	APHA(22nd Edi) 4500 C
3	Texture	--	sandyloam	Sandy Loam	Sandy Loam	Sandy loam	Sandy loam	Sandy Loam	--
4	Petroleum Hydrocarbon	mg/kg	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	PLPL-TPH
5	**Heavy Metals**								
5.1	Aluminum as Al	%	5.7	5.59	5.33	5	5.09	5.6	AAS APHA 3111 B
5.2	Total Chromium as Cr^{+3}	μg/kg	136	99.98	87.99	98	101	102	AAS 3111B
5.3	Manganese as Mn	μg/kg	820	879	735	880	829	770	AAS APHA 3111 B
5.4	Iron as Fe	%	2.42	2.12	2.13	2.8	2.42	2.6	AAS APHA(22nd Edi)3111 B
5.5	Nickel as Ni	μg/kg	32.4	35.9	38.98	50	43.98	48	AAS APHA(22nd Edi)3111 B
5.6	Copper as Cu	μg/kg	40.18	45.9	43.97	54	47.98	52	AAS APHA(22nd Edi)3111 B
5.7	Zinc as Zn	μg/kg	182	162	162	160	148	174	AAS APHA(22nd Edi)3111 B
5.8	Lead as Pb	μg/kg	1.14	1.88	1.99	2.2	1.47	1.8	AAS APHA(22nd Edi)3111 B
5.9	Mercury as Hg	μg/kg	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	AAS APHA- 3112 B
6	**Benthic Organisms**								
6.1	Macrobenthos	--	Sponges Bivalxes Corals Prawns	Polychaete worms Isopods Decapods Prawn	Echinoderms Decapods Isopods --	Mysids Isopods Echinoderms	Polychaete worms Echinoderms Decapods	Echinoderms Decapods Isopods	APHA (22nd Edi) 10500-C
6.2	MeioBenthos	--	Copepodes Bryozoans Mysids	Namatodes Foraminiferans -- --	Gastrotriches Copepods Ostracodes	Polychaete worms Copepods Ostracods Ciliates	Nematodes Foraminiferans --	Gastropods Copepods Ostracods	APHA (22nd Edi) 10500-C
6.3	Population	no/m^2	252	433	503	317	385	503	APHA (22nd Edi) 10500-C

POLLUCON LABORATORIES PVT. LTD. SURAT-3

H. T. Shah Lab Manager	Dr. ArunBajpai Lab Manager (Q)

RESULTS OF MARINE WATER [M11 MPT T1 JETTY N 22°42'278" E 069°43'450"]

SR. NO.	TEST PARAMETERS	UNIT	APRIL 2017		MAY 2017		JUNE 2017		JULY 2017		AUGUST 2017		SEPTEMBER 2017		TEST METHOD
			SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	
1	pH	--	8.06	8.17	8	8.09	8.02	8.11	8.08	8.32	8.12	8.33	7.62	7.27	IS3025(P11)83Re .02
2	Temperature	°C	29	30	28	29	29	30	28	29	29	30	28	29	IS3025(P9)84Re. 02
3	Total Suspended Solids	mg/L	20	22	16	20	14	20	17	24	19	25	20	24	IS3025(P17)84Re .02
4	BOD (3 Days @ 27 °C)	mg/L	4	6	BDL*	BDL*	3	4	3	6	5	6	4	5	IS 3025 (P44)1993Re.03Edition2.1
5	Dissolved Oxygen	mg/L	5.40	5.00	5.4	4.8	5.8	4.8	5.2	5	5.4	4.6	5.6	4.8	IS3025(P38)89Re .99
6	Salinity	ppt	42.40	43.60	39.6	40.2	40.3	41.6	37.82	38.3	31.8	33	42.1	42.93	APHA (22nd Edi) 2550 B
7	Oil & Grease	mg/L	BDL*	BDL*	0.4	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	APHA(22nd Edi)5520D
8	Nitrate as NO_3	mg/L	0.689	0.903	0.34	0.414	0.474	0.673	0.413	0.566	0.67	0.87	0.28	0.32	IS3025(P34)88
9	Nitrite as NO_2	mg/L	0.081	0.082	0.026	0.011	0.027	0.049	0.031	0.027	0.079	0.081	0.08	0.085	IS3025(P34)88 NEDA
10	Ammonical Nitrogen as NH_3	mg/L	0.489	0.602	0.221	0.351	0.64	0.76	0.672	0.766	0.69	0.79	0.44	0.46	IS3025(P34)88Cla .2.3
11	Phosphates as PO_4	mg/L	0.084	0.140	0.495	0.63	0.279	0.361	0.479	0.56	0.075	0.089	0.083	0.144	APHA(22nd Edi) 4500 C
12	Total Nitrogen	mg/L	1.258	1.593	0.587	0.776	1.141	1.482	1.116	1.359	1.45	1.74	0.8	0.865	IS3025(P34)88
13	Petroleum Hydrocarbon	mg/L	11.20	BDL*	6.2	BDL*	0.2	BDL*	19	BDL*	0.88	BDL*	1.7	BDL*	PLPL-TPH
14	Total Dissolved Solids	mg/L	35240	35180	46326	47880	47980	49710	39810	40180	38830	39620	34120	35330	IS3025(P16)84Re .02
15	COD	mg/L	16	22	9	19	14	18	24	28	24	28	18	20	APHA(22nd Edi) 5520-D Open Reflux
16	Oxidisable Particular Organic Carbon	%	0.940	0.380	0.55	0.43	0.44	0.62	0.48	0.29	0.78	0.49	0.88	0.4	SOP – PLPL - 07
A	**Flora and Fauna**														
17	Primary productivity	mgC/L /day	1.8	0.45	1.125	0.338	1.913	0.563	2.25	0.45	2.47	0.33	79.6	21	APHA (22nd Edi) 10200-J
B	**Phytoplankton**														
18.1	Chlorophyll	mg/m^3	2.290	0.740	1.44	0.32	1.816	0.908	1.7	0.507	2.35	0.32	1.922	0.824	APHA (22nd Edi) 10200-H

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18.2	Phaeophytin	mg/m^3	2.900	3.360	0.689	1.511	0.24	1.148	0.422	1.62	BDL*	1.86	0.32	0.992	APHA (22^{nd}Edi) 10200-H
18.3	Cell Count	Unit x 10^3/L	316	32.0	196	42	210	63	172	34	314	162	240	98	APHA (22^{nd} Edi) 10200-H
18.4	Name of Group Number and name of group species of each group	--	Bacillariophyceae Cocconeis sp. Cheatocerous sp. Biddulphia sp. Pinnularia sp. Green algae Pediastrum sp. Scenedesmus sp. Cyanophyceae Spirulina sp. Oscillatoria sp.	Bacillariophyceae Coscinodiscus sp. Gyrosigma sp. synendra sp. Pinnularia sp. Green algae Ulothrix sp. Pediastrum sp. Cyanophyceae Anabaena sp. Nostoc sp.	Bacillariophyceae Rhizosolenia sp. Nitzschia sp. Navicula sp. Coscinodiscus sp. Pleurosigma sp. Thallasionema sp. Cyanophyceae Oscillatoria sp. Nostoc sp. Green Algae Chlorella sp. Pediastrum sp. --	Bacillariophyceae Fragillaria sp. Nitzschia sp. Navicula sp. Gyrosigma sp. Green Algae Chlorella sp. Pandorina sp. -- -- -- -- -- --	Bacillariophyceae Rhizosolenia sp. Coscinodiscus sp. Gomphonema sp. Cymbella sp. Nitzschia sp. Navicula sp. Green Algae Ciismarium sp. Desmids Spirogyra sp. Hydrodictyon sp. Scenedesmus sp. --	Bacillariophyceae Nitzschia sp. Navicula sp. Pinnularia sp. Thallasiosira sp. Gyrosigma sp. Synedra sp. Green Algae Ulothrix sp. Chlorella sp. -- -- -- --	Bacillariophyceae Asterionella sp. Biddulphia sp. Synedra sp. Nitzschia sp. Navicula sp. Pinnularia sp.	Bacillariophyceae Pinnularia sp. Fragillaria sp. Navicula sp. -- Absent --	Bacillariophyceae Navicula sp. Nitzschia sp. Coscinodiscus sp. Fragillaria sp. Gomphonema sp. Skeletonema sp. Rhizosolenia sp. Cyanophyceae Anabaena sp. Microcystis sp. Oscillatoria sp. Green Algae Ankistrodesmus sp. Chlorella sp. Hydrodictyon sp. Volvox sp.	Bacillariophyceae Fragillaria sp. Gomphonema sp. Asterionella sp. Rhizosolenia sp. Cyanophyceae Microcystis sp. Oscillatoria sp. Nostoc sp. Green Algae Chlorella sp. Pandorina sp. Pediastrum sp. -- -- -- --	Bacillariophyceae Nitzschia sp. Navicula sp. Cymbella sp. Gomphonema sp. Coscinodiscus sp. Rhizosolenia sp. Green Algae Scenedesmus sp. Hydrodictyon sp. Spirogyra sp. Cosmarium sp.	Bacillariophyceae Synedra sp. Gyrosigma sp. Thallasiosira sp. Pinnularia sp. Navicula sp. Nitzschia sp. Green Algae Ulothrix sp. Chlorella sp. -- --	APHA (22^{nd} Edi) 10200-H
C	**Zooplanktons**														
19.1	Abundance (Population)	no/m^2	200	50	325	75	225	75	220	50	367	100	250	100	APHA (22^{nd} Edi) 10200-G

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19.2	Name of Group Number and name of group species of each group	--	decapods Echinoderms Fish egg Foraminiferans	Molluscans Bivalves Crustaceans	Polychaete worms Krill Isopods Gastropods --	Copepods Nematodes -- -- --	Chaetognathes Krill Ostracods Crustaceans Polychaetes --	Gastropods Decapods Nematods -- -- --	Nematodes Polychaete worms Gastrotriches Crustaceans Isopods	Decapods Isopods Nematodes -- --	Polychaete worms Echinoderms Amphipods Krill	Nematodes Gastrotriches -- --	Chaetognaths Krill Ostracods Cyclops Polychaete worms	Gastrotriches Decapods Nematodes -- --	APHA (22nd Edi) 10200-G
19.3	Total Biomass	ml/100 m^3	159	29	72	11	79.6	21	142	48.8	80.24	16	110.8	34.6	APHA (22nd Edi) 10200-G
D	**Microbiological Parameters**														
20.1	Total Bacterial Count	CFU/ml	1860	1450	1470	1180	1820	1690	1770	1460	1840	1680	1820	1580	IS 5402:2002
20.2	Total Coliform	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	APHA(22ndEdi)9221-D
20.3	Ecoli	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS:1622:1981Edi. 2.4(2003-05)
20.4	Enterococcus	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 15186 :2002
20.5	Salmonella	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 5887 (P-3)
20.6	Shigella	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 1887 (P-7)
20.7	Vibrio	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 5887 (P-5)

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RESULTS OF MARINE WATER [M12 SPM N 22°40'938" E 069°39'191"]

SR. NO.	TEST PARAMETERS	UNIT	APRIL 2017		MAY 2017		JUNE 2017		JULY 2017		AUGUST 2017		SEPTEMBER 2017		TEST METHOD
			SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	
1	pH	--	7.94	8.13	7.99	8.05	7.89	8.16	8.28	8.38	7.82	7.74	7.92	8.02	IS3025(P11)83Re.02
2	Temperature	°C	28	29	29	30	29	30	29	28	28	29	28	30	IS3025(P9)84Re.02
3	Total Suspended Solids	mg/L	20	24	20	26	20	29	21	26	24	30	16	26	IS3025(P17)84Re.02
4	BOD (3 Days @ 27°C)	mg/L	5	8	BDL*	BDL*	6	7	4	8	5	6	3	4	IS 3025 (P44)1993Re.03Edition2.1
5	Dissolved Oxygen	mg/L	5.20	5.00	5.8	4.6	5.8	4.8	5.6	4.8	5.2	4.8	5.8	4.8	IS3025(P38)89Re.99
6	Salinity	ppt	40.60	46.80	39.6	40.1	40.12	41.08	35.18	37.52	31.7	32.3	39.6	40.2	APHA (22nd Edi) 2550 B
7	Oil & Grease	mg/L	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	APHA(22nd Edi)5520D
8	Nitrate as NO_3	mg/L	0.580	0.720	0.458	0.888	0.474	0.581	0.612	0.566	0.508	0.61	0.24	0.18	IS3025(P34)88
9	Nitrite as NO_2	mg/L	0.084	0.088	0.037	0.063	0.044	0.068	0.054	0.061	0.075	0.097	0.089	0.09	IS3025(P34)88 NEDA
10	Ammonical Nitrogen as NH_3	mg/L	0.480	0.530	0.887	1.06	0.591	0.702	0.317	0.504	0.81	0.9	0.32	0.59	IS3025(P34)88Cla.2.3
11	Phosphates as PO_4	mg/L	0.120	0.340	0.585	0.675	0.117	0.139	0.56	0.718	0.16	0.189	0.09	0.15	APHA(22nd Edi) 4500 C
12	Total Nitrogen	mg/L	1.144	1.338	1.382	2.011	1.1	1.351	0.983	1.13	1.39	1.607	1.15	0.8	IS3025(P34)88
13	Petroleum Hydrocarbon	mg/L	BDL*	BDL*	1.56	BDL*	BDL*	BDL*	1.3	BDL*	1.8	BDL*	0.4	BDL*	PLPL-TPH
14	Total Dissolved Solids	mg/L	48130	48920	47310	47738	47980	48710	47900	48800	38400	39500	47290	48260	IS3025(P16)84Re.02
15	COD	mg/L	16	26	24	28	26	30	24	32	19	24	14	24	APHA(22nd Edi) 5520-D Open Reflux
16	Oxidisable Particular Organic Carbon	%	0.670	0.430	0.52	0.32	0.74	0.4	0.71	0.52	0.7	0.38	0.63	0.41	SOP – PLPL - 07
A	**Flora and Fauna**														
17	Primary productivity	mgC/L /day	2.47	0.450	1.575	0.225	2.138	0.338	1.755	0.563	2.25	0.789	2.25	0.22	APHA (22nd Edi) 10200-J
B	**Phytoplankton**														
18.1	Chlorophyll	mg/m^3	2.830	1.220	1.362	0.187	1.896	0.534	1.89	0.748	2.163	0.454	1.3	0.64	APHA (22nd Edi) 10200-H

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18.2	Phaeophytin	mg/m³	1.240	2.430	0.844	1.77	0.142	1.428	0.235	1.27	BDL*	1.602	0.74	1.11	APHA (22nd Edi) 10200-H
18.3	Cell Count	Unit x 10^3/L	304	38.0	225	31	208	60	164	26	223	62	178	70	APHA (22nd Edi) 10200-H
18.4	Name of Group Number and name of group species of each group	--	Bacillariophyceae Nitzschia sp. Surirella sp. Rhizosolenia sp. Pinnularia sp. Green algae Ankistrodesmus sp. Hydrodictyon sp. Pandorina sp. Desmids Closterium sp.	Bacillariophyceae Cocconeis sp. Navicula sp. Skeletonema sp. Green algae Spirogyra sp. Volvox sp. Cyanophyceae Anabaena sp. Spirulina sp.	Bacillariophyceae Rhizosolenia sp. Nitzschia sp. Navicula sp. Thallasionema sp. Coscinodiscus sp. Fragillaria sp. Cyanophyceae Oscillatoria sp. Nostoc sp. Green Algae Chlorella sp. Volvox sp.	Bacillariophyceae Thallasionema sp. Fragillaria sp. Synedra sp. Pleurosigma sp. Asterionella sp. Cyanophyceae Oscillatoria sp. Desmids Closterium sp. -- -- --	Bacillariophyceae Fragillaria sp. Navicula sp. Nitzschia sp. Pinnularia sp. Synedra sp. Skeletonema sp. Amphora sp. Biddulphia sp. Cyanophyceae oscillatoria sp. Anabaena sp. Nostoc sp. Green Algae Chlorella sp. Ankistrodesmus sp. Ulothrix sp.	Bacillariophyceae Melosira sp. Cheatocerous sp. Navicula sp. Coscinodiscus sp. Rhizosolenia sp. Green Algae Pandorina sp. Ulothrix sp. Volvox sp. -- -- -- -- -- -- --	Bacillariophyceae Synedra sp. Nitzschia sp. Navicula sp. Thallasionema sp. Coscinodiscus sp. Tubellaria sp. Cyclotella sp. Melosira sp. Sudioella sp. --	Bacillariophyceae Melosira sp. Fragillaria sp. Nitzschia sp. -- -- -- -- -- -- --	Bacillariophyceae Asterionella sp. Cocconeis sp. Fragillaria sp. Pinnularia sp. Rhizosolenia sp. Skeletonema sp. Thallasionema sp. Cyanophyceae Oscillatoria sp. Nostoc sp. Microcystis sp. Green Algae Ankistrodesmus sp. Chlorella sp. Hydrodictyon sp.	Bacillariophyceae Biddulphia sp. Pinnularia sp. Cocconeis sp. Gyrosigma sp. Thallasiosira sp. Cyanophyceae Microcystis sp. Green Algae Chlorella sp. Hydrodictyon sp. Pandorina sp. -- -- -- --	Bacillariophyceae Asterionella sp. Biddulphia sp. Coscinodiscus sp. Gyrosigma sp. Nitzschia sp. Rhizosolenia sp. Thallasiosira sp. Cyanophyceae Microcystis sp. Oscillatoria sp. Nostoc sp. Green Algae Ankistrodesmus sp. Chlorella sp. Pediastrum sp. Scenedesmus sp.	Bacillariophyceae Fragillaria sp. Nitzschia sp. Skeletonema sp. Asterionella sp. Cyanophyceae Oscillatoria sp. Nostoc sp. Green Algae Chlorella sp. Pandorina sp. Ankistrodesmus sp. -- -- -- -- --	APHA (22nd Edi) 10200-H

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Lab Manager (Q)

C	**Zooplanktons**														
19.1	Abundance (Population)	no/m^2	213	63	280	150	300	125	200	10	280	60	250	50	APHA (22nd Edi) 10200-G
19.2	Name of Group Number and name of group species of each group	--	Daphnia Copepods Fish egg Foraminiferans	Crustaceans Copepods Rotifers	Copepods Decapods Nematodes Isopods Krill	Isopods Hydrozoans Namatodes -- --	Copepods Decapods Nematods Gastropods Ostracods --	Polychaetes Chaetognathes Copepods -- -- --	Gastropods Polychaete worms Nematodes Isopods Mysids	Gastropods -- -- -- --	Copepods Ctenophores Krill Daphnia Ostracods Gastropods	Ctenophores Copepods -- -- -- --	Polychaete worms Echinoderms Amphipods Isopods Decapods	Copepods Molluscans -- -- --	APHA (22nd Edi) 10200-G
19.3	Total Biomass	ml/100 m^3	162	9	75	9	86.9	6.2	170	1.1	91.2	10.8	10.24	30.1	APHA (22nd Edi) 10200-G
D	**Microbiological Parameters**														
20.1	Total Bacterial Count	CFU/ml	1560	1320	1590	1320	1550	1230	1810	1560	1720	1360	1500	1310	IS 5402:2002
20.2	Total Coliform	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	APHA(22ndEdi)922 1-D
20.3	Ecoli	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS:1622:1981Edi. 2.4(2003-05)
20.4	Enterococcus	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 15186 :2002
20.5	Salmonella	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 5887 (P-3)
20.6	Shigella	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 1887 (P-7)
20.7	Vibrio	/ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	IS : 5887 (P-5)

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Lab Manager (Q)

RESULTS OF ETP WATER OUTLET

SR. NO.	PARAMETERS	UNIT	RESULTS OF ETP WATER OUTLET							GPCB Limit	TEST METHOD
			04/04/2017	03/05/2017	07/06/2017	16/06/2017	04/07/2017	04/08/2017	04/09/2017		
1	Colour	Co-pt	30	10	30	10	30	60	10	**100**	IS3025(P4)83Re.02
2	pH	--	6.55	6.78	7.04	6.58	7.55	6.9	6.93	**6.5 TO 8.5**	IS3025(P11)83Re.02
3	Temperature	°C	29	30	31	28	29	30	30	**40**	IS3025(P9)84Re.02
4	Total Suspended Solids	mg/L	28	22	34	22	30	62	58	**100**	IS3025(P17)84Re.02
5	Total Dissolved Solids	mg/L	1512	1302	1116	950	1528	1480	1436	**2100**	IS3025(P16)84Re.02
6	COD	mg/L	80	60	98	28	76	81	76	**100**	APHA(22ndEdi) 5520-D Open Reflux
7	BOD (3 Days @ 27 °C)	mg/L	21	18	26	8	22	27	22	**30**	IS 3025 (P44)1993Re.03Edition2.1
8	Chloride as Cl	mg/L	302	629	346	359	509	569	509	**600**	IS3025(P32)88Re.99
9	Oil & Grease	mg/L	BDL*	1.12	1.02	BDL*	1.04	1.08	BDL*	**10**	APHA(22ndEdi)5520D
10	Sulphate as SO_4	mg/L	60	152	138	33.52	138	130	112	**1000**	APHA(22ndEdi)4500 SO_4 E
11	Ammonical Nitrogen as NH_3	mg/L	2.44	2.52	2.4	2.39	2.4	12.6	1.74	**50**	IS3025(P34)88Cla.2.3
12	Phenolic Compound	mg/L	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	**1**	IS3025(P43)92Re.03
13	Copper as Cu	mg/L	0.014	0.014	0.024	0.015	0.017	0.031	0.027	**3**	AAS APHA(22ndEdi)3111 B
14	Lead as Pb	mg/L	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*	**0.1**	AAS APHA(22ndEdi)3111 B
15	Sulphide as S	mg/L	BDL*	BDL*	BDL*	BDL*	1.24	0.96	0.34	**2**	APHA(22ndEdi) 4500-S
16	Cadmium as Cd	mg/L	BDL*	BDL*	BDL*	BDL*	BDL*	0.28	0.19	**2**	AAS APHA(22ndEdi)3111 B
17	Fluoride as F	mg/L	BDL*	BDL*	BDL*	BDL*	0.62	0.31	0.42	**2**	APHA(22ndEdi) 4500 F D SPANDS

*Below detection limit

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RESULT OF AMBIENT AIR QUALITY MONITORING

ADANI PORT – T1 TERMINAL NR.MARINE BUILDING								
Sr. No.	Date of Sampling	Particulate Matter (PM10) µg/m^3	Particulate Matter (PM 2.5) µg/m^3	Sulphur Dioxide (SO2) µg/m^3	Oxides of Nitrogen (NO2) µg/m^3	Carbon Monoxide as CO mg/m^3	Hydrocarbon as CH_4 mg/m^3	Benzene as C_6H_6 µg/m^3
1	04/04/2017	52.58	18.71	5.65	15.34	0.18	BDL*	BDL*
2	07/04/2017	82.44	46.56	14.35	34.41	0.53	BDL*	BDL*
3	11/04/2017	71.42	26.61	18.05	26.16	0.39	BDL*	BDL*
4	14/04/2017	81.53	44.52	15.93	35.80	0.69	BDL*	2.24
5	18/04/2017	68.58	40.32	9.69	19.06	0.30	BDL*	BDL*
6	21/04/2017	55.29	24.53	13.42	24.27	0.48	BDL*	BDL*
7	25/04/2017	79.60	42.40	16.85	31.39	0.22	BDL*	BDL*
8	28/04/2017	65.63	28.68	6.30	18.31	0.36	BDL*	BDL*
9	05/02/2017	58.43	32.43	14.96	26.81	0.52	BDL*	BDL*
10	05/05/2017	73.33	27.44	9.57	21.41	0.29	BDL*	BDL*
11	05/09/2017	84.22	37.41	18.72	34.56	0.17	BDL*	BDL*
12	05/12/2017	70.62	40.74	5.62	19.27	0.38	BDL*	BDL*
13	16/05/2017	61.50	24.53	11.59	23.46	0.44	BDL*	BDL*
14	19/05/2017	56.27	29.52	7.00	29.33	0.14	BDL*	BDL*
15	23/05/2017	89.27	45.73	17.71	39.93	0.77	BDL*	BDL*
16	26/05/2017	67.23	33.67	13.60	36.47	0.57	BDL*	BDL*
17	30/05/2017	75.60	34.50	20.66	30.26	0.40	BDL*	BDL*
18	02/06/2017	82.62	43.65	15.19	36.35	0.80	BDL*	BDL*
19	06/06/2017	60.40	31.59	18.77	24.37	0.60	BDL*	BDL*
20	06/09/2017	59.78	23.70	12.79	32.31	0.33	BDL*	BDL*
21	13/06/2017	68.28	30.76	20.49	28.51	0.55	BDL*	BDL*
22	16/06/2017	54.18	25.36	8.96	19.24	0.30	BDL*	BDL*
23	20/06/2017	81.33	45.73	7.04	26.51	0.17	BDL*	BDL*
24	23/06/2017	77.57	35.75	16.14	31.00	0.21	BDL*	BDL*
25	27/06/2017	53.19	22.45	11.06	21.38	0.46	BDL*	BDL*
26	30/06/2017	61.20	32.43	5.97	17.10	0.40	BDL*	BDL*
27	04/07/2017	68.40	40.74	18.23	25.39	0.54	BDL*	BDL*
28	07/07/2017	72.59	38.66	13.09	32.79	0.78	BDL*	BDL*
29	11/07/2017	66.68	29.52	15.21	21.16	0.60	BDL*	BDL*
30	14/07/2017	76.77	33.70	10.59	29.21	0.52	BDL*	BDL*

Continue …

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Lab Manager

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RESULT OF AMBIENT AIR QUALITY MONITORING

ADANI PORT – T1 TERMINAL NR. (MARINE BUILDING)								
Sr.No.	Date of Sampling	Particulate Matter (PM10) µg/m³	Particulate Matter (PM 2.5) µg/m³	Sulphur Dioxide (SO2) µg/m³	Oxides of Nitrogen (NO2) µg/m³	Carbon Monoxide as CO mg/m³	Hydrocarbon as CH_4 mg/m³	Benzene as C_6H_6 µg/m³
31	18/07/2017	53.38	20.37	7.05	24.45	0.33	BDL*	BDL*
32	21/07/2017	46.73	19.54	12.92	17.45	0.29	BDL*	BDL*
33	25/07/2017	71.48	31.59	9.48	36.36	0.18	BDL*	BDL*
34	28/07/2017	59.23	34.50	5.64	19.39	0.45	BDL*	BDL*
35	01/08/2017	64.21	36.58	16.65	29.42	0.49	BDL*	BDL*
36	04/08/2017	71.60	44.48	11.64	31.69	0.42	BDL*	BDL*
37	08/08/2017	83.61	47.39	14.23	36.18	0.61	BDL*	BDL*
38	11/08/2017	56.27	26.61	19.95	28.46	0.46	BDL*	BDL*
39	15/08/2017	62.61	29.52	9.64	20.40	0.39	BDL*	BDL*
40	18/08/2017	76.28	33.67	12.88	26.48	0.66	BDL*	BDL*
41	22/08/2017	44.33	17.46	5.59	15.60	0.13	BDL*	BDL*
42	25/08/2017	79.30	35.75	15.21	27.33	0.24	BDL*	BDL*
43	29/08/2017	51.28	24.53	7.95	23.88	0.14	BDL*	BDL*
44	01/09/2017	50.30	19.54	6.25	17.21	0.11	BDL*	BDL*
45	05/09/2017	87.61	46.56	15.31	27.10	0.21	BDL*	BDL*
46	08/09/2017	72.89	32.43	18.77	32.26	0.44	BDL*	BDL*
47	12/09/2017	82.62	43.65	12.09	35.49	0.38	BDL*	BDL*
48	15/09/2017	57.63	27.44	14.22	30.54	0.14	BDL*	BDL*
49	19/09/2017	92.60	52.38	17.85	39.20	0.53	BDL*	BDL*
50	22/09/2017	68.40	29.52	10.61	22.59	0.41	BDL*	BDL*
51	26/09/2017	52.58	25.36	13.26	29.58	0.47	BDL*	BDL*
52	29/09/2017	76.22	33.67	16.01	25.33	0.61	BDL*	BDL*
	TEST METHOD	IS:5182(Part 23):Gravimetric CPCB - Method (Vol.I,May-2011)	Gravimetric-CPCB - Method (Vol.I,May-2011)	IS:5182(Part II):Improved West and Gaeke	IS:5182(Part VI):Modified Jacob & Hochheiser (NaOH-NaAsO2)	NDIR Digital Gas Analyzer	SOP: HC: GC/GCMS/Gas analyzer	IS 5182 (Part XI):2006/CPCB Method

*Below detection limit

H. T. Shah
Lab Manager

POLLUCON LABORATORIES PVT. LTD. SURAT-3

Dr. ArunBajpai
Lab Manager (Q)

RESULT OF AMBIENT AIR QUALITY MONITORING

NEAR FIRE STATION								
Sr. No.	Date of Sampling	Particulate Matter (PM10) µg/m^3	Particulate Matter (PM 2.5) µg/m^3	Sulphur Dioxide (SO2) µg/m^3	Oxides of Nitrogen (NO2) µg/m^3	Carbon Monoxide as CO mg/m^3	Hydrocarbon as CH_4 mg/m^3	Benzene as C_6H_6 µg/m^3
1	04/04/2017	77.71	42.49	11.64	30.34	0.56	BDL*	BDL*
2	07/04/2017	67.77	37.49	7.28	20.27	0.47	BDL*	BDL*
3	11/04/2017	82.38	40.40	10.41	24.18	0.66	BDL*	BDL*
4	14/04/2017	90.51	52.46	19.76	38.56	0.96	BDL*	BDL*
5	18/04/2017	79.59	44.57	23.22	42.37	0.54	BDL*	BDL*
6	21/04/2017	64.01	30.41	15.36	33.35	0.34	BDL*	BDL*
7	25/04/2017	88.62	50.40	5.32	21.62	0.11	BDL*	BDL*
8	28/04/2017	72.50	32.49	14.46	27.12	0.46	BDL*	BDL*
9	02/05/2017	67.59	35.41	17.80	36.45	0.33	BDL*	BDL*
10	05/05/2017	83.41	32.49	25.69	33.39	0.60	BDL*	BDL*
11	09/05/2017	94.32	52.48	5.95	23.74	0.31	BDL*	BDL*
12	12/05/2017	77.77	44.57	15.18	29.68	0.47	BDL*	BDL*
13	16/05/2017	90.93	49.57	22.25	41.37	0.78	BDL*	BDL*
14	19/05/2017	82.68	46.65	12.69	32.47	0.45	BDL*	BDL*
15	23/05/2017	96.20	54.57	20.75	44.52	0.87	BDL*	BDL*
16	26/05/2017	73.23	37.49	7.96	22.34	0.49	BDL*	BDL*
17	30/05/2017	87.17	41.65	11.89	27.23	0.72	BDL*	BDL*
18	06/02/2017	59.41	49.57	19.94	41.69	0.90	BDL*	BDL*
19	06/06/2017	65.77	34.57	15.85	33.67	0.49	BDL*	BDL*
20	09/06/2017	52.62	26.66	8.72	21.81	0.29	BDL*	BDL*
21	13/06/2017	79.23	38.32	10.67	25.34	0.34	BDL*	BDL*
22	16/06/2017	86.32	45.40	23.85	31.40	0.62	BDL*	BDL*
23	20/06/2017	73.59	41.65	12.04	30.88	0.45	BDL*	BDL*
24	23/06/2017	89.17	47.49	14.97	22.96	0.32	BDL*	BDL*
25	27/06/2017	69.53	31.66	21.54	39.20	0.81	BDL*	BDL*
26	30/06/2017	56.38	40.40	13.25	27.62	0.47	BDL*	BDL*
27	04/07/2017	89.29	48.32	9.62	22.00	0.36	BDL*	BDL*
28	07/07/2017	64.20	35.41	17.69	36.44	0.93	BDL*	BDL*
29	11/07/2017	77.23	31.66	22.85	29.20	0.51	BDL*	BDL*
30	14/07/2017	84.19	37.47	5.54	16.63	0.71	BDL*	BDL*

Continue …

H. T. Shah
Lab Manager

POLLUCON LABORATORIES PVT. LTD. SURAT-3

Dr. ArunBajpai
Lab Manager (Q)

RESULT OF AMBIENT AIR QUALITY MONITORING

NEAR FIRE STATION								
Sr.No.	Date of Sampling	Particulate Matter (PM10) µg/m^3	Particulate Matter (PM 2.5) µg/m^3	Sulphur Dioxide (SO2) µg/m^3	Oxides of Nitrogen (NO2) µg/m^3	Carbon Monoxide as CO mg/m^3	Hydrocarbon as CH_4 mg/m^3	Benzene as C_6H_6 µg/m^3
31	18/07/2017	72.38	29.57	15.87	27.11	0.29	BDL*	BDL*
32	21/07/2017	62.50	26.66	7.16	19.17	0.64	BDL*	BDL*
33	25/07/2017	55.41	23.74	19.30	29.97	0.45	BDL*	BDL*
34	28/07/2017	82.38	44.57	12.78	38.79	0.86	BDL*	BDL*
35	01/08/2017	79.47	45.40	25.57	36.90	0.41	BDL*	BDL*
36	04/08/2017	89.29	54.57	17.87	39.19	0.57	BDL*	BDL*
37	08/08/2017	74.20	41.65	19.59	42.45	0.73	BDL*	BDL*
38	11/08/2017	68.20	33.74	21.43	24.42	0.29	BDL*	BDL*
39	15/08/2017	90.32	43.74	12.90	38.59	0.68	BDL*	BDL*
40	18/08/2017	82.38	37.49	16.81	33.76	0.53	BDL*	BDL*
41	22/08/2017	56.68	23.74	9.89	20.90	0.19	BDL*	BDL*
42	25/08/2017	65.59	30.41	10.39	29.84	0.44	BDL*	BDL*
43	29/08/2017	59.41	27.49	11.62	26.77	0.37	BDL*	BDL*
44	01/09/2017	61.89	25.41	10.88	23.42	0.22	BDL*	BDL*
45	05/09/2017	70.20	35.41	12.99	32.26	0.39	BDL*	BDL*
46	08/09/2017	86.38	39.57	27.60	39.26	0.36	BDL*	BDL*
47	12/09/2017	96.63	53.32	20.71	42.30	0.52	BDL*	BDL*
48	15/09/2017	77.41	34.57	17.92	28.08	0.37	BDL*	BDL*
49	19/09/2017	82.50	48.74	22.86	45.41	0.65	BDL*	BDL*
50	22/09/2017	94.20	55.40	13.85	38.54	0.55	BDL*	BDL*
51	26/09/2017	74.20	40.40	21.76	26.29	0.24	BDL*	BDL*
52	29/09/2017	84.50	36.66	19.24	37.28	0.30	BDL*	BDL*
	TEST METHOD	IS:5182(Part 23):Gravimetric CPCB - Method (Vol.I,May-2011)	Gravimetric-CPCB - Method (Vol.I,May-2011)	IS:5182(Part II):Improved West and Gaeke	IS:5182(Part VI):Modified Jacob & Hochheiser (NaOH-NaAsO2)	NDIR Digital Gas Analyzer	SOP: HC: GC/GCMS/Gas analyzer	IS 5182 (Part XI):2006/CPCB Method

*Below detection limit

H. T. Shah
Lab Manager

POLLUCON LABORATORIES PVT. LTD. SURAT-3

Dr. ArunBajpai
Lab Manager (Q)

RESULT OF AMBIENT AIR QUALITY MONITORING

ADANI HOUSE								
Sr. No.	Date of Sampling	Particulate Matter (PM10) µg/m^3	Particulate Matter (PM 2.5) µg/m^3	Sulphur Dioxide (SO2) µg/m^3	Oxides of Nitrogen (NO2) µg/m^3	Carbon Monoxide as CO mg/m^3	Hydrocarbon as CH_4 mg/m^3	Benzene as C_6H_6 µg/m^3
1	04/04/2017	57.59	22.49	18.97	38.58	0.37	BDL*	BDL*
2	07/04/2017	62.61	28.73	22.04	29.64	0.44	BDL*	BDL*
3	11/04/2017	76.49	36.64	6.33	17.20	0.62	BDL*	BDL*
4	14/04/2017	74.49	41.57	9.60	30.46	0.82	BDL*	BDL*
5	18/04/2017	63.60	34.56	19.40	24.85	0.25	BDL*	BDL*
6	21/04/2017	50.71	20.40	8.79	19.88	0.57	BDL*	BDL*
7	25/04/2017	71.47	38.73	13.07	28.83	0.15	BDL*	BDL*
8	28/04/2017	60.50	30.40	11.62	21.45	0.60	BDL*	BDL*
9	02/05/2017	53.50	28.73	8.73	21.53	0.64	BDL*	BDL*
10	05/05/2017	66.20	26.65	20.91	26.53	0.24	BDL*	BDL*
11	09/05/2017	75.81	33.73	13.80	30.58	0.11	BDL*	BDL*
12	12/05/2017	63.23	30.40	10.95	25.14	0.68	BDL*	BDL*
13	16/05/2017	72.40	31.65	17.52	27.76	0.39	BDL*	BDL*
14	19/05/2017	61.18	24.57	21.50	42.48	0.30	BDL*	BDL*
15	23/05/2017	80.40	41.64	9.59	33.52	0.95	BDL*	BDL*
16	26/05/2017	58.58	29.57	18.64	29.85	0.53	BDL*	BDL*
17	30/05/2017	81.58	37.48	6.17	19.38	0.70	BDL*	BDL*
18	02/06/2017	74.51	37.48	8.89	30.88	1.02	BDL*	BDL*
19	06/06/2017	55.42	27.48	11.82	19.80	0.56	BDL*	BDL*
20	09/06/2017	49.53	19.57	10.51	26.73	0.13	BDL*	BDL*
21	13/06/2017	73.39	34.56	5.61	17.53	0.70	BDL*	BDL*
22	16/06/2017	59.32	22.49	18.45	28.06	0.26	BDL*	BDL*
23	20/06/2017	68.37	36.64	14.97	38.08	0.31	BDL*	BDL*
24	23/06/2017	82.38	30.40	9.63	29.40	0.14	BDL*	BDL*
25	27/06/2017	63.41	26.65	15.13	25.54	0.41	BDL*	BDL*
26	30/06/2017	45.62	29.57	7.16	22.45	0.72	BDL*	BDL*
27	04/07/2017	76.37	37.48	16.63	30.41	0.70	BDL*	BDL*
28	07/07/2017	66.89	32.48	11.95	27.42	1.02	BDL*	BDL*
29	11/07/2017	70.17	26.65	13.46	18.34	0.56	BDL*	BDL*
30	14/07/2017	61.20	28.68	12.72	24.52	0.62	BDL*	BDL*

Continue …

H. T. Shah
Lab Manager

POLLUCON LABORATORIES PVT. LTD. SURAT-3

Dr. ArunBajpai
Lab Manager (Q)

RESULT OF AMBIENT AIR QUALITY MONITORING

ADANI HOUSE								
Sr. No.	Date of Sampling	Particulate Matter (PM10) µg/m³	Particulate Matter (PM 2.5) µg/m³	Sulphur Dioxide (SO2) µg/m³	Oxides of Nitrogen (NO2) µg/m³	Carbon Monoxide as CO mg/m³	Hydrocarbon as CH_4 mg/m³	Benzene as C_6H_6 µg/m³
31	18/07/2017	59.57	23.74	17.59	31.21	0.12	BDL*	BDL*
32	21/07/2017	52.63	20.40	10.63	23.14	0.27	BDL*	BDL*
33	25/07/2017	69.18	33.73	15.89	33.38	0.31	BDL*	BDL*
34	28/07/2017	74.20	39.56	9.90	26.45	0.40	BDL*	BDL*
35	01/08/2017	54.61	30.40	10.19	33.76	0.45	BDL*	BDL*
36	04/08/2017	66.70	38.73	19.55	36.18	0.50	BDL*	BDL*
37	08/08/2017	59.32	33.73	12.83	26.53	0.85	BDL*	BDL*
38	11/08/2017	62.30	29.57	15.94	31.26	0.52	BDL*	BDL*
39	15/08/2017	78.60	37.48	17.48	23.06	0.33	BDL*	BDL*
40	18/08/2017	69.92	28.73	14.86	41.38	0.87	BDL*	BDL*
41	22/08/2017	49.59	19.57	11.44	24.60	0.23	BDL*	BDL*
42	25/08/2017	52.50	24.57	13.42	35.27	0.32	BDL*	BDL*
43	29/08/2017	46.31	21.65	9.71	29.30	0.25	BDL*	BDL*
44	01/09/2017	55.42	21.65	12.32	26.89	0.18	BDL*	BDL*
45	05/09/2017	78.42	40.39	24.31	37.44	0.26	BDL*	BDL*
46	08/09/2017	60.50	27.48	10.63	35.49	0.40	BDL*	BDL*
47	12/09/2017	71.91	38.73	26.14	39.15	0.46	BDL*	BDL*
48	15/09/2017	65.58	30.40	15.84	25.54	0.29	BDL*	BDL*
49	19/09/2017	56.22	25.40	20.59	30.11	0.60	BDL*	BDL*
50	22/09/2017	89.57	42.47	18.94	27.53	0.32	BDL*	BDL*
51	26/09/2017	68.19	37.48	14.90	33.61	0.54	BDL*	BDL*
52	29/09/2017	58.58	24.57	11.33	43.50	0.79	BDL*	BDL*
	TEST METHOD	IS:5182(Part 23):Gravimetric CPCB - Method (Vol.I,May-2011)	Gravimetric-CPCB - Method (Vol.I,May-2011)	IS:5182(Part II):Improved West and Gaeke	IS:5182(Part VI):Modified Jacob & Hochheiser (NaOH-NaAsO2)	NDIR Digital Gas Analyzer	SOP: HC: GC/GCMS/Gas analyzer	IS 5182 (Part XI):2006/CPCB Method

*Below detection limit

H. T. Shah
Lab Manager

SURAT-3 POLLUCON LABORATORIES PVT. LTD.

Dr. ArunBajpai
Lab Manager (Q)

RESULT OF AMBIENT AIR QUALITY MONITORING

NEAR SHANTIVAN COLONY'S STP					
Sr. No.	Date of Sampling	Particulate Matter (PM10) µg/m³	Particulate Matter (PM 2.5) µg/m³	Sulphur Dioxide (SO2) µg/m³	Oxides of Nitrogen (NO2) µg/m³
1	03/04/2017	49.62	27.44	8.83	23.41
2	06/04/2017	76.22	42.40	14.49	21.51
3	10/04/2017	45.50	22.45	5.31	25.31
4	13/04/2017	52.70	18.71	11.20	31.63
5	17/04/2017	62.80	32.43	9.63	11.60
6	20/04/2017	58.61	26.61	13.28	26.36
7	24/04/2017	72.59	41.57	10.53	29.52
8	27/04/2017	42.48	16.63	7.13	15.39
9	01/05/2017	56.21	19.54	7.17	18.58
10	04/05/2017	64.21	35.75	17.42	35.68
11	08/05/2017	72.40	39.49	20.51	27.21
12	11/05/2017	61.38	25.77	5.60	20.64
13	15/05/2017	76.77	23.70	12.67	29.35
14	18/05/2017	58.18	20.37	10.47	23.22
15	22/05/2017	45.50	27.44	15.11	32.61
16	25/05/2017	69.82	32.43	9.78	19.21
17	29/05/2017	55.47	29.52	13.42	25.34
18	01/06/2017	45.50	23.70	15.15	33.52
19	05/06/2017	72.40	34.50	20.43	27.29
20	08/06/2017	56.27	31.59	9.62	25.64
21	12/06/2017	61.38	25.36	16.76	32.54
22	15/06/2017	76.40	33.67	12.52	29.45
23	19/06/2017	58.61	26.61	10.32	30.17
24	22/06/2017	69.38	38.66	17.53	23.49
25	26/06/2017	55.59	29.52	13.37	28.44
26	29/06/2017	49.50	19.54	7.10	21.31
27	03/07/2017	76.40	41.57	21.94	27.72
28	06/07/2017	67.23	34.50	8.89	25.59
29	10/07/2017	58.61	29.52	19.34	34.54
30	13/07/2017	65.63	27.44	14.23	36.49

Continue …

H. T. Shah
Lab Manager

POLLUCON LABORATORIES PVT. LTD. SURAT-3

Dr. ArunBajpai
Lab Manager (Q)

RESULT OF AMBIENT AIR QUALITY MONITORING

NEAR SHANTIVAN COLONY'S STP					
Sr.No.	**Date of Sampling**	**Particulate Matter (PM10) µg/m^3**	**Particulate Matter (PM 2.5) µg/m^3**	**Sulphur Dioxide (SO2) µg/m^3**	**Oxides of Nitrogen (NO2) µg/m^3**
31	20/07/2017	63.41	28.68	15.80	33.48
32	24/07/2017	55.59	45.31	11.89	18.12
33	27/07/2017	47.78	18.71	13.16	21.11
34	31/07/2017	69.38	25.36	16.81	30.09
35	03/08/2017	67.23	42.40	14.14	31.50
36	07/08/2017	55.22	31.59	17.73	35.49
37	10/08/2017	62.43	33.67	11.53	29.41
38	14/08/2017	76.77	40.74	15.96	26.47
39	17/08/2017	69.38	32.43	13.61	33.47
40	21/08/2017	52.27	22.45	7.21	21.15
41	24/08/2017	84.53	39.49	16.70	25.52
42	28/08/2017	70.49	29.52	10.74	32.33
43	31/08/2017	49.19	20.37	12.64	24.50
44	04/09/2017	82.62	45.73	14.19	34.69
45	07/09/2017	56.21	34.50	9.75	28.40
46	11/09/2017	65.32	25.36	11.41	25.36
47	14/09/2017	72.40	28.68	7.95	22.64
48	18/09/2017	59.23	31.59	19.51	35.65
49	21/09/2017	67.23	23.70	16.85	26.50
50	25/09/2017	80.59	29.52	5.59	31.43
51	28/09/2017	71.17	27.44	8.90	33.60
	TEST METHOD	**IS:5182(Part 23):Gravimetric CPCB - Method (Vol.I,May-2011)**	**Gravimetric- CPCB - Method (Vol.I,May-2011)**	**IS:5182(Part II):Improved West and Gaeke**	**IS:5182(Part VI):Modified Jacob & Hochheiser (NaOH-NaAsO2)**

*Below detection limit

H. T. Shah
Lab Manager

POLLUCON LABORATORIES PVT. LTD. SURAT-3

Dr. ArunBajpai
Lab Manager (Q)

RESULTS OF NOISE LEVEL MONITORING

Result of Noise level monitoring [Day Time]

SR. NO.	Name of Location	T1 TERMINAL NR.MARINE BUILDING					
		Result [Leq dB(A)]					
	Sampling Date & Time	11/04/2017	15/05/2017	23/06/2017	14/07/2017	18/08/2017	15/09/2017
1	6:00-7:00	61.4	62.0	68.4	63.1	64.1	68.1
2	7:00-8:00	68.4	68.4	62.4	68.7	70.46	62.8
3	8:00-9:00	62.5	65.4	68.1	69.1	68.2	63.4
4	9:00-10:00	63.4	62.1	62.8	62.8	65.1	69.9
5	10:00-11:00	65.4	69.7	63.4	65.8	67.9	72.4
6	11:00-12:00	68.1	62.5	68.4	70.4	62.4	74.1
7	12:00-13:00	62.7	71.5	67.1	69.7	70.1	70.1
8	13:00-14:00	67.4	70.2	69.4	65.7	60.7	66.4
9	14:00-15:00	65.7	70.6	67.4	63.1	68.5	68.4
10	15:00-16:00	62.1	69.4	66.4	62.8	68.7	62.8
11	16:00-17:00	62.8	65.2	63.4	68.4	64.3	65.6
12	17:00-18:00	62.4	68.2	65.8	65.5	70.6	68.8
13	18:00-19:00	69.4	63.1	70.4	69.1	67.9	64.1
14	19:00-20:00	68.7	62.8	68.4	62.8	69.5	63.4
15	20:00-21:00	68.1	62.9	68.4	65.0	67.3	68.9
16	21:00-22:00	65.4	69.4	68.2	66.7	61.3	66.8
Day Time Limit*		75 Leq dB(A)					

Result of Noise level monitoring [Night Time]

SR. NO.	Name of Location	T1 TERMINAL NR.MARINE BUILDING					
		Result [Leq dB(A)]					
1	Sampling Date & Time	11/04/2017 & 12/04/2017	15/05/2017 & 16/05/2017	23/06/2017 & 24/06/2017	14/07/2017 & 15/08/2017	18/08/2017 & 19/08/2017	15/09/2017 & 16/09/2017
2	22:00-23:00	65.1	64.1	63.1	63.8	61.4	65.1
3	23:00-00:00	62.7	61.4	61.8	65.7	67.6	60.8
4	00:00-01:00	66.4	57.1	65.1	64.1	62.1	68.4
5	01:00-02:00	66.9	56.4	68.7	62.8	60.4	68.4
6	02:00-03:00	60.1	60.1	65.4	63.7	61.5	68.8
7	03:00-04:00	62.4	65.1	62.9	63.9	65.8	65.1
8	04:00-05:00	62.8	62.8	69.4	69.8	67.3	62.5
9	05:00-06:00	63.7	61.9	70.5	62.7	65.0	66.1
Night Time Limit*		70 Leq dB(A)					

H. T. Shah
Lab Manager

POLLUCON LABORATORIES PVT. LTD. SURAT-3

Dr. ArunBajpai
Lab Manager (Q)

RESULTS OF NOISE LEVEL MONITORING

Result of Noise level monitoring [Day Time]

SR. NO.	Name of Location	NEAR FIRE STATION					
		Result [Leq dB(A)]					
	Sampling Date & Time	18/04/2017	19/05/2017	06/09/2017	21/07/2017	11/08/2017	26/09/2017
1	6:00-7:00	68.4	68.1	68.1	63.7	61.2	68.4
2	7:00-8:00	65.1	62.7	65.4	61.8	63.8	65.1
3	8:00-9:00	65.2	65.1	63.1	65.4	64.7	63.4
4	9:00-10:00	69.4	65.9	70.4	69.4	67.8	65.1
5	10:00-11:00	73.4	68.2	73.1	74.1	70.4	72.1
6	11:00-12:00	72.4	63.7	65.1	72.5	65.5	68.8
7	12:00-13:00	71.5	65.4	69.4	68.4	63.4	65.1
8	13:00-14:00	69.4	62.8	68.4	65.4	70.2	69.8
9	14:00-15:00	70.4	69.1	63.1	61.5	72.1	67.2
10	15:00-16:00	67.4	67.1	62.4	60.4	68.8	65.3
11	16:00-17:00	65.1	63.4	65.1	69.1	61.2	62.1
12	17:00-18:00	62.5	69.1	68.4	62.4	63.4	63.4
13	18:00-19:00	63.8	71.1	68.1	62.9	68.5	65.8
14	19:00-20:00	68.4	68.1	62.4	67.1	67	66.9
15	20:00-21:00	62.8	65.2	61.8	62.8	64.3	71.4
16	21:00-22:00	66.1	68.1	62.4	65.1	63.8	72.8
Day Time Limit*		**75 Leq dB(A)**					

Result of Noise level monitoring [Night Time]

SR. NO.	Name of Location	NEAR FIRE STATION					
		Result [Leq dB(A)]					
1	Sampling Date & Time	18/04/2017 & 19/04/2017	19/05/2017 & 20/05/2017	09/06/2017 & 10/06/2017	21/07/2017 & 22/07/2017	11/08/2017 & 12/08/2017	26/09/2017 & 27/09/2017
2	22:00-23:00	64.1	65.1	63.7	69.4	68.8	61.5
3	23:00-00:00	63.4	68.7	65.1	66.2	62.4	68.4
4	00:00-01:00	62.1	59.4	69.4	68.1	65.4	65.1
5	01:00-02:00	60.4	60.8	64.1	62.8	58.4	60.4
6	02:00-03:00	68.4	63.1	66.1	68.4	59.3	69.4
7	03:00-04:00	63.4	62.4	62.8	62.8	63.4	62.8
8	04:00-05:00	65.4	60.4	68.4	66.7	66.8	66.1
9	05:00-06:00	67.1	60.8	62.7	62.8	61.7	68.7
Night Time Limit*		**70 Leq dB(A)**					

H. T. Shah
Lab Manager

POLLUCON LABORATORIES PVT. LTD. SURAT-3

Dr. ArunBajpai
Lab Manager (Q)

RESULTS OF NOISE LEVEL MONITORING

Result of Noise level monitoring [Day Time]

SR. NO.	Name of Location	ADANI HOUSE					
		Result [Leq dB(A)]					
	Sampling Date & Time	14/04/2017	05/12/2017	13/06/2017	18/07/2017	01/08/2017	19/09/2017
1	6:00-7:00	62.5	65.4	65.4	67.2	64.3	65.4
2	7:00-8:00	68.4	62.8	62.7	65.9	68.8	68.1
3	8:00-9:00	68.1	68.1	64.7	68.1	65.7	62.5
4	9:00-10:00	63.4	72.1	70.4	62.4	70.1	73.1
5	10:00-11:00	72.4	71.5	68.1	62.8	72.4	70.5
6	11:00-12:00	70.4	69.4	65.4	61.8	63.4	69.9
7	12:00-13:00	70.9	65.2	68.2	68.4	60.4	66.4
8	13:00-14:00	68.1	62.8	63.4	68.7	67.9	62.1
9	14:00-15:00	62.4	62.8	65.1	68.2	67.4	68.4
10	15:00-16:00	65.1	62.1	62.4	64.1	62.4	63.4
11	16:00-17:00	62.8	65.1	68.1	69.1	70.3	68.1
12	17:00-18:00	66.8	69.1	63.8	73.1	71.9	66.8
13	18:00-19:00	69.4	63.4	65.1	70.4	68.8	63.1
14	19:00-20:00	62.1	65.1	62.9	64.1	62.1	62.9
15	20:00-21:00	68.4	61.8	68.4	62.8	60.1	65.4
16	21:00-22:00	68.2	60.4	67.1	60.8	64.1	66.7
Day Time Limit*		**75 Leq dB(A)**					

Result of Noise level monitoring [Night Time]

SR. NO.	Name of Location	ADANI HOUSE					
		Result [Leq dB(A)]					
1	Sampling Date & Time	14/04/2017 & 15/04/2017	12/05/2017 & 13/05/2017	13/06/2017 & 14/06/2017	18/07/2017 & 19/07/2017	01/08/2017 & 02/08/2017	19/09/2017 & 20/09/2017
2	22:00-23:00	60.4	62.5	65.1	63.4	62.3	63.4
3	23:00-00:00	65.1	65.1	61.4	65.1	64.5	69.7
4	00:00-01:00	65.4	65.7	61.8	68.7	67.2	65.1
5	01:00-02:00	61.8	60.8	68.4	66.2	67.0	62.4
6	02:00-03:00	63.4	60.7	66.1	66.4	62.8	69.8
7	03:00-04:00	62.4	62.4	65.8	62.9	63.5	60.4
8	04:00-05:00	65.7	58.1	69.4	68.1	65.4	62.8
9	05:00-06:00	67.1	61.8	62.8	62.8	60.7	63.8
Night Time Limit*		**70 Leq dB(A)**					

SURAT-3 POLLUCON LABORATORIES PVT. LTD.

H. T. Shah
Lab Manager

Dr. ArunBajpai
Lab Manager (Q)

RESULTS OF NOISE LEVEL MONITORING

Result of Noise level monitoring [Day Time]

SR. NO.	Name of Location	AIRSTRIP					
		Result [Leq dB(A)]					
	Sampling Date & Time	12/04/2017	17/05/2017	06/02/2017	19/07/2017	23/08/2017	06/09/2017
1	6:00-7:00	52.1	57.1	54.1	52.1	49.5	55.2
2	7:00-8:00	56.4	56.1	58.1	59.7	47.7	60.1
3	8:00-9:00	63.1	60.1	60.4	60.4	58.5	59.4
4	9:00-10:00	62.4	59.8	62.4	55.1	53.4	63.1
5	10:00-11:00	68.4	59.1	68.4	63.8	59.1	54.1
6	11:00-12:00	61.4	62.4	59.4	65.8	62.4	63.1
7	12:00-13:00	60.4	63.1	60.4	65.4	63.1	60.4
8	13:00-14:00	58.4	66.4	62.1	63.9	57.3	60.9
9	14:00-15:00	60.4	64.1	58.7	68.2	52.1	63.2
10	15:00-16:00	60.9	62.7	56.1	62.9	56.4	62.8
11	16:00-17:00	63.1	62.8	58.4	60.8	64.8	65.1
12	17:00-18:00	61.4	60.4	60.4	59.7	58.8	60.8
13	18:00-19:00	65.4	65.1	55.8	62.7	60.0	60.6
14	19:00-20:00	62.4	62.7	59.8	62.8	58.4	57.2
15	20:00-21:00	60.4	60.8	56.4	60.8	65.2	59.1
16	21:00-22:00	60.7	63.4	58.4	60.4	63.3	62.4
Day Time Limit*		75 Leq dB(A)					

Result of Noise level monitoring [Night Time]

SR. NO.	Name of Location	AIRSTRIP					
		Result [Leq dB(A)]					
1	Sampling Date & Time	12/04/2017 & 13/04/2017	17/05/2017 & 18/05/2017	02/06/2017 & 03/06/2017	19/07/2017 & 20/08/2017	23/08/2017 & 24/08/2017	06/09/2017 & 07/09/2017
2	22:00-23:00	62.4	58.1	59.4	55.7	55	56.1
3	23:00-00:00	60.1	55.1	51.4	59.4	51.4	47.1
4	00:00-01:00	55.4	50.4	50.4	56.1	50.6	52.1
5	01:00-02:00	59.7	53.1	58.7	60.8	49.8	51.8
6	02:00-03:00	56.1	57.1	56.4	62.8	57.6	58.4
7	03:00-04:00	52.4	60.4	52.4	57.1	54.9	53.1
8	04:00-05:00	53.7	56.1	60.4	53.8	49.0	52.8
9	05:00-06:00	59.7	62.8	58.7	59.7	53.4	56.8
Night Time Limit*		70 Leq dB(A)					

H. T. Shah
Lab Manager

POLLUCON LABORATORIES PVT. LTD. SURAT-3

Dr. ArunBajpai
Lab Manager (Q)

RESULTS OF NOISE LEVEL MONITORING

Result of Noise level monitoring [Day Time]

SR. NO.	Name of Location	NEAR SHANTIVAN STP					
		Result [Leq dB(A)]					
	Sampling Date & Time	13/04/2017	04/05/2017	26/06/2017	03/07/2017	21/08/2017	21/09/2017
1	6:00-7:00	60.4	59.7	60.4	57.1	60.1	63.1
2	7:00-8:00	63.4	63.4	62.1	60.4	58.8	65.4
3	8:00-9:00	59.4	62.8	65.4	60.8	62.7	61.5
4	9:00-10:00	62.4	67.1	68.1	65.1	68.5	69.9
5	10:00-11:00	68.1	63.9	66.1	62.8	61.9	72.4
6	11:00-12:00	67.1	68.1	65.1	68.4	65.4	63.4
7	12:00-13:00	62.5	62.8	62.4	65.5	61.1	65.8
8	13:00-14:00	66.4	66.1	68.4	64.1	65.4	68.1
9	14:00-15:00	69.1	63.5	62.8	62.8	61.9	62.8
10	15:00-16:00	67.1	65.1	68.7	69.1	62.1	65.1
11	16:00-17:00	71.5	65.8	65.1	62.4	68.0	63.8
12	17:00-18:00	68.1	68.7	62.8	61.8	69.1	68.4
13	18:00-19:00	65.4	69.1	69.1	62.8	60.4	67.1
14	19:00-20:00	65.1	62.8	65.4	65.1	63.4	69.1
15	20:00-21:00	62.8	70.4	62.4	63.1	65.9	62.8
16	21:00-22:00	63.7	69.7	66.1	60.8	62.8	58.1
Day Time Limit*		75 Leq dB(A)					

Result of Noise level monitoring [Night Time]

SR. NO.	Name of Location	NEAR SHANTIVAN STP					
		Result [Leq dB(A)]					
1	Sampling Date & Time	13/04/2017 & 14/04/2017	04/05/2017 & 05/05/2017	26/06/2017 & 27/06/2017	03/07/2017 & 04/07/2017	21/08/2017 & 22/08/2017	21/09/2017 & 22/09/2017
2	22:00-23:00	62.4	62.4	58.4	67.1	64	60.8
3	23:00-00:00	59.4	61.8	54.1	65.2	65.1	63.4
4	00:00-01:00	56.2	59.7	62.4	62.8	62.4	60.8
5	01:00-02:00	60.4	55.1	61.4	67.1	68.8	65.4
6	02:00-03:00	59.4	60.4	60.4	65.3	63.4	62.8
7	03:00-04:00	63.1	58.2	60.8	63.9	61.8	66.4
8	04:00-05:00	62.4	59.1	63.4	68.4	64.5	69.7
9	05:00-06:00	64.1	56.2	64.7	65.6	67.3	65.4
Night Time Limit*		70 Leq dB(A)					

H. T. Shah
Lab Manager

POLLUCON LABORATORIES PVT. LTD. SURAT-3

Dr. ArunBajpai
Lab Manager (Q)

RESULT OF STACK MONITORING

SR. NO.	TEST PARAMETERS	UNIT	STD. LIMIT	THERMIC FLUID HEATER (BITUMEN-01)	THERMIC FLUID HEATER (BITUMEN-02)	HOT WATER SYSTEM-1	HOT WATER SYSTEM-2	TEST METHOD
				APRIL 17				
1	Particulate Matter	mg/Nm^3	**150**	14.57	--	27.55	21.73	IS:11255 (Part-I):1985
2	Sulfur dioxide	ppm	**100**	5.07	--	7.69	7.11	IS:11255 (Part-II):1985
3	Oxides of Nitrogen	ppm	**50**	34.04	--	32.75	40.61	IS:11255 (Part-VII):2005
				MAY 17				
1	Particulate Matter	mg/Nm^3	**150**	18.84	--	32.74	28.61	IS:11255 (Part-I):1985
2	Sulfur dioxide	ppm	**100**	5.72	--	6.85	8.89	IS:11255 (Part-II):1985
3	Oxides of Nitrogen	ppm	**50**	32.29	--	38.00	39.44	IS:11255 (Part-VII):2005
				JUNE 17				
1	Particulate Matter	mg/Nm^3	**150**	13.84	--	26.71	21.75	IS:11255 (Part-I):1985
2	Sulfur dioxide	ppm	**100**	4.35	--	8.75	6.77	IS:11255 (Part-II):1985
3	Oxides of Nitrogen	ppm	**50**	28.28	--	33.80	35.69	IS:11255 (Part-VII):2005
				JULY 17				
1	Particulate Matter	mg/Nm^3	**150**	10.82	--	20.25	15.52	IS:11255 (Part-I):1985
2	Sulfur dioxide	ppm	**100**	3.49	--	6.61	5.79	IS:11255 (Part-II):1985
3	Oxides of Nitrogen	ppm	**50**	25.40	--	38.30	33.60	IS:11255 (Part-VII):2005
				AUGUST 17				
1	Particulate Matter	mg/Nm^3	**150**	18.55	15.45	28.75	22.61	IS:11255 (Part-I):1985
2	Sulfur dioxide	ppm	**100**	4.62	5.19	5.59	6.47	IS:11255 (Part-II):1985
3	Oxides of Nitrogen	ppm	**50**	30.30	33.30	40.07	36.16	IS:11255 (Part-VII):2005
				SEPTEMBER 17				
1	Particulate Matter	mg/Nm^3	**150**	12.42	--	20.55	16.66	IS:11255 (Part-I):1985
2	Sulfur dioxide	ppm	**100**	3.87	--	5.75	7.28	IS:11255 (Part-II):1985
3	Oxides of Nitrogen	ppm	**50**	25.39	--	33.52	29.83	IS:11255 (Part-VII):2005

*Below detection limit
Results on 11 % O2 Correction when Oxygen is greater than 11 %.

H. T. Shah
Lab Manager

POLLUCON LABORATORIES PVT. LTD. SURAT-3

Dr. ArunBajpai
Lab Manager (Q)

MINIMUM DETECTION LIMIT [MDL]

Water parameter(mg/L)

Sr. No.	Test parameter	MDL
1	Total Suspended Solids	1
2	Oil & Grease	1
3	BOD	3
4	COD	5
5	Total Dissolved Solids	3
6	Sulphate	0.3
7	Ammonical Nitrogen	0.05
8	Nickel	0.01
9	Phenolic Compound	0.001
10	Fluoride	0.01
11	Copper	0.013
12	Sulphide	0.01
13	Cyanide	0.0001
14	Residual Chlorine	0.1
15	Boron	0.02
16	Insecticides/Pesticides	0.01
17	Nitrate Nitrogen	0.15
18	Phosphorous	0.15
19	Petroleum Hydrocarbon	0.01
20	Lead	0.005
21	Mercury	0.0005
22	Zinc	0.022
23	Cadmium	0.001
24	Arsenic	0.00015
Sediment parameter(mg/kg)		
1	Petroleum Hydrocarbon	0.2

Stack parameter

Sr. No.	Test parameter	MDL
1	Particulate Matter (mg/Nm3)	10
2	Sulphur Dioxide(ppm)	1.52
3	Oxides of Nitrogen (ppm)	2.65

Ambient Air Parameter

1	Particulate Matter (PM10)	10
2	Particulate Matter (PM 2.5)	10
3	Sulphur Dioxide (SO_2) (μg/m3)	5
4	Oxides of Nitrogen (NO_2) (μg/m3)	5
5	Benzene as C_6H_6 (μg/m3)	2
6	Carbon Monoxide as CO (mg/m3)	0.1
7	Hydrocarbon as CH_4 (mg/m3)	0.15
8	Hydrogen Sulphide (H_2S) (μg/m3)	6

H. T. Shah
Lab Manager

POLLUCON LABORATORIES PVT. LTD. SURAT-3

Dr. ArunBajpai
Lab Manager (Q)

Annexure – 6

Cost of Environmental Protection Measures

Sr. No.	Activity	Cost incurred (INR in Lakh)			Budgeted Cost (INR in Lakh)
		2015 – 16	**2016 – 17**	**2017 – 18**	**2017 – 18**
1.	Environmental Study / Audit and Consultancy	45.45	36.78	9.00	21.00
2.	Legal & Statutory Expenses	3.30	4.76	9.48	16.00
3.	Environmental Monitoring Services	26.80	27.95	12.00	36.00
4.	Hazardous / Non Hazardous Waste Management & Disposal	34.56	12.52	31.9	90.84
5.	Environment Day Celebration	7.18	6.71	2.68	10.00
6.	Treatment and Disposal of Bio-Medical Waste	1.22	1.27	0.75	1.44
7.	Mangrove Plantation, Monitoring & Conservation	73.64	72.38	60.0	60.0
8.	Other Horticulture Expenses	434.72	555.00	494.0	556.5
9.	O&M of Sewage Treatment Plant and Effluent Treatment Plant (including STP, ETP of Port & SEZ & Common Effluent Treatment Plant)	18.18	61.50	39.89	69.35
10.	Expenditure of Environment Dept. (Apart from above head)	135.90	131.83	22.83	104.91
	Total	**837.73**	**910.70**	**682.53**	**966.04**

Annexure – 7

O/c

adani

PCB ID: 17739

APSEZL/EnvCell/2017-18/031

Date: 04.08.2017

To,
Regional Officer
Regional Office,
Gujarat Pollution Control Board (East – Kutch),
Sector No. 8, Gandhidham,
Kutch – 370201.

Subject: Submission of compliance to observation/suggestion/instruction made by GPCB officials during inspection.

Reference: GPCB Inspection letter dated 20.07.2017, PCB ID: 17739

Dear Sir,

With reference to the above mentioned subject, APSEZL is submitting the compliance details of your observations as below:

- ✓ **Our Reply against your Observation:** Entire quantity of ETP sludge stored in open area beside ETP plant was collected and disposed to the co-processing site at Recycling Solutions Pvt. Ltd., Panoli on 31.07.2017. Photograph showing the same and Manifest copy is attached here as **Annexure – 2 & 3** respectively for your ready reference.

APSEZL is submitting the compliances regularly and hope the above mentioned submission is in line with requirement.

Thanking you,
For, **Adani Ports and Special Economic Zone Ltd.**

Authorised Signatory

Copy to:

Unit Head (Kutch unit)
Gujarat Pollution Control Board,
Paryavaran Bhavan, Sector – 10A,
Gandhinagar – 382010.

21/8/17
Gujarat Pollution Control Board
Sector No. 10 A,
Gandhinagar - 382 010.

Received
Gujarat Pollution Control Board
Regional Office
Kutch (East)
Rathod
14-08-2017

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ગુજરાત પ્રદૂષણ નિયંત્રણ બોર્ડ

પ્રાદેશિક કચેરી - કચ્છ (પૂર્વ)

ગુજરાત પ્રદૂષણ નિયંત્રણ બોર્ડના અધિકારીઓ દ્વારા આપના એકમની આજરોજ જુદા જુદા પર્યાવરણીય નિયમોને આધિન સ્થળ મુલાકાત લેવામાં આવેલ.

આપના એકમના સ્થળ ઈન્સ્પેકશન દરમ્યાન કરેલ અવલોકનો, આપે આપેલ માહિતી / દસ્તાવેજો અને પર્યાવરણીય નિયમોની જોગવાઈઓને આધીન, આપને નીચે મુજબ આદેશો આપવામાં આવે છે જેની પૂર્તતા અંગેનો અહેવાલ (કોમ્પલાયન્સ રીપોર્ટ) આ આદેશો મળ્યાની તારીખથી બે સપ્તાહની અંદર આ કચેરીને અચુક મોકલી આપશો.તેમ ન થતા આ બાબતે કોઈ રજુઆત નથી તેમ માની, આપના એકમ સામે ધોરણસરની કાનુની કાર્યવાહી કરવાની ફરજ પડશે. જેની નોંધ લેશો.

To
Adani Port & Special Economic Zone Ltd
at Navinal Island, Mundra, Kutch

ID - 17739
Dt - 20/7/20

(1) ETP ની જગ્યામાં ખુલ્લામાં પડેલ ETP sludge ને સ્ટોરેજ એરીયામાં સ્થળાંતર કરવો.

Sumit Paliwal
Sr. Manager

R. R. Virda
AEE

R. H. Jivani
S.O.

adani

PCB ID: 17739

ANNEXURE – 2

PHOTOGRAPH SHOWING ETP AREA

Adani Ports and Special Economic Zone Ltd
Adani House
PO Box No 1
Mundra, Kutch 370 421
Gujarat, India

Tel +91 2838 25 5000
Fax +91 2838 25 5110
info@adani.com
www.adani.com

Registered Office: Adani House, Nr Mithakhali Circle, Navrangpura, Ahmedabad 380 009, Gujarat, India

Annexure-3.

IND:M/s. Recycling Solutions Pvt. Ltd., Panoli
(Hazardous Waste Manifest)

Manifest No: 572243 31/07/2017

Copy 1

To be forwarded by the occupier to the State Pollution Control Board or Committee.

1	Occupier's Name & Mailing Address: Registration No: AWH-53736	17739 - Adani Ports & Special Economic Zone Ltd. PLOT NO: 169/P,AT-NAVINAL ISLAND, MUNDRA, KUTCH,Mundra - 370421 DIST : Kutch East, TAL : Mundra , GIDC : MPSEZ
2	Transporter's Name & Address :	Sathi Enterprize, MUNDRA, KUTCH Ph: 9998912166
3	Transporter's Registration No :	--
4	Vehicle No & Type :	GJ12Z1929 - TRUCK
5	Designated Facility Name & Site Add:	IND:M/s. Recycling Solutions Pvt. Ltd., Panoli
6	Facility's Reg No with PCB :	-
7	Waste Type :	Co-Incenerable Waste
8	Waste Description & Codes :	3.1,3.2,35.3
9	Total Quantity :	4.300 Metric Tonne Containers: 1
10	Consistency :	Solid
11	Waste Description :	PIG WASTE : 1.530 MT + TANK BOTTOM SLUDGE: 1.730 MT + ETP SLUDGE: 1.040 MT

12 **Occupier's Certificate :** I hereby declare that the contents of the consignment are fully and accurately decribed above by proper shipping name and are categorised, packed, marked, and labeled, and are in all respects in proper condition for transport by road according to applicable national government regulations.

Adani Ports and Special Economic Zone Limited MUNDRA

Name & Stamp of Industry Date: 31/07/2017 Signature

13 Transporter Acknowledgement of Receipt of Wastes

Stamp of: Sathi Enterprize Date : 31/07/2017 0:00 Signature

14 Discrepancy Note Space

15 Facility Owner or Operator's Certification of Receipt of Hazardous Waste

Stamp of: IND:M/s. Recycling Solutions Pvt. Ltd., Panoli Date : Signature

Sr	Quantity	Hazardous Waste Type
1	1.040	35.3 - Chemical sludge from waste water treatment
2	1.530	3.1 - cargo residue, washing water and sludge containing oil
3	1.730	3.2 - cargo residue and sludge containing chemicals

Annexure – 8

CONSERVATION AND MONITORING FOR NATURAL MANGROVE STANDS AT MUNDRA

Report Submitted to

Adani Ports and Special Economic Zone Limited
Mundra, Kachchh

Gujarat Institute of Desert Ecology,
P. B. No. 83, Mundra Road, Bhuj – 370001

November - 2015

CONSERVATION AND MONITORING FOR NATURAL MANGROVE STANDS AT MUNDRA

G.A.Thivakaran
Pranav J. Pandya
G.Thirumaran
Devi Velusamy
Leka Mera

Report Submitted to

**Adani Ports and Special Economic Zone Limited
Mundra, Kachchh**

**Gujarat Institute of Desert Ecology,
P. B. No. 83, Mundra Road, Bhuj – 370001**

November- 2015

1 Introduction

Coastal stretch of Kachchh district constitutes the entire northern coast of Gulf of Kachchh (GoK) which is one of the three major Gulf systems of India endowed with very high biological richness and physical and chemical peculiarities. Kachchh coast constitutes about 25.37% and 5.3 % of the coastal stretch of Gujarat and India. In spite of its high aridity (4 in a scale of 1- 4) and poor mean rainfall (340 mm), Kachchh coast has diverse ecological habitats and ecosystems like mangroves, sandy coasts, mudflats, creeks and other tidal incursions which enhance manifold its coastal landscape diversity and natural resources. Besides, extensive mangrove formations and a vast continental shelf of 1,64,000 sq.km facilitates a rich bioresource.

Kachchh coast has mangrove extent of 775 sq.km, constituting 74% of state's mangroves (1046 sq.km) which is the largest mangrove entity in India's west coast. Due to the presence of rich natural resources and favorable natural conditions, Kachchh coast has become a zone of intensive industrial development. Since late 1990's, industrial development is being promoted aggressively in view of its very rich mineral deposits, shortest sea route to Gulf countries and easy availability of land which is at premium in other coastal regions of the state. Announcement of tax holidays post 2001 earthquake by state government provided further impetus for coastal industrial development. Many of these developments are beginning to have implications on ecological, social and economic spheres. Kachchh coast faces threat from climate change, pollution and habitat change which are also important to understand impacts on mangroves.

In order to balance the economic growth and ecological health, MoEF is directing industrial houses to conserve their adjacent ecosystems by formulating management plan for the mangroves if any based on sound scientific principles. Having realized the importance of conserving and protecting the mangrove resources in their vicinity, Adani Ports and Special Economic Zone Ltd., (APSEZL) instituted this study through Gujarat Institute of Desert Ecology (GUIDE), Bhuj to analyze the present status of mangroves in the conservation zone of 1254 ha in its port vicinity. Based on intensive field studies this report narrates the present environmental status of the conservation zone.

Mundra Port is one of the fastest growing and largest private ports in the country and also a SEZ (Special Economic Zone). The port in year 2013-14 has handled >100 million tons of cargo. The port is equipped with road, rail and air connectivity which has attracted few big and small industries to this area.

On the other hand, the area also harbors a luxuriant mangrove forest which is very close to the Port and SEZ.

The present study has been instituted in order to meet the condition imposed while sanctioning Environmental Clearance (EC) by MoEF, Govt. of India. In conformity to the stipulated condition, efforts are being made to assess the mangrove vegetation structure and status in the 1254 ha of mangroves earmarked for intensive conservation measures.

1.1 Adani Ports and Special Economic Zone Ltd (APSEZL)

Gujarat Adani Port Ltd., now Adani Ports and Special Economic Zone Ltd (APSEZL) started its operations in Mundra during 1998 with an all-weather, open-sea jetty and port backup on Navinal Island. The Port has since then underwent four expansions, namely railway line and container terminal in 2000, Single Point Mooring and Crude Oil Terminal in 2004, a Multipurpose wharf Terminal-II in 2007 and Waterfront development project in 2009 which includes development of North Port, South Port, East Port & West Port. In addition to this now port based special economic zone and two thermal power plants exist which form a major industrial cluster in this coast.

1.2 *Origin of the Study*

Being close to the major port and active SEZ, the earmarked conservation zone encompassing 1254 ha of mangrove has become important area to be monitored regularly. Conservation and management of this mangrove formation has become crucial and an important responsibility of the Port authority. In the light of Port and SEZ expansions, Ministry of Environment and Forest (MoEF, GOI) has asked APSEZL to conserve the potential mangrove areas in its port vicinity and institute regular scientific monitoring studies. The present study was initiated with an aim to investigate the present status of the conservation areas of 1254 ha .

1.3 *Objectives of the Study*

In the backdrop of the narrated industrial development and the interest to conserve mangrove ecosystem in the conservation zone of 1254 ha, the present study was instituted with the following objectives.

- Monitoring of 1254 ha of potential mangrove area for conservation through seasonal assessment of vegetation status (density, growth, regeneration capacity etc.).

- Monitoring mangrove associated macrobenthic communities (which are good indicators of stand health) through seasonal density, diversity and Population studies.

- Monitoring temporal changes in the earmarked conservation zone of 1254 ha through GIS and Remote Sensing (GIS & RS).

1.4 *Description of the study Area*

Kachchh coast constitutes the entire northern shore of Gulf of Kachchh marked by narrow beaches and wide mudflats. Mangrove extent of Mundra taluka is about 19.1 km^2 distributed mostly along creek systems. Present study area covers the mangrove formation in the conservation zone of 1254 ha located in the eastern part of Mundra coast. The coastal stretch of Mundra is dissected by extensive mudflats and creek systems, many of which harbour good mangrove formations. Major creek systems in the area are Navinal, Bocha, Baradi mata and Kotadi creek. These creeks again divide into minor creek complexes. Many of these creeks support mangrove stands, especially along the eastern and western side of the waterfront area of APSEZ. Koylavali creek is luxuriantly lined by mangrove patches predominant with the species, *A. marina*. Adani Port and Special Economic Zone Ltd.-APSEZ is located at about 3 km from its mouth towards eastern extension. The present study was focused towards the mangrove stand at Bocha Island, East of Bocha, Kotadi creek and Baradimata creek adjoining to the waterfront area of APSEZ which falls within the earmarked conservation zone of 1254 ha (Fig.1.1).

Bocha and East of Bocha

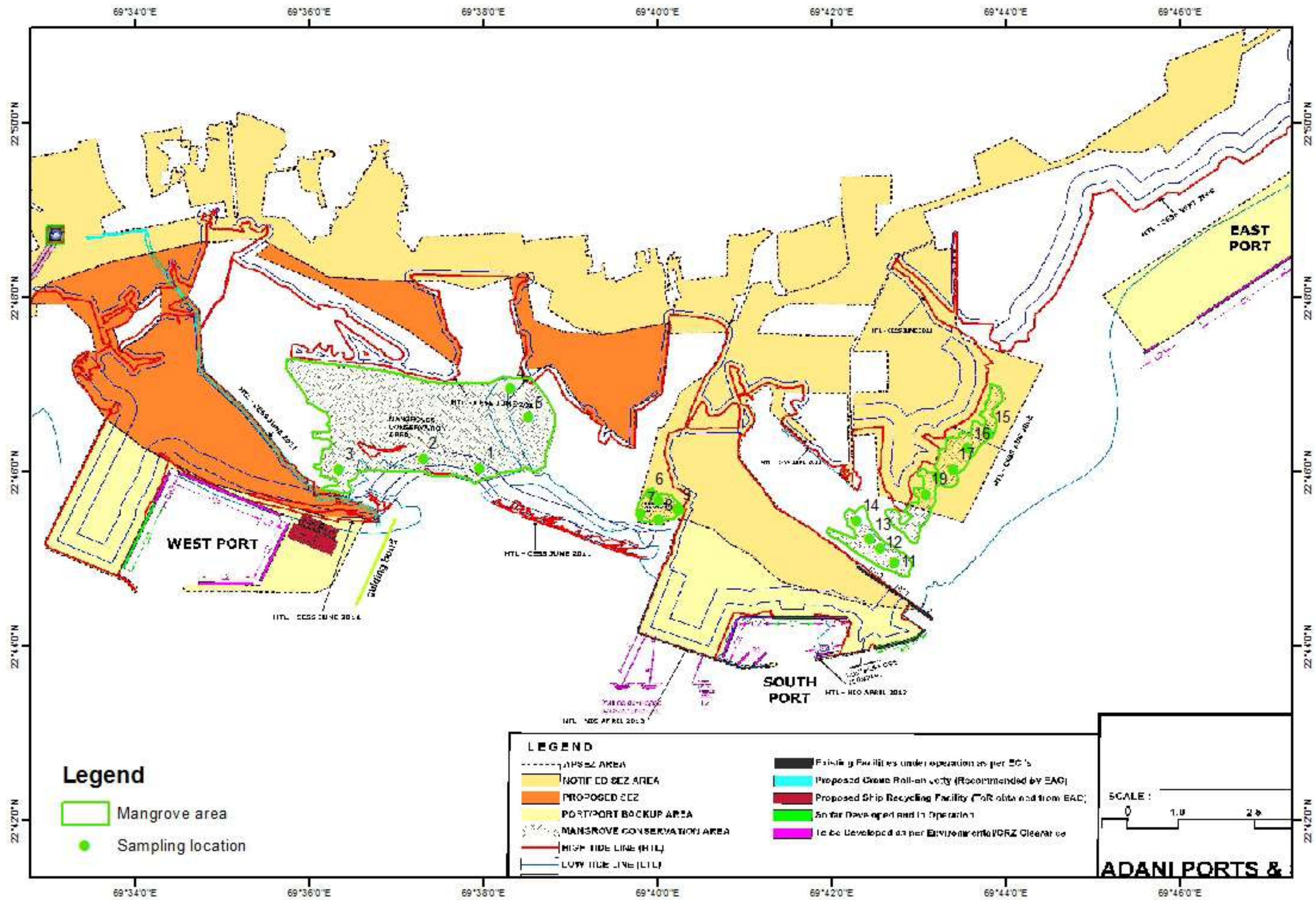
Bocha Island is a finger like projection surrounded by Bocha creek on west and Navinal creek on the east. The MICT container terminal is located right across the Bocha Island at a distance of 100m. The island supports a mature and healthy mangrove stand.

Kotadi and Baradimata creek systems on the western part of APSEZL area include luxuriant mangrove patch. These two creeks bifurcate further at their tail end into several minor creeks forming a complex water ways with many small Islands. Many of these Islands harbor healthy mangrove stands.

Tides at Mundra are mixed, predominantly semidiurnal type with Mean High Water Spring (MHWS) of 6.66 m and Mean High water Neap (MHWN) of 5.17 m. The phase difference is not uniform for successive tides in the Gulf and it varies as per tidal condition (ICMAM, 2002).

Due to its semi-arid nature, annual rainfall in Kachchh is poor, ranging from 250-350 mm which is often irregular. However, mean rainfall (1932 to 2001) was higher at Mundra (407 mm) comparing other coastal talukas. Rain during monsoon is confined to only 15-20 days and occurs as an instant downpour. Freshwater input into the near coastal waters is quite meager and appears to influence coastal flora like mangroves explaining poor floral diversity. Annual temperature fluctuation in the district is extreme, ranging from 7- 47^{o}C with a yearly average humidity of 60% which increases to 80% during south-west monsoon and decreases to 50% during November-December. The phenomenon of drought is common, with 2 drought year in a cycle of 5 years.

Fig. 1.1 . Mangrove stand at Bocha Island, East of Bocha, Kotadi creek and Baradimata creek in 1254 ha



2 Baseline Information

2.1 *Mangrove Vegetation and Structure*

2.1.1 *Methodology*

i. ***Zoning of the study area:*** Considering the extent of the area, the conservation zone mangrove formation was divided into smaller zones in order to facilitate better evaluation and understanding of the ecosystem. Accordingly, three zones as indicated belowand shown in Figure 2.1 was identified for the purpose of this study;

Zone 1: East of Bocha (area between Bocha and Abhan creek)

Zone 2: Bocha Island (The Island proper to the extent of conservation zone)

Zone 3: Baradimata creek and nearby and areas falling within the embarked zone.

Representative study points covering all the zones were investigated on ground and documented for baseline status

Zone I: East of Bocha (area between Bocha and Abhan creek):

The area between Bocha and Abhan creek holds some of the large and old mangroves and represents one of the healthy mangrove ecosystems of Kachchh (Fig. 2.1). Apart from *Avicennia marina*, the area has good population of another mangrove species, *Ceriopstagal.*

A noticeable patch of cut/lopped mangrove was observed (Lat. 22° 45' 20.3"E; long. 69° 43' 00.5"N) which was reported during the earlier seasonal studies. The same patch after 6 months has shown remarkable natural regeneration with an average density of 70 plants per 100m^2 quadrate. This proves that this area has high potential for natural regeneration if taken care of.

Fig. 2.1 Sampling locations at different mangrove stands in the earmarked 1254 ha at Mundra

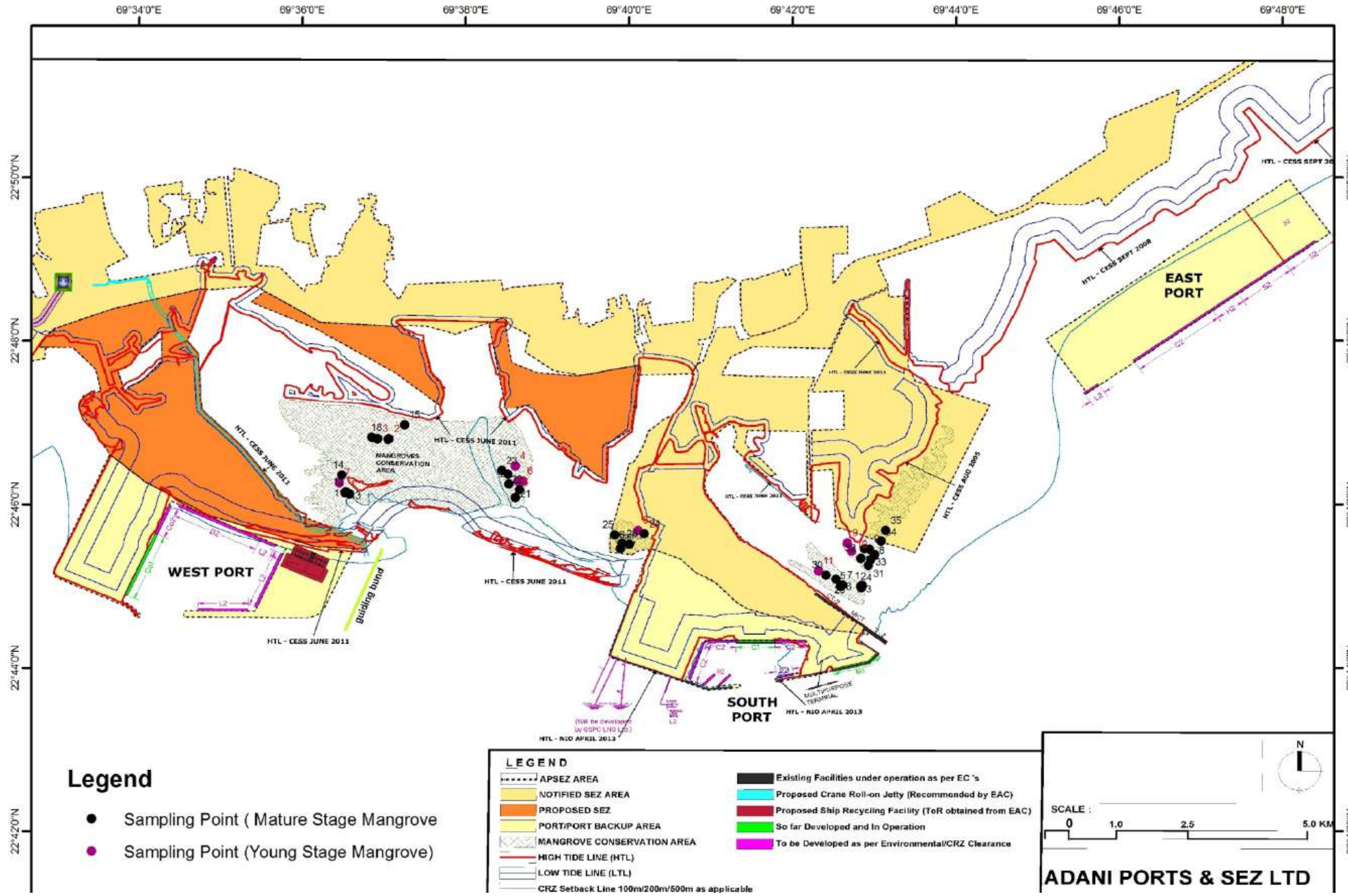


Fig. 2.2 Mangroves in Zone-I- East of Bocha

Zone II: Bocha Island

Bocha Island forms one of the integral areas of the Mundra mangroves with dense and healthy mangrove forests with an average density of 5285 to as high as 15000 trees/ha. Finger like shape of this Island surrounded by tidal waters in all the three sides with high tidal inundation enable the mangroves to develop into a mature and healthy formation. This fully grown healthy mangrove ecosystem has three mangrove species viz. *A. marina, C. tagal*and R. *mucronata.* The Island extends landward on the northern side forming minor creek systems.

Fig. 2.3 Mangroves atBocha Island

Zone III: Area between Navinal creek and west port (Baradimata creek and adjacent areas)

This zone supports complex creek systems formed of Baradimata and Kotadi creeks. Minor Islands supporting healthy mangrove formations characterize this zone. Most of the mangroves in this area are pristine since they are away from human influence. Mangrove stands, especially the thickets along the fringes of creeks in this zone are young and fully grown as compared to the mangroves of Zone I and II. The islands support fully grown mangrove forest and a maximum tree height of 7 m could be recorded in this zone.

Vegetation structure study was carried out at different representative mangrove formations in the conservation zone of 1254 ha. Mundra mangroves are distributed on open coastal stretch, along creeks and Islands. Keeping in mind the tidal cycle and workable conditions, a suitable low tide time was selected to carry out mangrove vegetation study. Since most of the mangrove formations are along the creeks and on small islands, a fishing boat was used to approach the mangrove formations. Vegetation analysis was carried out during low tide by quadrate method (Mueller-Dombois and Ellenberg, 1967; Kershaw, 1973). Thirty Five random plots of 10 × 10m were laid in different mangrove formations within the study area representing landscapes like creek systems, islands and coastal mangroves to analyse the vegetation structure. In each plot, the total numbers of trees were recorded. Fig. 2.1 shows the study area and sampling plots and quadrates for floral and faunal study.

The simple modified transect method was followed by walking perpendicular to the waterline in the mangroves. At few instances, Point Centre Quarter method (Cottamand Curtis 1956) was also used for the density assessment. For all trees in the plot, tree height and girth at breast height (GBH) were measured. GBH of all mature trees taller than 1 m was measured. To enumerate regeneration and recruitment classes, subplots of 1×1 m and 2×2 m, respectively, were laid randomly within all the bigger plots of 10 × 10m. The regeneration class includes seedlings that are germinating saplings which are less than 50 cm tall and the recruitment class includes well established saplings which are more than 50cm but less than 1m. Density of mature trees, regeneration and recruitment class for each station was expressed as number per hectare (No/ha).

2.1.2 *Results*

Overall structural characters of the mangrove formation in the earmarked area of 1254 ha such as density, height, GBH and the regeneration, recruitment and mature tree classes are presented in Table 2.1 and 2.2, respectively.

Mangrove *Diversity*

In total, three species were recorded in the study area viz. *Avicenna marina, Rhizophoramucronata and Ceriopstagal*. Similar to other mangrove formations of Gulf of Kachchh, Mundra mangroves are dominated by *Avicenna marina*. Small patches of *Rhizopora*sp were seen at Bocha Island and Kotadi creek. A healthy patch of *C. tagal* was recorded at East of Bocha during the field visits. Mangrove floral diversity is comparatively higher at Mundra region than any other Kachchh coast which mostly has only one species namely, *Avicennia marina*.

Mangrove Density

An overall average mature tree density of 4236 trees/ha was recorded for the dominant species *A. marina*from all the sampled stands within conservation area of 1254 ha (Table 2.1). The other two less dominant species recorded a density of 309 and 343 trees/ha. Transect-wise, occurrence of highest density of 15000trees/ha was recorded at the Bocha creek. This creek complex near the water front showed highly dense mangrove patch with a healthy habitat. Lowest mature tree density of 2000 trees/ha was observed at Bocha Island mangroves having highly mature trees with good spacing. The comparative analysis of tree density revealed that Baradimata creek showed the highest mangrove density with average of 5261/ha (Max. 14000/ha; Min. 2300/ha) followed by Bocha Island with an average density of 5050/ha. This was followed by Kotadi Island (3267/ha) and east of Bocha(3256/ha) (Table 2.1). In general, recorded tree densities are comparable with any healthy mangrove formations of west coast of India.

Tree Height

The mangrove stands within the conservation specific area of 1254 ha showed noticeable variation in tree height. Overall average height recorded from the four different stands was 249 cm (Min. 100 cm – Max. 480 cm) with the maximum plant height of 480 cm recorded at Baradimatha creek (Table 2.1). In other stands, marginal variation was recorded in average height.

Of the 35 quadrates, more than 10 quadrates showed the average height of 200-250 cm.Considering the overall height class of all the four mangrove formations studied, it can be interpreted that most mangrove stands fall in the height range of 200-300 cm(Fig. 2.2).

Tree Girth (Girth at Breast Height-GBH)

Mean Mangrove Girth (GBH) studied at 35 plots ranged from 10 cm to 73 cm (Table 2.1). Overall average girth based on the mean of all the plots was 27 cm. Only Bocha Island showed 5 trees with highest girth in the range of 60 to 120 cm. Most of the mangrove girth recorded fall in the range of 15 to 20cm (Fig.2.3).

Regeneration Class

Average density of regenerating mangroves (saplings with a height of <30 cm) was 59829 plants/ha (Table 2.2) which ranged from 120 plants/ha to 125300 plants/ha. This reflected high regeneration potential of mangroves in the area. A good regeneration of *C. tagal* was recorded (120 plants/ha) at Bocha Island, indicating favorable environment for this species at this site. Similarly, a small regenerating patch *R. mucronata* was recorded from Bocha Island with a regeneration class density of 330 plants/ha. Comparing overall regeneration of *A. marina*, it was seen that recruitment was moderately lower in the area. However, it was observed that regeneration and recruitment in some of the Islands and creek edges near the water front was much higher.

Recruitment *Class*

Average recruitment recorded in the area was 14110 plants/ha which ranged from 45 to 35600 plants/ha (Table 2.2). Less recruitment was evident at older and mature mangrove forests like Bochaapparently due to lack of canopy opening and resultant reduced exposure to sunlight. Vegetation structure and density of mature and younger classes in a forest indicate its regeneration behavior. Analysis of density of younger classes like seedlings (regeneration class) and saplings (recruitment class) generally indicates the future structure the forest and its population will assume. In the present study, high density of regeneration and recruitment classes in majority of the mangrove stands indicate that they are healthy and their germination and recruitment of younger classes is normal which will ensure a good and healthy stand in future if they did not face any disturbance. Only in patches like Bocha and Kotadi Island, ratio of mature tree to younger classes is very high indicating their climax nature.

Similar to other Kachchh mangroves, mangroves within the conservation zone of 1254 hais dominated by *A. marina* while occurrence of *R. mucronata* and *C. tagal* is patchy and restricted to few mangrove stands like Bocha Island and Kotadi creek. Most of the surveyed areas represent healthy mangrove stands. Moreover, some of the places like Bocha Island, Kotadi Island and of East Bocha represent older mangrove formations. Typically, most of the areas showed very few floral associates. Only at few places, associates like *Sueda*and*Salicornea sp.* were recorded.

Table 2.1 Mangrove vegetation structure and classification in the 1254 ha Conservation Zone

S.No	Site No	Sampling Locations	GPS Locations	*A.marina* Density	*Rhizophora* density /ha	*Ceriops* density/ha	Height (cm)			Girth(cm)		
							Min	Max	Avg.	Min	Max	Avg.
1	1	Bocha Island	22d 45' 0.20" N; 69d 42' 51.00" E	4000	0	0	310	350	330	8	12	10
2	2	Bocha Island	22d 44' 59.70" N;69d 42' 50.10" E	5000	0	0	170	340	220	26	60	43
3	3	Bocha Island	22d 44' 59.10" N; 69d 42' 50.40" E	5800	0	0	240	270	257.5	20	34	27
4	4	Bocha Island	22d 44' 58.60" N; 69d 42' 50.50" E	7600	0	0	156	200	126.2	12	34	23
5	5	Bocha Island	22d 44' 59.80" N; 69d 42' 35.10" E	2000	7100	0	170	340	277.5	7	62	35
6	6	Bocha Island	22d 45' 0.40" N; 69d 42' 35.50" E	5500	0	0	180	340	230	7	90	49
7	7	Bocha Island	22d 45' 0.50" N; 69d 42' 36.50" E	7100	0	0	300	350	239	25	120	73
8	29	Bocha Island	22d 45' 4.93" N; 69d 42' 31.72" E	4550	0	6500	135	200	168	15	54	35
9	30	Bocha Island	22d 45' 7.97" N; 69d 42' 24.54" E	3900	0	5500	126	340	233	17	49	33
		Average-Bocha Island		**5050**	**789**	**1333**	**199**	**303**	**231**	**15**	**57**	**36**
10	8	East of Bocha	22d 45' 23.00" N; 69d 43' 0.00" E	2200	0	0	100	600	340	15	60	38
11	9	East of Bocha	22d 45' 26.90" N; 69d 42' 56.50" E	2800	0	0	100	670	450	21	75	48
12	10	East of Bocha	22d 45' 27.20" N; 69d 42' 53.00" E	3900	0	0	100	390	290	15	28	22
13	31	East of Bocha	22d 45' 15.14" N; 69d 42' 55.66" E	2850	0	0	190	600	395	10	19	15
14	32	East of Bocha	22d 45' 20.33" N; 69d 42' 50.12" E	3100	0	0	210	670	440	15	60	38
15	33	East of Bocha	22d 45' 19.22" N; 69d 42' 57.30" E	3750	0	0	195	390	293	21	75	48
16	34	East of Bocha	22d 45' 32.96" N; 69d 43' 4.80" E	4050	3700	0	280	250	265	15	28	22
17	35	East of Bocha	22d 45' 40.68" N; 69d 43' 8.32" E	3400	0	0	230	450	340	16	49	33
		Average-East of Bocha		**3256**	**463**	**0**	**176**	**503**	**352**	**16**	**49**	**33**
18	11	Baradimata creeks	22d 46' 7.70" N; 69d 36' 34.60" E	5200	0	0	110	250	190	14	30	22
19	12	Baradimata creeks	22d 46' 9.10" N; 69d 36' 32.00" E	5700	0	0	300	450	450	26	45	36
20	13	Baradimata creeks	22d 46' 8.40" N; 69d 36' 31.40" E	4600	0	0	210	520	480	12	48	30
21	14	Baradimata creeks	22d 46' 21.50" N; 69d 36' 28.90" E	14000	0	0	100	330	210	9	18	14
22	24	Baradimata creeks	22d 45' 38.29" N; 69d 40' 11.07" E	2350	0	0	300	245	273	13	19	16
23	25	Baradimata creeks	22d 45' 37.48" N; 69d 39' 49.22" E	3100	0	0	100	240	170	15	26	21
24	26	Baradimata creeks	22d 45' 30.34" N; 69d 40' 0.18" E	2300	0	0	100	220	160	12	20	16
25	27	Baradimata creeks	22d 45' 27.53" N; 69d 39' 53.48" E	4900	0	0	100	210	155	8	26	17
26	28	Baradimata creeks	22d 45' 31.01" N; 69d 39' 54.61" E	5200	0	0	120	225	173	14	30	22

		Average-B.Matha Creeks		**5261**	**0**	**0**	**160**	**299**	**251**	**14**	**29**	**22**
27	15	kotadi creek	22d 46' 58.30" N; 69d 37' 15.00" E	3400	0	0	90	150	100	9	18	14
28	16	kotadi creek	22d 46' 47.60" N; 69d 37' 2.90" E	3500	0	0	120	210	140	6	26	16
29	17	kotadi creek	22d 46' 48.00" N; 69d 36' 55.20" E	4500	0	0	90	210	130	6	15	11
30	18	kotadi creek	22d 46' 49.10" N; 69d 36' 50.80" E	2600	0	0	130	190	160	9	26	18
31	19	kotadi creek	22d 46' 22.04" N; 69d 38' 30.85" E	2950	0	0	170	215	192.5	12	26	19
32	20	kotadi creek	22d 46' 14.81" N; 69d 38' 31.66" E	3100	0	0	240	185	212.5	15	26	21
33	21	kotadi creek	22d 46' 4.73" N; 69d 38' 36.34" E	3250	0	0	156	220	188	21	26	24
34	22	kotadi creek	22d 46' 10.65" N; 69d 38' 39.29" E	3400	0	0	170	180	175	12	17	15
35	23	kotadi creek	22d 46' 24.64" N; 69d 38' 26.41" E	2700	0	0	180	310	245	20	28	24
		Average-Kotadi Creek		**3267**	**0**	**0**	**150**	**208**	**171**	**12**	**23**	**18**
		Overall Average		**4236**	**309**	**343**	**171**	**323**	**249**	**14**	**39**	**27**

Table 2.2 Regeneration and Recruitment details of the sampling points

S.No.	Location	Latitude	Longitude	Species	Regeneration No/ha	Recruitment No/ha
1	Kotadi creek	22d46' 8.40" N	69d36' 31.40" E	*Am*	120000	28000
2	Kotadi creek	22d46' 47.80" N	69d37' 3.60" E	*Am*	28000	6000
3	Kotadi creek	22d46' 48.00" N	69d36' 55.20" E	*Am*	18000	3200
4	Kotadi creek	22d46' 27.90" N	69d38' 36.33" E	*Am*	68200	10300
5	Kotadi creek	22d46' 16.80" N	69d38' 38.23" E	*Am*	85400	15900
6	Kotadi creek	22d46' 16.91" N	69d38' 41.71" E	*Am*	102000	20900
7	Kotadi creek	22d46' 15.70" N	69d36' 27.22" E	*Am*	89500	16400
8	Baradimata	22d45' 40.87" N	69d40' 6.62" E	*Am*	125300	35600
9	East of Bocha	22d45' 31.34" N	69d42' 40.24" E	*Am*	35200	20500
10	East of Bocha	22d45' 25.54" N	69d42' 43.33" E	*Am*	45900	12350
11	Bocha Island	22d45' 10.78" N	69d42' 18.98" E	Ct	120	45
11	Bocha Island	22d45' 10.78" N	69d42' 18.98" E	Rm	330	120
				Average	**59829.17**	**14110**

Ct- Ceriopstagal; Am- Avicennia marina; Rm- Rhizophoramucronata

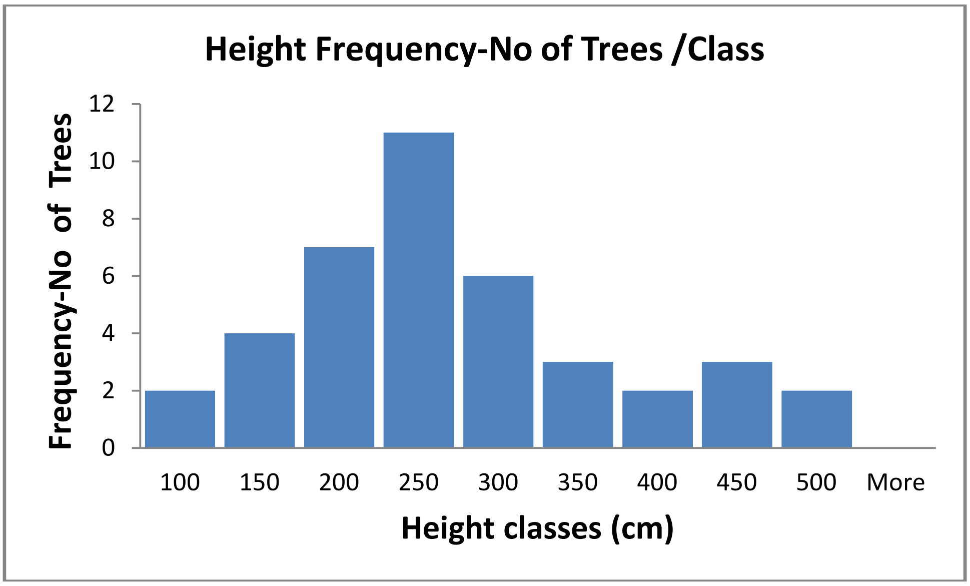


Fig. 2.2 Height freqency classes of mangrove stands at Mundra

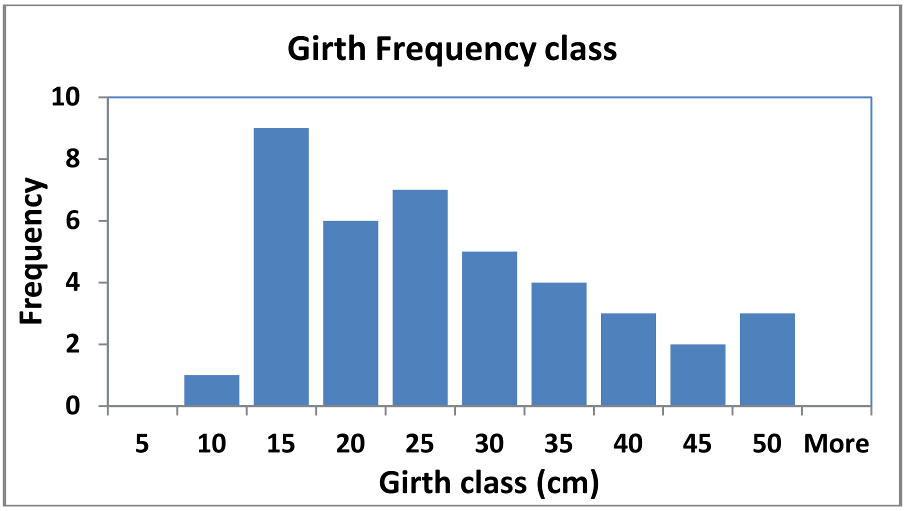


Fig. 2.3 GBH freqency classes of mangrove stands at Mundra

2.2 Mangrove Associated Macrofauna

2.2.1 *Introduction*

Mangrove vegetation plays an important role in maintaining environmental complexity and influencing the diversity and distribution of animals related to the ecological system (Lee, 1998; Roach and Lim, 2000; Liu *et al*., 2006; Gao*et al*., 2005). Afforestration of mangroves increase the diversity of Macrofaunal communities. At the same time, macrofauna plays an important role in mangrove ecological system; they are both the consumers and transporters in the energy flow and material circulation of the system. Through activities such as ingesting food and digging caves, macrofauna interact with their surrounding environment. Therefore, Macrofaunal community structure is the potential ecological index to recognize environmental changes in mangroves.

Considering these importance of intertidal fauna as a tool to assess the health of any coastal ecosystem, in the present study, intertidal fauna associated with the mangroves of the earmarked conservation zone which comprises Bocha, Baradimatha, Navinal and Kotadi creeks were studied. Major objective of this study is to understand the health of mangrove ecosystem in this stands by investigating different community characters of mangrove associated macrobenthos. This chapter consolidates the findings of three seasonal studies carried out within 1254 ha.

2.2.2 *Methodology*

Macro faunal analysis was carried out during low tide and faunal diversity and density for different mangrove stands was investigated in all the mangrove stands. Standard quadratesampling method was used wherein triplicates of 1.5 X 1.5 ft quadrates were randomly plotted in each 10 X 10 m mangrove plot studied. The result of the quadrate data was pooled to individuals per meter for easy and uniform analysis. Total species, dominant faunal group, average density of animals, etc., were analyzed based on the derived data. In all the four mangrove stands, this study was carried out in three seasons.

2.2.3 *Result*

Faunal Composition

During the study period there were forty-one species of macrofauna recorded at the four different mangrove stands belonging to 7 major groups (Table 2.3). The higher faunal groups were species of Gastropods (10 species), Bivalves (7 species), Crustaceans (12 species), Polychaetes (7 species), mudskipper (1 species), coelenterates (2 species) and others (2species), respectively. Crustaceans and Gastropods were the dominant groups encountered in all the quadrates.

Faunal Density

The highest average density was recorded for isopods (774.3 individuals/m^2) Amphipods (653.7 individuals/m^2) and Tanaids (336.8 individuals/m^2). Lowest average density was recorded for *Crassosrea costae*(4.7 individuals/m^2) and *Scylla serrata* (5.4 individuals/m^2). The seasonal average density was higher in January (winter) (isopod 157.6 individuals/m^2) and November (Post-monsoon) (amphipod 762.2 individuals/m^2). Overall percentage wise abundance of species for different groups and locations revealed that crustaceans comprising crabs, isopods and amphipods were most dominant, constituting 29.2% of the total abundance recorded. This was followed by gastropods (24.4%) and bivalves (17.1%), polychaetes (17.1%), coelenterates (4.9%), mudskipper (2.4%) and others (4.9%) (Fig. 2.4).

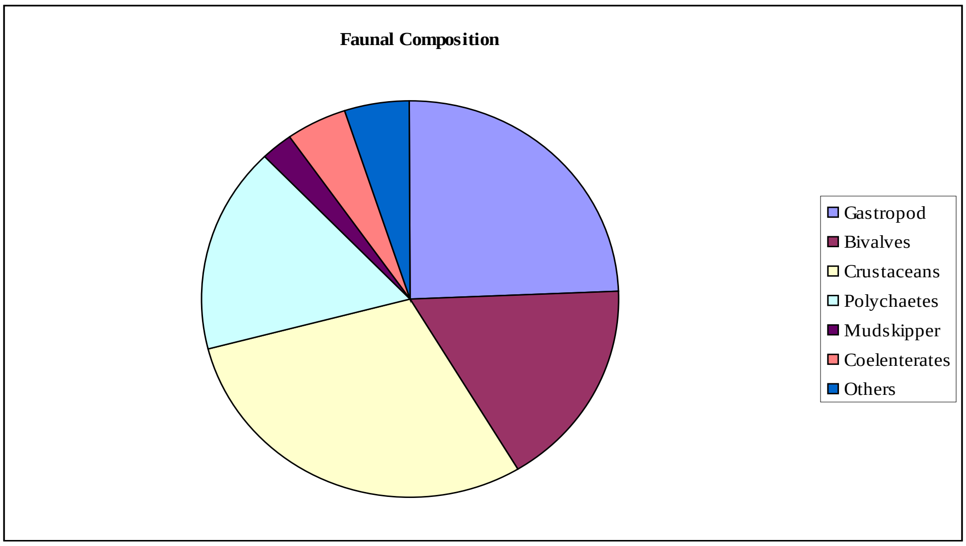


Fig. 2.4 Associated faunal composition of mangrove stands at Mundra

Species Occurrence

The total number of species was maximum (33 species) in January (winter) at Navinal creek and minimum (20 species) in November (Post-monsoon) at Baradimata creek. *Assiminea* species, *Cerithideacingulata*, *Solenlamarcki* and *Ceratonereis mirabilis* were recorded in all the seasons and stations. *Umboniumvestiarium* was recorded in only two stations (Abhan creek and Navinal creek) in November (Table 2.3). Among macrofauna, *Assiminea* sp., *Cerithideacingulata*, *Solenlamarcki* and

*Ceratonereismirabilis*showed 100% of occurrence due to their presence in all the quadrates and they were the highly abundant species. *Umboniumvestiarium* (16.6%)*Donaxcuneatus* (25%) and *Vergularia* species (25%) showed lower frequency of occurrence (Table 2.4).

Table 2.3 Density of different Macrofaunal species in each quadrate

	Season I- January				Season II- June				Season III- Nov.				Average
	BC	**AC**	**NC**	**BMC**	**BC**	**AC**	**NC**	**BMC**	**BC**	**AC**	**NC**	**BMC**	
Gastropods													
Assiminea sp.	178	414	608	342	123	111	206	388	0	12	34	8	202
Cerithideacingulata	321	204	262	189	129	245	194	234	168	65	24	151	182.1
Littorinascabra	43	34	219	64	42	34	201	315					119
Telescopiumtelescopium	11	8	12	9	6	6	6	5					7.8
Haemainea	16	309	343	98	99	167	213	179					178
Melampus	27	21	42	54	12	17	27	17					27.1
*Pythia*sp	11	12	18	8	9	6	9	10					10.3
Thais bufo			5						6	24	6	6	9.4
N. dorsatus									25	6	32	6	17.2
Umboniumvestarium										31	54		42.5
Bivalves													
Crassostrea sp.	11	21	62	22	78	125	85	18					52.7
Crassostreaedulis	99	102	58	148	67	90	51	160					96.8
Lingulatranslucida	29		29		26	2	19	5					18.3
Solenlamarcki	23	44	26	12	19	34	21	12	35	21	41	45	27.7
Meretrixcasta	4					12			15	9	6	17	10.5
Pholasorientalis	3	13	1	6					23		6	24	10.8
Donaxcuneatus			3						8		12		7.6
Crustaceans													
*Ocypode*sp	51	41	48	43	32	31	30	27					37.8
*Sesarma*sp	17	9	28	17	20	11	20	15					17.1
Hermit crab	19	12	36	28	10	17	22	19					20.3
B. balanoidus	231	109	93	134	112	146	68	124					127.1
Ucaannulipes	44	28	32	38	29	23	20	28					30.2
*Metaphagraphus*sp	76	102	123	82	30	53	57	30					69.1
M. messor	20	2	18	11	8	21	14	8					12.7

Mud lobster	8	1	8	9	6	9	5	8					6.7
Amphipods	789	1356	3	778	234	328			1283	630	570	566	653.7
Isopods	1139	2333	1		456	234			291	560	822	1133	774.3
Tanaids	456	124	3	567	234	321			255	664	449	295	336.8
Scylla serrata	7	9	8		6	4			6	3	3	3	5.4
Polychaetes													
Ceratonereis mirabilis	28	219	83	127	163	265	81	211	28	9	44	286	128.6
C. costae			3						6	7		3	4.7
*Marphysa*sp.	67	59	63	50	182	67	44	39					71.3
Lumbrinereisheteropoda	9							54	3	12	7	17	
Diopatracuprea		8							25	27	114	21	39
Armandialeptocirrus	11								38	9	55	12	25
Terebellids		5							6	9	15	3	7.6
Fishes (Mudskipper)													
Boleophthalmus sp.	85	124	61	40	85	135	58	40					78.5
Coelenterata													
Sea anemone		4		3	3	2			27	3		3	6.4
Vergularia sp.		7	6								164		59
Others													
Asicidian	23		3			1			38	32		75	28.6
Nemerteans			23			2			33	24	15	15	18.667
Number of Species	31	31	33	25	27	30	22	23	21	20	16	20	25

Table 2.4.Macrofaunal Diversity and their respective frequency

S. No.	Species	Group	Frequency
1	*Assiminea* sp.	Gastropod	100
2	*Cerithideacingulata*	Gastropod	100
3	*Littorinascabra*	Gastropod	66.6
4	*Telescopiumtelescopium*	Gastropod	66.6
5	*Haemainea*	Gastropod	66.6
6	*Melampus*	Gastropod	66.6
7	*Pythia*sp	Gastropod	66.6
8	*Thais bufo*	Gastropod	41.6
9	*N. dorsatus*	Gastropod	33.3
10	*Umboniumvestarium*	Gastropod	16.6
11	*Crassostrea* sp.	Bivalve	66.6
12	*Crassostreaedulis*	Bivalve	66.6
13	*Lingulatranslucida*	Bivalve	50
14	*Solenlamarcki*	Bivalve	100
15	*Meretrixcasta*	Bivalve	50
16	*Pholasorientalis*	Bivalve	58.3
17	*Donaxcuneatus*	Bivalve	25
18	*Ocypode*sp	Crustacean	66.6
19	*Sesarma*sp	Crustacean	66.6
20	*Hermit* crab	Crustacean	66.6
21	*B. balanoidus*	Crustacean	66.6
22	*Ucaannulipes*	Crustacean	66.6
23	*Metaphagraphus*sp	Crustacean	66.6
24	*M. messor*	Crustacean	66.6
25	Mud lobster	Crustacean	66.6
26	Amphipods	Crustacean	83.33
27	Isopods	Crustacean	75
28	Tanaids	Crustacean	83.33
29	*Scylla serrata*	Crustacean	75
30	*Ceratonereis mirabilis*	Polychaete	100
31	*C. costae*	Polychaete	33.3
32	*Marphysa*sp.	Polychaete	66.6
33	*Lumbrinereisheteropoda*	Polychaete	50
34	*Diopatracuprea*	Polychaete	41.6
35	*Armandialeptocirrus*	Polychaete	41.6
36	*Terebellids*	Polychaete	41.6
37	*Boleophthalmus* sp.	Mudskipper	66.6
38	Sea anemone	Colenterata	58.3
39	*Vergularia* sp.	Colenterata	25
40	Asicidian	Others	50
41	Nemerteans	Others	50

2.2.4 *Conclusion*

Mangroves in the study area support diverse assemblage of macrobenthic faunal organisms numbering 41 species. Most of the families and species inhabiting mangrove ecosystem have been recorded from the studied four mangrove stands. These fauna include bivalves and gastropod molluscs, crustaceans such as crabs and amphipods, and families of polychaete worms. Recorded faunal assemblage clearly indicates that the structural complexity of the mangrove environment of Mundra is natural and no indication of stress on the ecosystem could be gleaned based on the composition, density and diversity of the associated faunal assemblage.

2.3 Physico-chemical parameters

2.3.1 *Introduction*

The healthy aquatic ecosystem depends on the physico-chemical and biological characteristics (Venkatesharaju et al., 2010). Major questions in mangrove geochemistry concern the reciprocal interactions between sedimentary substrate and the vegetation (McKee, 1993). Salinity, redox potential, pH and sulphide concentration are pore-water parameters that play key roles in the development of mangroves and their spatial distribution. To cope with the variation of these properties, mangroves have developed many adaptations that give them wide ranges of tolerance. These adaptations result in geochemical modifications in the sediment. Additionally, climate, tidal flooding, vegetation evolution, bioturbation and organic matter content are parameters that also contribute to the complexity of the geochemistry of mangroves.

Crucial basic parameters like pH, pore-water salinity, sediment texture and Total Organic carbon (TOC) were analysed for selected mangrove stands in the present investigation. These parameters are direct indicators of the health status of the mangrove environment. Since they influence the vegetation status of mangroves, alteration in their normal range indicates interference in the ecosystem.

2.3.2 *Methodology*

Standard protocols (APHA, 1995) were followed for the sample collection and analysis. Water samples were collected using sterile polyethylene containers. Salinity (ppt-%$_o$) was estimated using a pre-calibrated Refractometer (Aatago–Japan). Collected pore water was analysed for pH and Salinity.

2.3.3 *Result*

2.4 Water Quality

Salinity

Sea water salinity is the most important factor that determines many life processes. The salinity in the four mangrove stands varied from 36.6ppt to 38.7ppt with an average value of 38.05ppt (Fig 2.5). The salinity was maximum at Kotadi(38.7 ppt) and minimum atBocha (36.8ppt). Recorded values of salinity are within the expected range usually prevailing in mangrove environment.

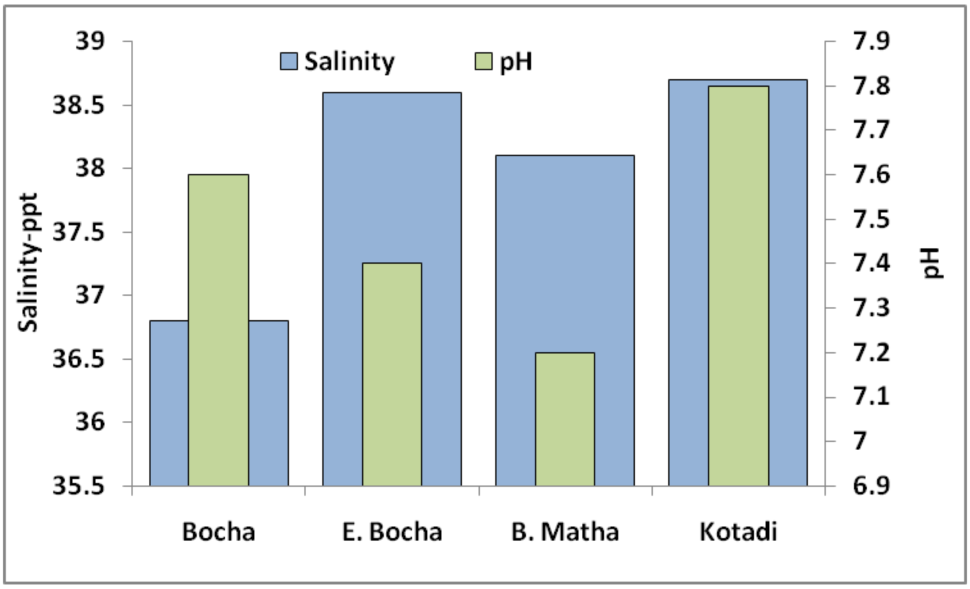


Fig. 2.5 Surface water salinity and pH in the study stations

Hydrogen Ion Concentration

The surface water pH of the study area was moderately alkaline in nature. During the study period, pH ranged from 7.2 to 7.8 with an average value of 7.5 (Fig

2.5). Highest pH of 7.8 was recorded at Kotadi creek and lowest pH was at Baradimatha(7.2) and East of Bocha (7.4).

Pore water Salinity

Pore water salinity in low tide line (LTL) ranged from 35ppt to 46 ppt with an average value of 41.42 ppt (Fig. 2.6). Pore water salinity at mid tide (MTL) and high tide line (HTL) varied from 40.1 ppt to 53 ppt; 44 ppt to 56 ppt, with an average value of 47.01 ppt and 50.76 ppt respectively. The cumulative average of pore water salinity was maximum at Baradimatha, with a value of 50 ppt whereas it was lowest at East of Bocha (43 ppt). Levels of pore water salinity did not show any abnormality and was quite within the expected range.

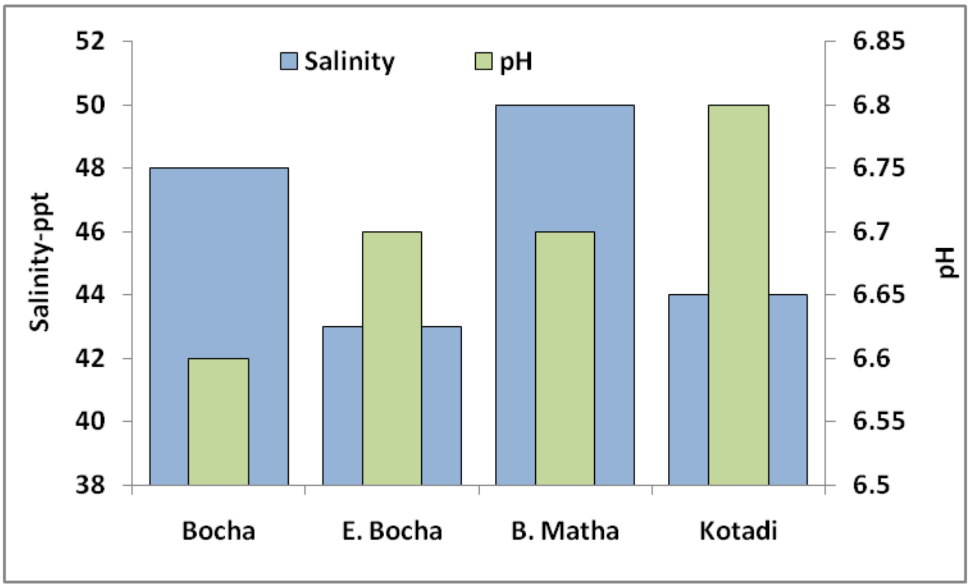


Fig.2.6 Pore water salinity and pH of the study stations

Pore water pH

The pore water pH in all the four studied mangrove stands was marginally acidic in nature. At low tide line it ranged from 6.4 to 7.1 with an average value of 6.68 and maximum was recorded at Navinal and minimum atBaradimatha (Fig. 2.6). Both higher and lower values at mid tide line was observed at Bochawith a value of 6.9 and 6.5. High Tide Line pore water pH ranged between 6.4 to 6.9 with an average value of 6.76 and maximum was recorded at Baradimatha. During the present study the overall pH average of pore water sample recorded maximum in mid tide line.Overall average of pH in all the four sampling stations fluctuated nominally and ranged from 6.6 to 6.8 (Fig. 2.6).

Dissolved Oxygen

Dissolved oxygen of the present study varied between 3.9 to 4.5 mg/l with an average value of 4.1 mg/l (Fig. 2.7). The higher value was recorded at Baradimathacreek (4.5 mg/l) followed by East of Bocha (4.1 mg/l),Bocha (3.9 mg/l) and Kotadi (3.9 mg/l).

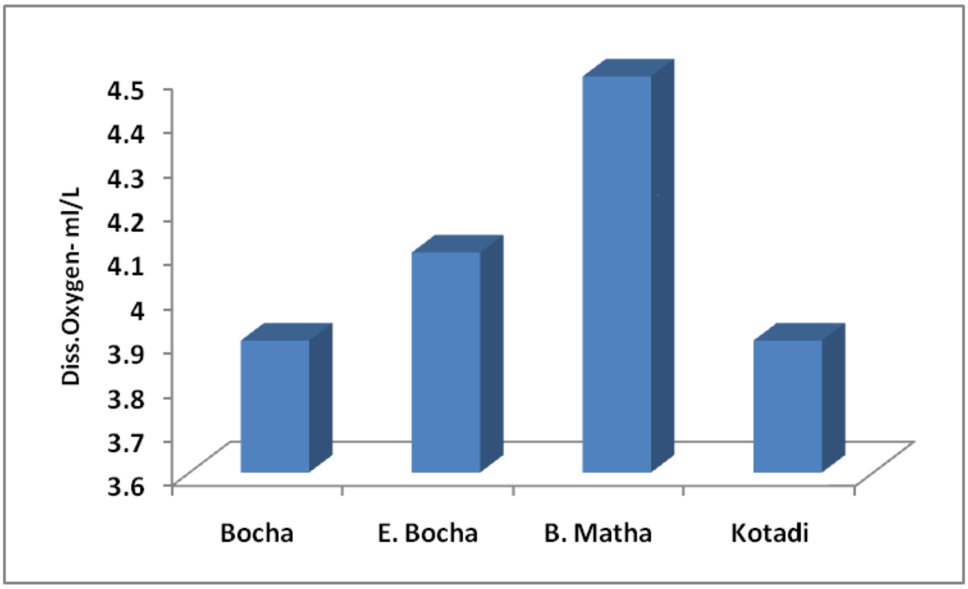


Fig. 2.7 Dissolved Oxygen of the study stations

Turbidity

Turbidity is considered as a good indicator of the quality of watersince it controlsphotosynthesis in the water column. The turbidity in the surface water during the entire study ranged from 89 to 142 NTU with an average of 113 NTU (Fig. 2.8). Maximum (142 NTU) and minimum (89 NTU) were recorded at Bocha and Kotadi creek, respectively. During the present study the levels of turbidity were on the higher side. Generally at mangrove environment, levels of turbidity will be higher.

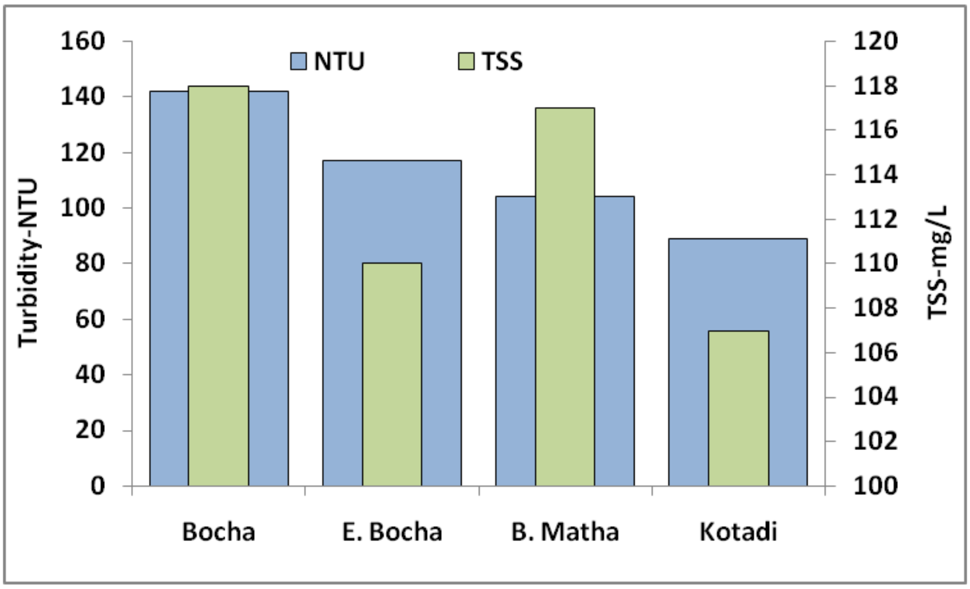


Fig. 2.8 Turbidity (NTU) and TSS in the study stations

Total Suspended Solids

Total suspended solids in seawater originate either from autochthonous (biological) or allochthomous (derived from terrestrial matter) sources. Similar to turbidity, TSS levels in water column also determines photosynthesis and in turn productivity of the water body. During the present investigation, total suspended solid levels ranged from 107 to 118 mg/l with an average value of 113 mg/l (Fig. 2.8). The maximum total suspended solid level (118 mg/l) was recorded at Bocha and minimum (107 mg/l) was at Kotadi.

2.5 Sediment Quality

Sediment Salinity

Sediment salinity of the present study varied from 47ppt to 51 ppt with an average value of 48.75ppt(Fig. 2.9). The maximum salinity of 51 ppt was recorded at Baradimatha followed by East of Bocha(49ppt), Kotadi (48 ppt) and Bocha (47ppt).

pH

Sediment pH in the sampling locations of the four mangrove stands did not vary much and it was 6.8 at Baradimatha and 6.9 in the rest of the three stations (Fig 2.9).

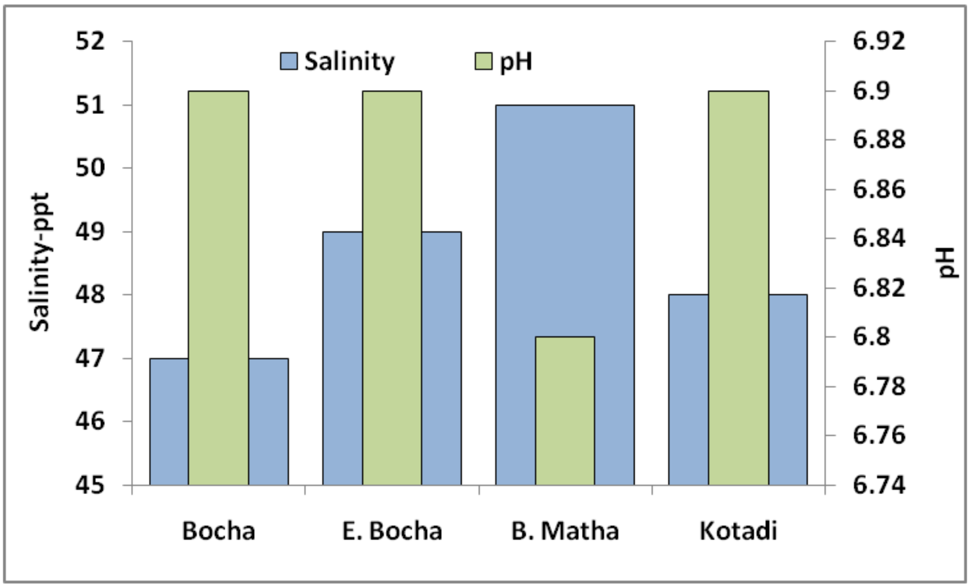


Fig. 2.9 Sediment Sanity and pH concentration of the study stations

Total Organic Carbon

The total organic carbon of the present study ranged between 0.45% to 1.5% with a mean value of 1.06% (Fig. 2.10). Higher TOC value was recorded at east of Bocha(1.5%) followed by Baradimatha(1.3%), Bocha (1 %) and Kotadi creek (0.45 %).

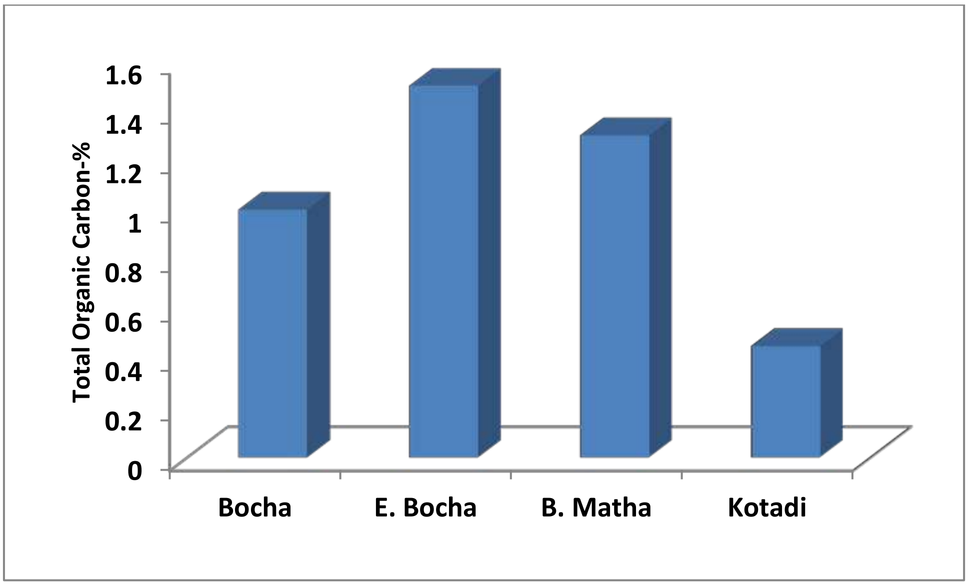


Fig. 2.10. Total Organic Carbon (TOC) in the study Sations

Sediment Texture

Sediment texture of the present study varied widely among stations (Fig 2.11). Sediment texture typically represents percentage composition of sand, silt and clay.

The percentage composition of sand was maximum and minimum at two locations of East Bocha (BQ 3- 68.6% and BQ 2 45.6%) with an average value of 59.5%. The silt composition was maximum in Baradimatha creek (BQ 5-32.6%) followed by Kotadi creek (BQ 8-32.3%) and minimum at Kotadi creek (BQ 9-12.6%) with a mean value of 24.25%. Percentage composition of clay varied from 8.4% to 32% with an average value of 16.24%. Higher composition of clay was recorded at East Bocha (BQ 2) and lower in BQ 7 of Kotadi creek.

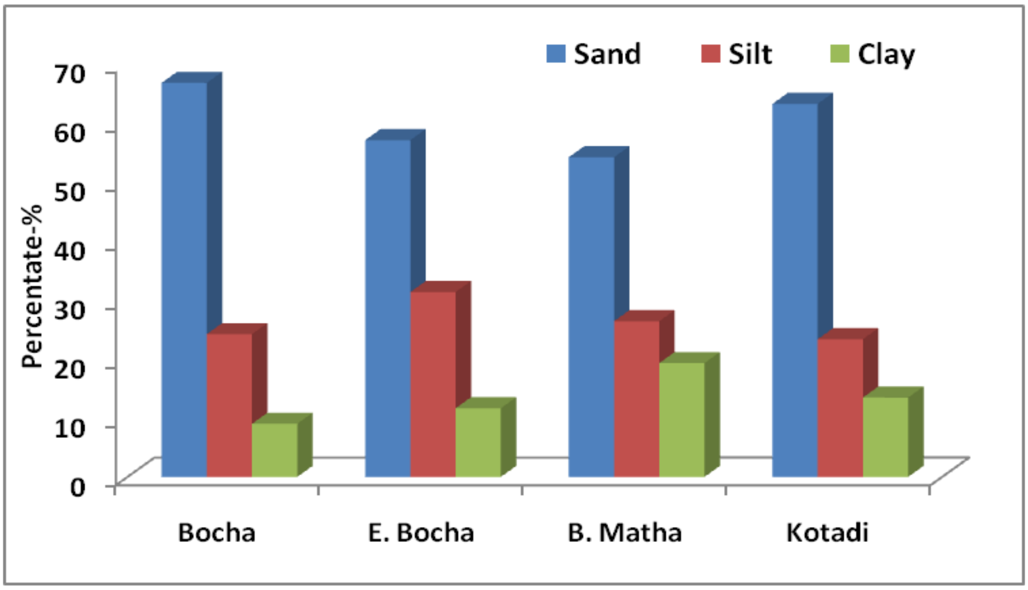


Fig. 2.11Sediment Texture in the study Sations

2.3.4 Conclusion

Analysis of mangrove health through examination of 7 creek water and 2 sediment parameters indicated most of the parameters are well within the prescribed limits for mangrove environment. Important parameters like dissolved oxygen, creek and pore water salinity either comparable with the other mangrove environment or are within the prescribed limits. However, elevated levels of salinity, suspended solids and turbidity could be observed. Higher levels of salinity is apparently due to the aridity of the zone and the resulting poor terrestrial run-off coupled with the high evapo-transpiration rates prevailing in Gulf of Kachchh waters. Suspended sediments and turbidity observed in the present study is on the higher side. Generally, suspended load (TSS) in Kachchh coast is comparatively higher than southern Gulf waters despite poor fluvial input. This is mainly due to re-suspension of sediments by tidal currents, shallow bathymetry (~60 m) and fine grained sea floor and more importantly, due to the presence of a dynamic barrier in the central gulf, preventing uniform mixing. The main source of sediments to the gulf is the Indus river discharge and its meso and micro-tidal creeks (Chauhan *et al*. 2006; Ramaswamy*et al*. 2007). Recorded values of dissolved oxygen are well within the safer limits.

3 *Land-use and Land Cover Changes*

3.1 *Introduction*

In order to understand the Land Cover pattern in the earmarked conservation zone of 1254 ha mangrove formation at Mundra during the year 2011, Remote Sensing and GIS technique has been employed. Land cover classification was carried out using digital satellite imagery acquired from NRSA, Hyderabad. Images of LISS III for Mundra area for the year 2011 for the month of February were acquired and used for this study (IRS P6 LISS-III; Pixel Resolution 23.5 m; Band-4). These were brought to UTM projection with spheroid and datum named WGS 84 in UTM zone 42 North.

3.2 *Methodology*

The Methodology employed to delineate the land use is shown below (Fig. 3.1).

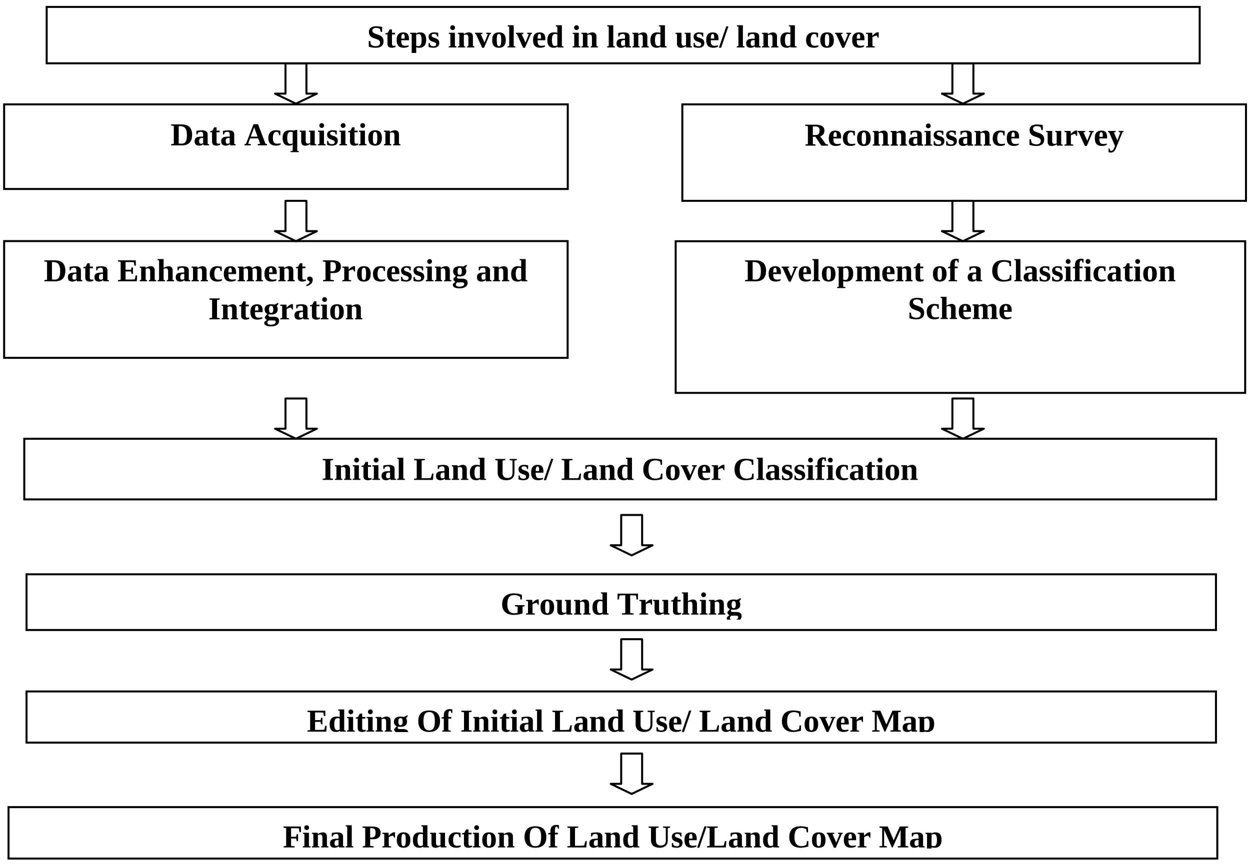


Fig. 3.1 Methodology flowchart

ERDAS Imagine 9.3 was used for satellite image processing, classification and data transformation whereas ARC GIS 9.3 was used for the map preparation. For word processing, graphs and databases, MS WORD and MS EXCEL were used.

Ground truth study comprises of data collection of ground features along with the respective geographical positions in terms of latitudes and longitudes with GPS. The data was interpreted using all the collected information.

Based on the tonal variation and pixel values in the imagery, classification of different land cover patterns including dense and sparse mangroves was generated using Maximum Likelihood supervised classification method.

3.3 *Land Cover pattern in the 1254 ha Conservation Zone during 2011*

In total, five land cover classes were delineated in the earmarked conservation zone of 1254 ha at Mundra coastal belt, *viz*., Dense Mangroves, Sparse Mangroves Mud flats, saline soil and water. Classified land cover pattern of these classes is presented in Fig 3.2 & 3.3 and their areal cover is tabulated in Table 3.1. In the earmarked area, most predominant land feature is mudflats covering 576.14 ha during 2011. Dense and sparse mangroves are about 327.14 and 312.5ha. Saline soils were about 7.58 ha and water spread was 44.73 ha (Table 3.1).

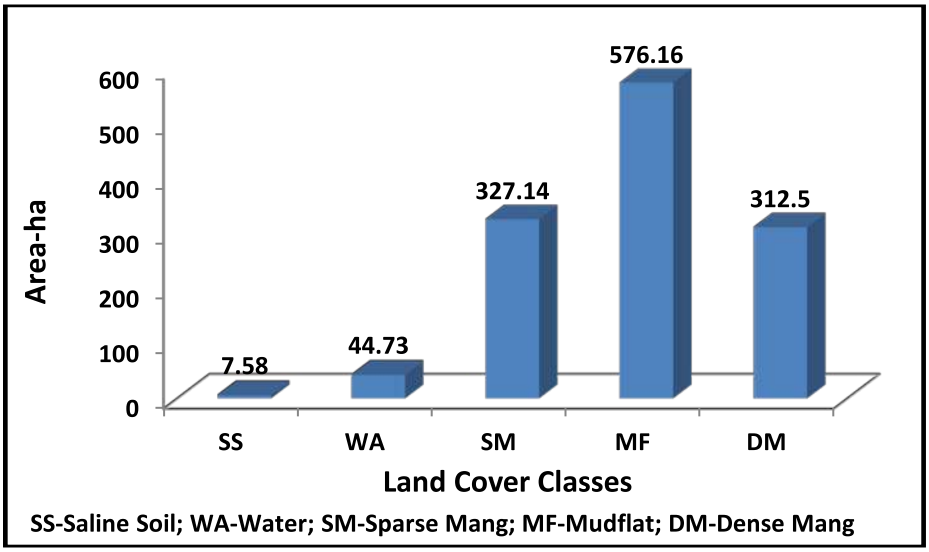


Table 3.2. Land Cover Pattern in the Conservation Zone

Land Cover Type	Area-ha
Saline soil	7.585
water	44.7345
Sparse Mangrove	327.1475
mud flat	576.16
Dense Mangrove	312.5
Total	**1268.127**

Sparse and dense mangroves together constitute about 639.64 ha forming about 51% of the total extent of 1254 ha. Mudflats (576.16 ha) forms about 45.9% proving that there is good scope for plantation activities within the conservation zone.

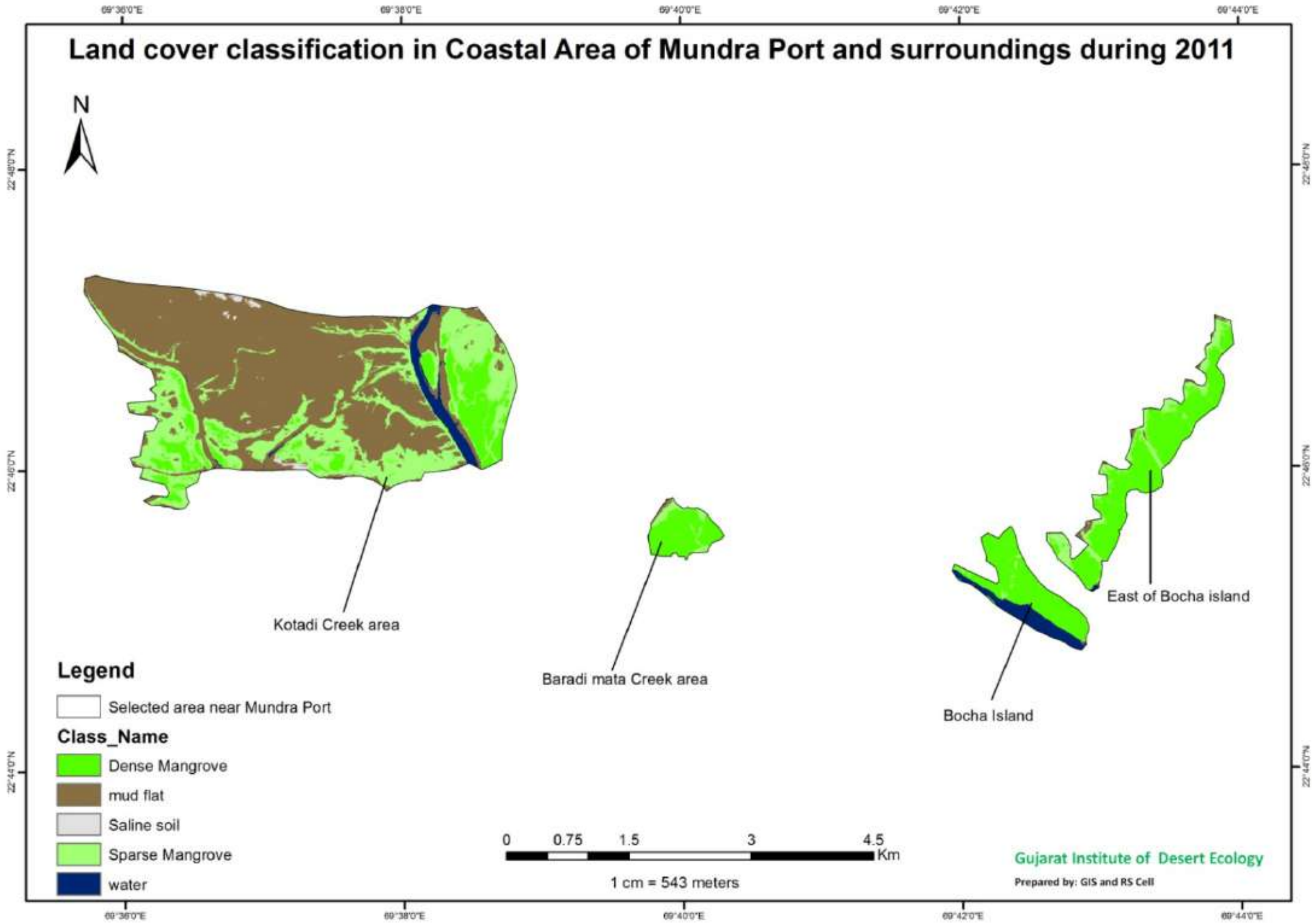


Fig. 3.3 Land Cover Scenario in the conservation zone of 1254 ha during 2011.

4 *Threats and Pressures*

4.1 *Introduction*

Mundra coast harbours a pristine mangrove ecosystem of Kachchh covering approximately 20 sq.km of mangroves. Coastal belt of Mundra is marked with extensive and rich creek systems which promote ideal condition for the extensive mangrove cover. Present study area covers the mangrove patches located in Mundra coast. Adani Port and Special Economic Zone Ltd. (APSEZ) is a major industrial cluster in the Mundra coast. The on-going activities of port and allied developmental activities like thermal power stations and auxiliary units may exert pressure on the surrounding mangroves and their habitat directly and indirectly prompting this study.

The present study aims to derive a management and conservation plan for the Mundra mangroves. Baseline data on ecological setting of mangroves and other allied biotopes gathered as a part of this study is used to analyse and identify the actual anthropogenic and natural pressures faced by these mangrove formations and formulate viable management and conservation solutions. Apart from the baseline generation, identification of natural and anthropogenic threats and pressures on the mangrove ecosystem is the basic and vital exercise required to derive management and conservation plans. In lieu of this stated background, the present chapter describes the threats and pressures in an overall and point specific manner in Mundra mangroves.

4.2 *Approach*

Basic approach for the present exercise involved identification of threats and pressures on the mangrove ecosystem, assigning cumulative threat/pressure levels for different zones and quantifying magnitude for particular threat/pressure for different locations.

4.3 *Methodology*

Following methodology was adopted for multi-faceted evaluation of threats and pressures.

i. ***Zoning of the study area:*** Considering the extent of the area, the whole Mundra mangrove formation was divided into smaller zones in order to facilitate better evaluation and understanding of the ecosystem. This kind of zoning helps to analyze the root cause of the issues and enable better understanding of the ecosystem level problems. Accordingly, Mundra coast was divided into three zones as indicated below for the purpose of this study;

   Zone 1: East of Bocha (area between Bocha and Abhan creek)

   Zone 2: Bocha Island (The Island Proper and areas in and around Adani house)

   Zone 3: Baradimata creek (Navinal creek to West Port)

   Representative study points covering all the zones were investigated on ground and documented for baseline status, prevailing pressures/threats based on direct and indirect evidences, levels and their impacts, etc. Fig. 4.1 shows the demarked zones and the sampling points in the study area.

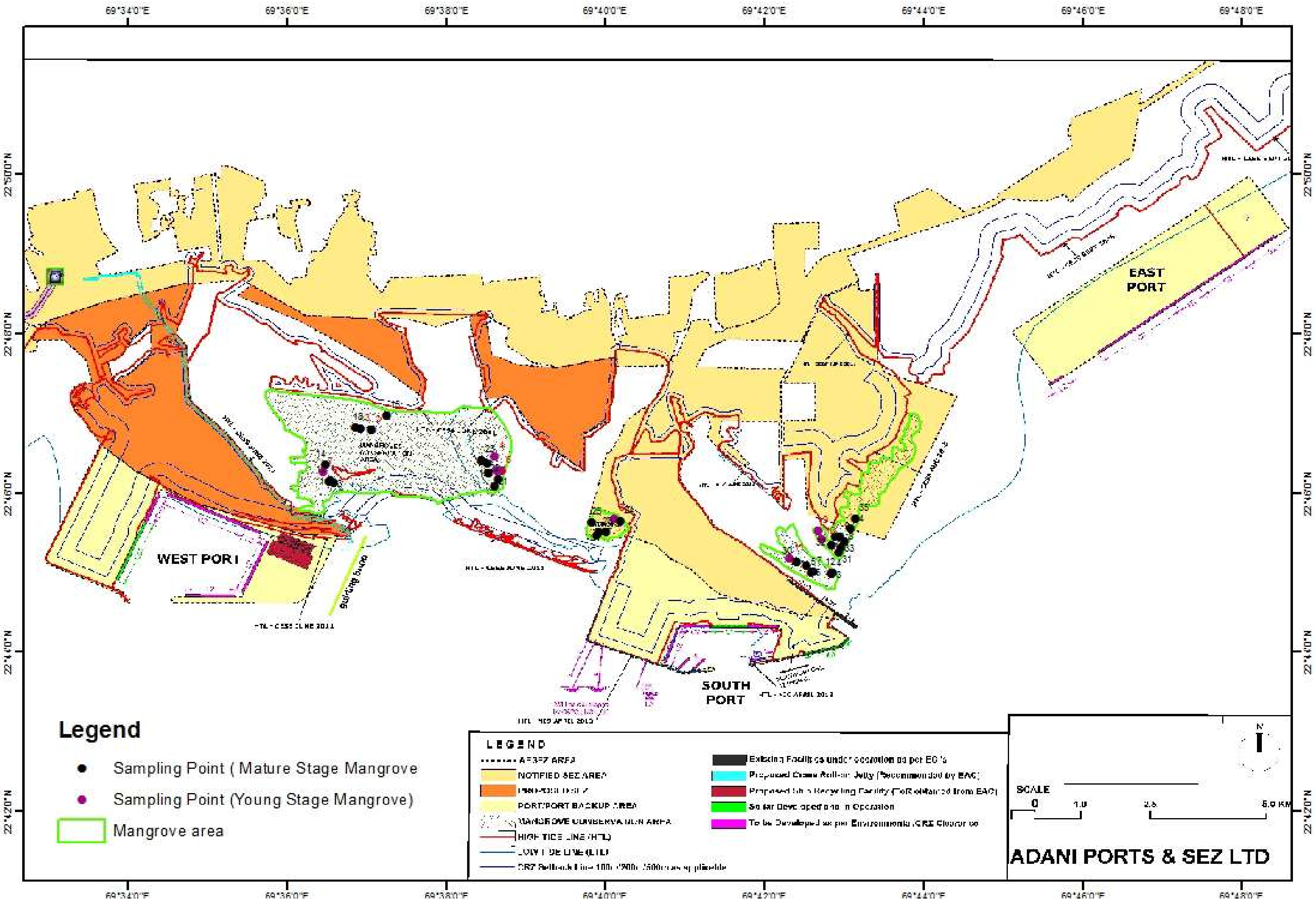


Fig. 4.1. Earmarked zones and sampling points within 1254 ha area of Study

ii. ***Identification of threats and pressures:***On ground surveys were carried out covering the entire study area. The island and creeks were reached by a fishing boat. The pressures and threats were recorded visually at different sites. The threats were categorized into two categories *viz.* Natural and Human induced. Additionally, threats observed by visiting mangrove habitats and those which could be gleaned based on the surrounding activities were recorded. The threats were derived based on ongoing the visual observation in the habitat, forest or the ecosystem. Apart from this, the possible threats which may hamper the healthiness of the ecosystem were also identified and recorded. These probable threats/pressures which may have originated from the ongoing human activities (Transport/Port operations/other SEZ activities), developmental activities, change in geomorphology, encroachment in or close to the mangrove ecosystem, pollution, dredging, local community pressure, etc. were also recorded.

iii. ***Assigning level (score) to the threat and pressures:*** For the sake of better evaluation and understanding, a modified 'Threat –Analysis method' was used. A threat-analysis is designed to assess ecosystems' current and a future response to developmental pressure (Theobald, 2003). A modified threat-analysis was applied to evaluate the pressure and threats in the study area. A simplified Threat - analysis was applied in which factors (pressures/threats) influencing the ecosystem or a species and its potential influence are scored. The score was given in two ways;

   a. *Pressure score:* A score out of 10 was given for individual pressure at every site wherein '10' indicate the maximum amount of pressure and '0' no pressure. This quantifies how much pressure a particular site faces, e.g. Cutting and loafing: Score 10.

   b. *Pressure Impact:* The severity of impact of each pressure justifies how severe the pressure is for the existing environment.

iv Quantification of pressures:Apart from assigning pressure levels and scores, some of the pressures (e.g. loafed trees, erosion, air borne particulate deposition, etc.,) were quantified in order to glean and assess the extent of severity. Some of the quantified pressures and the respective methodology adopted are as under;

c. *Cutting and loafing:* A regular quadrate method was employed wherein cut/loafed tree stems were counted per unit area.

d. *Erosion and tree felling:* Felling of healthy plants due to coastal erosion was calculated. Number of trees per unit distance (transect method) were counted and analysed.

e. *Air Borne Particulate deposition on mangrove:* Deposition of particulate (sand/coal particles) was calculated by randomly collecting mangrove leaves and weighing them pre and post cleaning.

4.4 *Result*

Threats and Pressures in general

Promoting industrial development and protecting environment simultaneously is challenging and the balance between both is usually referred to as sustainable development. Mundra mangrove ecosystem is one of the rich mangrove ecosystems of Kachchh. On the other hand, industrial development in terms of SEZ, ports, vessel movement, and other coastal industries along with the local community dependence has imposed pressure on this mangrove ecosystem. Followed by baseline data generation for the area as platform (as discussed in Chapter – 2), the second phase attempted to delineate and quantify threats and pressures for the Mundra mangroves. Following seven threats/pressures were identified as the dominant degrading factors on Mundra mangroves;

i. ***Cutting and lopping***: Lopped remnants of stems at many sites within the study area evidenced the pressure of cutting or lopping of old/healthy mangrove from the area. Discussion with the fishermen and villagers close by indicated that cutting and lopping is regularly done by fishermen from nearby coastal communities either for fuel wood or fishing purpose.

ii. ***Coastal erosion***: Coastal erosion is believed to be one of the critical threats to the healthy mangrove ecosystem. Many of the creeks and Islands showed signs of erosion that impact mangrove ecosystemresulting in uprooting of fully grown mangrove trees on the fringes of Islands. In places like the Bochacreek, a sign of erosion was observed in the intertidal areas; as a result, the shoreline has reached mangrove proper, and felling of fully mature and grown up trees.For example, Fringes of Bocha creek faces erosion that affects mangrove formation in the island. Erosion is a natural process that gets accelerated due to local geomorphology and other human activities nearby. In a recent study, Anna University, Chennai (**www.iomenvis.nic.in**) has categorized different parts of Gujarat coast as low, medium and highly vulnerable to coastal erosion. Coastal stretch of Kachchh district faces erosion at different degrees and some coastal belts are also marked as accrediting coast similar to other coastal districts of Gujarat. Mundra coast is generally considered to be vulnerable to medium erosion(http://www.gczma.org/uploads/Docs/DetailsofShorelinechanges- Gujarat State.pdf). However, at places like Bocha and Navinal, erosion and accretion was simultaneously recorded in the present study changing the coastal geomorphology.

iii. ***Substrate Nature***: It is important to ensure that habitat alteration do not take place by way of change in substrate nature due to altered suspended particle dynamics as it may pose threat in future in Navinal Island and Bocha creek mouth which will gradually impact the mangrove ecosystem in future. Generally coastal stretches exposed to high currents and wave action show this phenomenon of changed suspended particle dynamics. Hence, it is important to keep a watch on the natural process of sand accretion due to tidal currents and increased wave action as they are the primary causative factors for change in substrate nature.

iv. ***Modification in natural geomorphology***: Changes induced by human activities when persisting over a long period of time may hamper the healthiness of the ecosystem. Other than developmental activities in close vicinity impacting the present ecosystem, geomorphological processes such as siltation in the natural canals that inundates mangrove proper may lead to structural changes within mangrove forest. It is advisable to keep a watch on such physical changes in the mangrove proper.

v. ***Air Borne Particulate deposition on mangroves***: Mangrove patches close to the port is likely to undergo deposition of air borne particulates on the vegetation. This is likely due to the handling of assorted materials in the nearby port premises. Fine deposition on leaves and other parts of the vegetation may interfere with life supporting activities of the plant like photosynthesis and impedes its physiology and normal metabolic activities. If persists for long, this may affect healthy growth of plant and disturb the aesthetic value of the mangrove ecosystem.

vi. ***Plastic and non-biodegradable debris:*** Plastic and non-biodegradable debris in mangroves was seen at few places. Tidal currents carry this solid waste to the interior of mangroves where they get trapped during the receding tide. A large proportion of this solid waste also originate from local fishing activities as evidenced by materials like discarded fishing nets, plastic sheets, nylon ropes, discarded water bottles, etc.

Severity of Threats and Pressures in General

Identified threats and pressures persisting on Mundra mangroves were categorized as per their severity or impact level.

Definition of severity: Severity is defined as how influential or potentially detrimental a particular threat is in terms of its impact on the ecosystem. Levels were assigned to these different factors wherein;

Level – III: High impact on the mangrove ecosystem

Level – II: Moderately influential

Level – I: Gradual and slow influence

Extent of Pressures

Knowledge of whether the visualized pressure persists at particular point or has a broad scale influence on various mangrove patches defines the extent of the pressure. Percentage was assigned spatially based on in how much area a particular pressure is seen out of the total Mundra mangrove area.

Table 4.1. Severity and extent of pressures and threats in Mundra mangroves

S. No.	Threat/Pressure	Influence level	% extent in entire area	Recorded/Visualized impacts
1	Coastal erosion	Level - III	50%	Uprooting fully grown and old trees, loss of mangrove habitat, removal of frontline mangroves and rendering interior mangroves more vulnerable to erosion.
2	Modification in natural geomorphology	Level - III	60%	Loss of mature mangrove forests (acute and chronic), damage to mangrove regeneration (mudflats), reduced tidal flushing, and impact on adjacent mangrove patches.
3	Cutting and lopping	Level - III	60%	Acute loss of mangroves, habitat change.
4	Change of habitat (sand deposition or land amendments)	Level - II	40 %	Reduction in mudflats, gradual loss of mangroves due to plant death, direct plant removal due to amendment activity, reduction in regenerative and self-healing capacity of the ecosystem.

5	Air Borne Particulate deposition (Sand/coal)	Level - II	40 %	Hampered growth, gradual change in physico-chemical character of soil and water, decreased faunal density, declining aesthetic value
6	Plastic and non-biodegradable debris	Level - I	60 %	Covering pneumatophores, causing harm to soil and water chemistry, impact on burrowing fauna, loss of aesthetic value.
7	Grazing	Level - I	25 %	Hampered growth, stunted mangroves, stamping young classes, hardening of soil, reduced regeneration and recruitment capacity, disturbance to ground fauna, meager fringe mangroves.

It is inferred that the on-going activities along with natural processes may cause change in geomorphology at some places in future along with cutting and lopping, littered plastic and other debris and erosion. Similarly, factors such as change of habitat, particulate deposition and grazing which was visible at few places need to be taken care of. The details of the pressures, their level, their spread in the area and probable impacts on the ecosystem are described in aforementioned Table 4.1.

Threats and Pressures – Site Specific

In order to study the issue at source level and draw out a viable conclusion, identified threats and pressures were studied for each zone (i.e. site specific). This was based on the hypothesis that type and level of pressures will differ from site to site and help in deriving a suitable conservation plan for the ecosystem. With this background, the area was divided into three zones as earlier mentioned (Fig. 4.1) and each zone was elaborated individually.

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Zone I: East of Bocha (area between Bocha and Abhan creek):

The area between Bocha and Abhan creek holds some of the large and old mangroves and represents one of the healthy mangrove ecosystems of Kachchh (Fig. 4.3). Apart from *Avicennia marina*, the area has good population of another mangrove species, *Ceriopstagal.*

A noticeable patch of cut/lopped mangrove was observed (Lat. 22° 45' 20.3"E; long. 69° 43' 00.5"N) which was reported during the earlier seasonal studies. The same patch after 6 months has shown remarkable natural regeneration with an average density of 70 plants per 100m^2 quadrate. This proves that this area has high potential for natural regeneration if taken care of. Moreover, following on-going pressures and threats were noted at the site;

Fig. 4.3. Erosion and Sand Deposition in Zone-I- East of Bocha

- It was informed by APSEZL that earlier, pipeline was placed in this area for transporting the dredging material which was removed immediately in December 2010. After that APSEZL had replanted that area with mangroves and also gap filling activities are being carried out every year. (Fig. 4.4). However, the cleared approach amidst thick mangroves is used by fishermen to access large trees in the interior mangroves and regular cutting and lopping is evident on both sides of the cleared corridor. In a 10 × 10 m quadrate, 13 trees with 6 total cut and 7 lopped trees were recorded which is apparently attributable to cutting by fishermen. The remains of stems of cut plants indicate the occurrence of the individual lopping of trees might be going on in this area for quite some time.
- The same site has shown habitat change as a result of sand deposition on the mudflat as well as fringe mangroves. The gradual deposition of sand in this site (Lat. 22° 45' 20.3"E; Long. 69° 43' 00.5"N) is altering mangrove habitat nature and thereby change in faunal communities. In addition, deposition of air-borne suspended particulate matter on the vegetation is severe in this site.

Fig. 4.4 Mangrove habitat Degradation

- In this site, the intertidal stretch shows signs of erosion due to direct tidal currents which hit the shore with high velocity. The eroding beach has progressed till the mangrove proper. Intense uprooting of grown trees due to erosion has been noticed in this area.

To sum up three major factors namely erosion, cutting and air borne particulate matter (sand) deposition pose serious threats in Zone I. Quantification and magnitude of each of these threats are shown in Table 4.2.

Table 4.2. Pressure index for Zone – I

S. No.	Pressure/threat	Pressure score (out of 10)	Level
1	Cutting	07	High
2	Particulate (sand) deposition	04	Medium
3	Erosion	06	High

Zone II: Bocha Island and areas in and around Adani house:

Bocha Island forms one of the integral areas of the Mundra mangroves with dense and healthy mangrove forests with an average density of 5285 to as high as 15000 trees/ha. Finger like shape of this Island surrounded by tidal waters in all the three sides with high tidal inundation enable the mangroves to develop into a mature and healthy formation. This fully grown healthy mangrove ecosystem has three mangrove species viz. *A. marina, C. tagal*and*mucronata.* The Island extends landward on the northern side forming minor creek systems behind Adani house. This creek system is fringed by sparse mangrove forest and intermediate mangrove pockets acting as a buffer zone. This area faces variety of threats and pressures due to many natural causes.

Erosion: Erosion due to natural factors seems to play major havoc along the mangrove fringes. In addition, some human activity accelerates and supplements the natural process of erosion on the fringes of the Island. Low level of erosion was observedin and aroundBocha creek towards Navinaland also on the eastern side in Bocha creek(Fig. 4.5). Based on the present three seasonal observations, it is recommended that management action could be explored as suggested in the proceeding chapters to arrest erosion, especially in the fringes of the mangrove lined Islands.

Fig. 4.5 Erosion on the western and Northern Bocha Island

Tree cutting was also recorded from the island during this study. Signs of cut individual trees were noticed in the interior of the island with total clearance of nearly half a hectare of mangrove patch on the tip of the island (lat. 22° 44' 51.0"E; long. 69° 42' 51.1"N). This mangrove clearance at the tip has exposed the area to direct currents leading to deposition of course sand in the mangrove patch (Fig. 4.6 a & b). As a result, mangrove breathing roots (pneumatophores) are buried in the sand causing mortality of the whole tree. Presently, the process of sand deposition is progressing further and has covered adjacent mangrove mudflat with sand. Modification of the substrate nature and habitat will gradually cause loss of the mangroves and associated fauna.

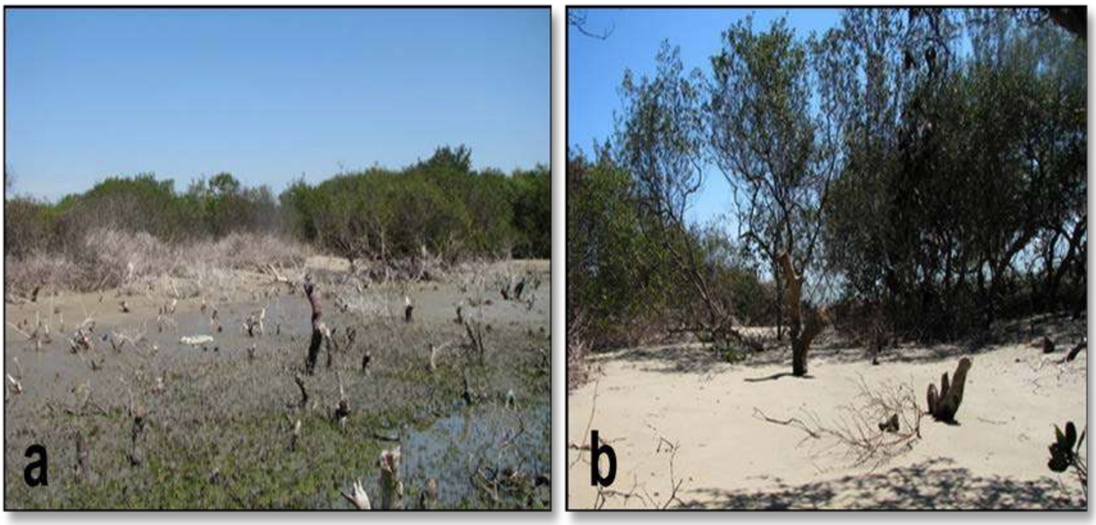

Fig. 4.6 (a) Cutting of mangrove at the tip of Bochaisland (b) Resultant sand deposition in the adjacent mangrove habitat.

Based on the above mentioned pressures recorded during the field visits, following scores can be given for the Zone – II (Table 4.3) to summarize the comments.

Table 4.3. Pressure index for Zone - II

S. No.	Pressure/threat	Pressure score (out of 10)	Level
1	Cutting and lopping	05	Medium
2	Particulate (sand) deposition	04 (overall) 06 (on western Bocha)	Medium
3	Erosion	08	High
4	Solid Waste Deposition-Plastics and other non-degradable waste	04	Medium
5	Change in natural geomorphology (behind Adani house)	06	High

<u>Zone III: Area between Navinal creek and west port (Baradimata creek and adjacent areas)</u>

This zone supports complex creek systems formed of Baradimata and Kotadi creeks. Minor islands supporting healthy mangrove formations characterize this zone. Most of the mangroves in this area are pristine since they are away from human influence. Mangrove stands, especially the thickets along the fringes of creeks in this zone are young and fully grown as compared to the mangroves of Zone I and II. The islands support fully grown mangrove forest and a maximum tree height of 7 m could be recorded in this zone. High degree of pressure and human interventions that characterize Zone I and II is absent here. Nevertheless, some on-going activities in the mangrove vicinity are likely to induce pressure in this area in future (Table 4.4).

Table 4.4. Pressure index for Zone III

S. No.	Pressure/threat	Pressure score (out of 10)	Level
1	Grazing	03	Low
2	Particulate (coal) deposition	04	Medium
3	Erosion	03	Low
5	Change in natural geomorphology (behind Adani house)	04	Low

Table 4.5 Presence of threat on Mundra mangroves and their long term impact

Pressure	Zone I	Zone II	Zone III	Long term impact
Coastal Erosion	+	+	+	Loss of mangroves, reduction in mangrove area and habitat for regeneration
Modification in natural geomorphology	+	+	-	Gradual reduction in mangrove habitat, loss of mangroves, change in faunal composition
Cutting and lopping	+	+	-	Change in canopy structure, habitat fragmentation
Change of habitat (sand deposition or land amendments)	+	+	-	Gradual death of mangrove, loss of mangrove fauna, induced succession
Particulate deposition (Sand/coal)	-	+	+	Retarded growth rate
Plastic and non-biodegradable debris	+	+	-	Change in chemical properties of soil
Grazing	+	-	-	Altered regeneration & recruitment pattern, stunted growth.

The identified threats and pressure in the study area as narrated above help to design and frame target oriented conservation measures and actions (Table 4.5). Synthesizes types of threats, their presence/absence and their long term impact on Mundra mangroves. Keeping this as a background and baseline information, the chapter discusses the actions and plans for conserving and restoring this mangrove ecosystem.

5 Conservation and Management

5.1 *Introduction*

Mangroves are major ecosystem in the coastal belt of Mundra. It is imperative to conserve this mangrove and ensure that no significant adverse impact is caused to the mangroves in the port vicinity. Meticulous and long term plan to conserve mangroves, especially in the major creek systems like Navinal, Bocha, Aban and Baradimatha is highly imperative. A mangrove conservation plan through protection, regular monitoring and massive plantation is already being implemented by APSEZ authorities and a mangrove plantation of 1215 ha have been implemented in different parts of Kachchh coast till the end of 2015. In addition to this on-going plantation, it would be ecologically sensible to conserve mangroves in the immediate port vicinity. In tune with this, the present report presents plans to conserve natural stands in the immediate port environ which needs to be given priority since established natural stands will render better ecological services than the created one. Mundra mangroves are comparatively more diverse than other Kachchh mangrove stands with the presence of additional true mangrove species such as *Rhizophoramucronata* and *Ceriopstagal,* especially in Navinal and Bharadimatha stands. Special efforts are to be taken to conserve this biodiversity.

In the light of baseline information generated and threats and pressures visualized during the present study, this chapter presents a conservation and management plan for Mundra mangrove ecosystem. This conservation plan attempts to address the pressurized areas, areas which need proper care and other specific issues.

In order to identify conservation priorities, the area was classified into Area of special attention and Areas with Regeneration potential.

5.2 *Areas of Special Attention*

It was observed that some mangrove stands are undergoing rapid degradation because of natural and human pressures like erosion, habitat change and direct wood cutting. Of all the pressures and threats identified, erosion of coastal belt and mangroves needs to be paid high priority since they threaten many pristine mangrove formations. Hence areas facing erosion are to be considered as areas of special attention. These stands demand appropriate planning, steps and actions in order to check or mitigate further damage.

5.3 *Conservation Plan for Special Attention Areas*

Erosion

Almost the whole fringes of the Bocha Island as well as part of eastern extension of Bocha are directly exposed to high tidal currents and erosion. Similarly, erosion of high magnitude has been recorded in some areas of Zone-III. This ongoing natural process is taking a heavy toll of many fully grown and healthy mangrove trees on the Island periphery. Following actions are recommended for controlling erosion and check further uprooting of mangroves.

- Initial earmarking of erosion prone sites along all the creek system.
- Since the process of erosion is highest along Bocha and east of Bocha it could be controlled only by physical means by constructing appropriate civil engineering structures. Erosion control structures or constructing embankment of stones or any suitable material along the erosion site is strongly recommended. The proposed embankment should be eco-engineering design with a gentle slope of appropriate angle to the tidal action that will allow natural flushing while totally controlling erosion.
- Since construction of stone pitching takes time, other immediate measures have to be resorted to. Trees which are felled due to erosion remain live and partially rooted for days together till they are completely washed off and uprooted. To prevent loss of such grown trees, one viable option is to replant these trees. Fringes of Bocha creek opposite to Container terminal require this measure immediately.

- Oceanographic factors that cause erosion in the immediate port vicinity need to be understood and remedial measures through physical amendments could be explored to abate this on-going natural process. Technical expertise of suitable agencies that has the expertise in civil engineering measures could be utilized.

- A rapid survey through the survey department of APSEZL could be undertaken at regular time intervals to identify coastal stretches within the port limit which are prone to high erosion. These high erosion coastal stretches could be provided with gentle slopes with stone pitching and other civil engineering works which will reduce the rate of erosion.

Cutting and Habitat Change

Individual cutting of trees and mass clearance has been recorded in areas especially in Zone–I (East of Bocha). Following conservative measures are suggested to control this.

- Proper check by appointing regular watch and ward to stop mangrove cutting by locals.

- Developmental plans should be eco-friendly assuring zero mangrove loss.

- Awareness to local community and corporate and security staff about importance of mangrove ecosystem and its conservation.

- The mangrove cleared area should be restored at priority in order to avoid fragmentation of habitats.

5.4 *Regeneration Potential Areas*

Many of mangrove patches shows gradual degradation (as per pressure scores) but simultaneously, such areas have self-healing properties. This could be seen by high regeneration rate as evidenced by appearance of new recruitments. This is quite evident in Baradimatha mangroves (Fig. 5.1). Such areas were considered as Regeneration potential areas. These are mostly found in close vicinity of creek systems which get regular tidal flushing and offer favourable conditions to grow. These habitats do not demand any special actions or amendments and instead allowing those to develop naturally assuring least disturbance or pressure on them can be the best conservation practice for such areas. Every care should be taken to preserve this area from degradation.

Fig. 5.1 shows regeneration stages of mangrove forest in Mundra area
a. Regeneration saplings grown due to seed dispersal
b. Final recruitment
c. A young mangrove forest developed

7.5 *Conservation Plan for Potential Regeneration Areas (PRA's)*

- Potential regeneration areas should be earmarked and well documented. This includes mostly Baradimatha creek and part of Navinal creek. Earmarked Potential Regeneration Areas should be protected with watch and ward.

- In such earmarked Potential Regeneration Areas, regular monitoring of the ratio among different age classes like Regeneration class (<50 cm height), Recruitment class (>50 cm but < 1 m height) and mature trees (> 1m height) will indicate status of the forest and whether it is dynamic or not. High ratio indicates healthiness of the ecosystem and better restoring capacity while low ratio can be indicative of certain pressures which may be natural or anthropogenic. Appropriate remedial measures could be contemplated based on the results. Baseline studies presently carried out indicates a high potential for regeneration in these areas.
- A close watch is required on pressures on these areas. Especially Grazing, erosion or disturbance nearby these areas can lower the natural growth.
- Since these areas show high and healthy natural regeneration, plantation in this area should be avoided so as to allow natural extension of the developing forest.
- Developmental activities in close vicinity could harm PRAs directly or indirectly. Such activities involving change in natural geomorphology can cause irregularity in tidal flushing, change in sediment composition, erosion and sediment deposition on younger classes. Hence, such areas to the maximum possible extent could be avoided for port developmental activities. In the event development becomes imperative, utmost care should be exercised to avoid any adverse impact on the natural stand.

Conservation of Bocha Island

Bocha Island (Zone – II) is one of the important mangrove stands of Mundra supporting healthy, fully grown and functional mangrove ecosystem. The area is undergoing rapid degenerative changes due to the coastal erosion causing shrinkage of the area and uprooting of mature and fully grown trees. The Island needs special care and attention since it is very close to the MICT Container terminal of Adani Port and thus highly prone to anthropogenic as well as natural threats.

Moreover, the mangrove patch at the tip of Bocha Island is facing erosion threats due to natural causes (Fig. 5.2). The process of erosion is very severe at the tip of the island which faces the open sea directly, rendering it highly susceptible to erosion. Against the advancing tidal currents and the current induced erosion, mature and fully grown mangrove trees act as physical barriers reducing the wave energy and sand deposition by waves. The clearing of mangrove patch has made the interior mangrove vulnerable to high energy waves thereby accelerated the action of erosion. Moreover, it has also caused deposition of coarse sand in the mangrove ecosystem whose substrate is otherwise muddy clay in nature. This is one area which requires immediate attention. Appropriate remedial measures are suggested in the proceeding paragraphs which need to be implemented on priority basis.

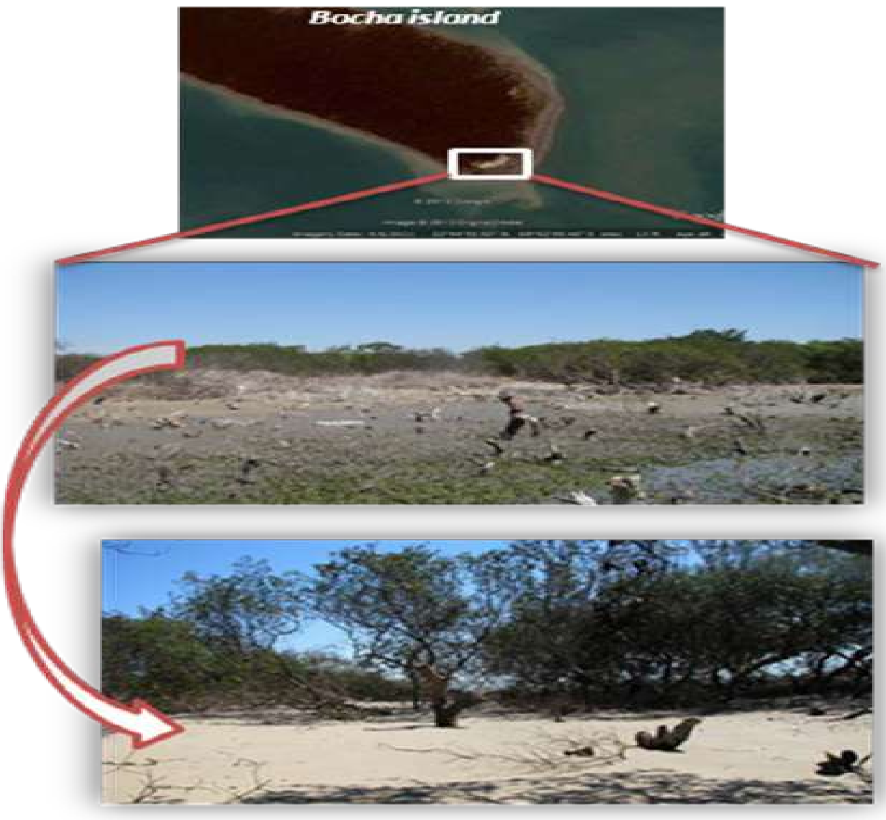

Fig. 5.2 Cleared mangroves and resultant sand deposition-Bocha Island

Restoration Measures for Bocha Mangroves

- Erosion preventive structures like stone pitching; laying multi-dimensional cement blocks(in uneven fashion) in a slope are the best alternatives to prevent erosion in the fringes of Bocha Island. Care should be taken to ensure that the structure should be an eco-engineered design to control erosion to the maximum extent. A gentle slope should be given to such structures which helps in reducing the wave energy and allow tidal flushing also. Uneven blocking will reduce the high energy waves more efficiently besides providing microhabitat to many marine organisms there by supporting and promoting intertidal biodiversity.

- *Restoration model' for Bocha Sand deposition*: The on-going sand deposition caused due to clearance of frontline mangroves needs to be checked immediately. The solution requires proper civil engineering work to restore the system and check on-going erosion and sand deposition. Restoration structure as indicated in Fig. 5.3 can be erected in which a gentle slope with unevenly designed cement blocks at the fringes will reduce the wave energy and a second line of physical barriers in the form of alternate rows of cemented poles at specific distance will partially block the sand and at the same time allows regular tidal flushing. This cement poles act as substitute to removed mangrove trees. Later, the deposited sand should be removed and the cleared patch can be restored with mangrove plantation. This Restoration model is presented below in Fig. 5.3.

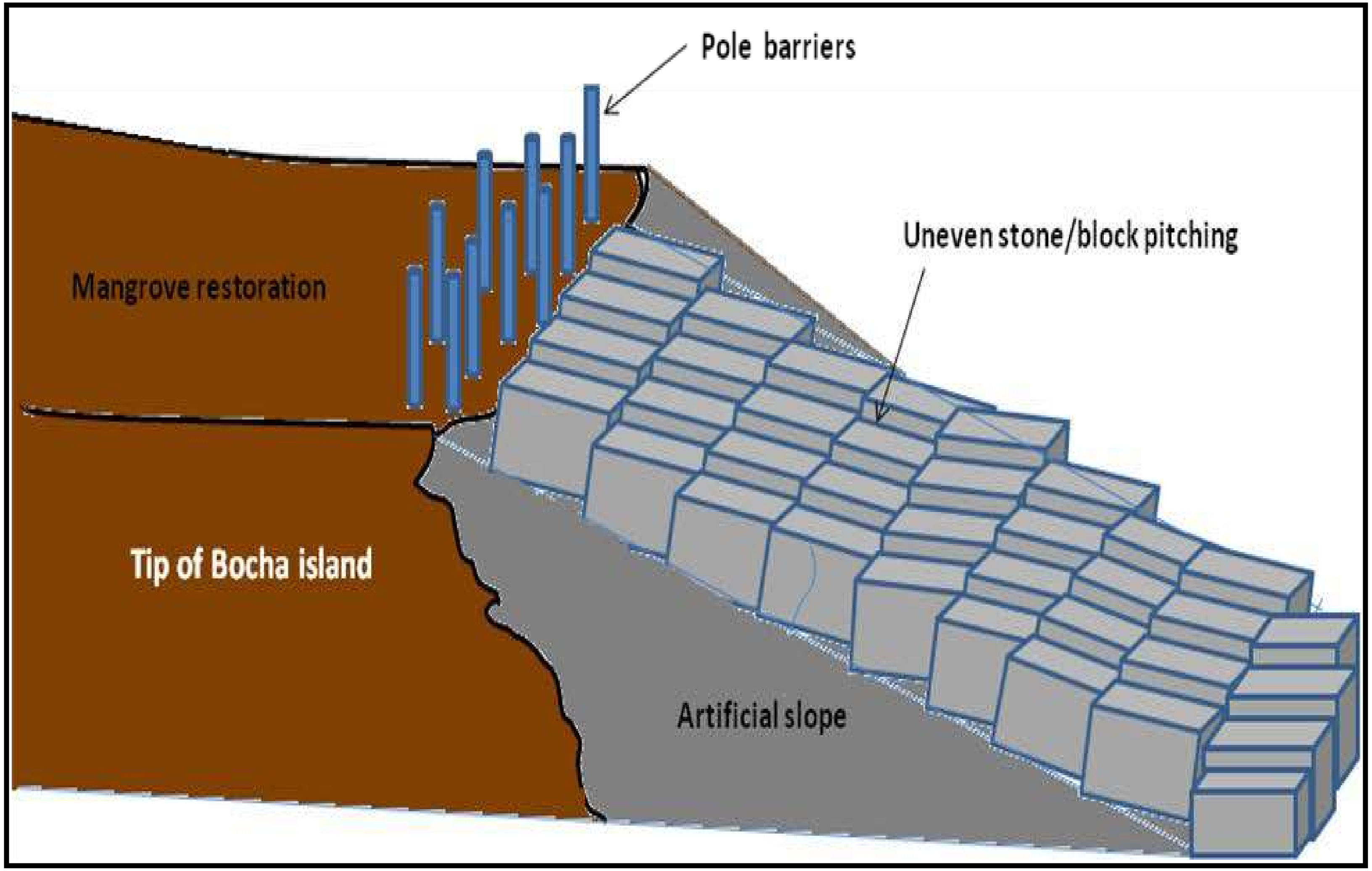

Fig. 5.3 Restoration model for Prevention of Sand deposition at southern tip of Bocha Island.

- The trees uprooted due to erosion at the fringes are still alive can be transplanted in other suitable sites within the Island. Even a moderate survival rate will fetch high environmental gain by restoring a full grown tree to the system. The *partially uprooted live trees can be replanted using soil from the nearby area or open creek once the above narrated civil structure is in place which will offer support and protection to the mangroves.*
- Plastic and other non-degradable waste from the nearby areas finally ends up in mangrove ecosystem carried in by tidal flushing. Moreover, discarded fishing nets and materials of fishermen are also strewn around in the mangrove proper. These, apart from harming the ecosystem, spoil the aesthetic value of the mangrove forest. The area should be declared waste free and measures should be implemented for proper waste disposal.

General Mundra Mangrove Conservation Plan

Apart from above discussed site specific and area specific measures, following are some of the conservative measures which can be implemented for proper conservation and management of Mundra mangroves;

- Proper documentation of Mundra mangroves in terms of Potential Regeneration areas, areas under threat and Restoration areas is required and should be monitored and updated effectively. This will prioritize the conservation and management actions.
- Erosion seems to be the major natural factor at Mundra coast threatening mangroves. Erosion prone sites should be earmarked and as earlier discussed measures can be taken depending on the level of ongoing damage. A Mundra Coast specific erosion study can be instituted focusing on impact level, root cause and mitigation methods. Though the present study has partially touched the issue, a proper

physical oceanographic study will throw more light on responsible factors.

- PRAs (Potential Regeneration Areas) should be allowed to grow naturally and plantation should not be attempted in these areas.

- In addition to mangrove plantation, a simplified restoration or rejuvenation of mangrove will render the ecosystem healthier and ecologically viable. For example, mangrove area behind Adani House (Zone –II) has good sparse mangrove cover. Yet the mangroves are stunted as compared to other areas because of improper tidal flushing. Simple soil amendment like creating more minor channels for proper tidal circulation, widening/deepening of channels will enable enhanced tidal flushing to the degraded mangroves enabling it to grow into a mature and healthy forest ecosystem. In many instances, restoration will yield better results than creating a new plantation.

- Any developmental activities or civil amendment should be well planned in such a way that it should not harm mangrove ecosystem. Specially, the change in natural habitat should not be done even in buffer zone of mangrove ecosystem.

6 *Summary*

Adani Port and SEZ is one of the fastest growing and largest private ports in the country with many allied industrial activities like thermal power plants, storage structures, Special Economic Zones, etc. The port is equipped with road, rail and air connectivity that has attracted many small and big industries to this area.

On the other hand, the area also harbours luxuriant mangrove forests in close proximity to the Port and SEZ. This economic and ecological development in this coast has made the mangrove ecosystem vulnerable necessitating immediate conservation measures.

The ministry of Forests and Environment (MoEF), New Delhi has made it mandatory that mangroves in and around the Mundra region where the APSEZL is located, be preserved through adequate measures. In accordance with this directive, APSEZL authorities engaged Gujarat Institute of Desert Ecology, Bhuj to carry out a study in Mundra mangroves and come out with conservation and management plan. Following this, a three seasonal field investigation was carried out by GUIDE in order to understand the present status of the Mundra mangroves and formulate conservation and management measures. This report presents the outcome of the study.

Three true mangrove species were recorded in Mundra region viz. *Avicenna marina, Rhizophoramucronata and Cereopstagal* with the dominance of *Avicenna marina* with an overall average mature tree density of 6372 trees/ha. Studied mangrove stands showed noticeable variation in tree height that ranged from 100 cm to 570 cm. Girth at Breast Height (GBH) ranged from 6 cm to 120 cm with mean value of 19 cm. High regeneration potential with an average density of 44666 plants/ha has been recorded. High density of younger classes in majority of the mangrove stands indicates that they are healthy and their recruitment of younger classes is normal which will ensure a good and healthy stand in future if left undisturbed. Exception to this are patches at Bocha and Kotadi Islands where ratio of mature tree to younger classes are very high indicating their climax nature.

Forty-one species of macrofaunawere recorded at the four different mangrove stands belonging to seven major groups such as Gastropods (10), bivalves (7), crustaceans (12), polychaetes (7), mudskipper (1), colenterates (2) and others (2), respectively. Crustaceans and gastropods were the dominant groups. As an indicator of stand health, recorded faunal assemblage clearly establishes that the structural complexity of the mangrove environment of Mundra is natural and no indication of stress on the ecosystem could be gleaned.

Analysis of mangrove health through examination of seven creek water and two sediment parameters indicated most of the parameters are well within the prescribed limits of Central Pollution Control Board (CPCB) for port environment. Values obtained for these parameters are either comparable with the other mangrove environment or are within the prescribed limits.

Threats and pressure acting on Mundra mangroves were investigated by zoning the study are into three major zones, which are as follows.

Zone 1: East of Bocha (area between Bocha and Abhan creek)

Zone 2: Bocha Island, (The Island Proper and areas in and around Adani house)

Zone 3: Baradimata creek (Navinal creek to West Port)

In these three zones, the following seven threats/pressures have been identified as the dominant degrading factors for Mundra mangroves;

<u>Coastal erosion</u>**:** Coastal erosion is one of the critical threats to the healthy mangrove ecosystem in Mundra coast. In Bocha and east of Bocha, heavy to moderate level of coastal erosion has been recorded. This results in falling of fully grown mangrove trees on the fringes of Islands.

Cutting and lopping: Cutting and lopping is regularly done by fishermen from nearby coastal communities either for fuel wood or fishing purpose. Few patches east of Bocha in Zone-1 showed severe cutting and looping pressures.

Habitat Alteration (sand deposition): Tidal turbulence induced habitat alteration by way of change in substrate nature caused by sand deposition in mangrove has been recorded in Navinal Island and Bocha creek mouth. This gradually degrades the mangrove ecosystem.

Modification in natural geomorphology: Activities that alter natural geomorphology of coast and change or blockage in natural flushing of tidal waters noted in many places like Bocha and east of Bocha.

Air Borne Particulate deposition on mangroves: Mangrove patches close to the port has shown visible deposition of air borne particulates on the vegetation. Fine deposition on leaves and other part of the vegetation interferes with life supporting activities of the plant and impedes its normal metabolic activities.

Plastic and non-biodegradable debris: Stranding of plastic and non-biodegradable debris in mangroves was recorded at many places. Besides, large proportion of solid waste like discarded fishing nets, plastic sheets, nylon ropes, discarded water bottles, etc. were noticed in mangrove proper.

Grazing: *E*vidence of the livestock grazing was recorded in certain patches of mangroves towards western stretches like Baradimatha creek which affects the regenerating mangroves.

Coastal erosion, modification of coastal geomorphology and deposition of plastic and non-degradable wastes received were estimated to be the major threats that scored maximum. Identified threats and pressures were studied in all the three zones. In Zone I (East of Bocha), pressures like cutting (Pressure score 07), air borne particulate deposition (pressure score 04) and coastal erosion (pressure score 06) are the major pressures recorded.

In Zone II (Bocha Island and Adani House) five major pressures/threats have been identified which include cutting and lopping (pressure score 05), particulate sand deposition (pressure score 04), erosion (pressure score 08), solid waste dumping (pressure score 04) and change in coastal geomorphology (pressure score 06).

In Zone III (Baradimatha and adjacent areas), pressures and threats were comparatively moderate and their scoring is as follows: Grazing (pressure score 03), particulate sand deposition (pressure score 04), erosion (pressure score 03) and change in coastal geomorphology (pressure score 04).

Based on the identified pressures and threats the following conservation measures have been suggested.

Almost the whole fringes of the Bocha Island and part of eastern extension of Bocha are facing erosion of high magnitude. In these sites, erosion could be controlled by constructing embankment of stones as per the given model. Oceanographic factors that cause erosion in the immediate port vicinity need to be understood. A rapid survey through the survey department of APSEZL is recommended to identify coastal stretches within the port limit that are prone to high erosion. These high erosion coastal stretches could be provided with gentle slopes with stone pitching and other civil engineering works which will reduce the rate of erosion.

Intensified watch and ward and proper inculcation of knowledge about mangrove ecosystem to port staff could control cutting and lopping in all sites. Developmental activities in close vicinity could harm potential regeneration sites like Baradimatha directly or indirectly. Such activities involving change in natural geomorphology can cause irregularity in tidal flushing, change in sediment composition, erosion and sediment deposition on younger classes. Hence, while undertaking developmental activities in such areas, care should be exercised to avoid any adverse impact on the natural mangrove stands.

Bocha Island (Zone – II), harbouring fully grown and functional mangrove ecosystem is undergoing rapid degenerative changes due to severe process of erosion at the tip of the Island. Erosion preventive structures like stone pitching; laying multi-dimensional cement blocks (in uneven fashion) in a slope are the best alternatives to prevent erosion in Bocha Island. Restoration structures with gentle slope with unevenly designed cement blocks is suggested which will reduce the wave energy and erosion.

Proper documentation of Mundra mangroves in terms of Potential Regeneration areas, areas under threat and Restoration areas is required to prioritize the conservation and management actions.

In general, erosion seems to be the major natural factor at Mundra coast threatening mangroves. Erosion prone sites should be earmarked and physical measures could be taken depending on the level of on-going damage. Mundra Coast specific erosion study can be instituted focusing on impact level, root cause and mitigation methods.

Mangroves at Potential Regeneration Areas like Baradimatha should be allowed to grow naturally and plantation should not be attempted in these areas.

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Annexure – 9

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Headquarter
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Udyog Bhavan, Sector-11
Gandhinagar 382010

Quoting: 7563

07 Nov 16

The DGM Marine Service
(Kind Attn Capt. Rahul Agarwal)
Adani Port and SEZ Ltd
Adani House, P.O. Box 1
Mundra –Kutch-Gujarat- 370421

APPROVAL OF OIL SPILL CONTINGENCY RESPONSE PLAN- APSEZ MUNDRA

Sir,

1. Kindly refer to Headquarters No.1 Coast Guard Dist (Guj) letter 711/1(i) dated 18 Oct 16 (not addressed to all).

2. The Oil Spill Contingency Plan (OSCP) in respect of M/s Adani Port & SEZ Ltd Mundra is approved.

3. It is requested that OSCP to be updated every year and the plan be revised every five years, or earlier if deemed necessary.

Regards,

(Sumit Pant)
Commandant
Regional Pollution Response Officer (AOD)
for Commander
Coast Guard Region (NW)

Copy to:-

The Director General
{for D (F&E)}
Coast Guard Headquarters
New Delhi - 110001

The Commander
No. 1 Coast Guard District (Gujarat)
Porbandar - 360575

The Commanding Officer
ICGS Mundra
Port User Building (5 B) Navinal Island
Mundra (Kutch) Gujarat 370421

भारतीय तटरक्षक अवस्थान मुंद्रा
Indian Coast Guard Station Mundra
डाक क्र. सं. Mail SL No. 3717 दिनांक Date 17 NOV 16
कमान अधिकारी CO
कार्यकारी अधिकारी EXO
अवस्थान प्र. प्र. को अधिकारी SOPO
अवस्थान तकनीकी अधिकारी STO
प्र. चिकित्सा अधिकारी PMO
स्टाफ अधिकारी SO
कार्यवाई Action by Operations
मिसिल सं

adani

Date: 04 Sep 2017

APSEZ/MARINE/CG/04

To,

The Commander
(For Regional Pollution Response Officer)
Headquarter Coast Guard Region (NW)
Gandhinagar

Sub: **Updating of Oil Spill Contingency Response Plan (Tier 1) – APSEZ, Mundra**

Dear Sir,

The Oil Spill Contingency Plan was approved vide your letter no 7563 dated 07th November 2016.

The Oil Spill Contingency Plan was updated in the month on 04th Sep 2017(copy enclosed). The details of changes incorporated are mentioned below:

Sl No	Amendment	Page No
1	Added Annexure 16- List of agency for support & guidance for rescue & rehabilitation of oiled bird & mangroves management during oil spill	92
2	Clause No 3.6- Additional Information added	45
3	Contact details of Adani Group Personnel updated	78

The above is for your kind information.

Thanking you,

Yours faithfully,
For Adani Ports and SEZ Ltd

Capt Sansar Chaube
Head– Marine Services
E Mail: Sansar.Chaube@adani.com
Mob: +91 99252 23674

CC: The Commanding Officer, Indian Coast Guard Station, Mundra

Enclosure: Oil Spill Contingency Plan

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O/C

OIL SPILL CONTINGENCY RESPONSE PLAN TIER 1

(To be used in conjuction with OSRA Vol-1 and Vol-2)

ADANI PORTS AND SPECIAL ECONOMIC ZONE LIMITED
POST BAG NO. 1
NAVINAL ISLAND
MUNDRA 370 421
PH. : (02838) 289221 / 289371
FAX : (02838) 289170 / 289270

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Section 02: Amendment Records

			AMENDMENT RECORD SHEET				
Sr. No.	**Section**	**Sub-section**	**Page No.**	**Revision No.**	**Revision Date**	**Description of Revision**	**Approved**
1.	Annex 3		75			Location of Oil Spill Equipment mentioned	Approved
2.	Annex 15		91			List of recycler approved by state of Gujarat	Approved
3.			96			Contingency Planning Compliance Checklist	Approved
4	Annex 16		92		29.08.2017	List of agency for support & guidance for rescue & rehabilitation of oiled bird & mangroves management during oil spill	Approved
5	03	3.6	45		29.08.2017	Additional information added	Approved

Section 03: Strategy

1 Introduction

- **1.1** Authorities and responsibilities
- **1.2** Coordinating committee
- **1.3** Statutory requirements
- **1.4** Mutual aid agreements
- **1.5** Geographical limits of plan
- **1.6** Interfaces with ROSDCP and NOSDCP

2 Risk assessment

- **2.1** Identification of activities and risks
- **2.2** Types of oil likely to be spilled
- **2.3** Probable fate of spilled oil
- **2.4** Development of oil spill scenarios including worst case discharge
- **2.5** Shoreline sensitivity mapping
- **2.6** Shoreline resources, priorities for protection
- **2.7** Special local considerations

3 Response strategy

- **3.1** Philosophy and objectives
- **3.2** Limiting and adverse conditions
- **3.3** Oil spill response in offshore zones
- **3.4** Oil spill response in coastal zones
- **3.5** Shoreline oil spill response
- **3.6** Storage and disposal of oil and oily waste

4 Equipment

- **4.1** Marine oil spill response equipment
- **4.2** Inspection, maintenance and testing
- **4.3** Shoreline equipment, supplies and services

5 Management

- **5.1** Crisis manager and financial authorities
- **5.2** Incident organization chart
- **5.3** Manpower availability (on-site, on call)
- **5.4** Availability of additional manpower
- **5.5** Advisors and experts – spill response, wildlife and marine environment
- **5.6** Training / safety schedules and drill / exercise programme

6 Communications

- **6.1** Incident control room and facilities
- **6.2** Field communications equipment
- **6.3** Reports, manuals, maps, charts and incident logs

Action and operations

7 **Initial procedures**

- **7.1** Notification of oil spill to concerned authorities,
- **7.2** Preliminary estimate of response tier
- **7.3** Notifying key team members and authorities
- **7.4** Manning Control Room
- **7.5** Collecting information (oil type, sea / wind forecasts, aerial surveillance, beach reports)
- **7.6** Estimating fate of slick (24, 48, 72 hours)
- **7.7** Identifying resources immediately at risk, informing parties

8 **Operations planning**

- **8.1** Assembling full response team
- **8.2** Identifying immediate response priorities
- **8.3** Mobilizing immediate response
- **8.4** Media briefing
- **8.5** Planning medium-term operations (24, 48 and 72 hour)
- **8.6** Deciding to escalate response to higher tier
- **8.7** Mobilizing or placing on standby resources required
- **8.8** Establishing field command post communications

9 **Control of operations**

- **9.1** Establishing a Management team with experts and advisors
- **9.2** Updating information (sea, wind, weather forecasts, aerial surveillance, beach reports)
- **9.3** Reviewing and planning operations
- **9.4** Obtaining additional equipment, supplies, manpower
- **9.5** Preparing daily incident log and management reports
- **9.6** Preparing operations accounting and financial reports
- **9.7** Preparing releases for public and press conferences
- **9.8** Briefing local and government officials

10 **Termination of operations**

- **10.1** Deciding final and optimal levels of beach clean-up
- **10.2** Standing down equipment, cleaning, maintaining, replacing
- **10.3** Preparing formal detailed report
- **10.4** Reviewing plans and procedures from lessons learnt

Data Directory

Maps / Charts

1. Coastal facilities, access roads, telephones, hotels etc.
2. Coastal charts, currents, tidal information (ranges and streams), prevailing winds
3. Risk locations and probable fate of oil
4. Shoreline resources for priority protection
5. Shoreline types
6. Sea zones and response strategies
7. Coastal zones and response strategies
8. Shoreline zones and clean up strategies
9. Oil and waste storage / disposal sites
10. Sensitivity Maps/ Atlas

Lists

1. **Primary Oil spill Equipment:** booms, skimmers, spray equipment, dispersant, absorbents, oil storage, Radio communications etc. (Manufacturer, type, size, location, transport, contact, delivery time, cost and conditions)
2. **Auxiliary Equipment:** Tugs and work boats, aircraft, vacuum trucks, tanks and barges, loaders and graders, plastic bags, tools, protective clothing, communication equipment etc. (Manufacturer, type, size, location, transport, contact, delivery time, cost and conditions)
3. **Support Equipment:** Aircraft, communications, catering, housing, transport, field sanitation and shelter etc. (Availability, contact, cost and conditions)
4. **Sources of Manpower:** Contractors, local authorities, caterers, security firms (Availability, numbers, skills, contact, cost and conditions)
5. **Experts and Advisors:** Environment, safety, auditing (Availability, contact, cost and conditions)
6. **Local and National Government contacts:** Name, rank and responsibility, address, telephone, fax, telex.

Data

1. Specifications of oils commonly traded
2. Wind and weather
3. Information sources

Annexures

Annexure 1 Initial Oil Spill Report

Annexure 2 POLREP Report

Annexure 3 List of resources available

Annexure 4 List of Telephone numbers of Expert and advisors

Annexure 5 Responsibilities: Marine Officer / SPM Officer

Annexure 6 Responsibilities: Marine Manager / On Scene Commander

Annexure 7 Responsibilities: SPM Pilot

Annexure 8 Responsibilities: HOD – Marine

Annexure 9 Oil Spill Progress report

Annexure 10 Emergency response Log

Annexure 11 Classification of oils

Annexure 12 Response Guidelines

Annexure 13 Site Specific Health and Safety Plan.

Annexure 14 Indian Chart 2079

Annexure 15 List of recycler approved by state of Gujarat

Annexure 16 List of agency for support & guidance for rescue & rehabilitation of oiled bird & mangroves management during oil spill

Strategy

1. Introduction

The movement of Petroleum/ Petroleum-products from the production centre in middle east to Adani Ports and SEZ Ltd and various other ports in Gulf of Kutch is handled through ships at sea and to refineries using pipe lines on ground. Like any other port, Adani Port is very much vulnerable to oil spill disaster arising due to collision, leakage or grounding of vessels in sea and damage to pipelines on ground.

This action plan prepared by Adani Ports and SEZ Ltd, Mundra is to combat the oil spill (LOS-DCP) is in accordance with the NOS-DCP, International Petroleum Industry Environmental Conservation Association (IPIECA).

1.1 Authorities and responsibilities

Adani Ports and SEZ Limited

APSEZL has responsibility for dealing with oil spillages which occur within port limit if the estimated quantity of product lost is 700 tons or less.

Should the spill migrate to other areas, the Coast Guard Monitor will assume the position of On Scene Commander and will direct the response effort. In both cases, APSEZL will act and deploy their resources as required by the relevant On Scene Commander.

This operational version of Oil Spill Contingency Response Plan for the Adani Ports and SEZ Ltd, Mundra is intended for use by all such personnel like Marine Personnel, Tug Masters and all others as indicated in the Spill Response Organization who may be involved in the response to oil spills which may occur within Adani Port Limits.

This plan has been prepared as per the stipulation of Ministry of Environment and Forest Clearance (MoEF) and Coast Guard Requirements.

Gujarat Maritime Board

While responsibility for oil spill contingency remains with conservator of the port – Gujarat Maritime Board Port Officer, this plan (Tier 1) demonstrates the readiness of Adani Port for mitigating oil spill incidents.

Port Conservator will monitor and provide the necessary assistance required for administering the oil spill operation within the port limit.

Indian Coast Guard

The Indian Coast Guard has a statutory duty to protect the maritime and other national interests of India in the Maritime Zones of India and to prevent and control marine pollution. Coast Guard is also the Central Co-coordinating Authority for marine pollution control in the country. The Indian Coast Guard is responsible for implementation and enforcement of the relevant marine pollution laws.

The National Oil Spill Disaster Contingency Plan stipulates the organizational and operational details to effectively combat a national oil spill contingency. The plan promotes the development of Regional and Local Contingency Plans in the three Coast Guard Regions.

The Coast Guard Monitor will assume the role of On Scene Commander in the event that any oil spill involving PLL operations exceeds 700 tons.

Gujarat Pollution Control Board

The Gujarat Pollution Control Board is responsible for, and control, waters up to 5 km from the shoreline. They require to be advised of all pollution incidents.

Ministry of Environment, Gujarat

The Ministry requires to be informed of all pollution incidents.

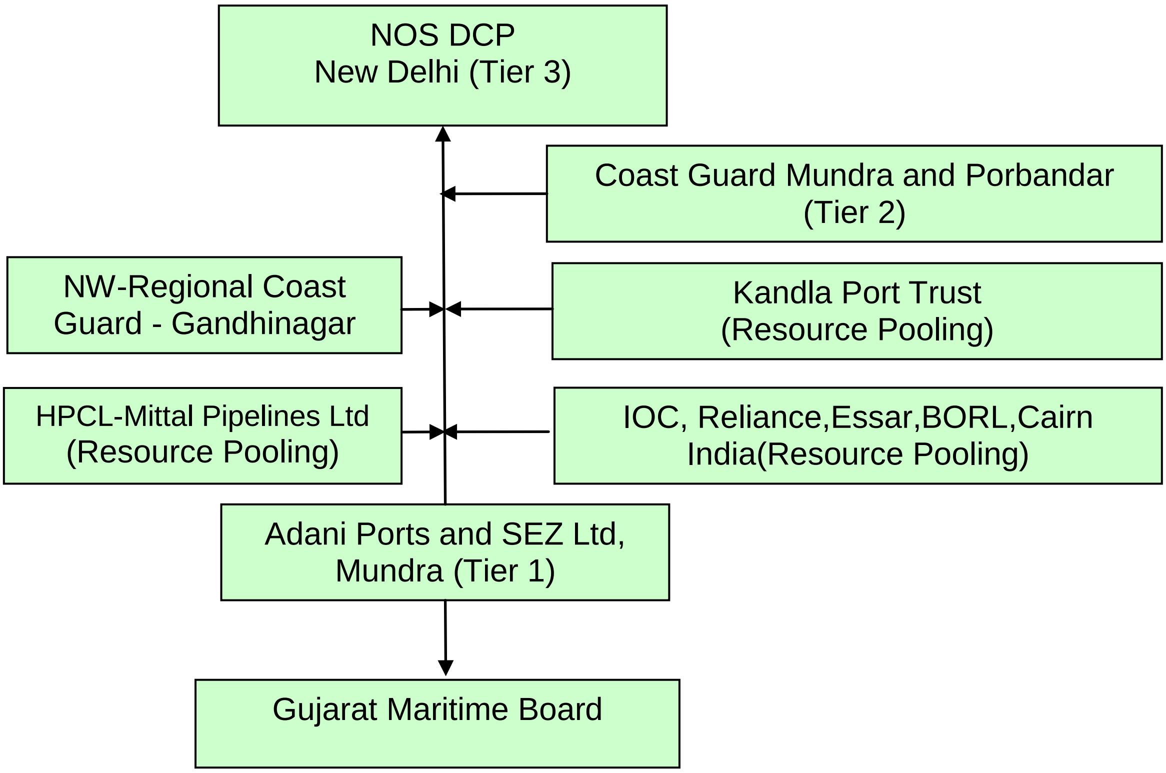
Emergency Response Team

Emergency Response Team (ERT) is the nomenclature used to describe the command and control team established for an oil spill incident at the jetty or in the jetty approaches, with representatives of organisations attending as described in section 2.4.

The ERT will convene at the Terminal Control Room, under the chairmanship of the Terminal Manager, and will consist of a Management Team and a Support Team as noted in section 2.3.

It is a strategic plan to quickly call on additional resources in a systematic manner firstly from Adani port and subsequently from other ports.

1.2 Coordinating Committee



1.3 Statutory requirements

The Indian Government is a signatory to the International Convention on Oil Pollution Preparedness, Response and Co-operation which came into force in May 94. Under the NOSDCP, it is obligatory for a port to have a Local Oil Spill Contingency Plan to combat oil spills within port limits.

This oil spill contingency response plan (Tier 1) is the response plan in accordance with the facilities available at Adani Port only.

This plan is prepared in accordance with:

a) Marine Environmental Impact Assessment of SPMs, COTs and connecting pipelines of APSEZL at Mundra dated February 2001, prepared by National Institute of Oceanography, Mumbai.

b) Report on Risk assessment study and On-site disaster management Plan for SPMs, COTs and connecting Pipelines of Adani Ports and Special Economic Zone Limited, by TATA AIG Risk Management Services Limited, dated February 2001.

c) HAZOP study report of SPM Terminal pipeline project by Intec Engineering, dated 26/02/2004.

d) IPIECA guide to Contingency planning for oil spills on water.

e) Oil spill risk assessment and contingency plan study done by M/s Environ Software Pvt. Ltd. (Copy enclosed)

1.4 Mutual aid agreements

APSEZL signed MOU with HPCL Mittal Pipelines Limited, Mundra operating in the region of Gulf of Kutch to have mutual aid agreement for the purpose of assisting each other within stipulated time frame with best combination of resources to combat and overcome any large and worst spill with the intent of maximizing the availability of the private, public and government sector response resources during oil spills where assistance is requested by another member.

As per agreement, the member agencies of the affected member state or province may directly request cascadable response resources located in oil handling agencies operating in the region of Gulf of Kutch.

1.5 Geographical limits of plan

Adani Ports and SEZ Ltd, Mundra is situated at the North head of Gulf of Kutch which is at the west coast of India. Ships calling Adani Port therefore have to traverse across the GOK. This oil spill contingency response plan (Tier 1) is applicable for the following:

1) Loading and Unloading of liquid cargo at the Multi-purpose terminal jetty at the Adani Port.

2) Unloading of the crude oil the vessels at the single point mooring (SPM) to offload 70,000 to 3,00,000 DWT.

3) Bunkering operations carried out within the port limits.

4) Any spill that occurs from any source within port limit (including West Basin, South Basin and LNG Terminal) whether at berths, anchorages or in the channel.

APSEZL falls within the area jurisdiction of The Commander, No.1 Coast Guard District (Gujarat), located at Porbandar. Mundra has a full-fledged Indian Coast Guard Station. The Port limit of APSEZL, Mundra is shown in enclosed chart in annexure 14.

1.6 Interface with ROSDCP and NOSDCP

For responding to oil spill, the Indian Coast Guard has developed the National Oil Spill Disaster Contingency Plan NOSDCP which has the approval of the Committee of Secretaries and has been in operation since 1996. The NOSDCP brings together the combined resources of the various organizations and departments, Coast Guard, Ports and Oil handling Agencies, and related industries, to provide a level of preparedness to the threat posed to the marine environment by oil spills.

The NOSDCP sets out a clear definition of the responsibilities of the major participants, such as the Coast Guard, various ministries and departments, ports and oil industry.

The national oil spill contingency plan hierarchy outlined in Figure 1 consists of NOSDCP at the apex level to coordinate significant or disaster type spills, the Regional Oil Spill Disaster Contingency plan (ROSDCP) to coordinate spill in the Gulf of Kutch, utilizing the resources available within the region.

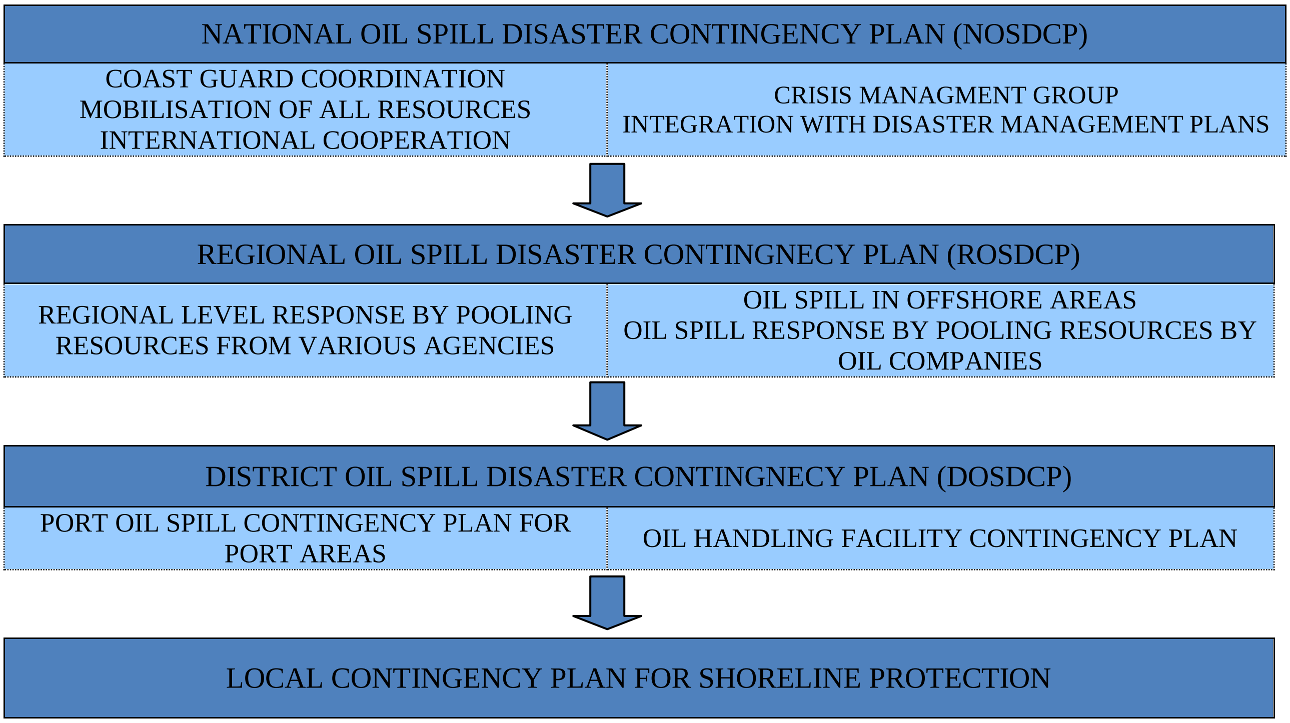


Figure 1 - Contingency Plan hierarchy

The aim of Local Contingency Plan - for the Mundra Port, is to outline arrangements for responding to oil spills in the coastal and shoreline areas, with the aim of protecting against environmental pollution as a result of oil spill or, where this is not possible, minimise the effect and respond the oil spill in an environment friendly manner and dispose the collected oil/debris in according to the existing laws/regulations/orders in force. CONTINGENCY PLAN FOR SHORELINE PROTECTION
ISTRICT OIL SPILL CONTINGN

2 Risk Assessment

The number of vessels calling annually at APSEZL is more than 3000 including Chemical and oil tankers. The threat of oil spill is much high in Gulf of Kutch and is very oil spill sensitive area. A marine national park is located in the Southern shore of GOK. There is a popular beach spot on the Northern shore namely Mandvi. Lastly, as GOK is a closed system, any oil spilled will arrive to the shores.

2.1 Identification of activities and risks

The scenario of the spill are classified under two categories :

- Oil Spill at Mundra Port Multi-Purpose Terminals
- Oil Spill at SPM

The oil spill could occur due to various reasons at any of the APSEZL's marine facilities (SPMs, Basins/ berths, anchorage or approach channel) within the new Mundra Port limit. The spills beyond these areas are not covered in this plan. Both the categories are discussed in detail

Accidental oil spill at Multipurpose terminals/ Basins/ berths, anchorage or approach channel is possible from overflow of slop tanks, bunker tanks, reception facility and road tankers (generally a low pressure operation).

Accidental oil spill at the SPM may be due to hose puncture while unloading, failure of swivel joint of SPM or Leakage of Crude Oil at PLEM or from the submarine pipeline.

Following risks are being addressed to mitigate incident of oil pollution:

- Connection of hoses with established work instructions for use of blank flanges, drip trays etc.
- Thorough understanding of use of OSD and limitations of vessel surging due to slack mooring ropes in given weather conditions.
- Monitoring of ships pump room atmosphere, display of fire notices and acknowledging accidental explosion through the use of IMO ship / shore check list.
- Spillage of F.O. during bunkering operations by using bunkering check list
- Ballast discharge contamination or malfunction of ship's sea side valves by prohibiting such operations without written permission of the port.
- Non use of reception facility of the port by ships on cost plus basis.

Operational leakage

Spill due to floating hose failure at SPM: (183 t, at pumping rate of 10000 m^3/h of crude oil for 75 sec): (Spill points - S1 at HMEL SPM & S2 at Mundra SPM)

Crude oil pumping rate from the tanker to the shore tanks will be varying between 5000 m^3/hr and 10000 m^3/hr. In the present study, the maximum pumping rate of 10000m^3/hr has been considered to assess the risk on a higher side. The Safety Break Away Coupling in the crude oil transfer hose will be activated within a few seconds in the event of hose rupture or hose failure. Again for the sake of assessing higher risk, a response time of 60 sec – 75 sec (worst case scenario) is considered to estimate the amount of oil that would spill at the SPM. Thus the quantity of crude oil spill has been estimated to be a maximum of 183 tons in the event of hose failure or rupture.

Spill due to rupture of sub-sea crude oil pipeline from SPM to shore tanks: (384 tons of crude oil, at pumping rate of 10000 m^3/hr for 60 sec): Spill point S3 taken at midpoint of the pipeline from HMEL SPM to LFP)

Crude oil pumping rate from the tanker will be in the range of 5000 m^3/hr to10000 m^3/hr. In the present study, to assess the maximum risk, pumping rate of 10000 m^3/hr has been considered. The minimum wall thickness of sub-sea crude oil pipeline is 15.6 mm and the maximum thickness is 24 mm. Moreover all along, 5 inches concrete cladding (weight coating) is provided on the surface of the pipeline. Crude oil pipelines designed, constructed and laid as per the international norms are safe and leakages are extremely rare during their designed life. However, a rupture of size 1 cm x 12.7 cm has been assumed for assessing the quantum of oil spill through sub-sea pipeline.

The maximum manifold pressure will be 12 kg/cm^2 and crude oil will be pumped to the shore tanks without any boosting device in-between. As the level in the tanker depletes, discharge pressure would also be reduced. Moreover, with the flow distance the crude oil pressure inside the pipe drops. For the sake of assessing the amount of oil spill in case of rupture of sub-sea pipeline, an average pressure of 10 kg/cm^2 and a water column height of 35 m have been considered.

Accordingly the quantity of Crude oil spill has been estimated using the formula given by

$$Q = C_d A (2gH)^{1/2}$$

Where,

Q = quantity of spill (m^3/s)

C_d = coefficient of discharge (0.9)
A = Area of rupture (m^2) (1 cm x 12.7 cm)
H = Net head (m) (6.5 kg/cm^2 = 65 m)

This would give a value of 0.04 m^3 of crude oil per sec spilling out of the pipeline through the rupture as the pump will be in operation.

The availability of solenoid operated hydraulic shutoff valves in the sub-sea pipeline, which will get activated in less than 15 seconds time as soon as the pressure falls, will limit the amount of oil leaked in case of pipe rupture and consequent drop inside the pipeline. However 60 sec response time has been considered for quantification of oil spill. Accordingly the quantity of Crude oil spill has been estimated to be 2.4 m^3 before the pump discharge valve closes. However, there will be high pressure inside the pipeline initially and the oil inside the pipeline will start leaking into the waters through the hole as the pressure inside the pipe line is higher than the outside pressure, even after the valve is closed and pumping is stopped. Even after the pipeline inside pressure equalises the outside static pressure acting on the rupture, oil continues to start leaking as the density difference between the oil and water; oil being lighter and LFP is higher in elevation compared to the pipeline elevation. Two factors need to be considered here; the specific gravity of the crude oil inside the pipeline is less than 1 whereas the sea water specific gravity is more than 1. Also depending on the location of the hole/leak, there will always be a static head of sea water acting on the leak when the oil tries to flow out and sea water trying to flow in to occupy the place vacated by the leaked oil. Hence all the oil in the pipeline will not leak and there would be an equilibrium point reached when there would be no more oil leaking from the hole as the sea water pressures effectively blocks the oil leak. Also, the leak would be attended to within the stipulated time as per the standard maintenance procedures followed by the organisation. For the purpose of this study and as a worst case scenario before the leak is repaired by the established maintenance procedures, it is assumed that a maximum of 5% of the pipeline oil volume would leak and though it would be a continuous leak, this total quantity is taken to be instantaneous for the purpose of the study.

The pipeline length is approximately 10 km (from SPM to LFP) and the pipeline size is 42" NB. The pipeline volume works out to be approximately 8662 m^3 or 7622 t.
Hence the total oil leaked due to rupture in sub-sea pipeline will be 2.15 t + 5% of pipeline volume of oil in t (0.05 x 7622 =381 t) which works out to be a maximum of 383.45 t, say 384 t of crude oil.
For the purpose of simulation studies, this spill on the pipeline is assumed to have taken place at the midway point from HMEL SPM to LFP (designated as spill point **S3** in the report) and is taken on the sub-sea pipeline from HMEL SPM to LFP. As the pipeline from HMEL SPM to LFP and the Mundra SPM to LFP run very close only one leak point in the pipeline is studied as it gives a representative oil spill study for the pipeline leakage scenario.

Spill due to collision at SPM: (Spill points S1 & S2)

Crude Oil is received at SPM by ocean tankers having capacity between 90,000-360,000 metric tons. Crude Oil is pumped to shore tanks through pipeline/s from the SPM. In the present scenario, collision of the vessel at the SPM or tanker route with another vessel enroute to other terminals can cause partial damage to the vessels cargo tanks (not more than 3 nos. of cargo tanks) leading to a maximum oil spill of about 700 tons to 25,000 tons of crude oil. In the present study, the probable quantity of crude oil spill due collision at SPM is considered as 700 tons at the minimum and as 25,000 tons at the maximum.

Spill due to collision or grounding in the tanker route: (Spill point S4)

Tankers are expected to call at the SPMs frequently depending upon the demand for the refineries for the crude oil. These tankers may meet accidents like collision with other vessels or grounding in the vicinity of the SPM. In case of such accidents, the spillage may vary depending on the size of the tanker and the extent of damage and number of cargo tanks ruptured etc. In the present study the probable quantity of spill in the tanker route considered for modelling is 25000 tons at a point which lies on the tanker route to SPM not exactly within Mundra port limit; but a spill point is taken along the tanker route in the Gulf but close to the Mundra port limit.

Spills at the berths (applicable to berths at West Basin, South Basin, East Basin, North Basin, LNG berth and existing cargo berths of Mundra port.)

Oil spills can take place at the berths in the basins during the loading / unloading as well as berthing and traversing operations. The likely spill scenarios are discussed below:

a) Spills during the navigation of the vessel along the approach channel: (Spill point S7 for West Basin)

The spill location can be anywhere in the path. One location along the approach path has been selected for carrying out for model runs.

b) Spills around the jetty (in the maneuvering basin / turning circle): (Spill point S6 for West Basin and Spill point S10 for South Basin)

This can occur due to tug boat impacting the vessel and grounding of the vessel. One location around the jetty at the turning circle has been considered for the computational runs

c) Spills at the berths: (Spill point S5 for West Basin, Spill point S9 for South Basin, Spill point S13 for East Basin, Spill point S14 for North Basin, Spill point S8 for LNG jetty, Spill point S11 for MMPT 1 and Spill point S12 for MICT / AMCT berth locations)

During the loading/unloading operations spills may take place due to one or more of the following: –

Hose/ loading arm leakage (liquid products handled at the liquid berth), overflow on the vessel deck, vessel grounding at the jetty, vessel colliding with jetty, fire and explosion on the vessel or at the jetty, during bunkering operations etc.

Spills along approach Channel / Route

Vessels to the port berths follow the Deep Water route in Gulf of Kutch and Pilot boards at Pilot Boarding Ground “A” or “B”, subject to tide and the berth allotted to the tanker.

While the risk of grounding is low, it cannot be wholly eliminated; the most likely causes are steering or propulsion system failure or navigational error, any of which could result in grounding on the channel margins. Given that the bed of the Gulf is rocky at some places the likelihood of any significant hull damage cannot be ruled out. In a general case scenario, weld fractures in the forward bunker tanks could give rise to a release of approximately 10 Tons of diesel oil and in a worst case scenario extensive damage to the bunker tanks may occur which would cause a spill of 500 to 700 t of FO spill.

Collision

The risk of collision while transiting the channel is negligible given the reason that port authorities use sophisticated ship tracking and navigational systems as the Gulf traffic has increased. These systems would ensure that the chances of any collision are remote or non-existent when ships / marine craft traverses / transits through the channel. However, even if any collision occurs, it is beyond reasonable doubt that such an incident would result in the fore part rather than the parallel mid-body of the vessel and the loss of integrity of hull plating of a cargo tank is most unlikely. A spill quantity of 700 t can be the maximum in such a scenario.

Berthing Incident

Oil and/ or liquid chemical spill can occur as a result of hull coming in contact with the corners of the jetty structure during ship berthing or un-berthing maneuvers. Such incidents are generally due to failure of a

vessel's main propulsion or steering systems, loss of control onboard on support tug in attendance or Master error or wrong judgment.

The potential spill quantities involved depend on the vessel type and the location and extent of the impact damage; hull damage to a 20000 DWT – 80000 DWT tanker / vessel in way of a forward or aft wing tank, for example, could give rise to a release of some 500 Tons of product. The potential spill quantity, should hull plating be ruptured in way of an aft wing diesel oil bunker tank can, historically, be up to 100 Tons.

Tug Impact

There are well-documented incidents where cargo or bunker oil has been released as a result of hull impact damage by tugs. This can occur when tugs are approaching a vessel underway prior to berthing, or when coming alongside a moored vessel prior to un-berthing. The potential spill quantities again depend on the location and extent of the impact damage but can be over 20 tons for Diesel oil and 100 Tons for cargo (FO) oil. Spills from this cause are considered to be of low likelihood but the risk is acknowledged.

Loading Arms / Flexible hoses

The operation of loading arms / flexible hoses can lead to minor releases of oil. Common sources are vent valves, swivel joints and hydraulic lines. Such spillage seldom exceeds 0.1 Tons.

Cargo Tank Overflow

Cargo tank overflows can occur on board loading vessels; spills of this nature can be due to instrumentation failure, tank valve mismanagement or operator error. The spill quantity is a function of the flow rate and also the number of tanks being loaded at the time of the incident. Some of the oil and/or chemical will be retained on deck but, in a worst case scenario, up to 3 tons could escape overboard.

Hull Failure

The incidence of oil pollution due to hull failure is low and some 84% of the incidents attributed to this cause by ITOPF involved spill quantities of less than 7 tons; these spills were caused mainly by minor hull fractures and weld failures. The potential for more serious incidents with spill quantities in excess of 700 tons must however is acknowledged.

Fire and Explosion

Fires and explosions on board ship represent a safety hazard with the risk of pollution as a secondary impact. Most tankers engaged for trading will be equipped with inert gas systems. Given the controls, which are imposed and enforced by APSEZL authorities in respect of the oxygen content of cargo tanks, the risk of fire and/or explosion in the cargo spaces must be regarded as minimal, insofar as cargo transfer operations are concerned.

Strict monitoring and control of the main cargo pump room atmosphere will minimize the fire and explosion risks associated with this space.

Fires resulting from uncontrolled smoking in the accommodation, unauthorized hot work such as welding, and engine room fires can spread rapidly if not dealt with swiftly and can give rise to incidents of a very serious nature.

While the likelihood of fire or explosion occurring on board vessels berthed at the Mundra port berths is low, the risk is nevertheless acknowledged. Such an incident could give rise to a spillage of 700 tons or more.

Bunkering – spillage of fuel oil

Bunkering at the port may sometimes give rise to spills due to hose failure and / or bunker tank overflow etc. in spite of the strict regulatory supervision of the port operations. These spills could be as small as a few kgs to a maximum of 500 t of FO.

As can be seen from the spill scenarios mentioned above, the spills range from extremely negligible quantities to enormous quantities in rare catastrophic events. The simulation of oil spills does not vary significantly in various scenarios except for the magnitude of impact zone and the quantity involved in such impacts. Though the software is intended to be used for specific scenarios so as to get the trajectory and other weathering information; in this study, a few hypothetical scenarios have been simulated and computations carried out considering the worst-case scenarios of oil spills at the different likely locations in the domain.
Based on the above deliberations, the following scenarios for computations have been selected for carrying out modeling studies for the oil spill trajectory and weathering processes.

Computational Scenarios:

Spill Locations	**Pre-monsoon (Jan)**	**Monsoon (July)**	**Post monsoon (Nov)**
SPM			
Crude oil spill of 183 t at the pumping rate of 10000 m^3/hr (for 75 sec release) at the SPMs (due to Hose failure) Spill points: **S1** and **S2** During spring and neap tide conditions (tide conditions : PF and PE)	▪	▪	•
Instantaneous crude oil spill of 700t at the SPMs Spill points: **S1** and **S2**	▪	▪	•
Instantaneous crude oil spill of 25000t at the SPMs -- Spill points: **S1** and **S2**	▪	▪	•
Pipeline Leakage			
Crude oil spill of 384 t at the pumping rate of 10000 m^3/hr (for 60 sec release) along the pipeline corridor at a select (midway) point of subsea pipeline in the pipeline routes. -- Spill point: **S3**	▪	▪	•
Tanker route			
Instantaneous crude oil spill of 25000t along the tanker route at select location. Spill point: **S4**	▪	▪	•

West Basin (berths)			
100 tons (due to Berthing incident/ collision) at the West Basin berths (FO) Spill point: **S5**	▪	▪	•
50 Tons (due to Berthing incident/ collision (diesel oil tanks) at the West Basin berths (HSD) Spill point: **S5**	▪	▪	•
700 Tons due to Hull Failure / Fire / Explosion (FO) at the berths -- Spill point: **S5**	▪	▪	•
In the maneuvering basin: o 20 Tons of HSD oil due to Tug Impact (HSD) o 100 Tons of FO due to Tug Impact Spill point: **S6**	▪	▪	•
Along the vessel route at one location: Instantaneous oil spill of 700t along the tanker route at a select location.(FO): Spill point: **S7**	▪	▪	•
LNG Berth			
100 tons (due to Berthing incident/ collision) at the LNG berth (FO) -- Spill point: **S8**	▪	▪	•
50 Tons (due to Berthing incident/ collision (diesel oil tanks)) at the LNG berth (HSD) – Spill point: **S8**	▪	▪	•
700 Tons due to Hull Failure / Fire / Explosion (FO) at the berth-- Spill point: **S8**	▪	▪	•
South Basin (Berths)			
100 tons (due to Berthing incident/ collision) at the South Basin berths (FO) **--** Spill point: **S9**	▪	▪	•
50 Tons (due to Berthing incident/ collision (diesel oil tanks) at the South Basin berths(HSD) – Spill point: **S9**	▪	▪	•
700 Tons due to Hull Failure / Fire / Explosion (FO) at the berth -- Spill point: **S9**	▪	▪	•
At the turning circle: o 20 Tons of HSD oil due to Tug Impact o 100 Tons of FO due to Tug Impact Spill point: **S10**	▪	▪	•
At the existing MMPT 1 Berth: **: Spill Point S11**			
100 tons (due to Berthing incident/ collision) at the berth(FO) -- Spill point: **S11**	▪	▪	•
50 Tons (due to Berthing incident/ collision (diesel oil tanks)) at the berth (HSD) – Spill point: **S11**	▪	▪	•
700 Tons due to Hull Failure / Fire / Explosion (FO) at the berth	▪	▪	•

At the existing MICT / AMCT Berths: **: Spill point S12**			
100 tons (due to Berthing incident/ collision) at the (FO) - Spill point **S12**	▪	▪	•
700 Tons due to Hull Failure / Fire / Explosion (FO) at the berth - Spill point **S12**	▪	▪	•
At the East Basin: **Spill point S13**			
100 tons (due to Berthing incident/ collision) at the East Basin berth (FO) - Spill point **S13**	▪	▪	•
At the North Basin: **Spill point S14**			
100 tons (due to Berthing incident/ collision) at the North Basin berth (FO) - Spill point **S14**	▪	▪	•

2.2 Types of oil likely to be spilled

Mundra Port mainly deals with Vegetable oils, Furnace oil, Naphtha, Methanol, High Speed Diesel, Super Kerosene Oil and other light oils at its Multi-Purpose terminal. The vessels calling at the port (or the designated anchorage areas) may spill fuel, diesel or a minimal quantity of lubricating oils. The SPM is being used to discharge crude oils from tankers.

At Berths:

- Vegetable oils,
- Furnace oil,
- Naphtha,
- Methanol,
- High Speed Diesel,
- Super Kerosene Oil,
- Carbon Black Feed Stock (CBFS),
- Motor Spirit,
- Other light oils

At SPM:

- Crude oil

At anchorages or within port limits:

- Fuel oil,
- Diesel oil,
- Minimal quantity of lubricating oil.

2.3 Probable fate of spilled oil

APSEZL is all weather, commercial port with geographical and hydrological advantages on the West Coast of India, in the Gulf of Kutch. Tidal range is between +0.37 m during Neaps and + 6.40 m during springs. Tidal streams flow $070^0 – 250^0$ at an average rate of 3 kts and 4-5 kts during spring tides.

It has been observed from the modeling study that during pre-monsoon season, the spills occurring at the APSEZL marine facilities move towards the southern / southwestern part of the Gulf of Kutch nearer to the facilities depending on tide phase.

The spills taking place at the APSEZL marine facilities move towards northern coast of Gulf of Kutch during monsoon season and affect the coast near Mundra, Kandla etc.
During post - monsoon season, the spills taking place at the APSEZL marine facilities move towards south / southwest and affect the islands /coast on southern side of the Gulf of Kutch.

The surface or subsurface oil spill consists of slick floating on the water surface, which partially dissolves in the water and partially evaporates into the atmosphere. There is a continuous exchange between the suspended and surface oil (floating oil). The assumption made in deriving the governing equations is that the thickness of the oil layer is negligible in comparison with the water depth.

In addition to the location, size and physico-chemical properties of the spill, other major factors affect the fate of the oil slick are governed by complex interrelated transport (turbulence) and weathering processes (evaporation, emulsification and dissolution). The spilled oil spreads and moves by the forces of winds and currents. A small portion of hydrocarbons begin to go into solution in the underlying water column, but most of the oil is lost through evaporation into the atmosphere. In the present model, all these processes are considered in the transport of Oil Slick.

Out of the above mentioned oils the vegetable or light oils do not pose any significant threat to the environment.

The spilled 'persistent' crude oil (or fuel oil) undergoes a number of physical and chemical changes known as "weathering". The major weathering processes are spreading, evaporation, dispersion, emulsification, dissolution, oxidation sedimentation and biodegradation.

> *The term persistent is used to describe those oils which, because of their chemical composition, are usually slow to dissipate naturally when spilled into the marine environment and are therefore likely to spread and require cleaning up. Non-persistent oils tend to evaporate quickly when spilled and do not require cleaning up. Neither persistence nor non-persistence is defined in the Conventions. However, under guidelines developed by the 1971 Fund, an oil is considered non-persistent if at the time of shipment at least 50% of the hydrocarbon fractions, by volume, distill at a temperature of 340ºC (645ºF), and at least 95% of the hydrocarbon fractions, by volume, distill at a temperature of 370ºC (700ºF) when tested in accordance with the American Society for Testing and Materials Method D86/78 or any subsequent revision thereof."*

a) **Spreading**: is one of the most significant processes during early stages of a spill is initially due to gravity. The oil spreads as a coherent slick and the rate is influenced by its activity. After a few hours, the slick begins to break-up and after this stage, spreading is primarily due to turbulence. Wind and wave actions also tend to fragment the slick, breaking it up into islands and windrows.

b) **Evaporation**: The rate and extent of evaporation depends primarily on the volatility of the oil. In general, oil components with a boiling point below 200 D C evaporate within 4 to 16 hours in tropical conditions. Spills of refined products such as kerosene and gasoline evaporate completely and light crude lose up to 40 % of its volume within a few hours. In contrast, heavy crude and fuel oils undergo little evaporation.

c) **Dispersion**: Waves and turbulence act on the slick to produce droplets of oil of different sizes. Small droplets remain in suspension while the larges ones rise to the surface. The rate of dispersion mainly depends on the nature of the oil and the sea state. Oils which remain fluid can spread unhindered by other weathering processes can disperse completely in moderate sea conditions within a few days. Viscous oils tend to form thick lenses on the water surface with slow tendency to disperse, which can persist for several weeks.

d) **Emulsification**: Several oils have tendency to absorb water to form water-in-oil emulsions thereby increasing the volumes of the emulsified mass by a factor of 3 to 4. The arte at which the oil is emulsified is largely a function of sea state though viscous oils absorb water slowly. In turbulent sea conditions, low viscosity oils can incorporate as high as 80 % water by volume within 2 to 3 hours.

e) **Dissolution**: The heavy components of crude oil are virtually insoluble in sea water while lighter compounds are slightly soluble. Hence levels of dissolved PHc rarely exceed 1 mg/l following a spill. Therefore, dissolution, does not make a significant contribution to the removal of oil from the sea surface.

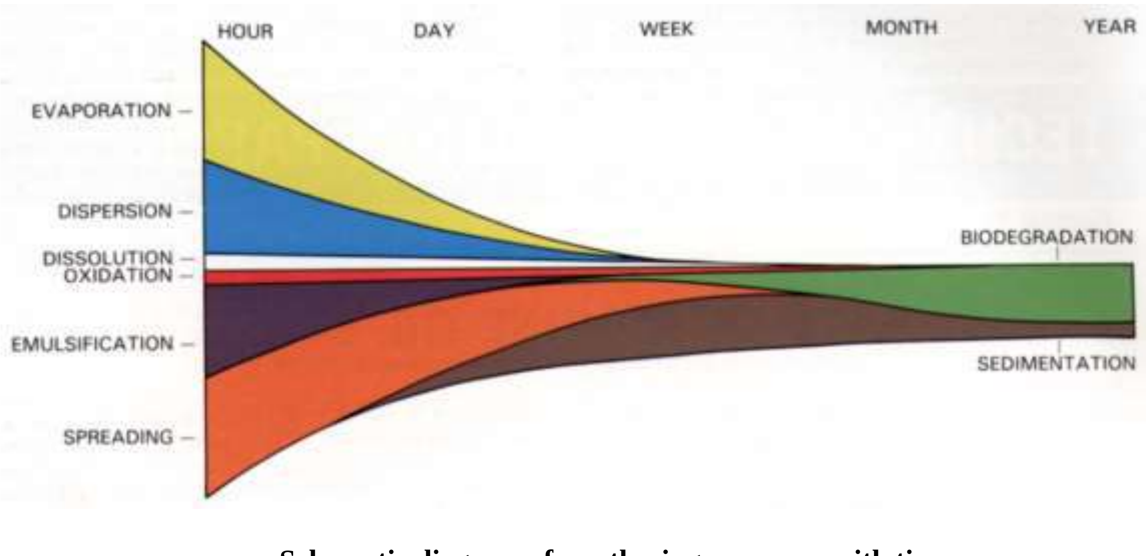
f) **Sedimentation**: Very few oils are sufficiently heavy to sink in sea water. However, the weathered residue gets mixed up with the suspended substances in water and may sink. This process becomes significant when water-in-oil emulsions attain specific gravity near to one and therefore need very little suspended substances to exceed the specific gravity of sea water (1.025).

g) **Oxidation:** Hydrocarbon molecules react with oxygen and either breaks down into soluble products or combine to form persistent tars. Many of these oxidation reactions are promoted by sunlight and their effect on overall dissipation is minor in relation to other weathering processes.

h) **Biodegradation** : Sea water contains a range of marine bacteria, moulds and yeasts which can use oil as source of carbon and energy. The main factors affecting the rate of biodegradation are temperature and the availability of oxygen and nutrient, principally compounds of nitrogen and phosphorous. Each type of micro-organism tends to degrade a specific group of hydrocarbons and whilst a range of bacteria exists between them which are capable of degrading most of the wide variety of compounds in crude oil, some components are resistant to attack.

Because the micro-organisms live in sea water, biodegradation can only take place at an oil/water interface. At sea, the creation of oil droplets, either through natural or chemical dispersion, increases the interfacial area available for biological activity and so enhances degradation.

The processes of spreading, evaporation, dispersion, emulsification and dissolution are most important during the early stages of a spill whilst oxidation, sedimentation and biodegradation are long-term processes, which determine the ultimate fate of oil. Fig.3.1 shows schematic diagram of weathering processes with time.



Schematic diagram of weathering processes with time

It should be appreciated that throughout the lifetime of an oil slick, it continues to drift on the sea surface, independent of these processes. The actual mechanism governing movement is complex but experience shows that oil drift can be predicted by taking into account wind-induced effects and surface water currents. These can be calculated using mathematical modeling to determine the oil spill trajectory. The wind-induced effect is normally taken as 1-3% of the wind velocity, and the current effect as 110% of the current velocity. Reliable prediction of slick movement is clearly dependent upon the availability of good wind, tide and current data.

An understanding of the way in which weathering processes interact is important in forecasting their combined effect in changing the characteristics of different oils and the lifetime of slicks at sea. In order to predict such interactions, numerical models have been developed, based on theoretical and empirical considerations.

Accidental oil spills as indicated in ‘Oil Spill Scenario’ in section 2.1 of this plan might occur in the area of SPM. On the basis of the data modeled, the results indicate that

a) about 38 % of hydrocarbons are lost by evaporation, 2.8 % by emulsification and 0.75 % by dissolution within 5 hours;
b) the quantum of dissolved oil increases up to initial 5 hours and thereafter decreases as lighter (more soluble) hydrocarbons evaporate;
c) after 50 hour, no oil dissolves;
d) the trend of emulsified oil is similar to that of evaporated oil but emulsification occurs at a slow rate;
e) the radius of oil slicks increases to nearly 1400 m at the end of 148 hours; and
f) the maximum PHc concentration in water is about 39 μg/l.

The spill trajectories clearly reveal the dominance of wind in deciding the location of landfall of the weathered oil. Thus during June-August, the spill will be preferentially transported in the north east direction under the influence of south west winds while during October-November, and possible up-to February, the oil will be predominantly carried to the southern shore. It is also evident that under the influence of the southwest winds, the oil will be deposited on the northern shore within 60 hours, while it might take about 80 hours to reach the southern shore during north east winds.

2.4 Development of oil spill scenarios including worst case discharge

The scenario of the spill are classified under two categories:

1. Oil Spill at Mundra Port Multi-Purpose Terminals/ Basins
2. Oil Spill at SPM

Oil Spill at Mundra Port Multi-Purpose Terminals/ Basins

a) Leak during cargo transfer operations Minor (250 liters)

   This can occur at the start of cargo operations, during operation due to leakage in pipes, expansion joints, and at the time of disconnection of hose at manifold. However, such instances are remote on implementation of International Safety Management by Ships and Quality Management systems by Port.

b) Slop tank / bunker tank overflow at, Jetty / Ship Minor (250 - 1000 ltrs.)

This source of pollution is purely of an accidental nature. The ship is expected to be ship shape with good trained crew and this has been emphasized to the Master of the vessel at the time of cargo transfer / bunkering. Based on a rate of 20 cbm/hr. and reaction time of 1 min, and hose content of 150 ltrs., likely spill is only 250 litres. A ship shore check list for cargo operations and bunkering is employed. A joint declaration is made by Marine Staff and Chief Officer / Master and enforced by Marine Manager. This results in good ship / shore co-ordination.

c) Spill during berthing (tug impact) Moderate (3000 liters)

Accidental contact with tugs or another marine structure is a possibility but quantum is not going to be significant because of Fendering system employed and training given to tug crews. Also with concept of double hull tanker the entire cargo compartments are protected by another hull, thus cargo spillage due to impact of tug is remote.

d) Grounding / Hull Damage :

APSEZL operates dry cargo & liquid cargo berths. Tankers mainly carry Furnace oil, Naphtha, Methanol, High Speed Diesel, Super Kerosene Oil and Vegetable oil. Oil transfer operations at the jetty are supervised by Liquid terminal staff. Manifold area has receptacle facilities to prevent accidental spills at connection / disconnection time. Berthing is done under controlled conditions and spill due to contact damage to underwater oil tanks is very remote. Radio officer controls movement of vessels in and around the berth and traffic presently is insignificant to pose any collision damage risk. Under water sea bed characteristic is soft sand. The berth area of about 500^2 m is surveyed monthly for any changes and underwater obstructions; hence grounding resulting into oil spill is very remote.

Oil Spill at SPM

a) Hose Puncture while unloading:

In such an event, crude oil, about 10670 Kgs may spill onto water. On spillage the oil slick will be carried away at a distant location depending upon water current and wind direction. The trained crew of the maintenance vessel patrolling the area during unloading, would control the oil slick movement by using booms and subsequently, the oil will be collected by the skimmer.

b) Failure of Swivel joint of SPM:

In this event about 17780 Kgs of crude oil may spill onto water. In this case the leakage may be detected visually by the personnel monitoring the operation from the ship tanker or by the detectors provided on the SPM.

c) Leakage of Crude oil at PLEM or from the submarine pipeline:

This case will occur at least 20 m below the water surface, oil being lighter than water will travel upward and float on to water. By the time oil water reaches the sea water surface, the oil droplets may start undergoing “weathering process” and it may form emulsion along with water.

d) Ship Collision Frequency :

Based on the statistical data and its analysis carried out by National Institute of Oceanography, the probability of this type of accident is about one in every seven years for the traffic projection and hence, this case is ignored.

e) Ship Grounding Frequency :

Based on the statistical data and its analysis carried out by National Institute of Oceanography, the probability of this type of accident is about one in eleven years for the traffic projection and hence, his case is also ignored. Also with concept of double hull tanker the entire cargo compartments are protected by another hull, thus cargo spillage due to grounding is remote.

2.5 Shoreline sensitivity mapping

Gulf of Kutch is a typical semi-enclosed basin where the tidal forces interact with the open ocean waters of the sea, across its western open boundary at Okha. The currents of the region are tidal-driven and the water column is vertically well mixed. These features make the numerical modeling task easier, as a 2-D hydrodynamic model is sufficient to accurately reproduce the tides and currents for the study region in the Gulf of Kutch at Mundra.

The model domain of longitudes of 68° 50’ 56.7” E and 70^0 27’ 36.9’’ E and the latitudes of 22°14’ 58.8” N and 23° 01’ 49.1’’ N is selected for carrying out sensitivity analysis and predicting the fate and transport of oil spill that may take place at APSEZL’s SPMs, Basins, berths and tanker route near Mundra coast in Gulf of Kutch.

The bottom roughness in the Gulf of Kutch varies due to the variation of bed sediment grain sizes. The bed consists of various sizes of clay, sand, silt and rocky soils. In the present study a uniform Manning’s roughness coefficient has been used for numerical runs of hydrodynamic processes. The filled contours of Chezy’s roughness coefficient are shown in Fig. A.1.4. The same roughness coefficient has been used to predict tides and tidal velocities in the Mundra area for prediction of oil spill trajectory.

The interpolated Chezy’s coefficient calculated based on Manning’s roughness and total water depth is shown in Fig.A1.4. The sensitivity analysis has been carried out with various Manning’s value, which is the combined effect of d_{50} sediment size and bed configuration, to calibrate the model with respect to the tide data of March and October 1994, at Sikka. The computational runs were continued with various sets of various bed roughness values till computed and measured tide levels are within the acceptable limit.

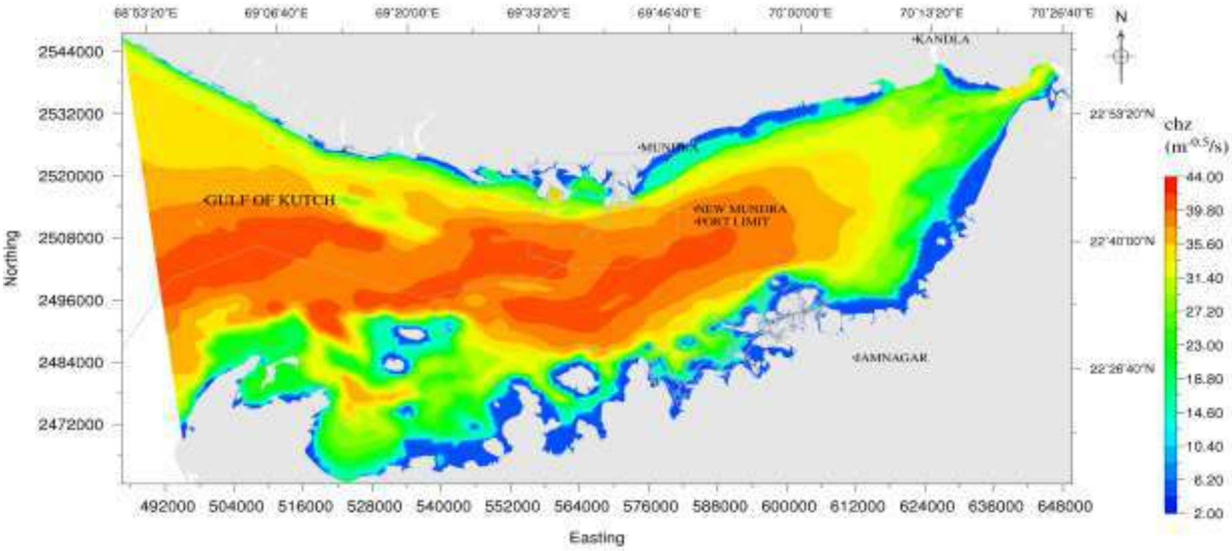


Fig.A1.4 Chezy’s coefficient

For Shoreline sensitivity mapping refer Volume 2 (Annexure-V, VI and VII) of Oil Spill Risk Assessment.

2.6 Shoreline resources, priorities for protection

The SPMs and the Marine facilities (Existing Berths, South Basin, West Basin, North Basin, East Basin and LNG Berth etc.) are located in the Northern side of Gulf of Kutch at Mundra. VLCCs bring Crude oil and unload at the two SPMs which are connected to the Shore tanks by means of Submarine pipelines. The Crude unloaded at these SPMs is pumped through Submarine pipeline to Shore tank farm area.

Various Marine craft / solid cargo/ liquid cargo vessels traverse through the Gulf waters to berth at the various Terminals / Berths located in the new Mundra port limit. The general layout of the various facilities like SPMs, terminals etc. within the Mundra port limit area are shown in Fig.1.1 to Fig.1.4 in chapter 1. There is a probability of spillage at SPMs, along the sub-sea pipelines and tanker route during unloading operations and transportation. Apart from these operations at the SPMs, loading / unloading operations at the different berths of the Mundra port – South Basin, West Basin, North Basin, East Basin, LNG jetty and existing berths also may give raise to accidental spills at the berth locations. The spills at these locations may affect the shore and other facilities along the coast of Gulf of Kutch. The coast of Mundra has tidal flats, sand bars and not much in the way of mangroves. The mangroves, Marine Park / Marine Sanctuary etc. are on the Southern side of Gulf of Kutch. As it was observed that the spills occurring at the various locations of the APSEZL Marine facilities may reach the Coast on the Northern side as well as on the Southern side of the Gulf depending upon the season, there is a need to protect the environment in the event of an oil spill at any of the APSEZL Marine facilities.

Shoreline Resources available with APSEZL, Mundra for deployment during shoreline cleanup/ emergent situation:

Item	Quantity
Oil Spill Dispersants	15000 liters
Absorbent pads	1000
Portable dispersant storage tank: 1000 ltr capacity	1 no.
Portable pumps	2 nos.
Oil discharge hose, 3”, 2 x 10 m	1 set
Rachet belt (Eco make)	10 nos.
Tool box (Eco)	6 nos.
Tanker Trucks	04 nos.
Mini Vacuum Pump (30 m3 / hr)	02 nos.
Slurry Pump (60 m3 / hr)	01 no.

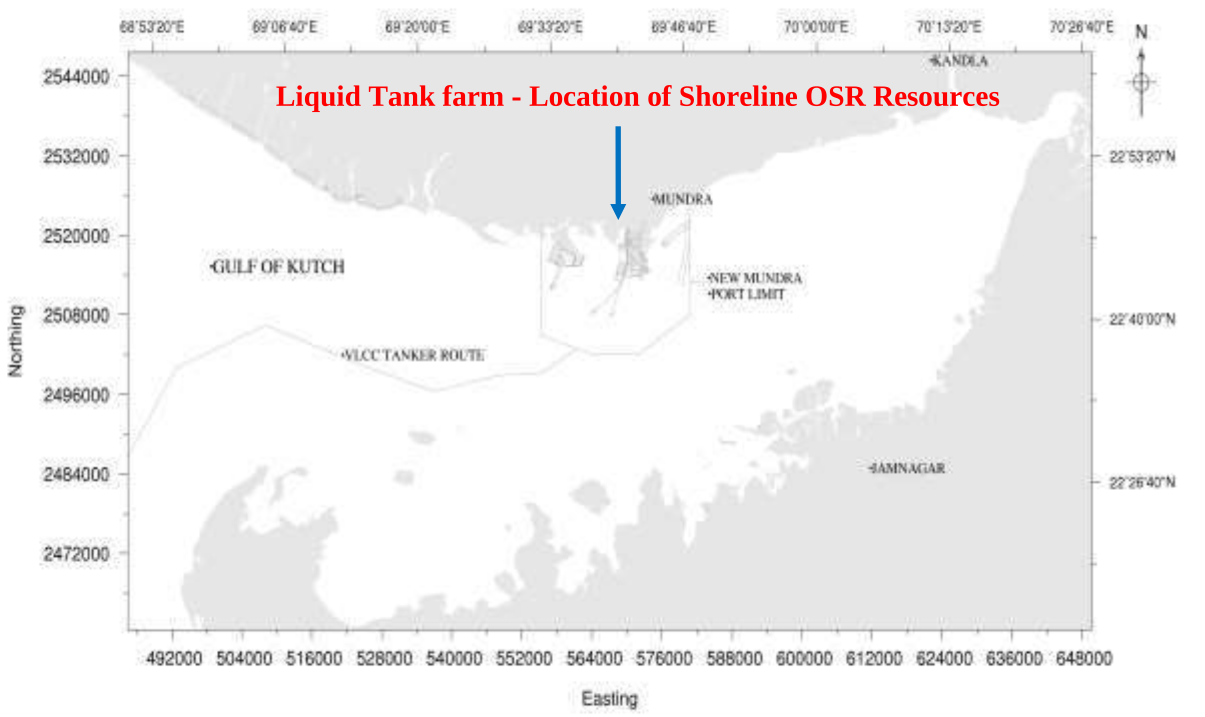


Fig.1.1 :General Arrangement of the marine facilities at Mundra port showing the VLCC route and facilities within the new Mundra port limit considered for carrying out the oil spill risk assessment studies.

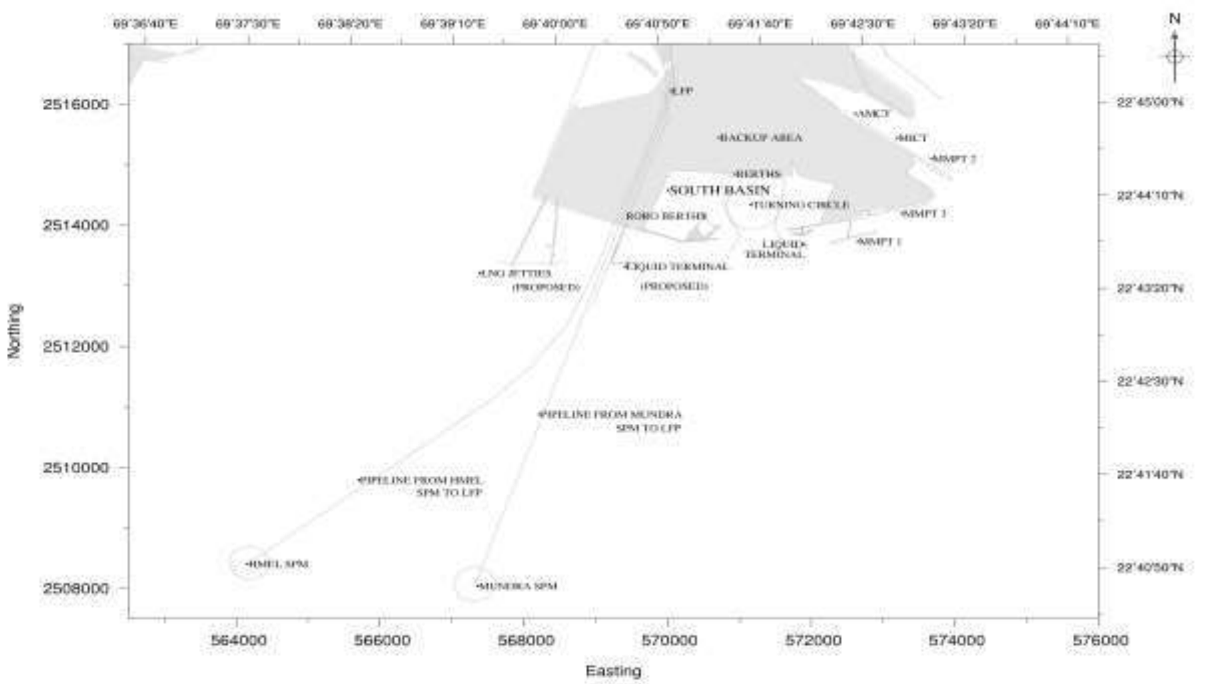


Fig1.2: Zoomed up portion of the South Basin showing the berths, turning circle, LNG jetty and existing berths as well as SPMs.

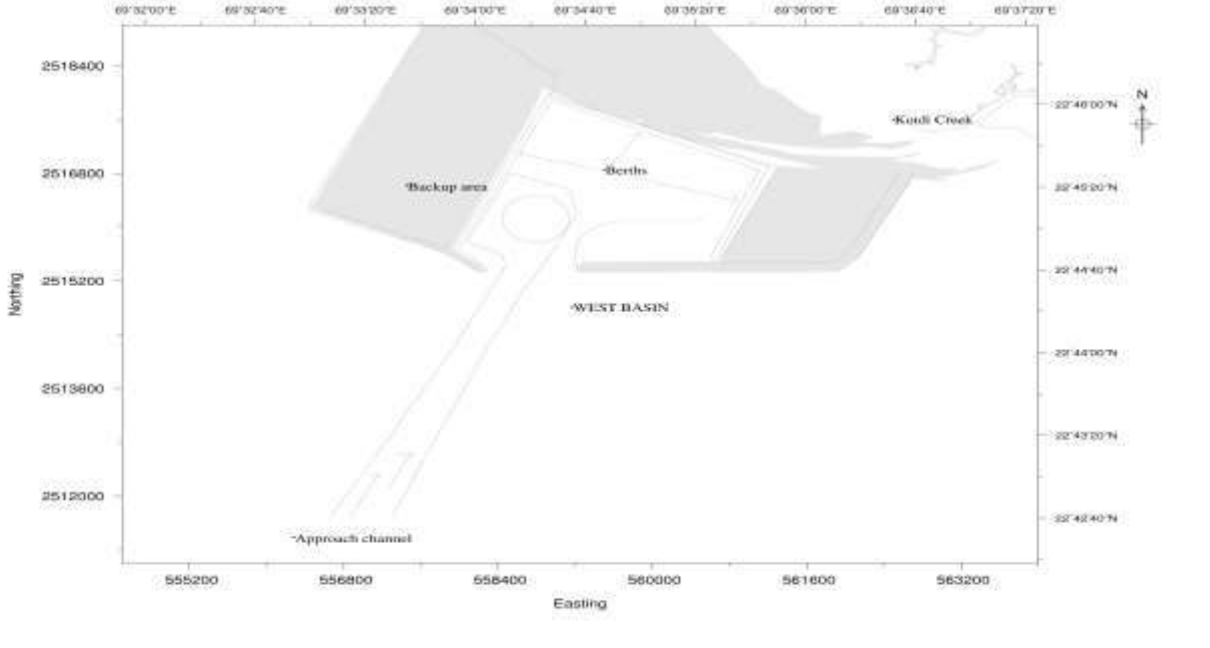


Fig.1.3 Zoomed up portion of the West Basin showing the berth locations and the approach channel for the vessels

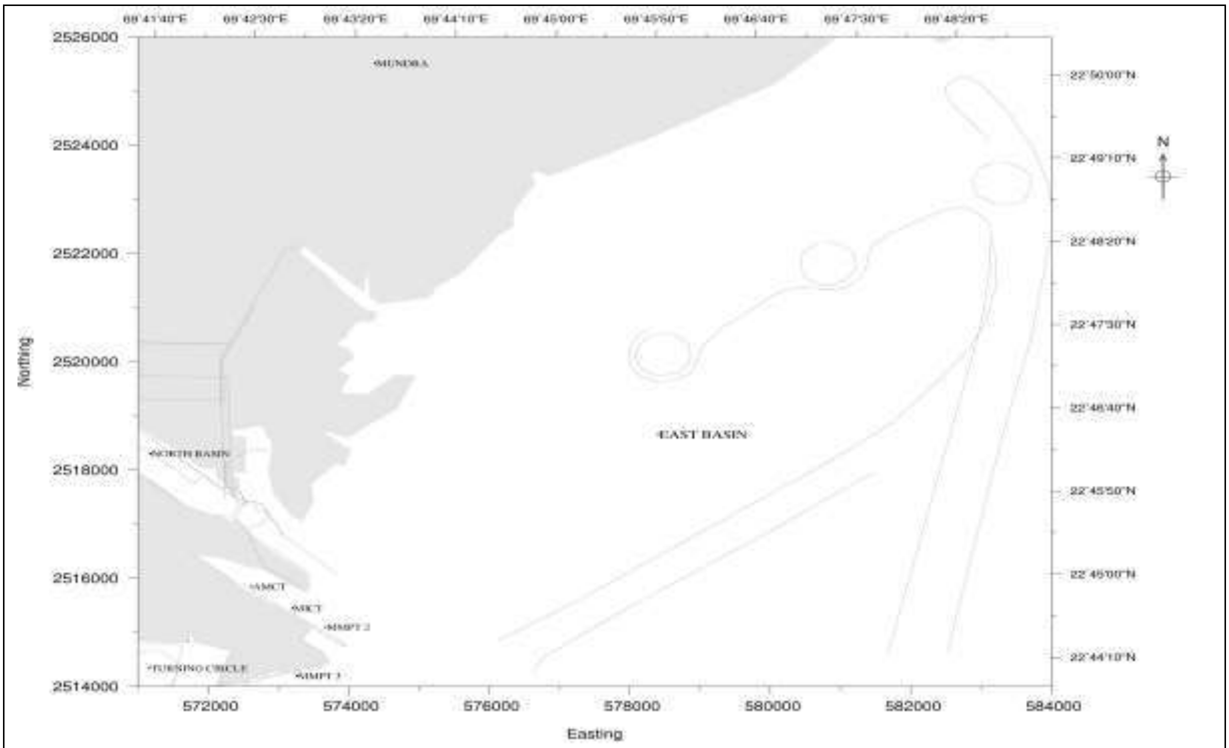


Fig.1.4 Zoomed up portion showing the East Basin & North Basin

Marine resources in Gulf of Kutch

Phytoplankton

Phytoplanktons are vast array of minute and microscopic plants passively drifting in natural waters and mostly confined to the illuminated zone. In an ecosystem these organisms constitute primary producers forming the first link in the food chain. Phytoplankton long has been used as indicators of water quality. Some species flourish in highly eutrophic waters while others are very sensitive to organic and/or chemical wastes. Some species develop noxious blooms, sometimes creating offensive tastes and odours or anoxic or toxic conditions resulting in animal death or human illness. Because of their short life cycles, plankton responds quickly to environmental changes. Hence their standing crop in terms of biomass, cell counts and species composition are more likely to indicate the quality of the water mass in which they are found. Generally, phytoplankton standing crop is studied in terms of biomass by estimating chlorophyll and primary productivity, while in terms of population by counting total number of cells and their generic composition. When under stress or at the end of their life cycle, chlorophyll in phytoplankton decomposes to phaeophytin as one of the major products.

Phytopigments

During April 2010, the phytoplankton pigments viz. chlorophyll a (1.7 – 2.4 mg/m3; av 1.9 mg/m3) and phaeophytin (0.3 – 1.2 mg/m3; av 0.7 mg/m3) varied considerably. In October 2010, chlorophyll a ranged from 2.0 – 4.2 mg/m3 (av 3.1 mg/m3) and phaeophytin from 0.7 - 1.1 mg/m3 (av 0.7 mg/m3) (Tables 8.1 and 8.2). The average concentration (mg/m3) of chlorophyll a off Vadinar during different sampling events (2010) is listed in Table 8.1:

Table 8.1: Average chlorophyll a (mg/m3) off Vadinar (April 2010 to October 2010)

Area	Pathfinder	Nearshore	ESSAR DP	IOC SPM	ESSAR SPM	Salaya Creek	Gulf
April 2010	2.4	2.1	1.9	1.4	2.0	2.0	1.7
Oct 2010	2.1	4.2	2.8	4.1	2.0	-	3.7

The values of phaeophytin during the present monitoring period are given in Tables 8.2, while, the average concentrations (mg/m3) between different sampling events (April 2010 and October 2010) are listed in Table 8.2.

Table 8.2: Average phaeophytin (mg/m^3) off Vadinar (April 2010 to October 2010)

Month	Pathfinder	Nearshore	ESSAR DP	IOC SPM	Essar SPM	Salaya Creek	Gulf
April 2010	1.2	0.6	0.8	0.3	0.6	0.8	0.6
Oct 2010	1.1	0.9	1.1	0.9	0.7	-	0.8

Phytoplankton population

As is generally the case with Coastal waters, the phytoplankton population density (68-332 nox10^3/l; av 186 no x 10^3/l) and generic diversity (11-30 no; av 18 no) varied over a wide range and in a random manner during April 2010 (Table 8.3). In October 2010 the phytoplankton population density ranged from 100-789.6 nox10^3/l (av 329.4 no x 10^3/l) and generic diversity ranged from 12-25 no (av 19 no) (Table 8.4) off Vadinar.

Table 8.3: Average phytoplankton population density (no x 10^3/l) and total genera (no) off Vadinar (April 2010 to October 2010)

Month	Pathfinder		Nearshore		ESSAR DP		IOC SPM	
	Cell count (nox10^3/l)	Total genera (no.)	Cell count (nox10^3/l)	Total genera (no.)	Cell count (nox10^3/l)	Total genera (no.)	Cell count (nox10^3/l)	Total genera (no.)
Apr-10	216.2	19	200.5	17	192.7	15	127.7	18
Oct 2010	203.1	19	446.6	20	323.6	23	360.4	18

Month	Essar SPM		Salaya Creek		Gulf	
	Cell count (nox10^3/l)	Total genera (no.)	Cell count (nox10^3/l)	Total genera (no.)	Cell count (nox10^3/l)	Total genera (no.)
Apr-10	124	16	198.5	18	211	15
Oct 2010	260	16	-	-	487.6	14

The above results indicated wide temporal and spatial fluctuations in the standing stock of phytoplankton between April 2010 and October 2010 off Vadinar. In general, the coastal waters revealed high average cell counts during October 2010 as compared to previous data. The generic diversity of phytoplankton during April 2010 widely varied with the dominance of genera such as Nitzschia (17.7%), Guinardia (16.7%), Skeletonema (9.1%), Thalassiosira (7.4%), Hemiaulus (7.2%), Navicula (6.1%), Rhizosolenia (4.5%), Biddulphia (3.4%) and Leptocylindrus (3.4%). In October 2010, the dominant phytoplankton genera were Leptocylindrus (57.6%), Guinardia (13.9%), Nitzschia (8.1%) and Chaetoceros (7.2%)

Mangroves

According to one estimate the dense mangrove cover of Narara Bet is spread over an area of 5.5 km^2. The mangrove area has increased in recent years due to extensive plantations made by the Forest Department. Mangrove cover and mudflat areas (km^2) in Jamnagar, Lalpur, Khambalia and Kalyanpur Talukas estimated based on satellite data are given in Table 8.4 below:

Table 8.4: Mangrove areas (km^2) along Jamnagar coast

Taluka	Mangroves (Dense)	Mangroves (Sparse)	Tidal mudflats
Jamnagar	12.03	23.91	83.53
Lalpur	1.96	3.95	50.50
Khambalia	3.86	11.48	101.94
Kalyanpur	0.04	0.01	0.78

*Singh H.S., 2000. Mangrove in Gujarat, GEER foundation

Mangroves at Vadinar

The intertidal expanse in the vicinity of Dargah ranged in 1 – 1.2 km. Lower intertidal zone was muddy with dense algal growth. The mid and upper intertidal zone sustained mangrove vegetation of ~ 500 m width. The zone around HTL was dominated by a sandy beach with ~ 5 m width and a narrow beam at the backshore. The distribution of mangroves at Vadinar during the present monitoring (April 2010) is given in Table 8.5 below:

Table 8.5: Distribution of mangroves at Vadinar (Dargah - North side)

	Location	Species	% FQ	Density	Height (m)	DBH (cm)	Seedling (no/m^2)
D1	22^o 26'42.6''N 69^o 42' 07.8''E	*A. marina*	100	Sep-67 -38	0.5 - 3.5	<2.6 - 6	0 - 2
D2	22^o 26' 50.5''N 69^o 41' 52.9''E	*A. marina*	40	0 - 5 -2	0.5 - 1.5	<2.5 - 4	0 - 1
Vadinar (Dargah - south side; afforested area)							
D3	22^o 26' 30.8''N 69^o 42' 05.6''E	*A. marina*	100	(20 - 75) -50	1.0 - 2.3	<1.5 - 5	0 - 15

As evident from above data, the stand density of *A.marina* at two locations (D1 and D2) along North-east of Vadinar Dargah varied from nil to 67 plants/100 m^2 with higher density of plants noticed at location D1. Frequency of occurrence ranged from 40 - 100% in the mid and upper intertidal zones. The height varied from 0.5 to 3.5 m. Mostly the plants were dwarf (av 1 m) with occasional tall plants of 3.5 m. Diameter at Breadth Height (DBH) varied from <2.5 to 6 cm. The seedling density was poor and varied from 0 - 2 no/m^2. The mid intertidal segment was the popular feeding site for flocks of flamingos.

The upper intertidal expanse along South-west of Vadinar Dargah (D3) showed good growth of afforested mangroves (Table 8.5). The density of mangroves ranged from 20 - 75 plants/100 m^2 with an average of 50 plants/100 m^2. The plant height varied from 1.0 to 2.3 m and the DBH ranged from <1.5 to 5 cm. The seedling density was low (0-15 no/m^2), however, better than that noticed along North-east of Vadinar - Dargah (D1 & D2). Present results are comparable with earlier monitoring studies (2007 - 2009).

Mangroves at Narara

The intertidal expanse along the IOCL pipeline corridor varied from 2000 - 2200 m. The mangroves vegetation from upper intertidal region was observed to be healthy, dominated by *A.marina* on both sides of the pipeline corridor. Four locations (N1 to N4) were selected for monitoring of mangroves at Narara as detailed in below given Table 7.6.

Table 8.6: Distribution of mangroves at Narara

	Location	Species	% FQ	Density	Height (m)	DBH (cm)	Seedling (no/m^2)
N1	22° 27' 56.8''N 69° 43' 43.2''E	*A.marina*	100	20-45 (38)	2-3	3-8	0-85
		C.tagal	10	0.7*	-	-	-
		R.mucronata	5	0.2*	-	-	-
N2	22° 27' 59.1''N 69° 43' 21.3''E	*A.marina*	100	60-90 (85)	2-4	25-12	0-7
N3	22° 28' 03.5''N 69° 43' 27.4''E	*A.marina* *R mucronata*	100 3	28-85 (50)	0.5-2.5 -	<15-7 -	0-55 -
N4	22° 28' 07.2''N 69° 43' 24.6''E	*A.marina*	100	30-130 (80)	0.5-3.5	<2.0-3.5	0-10

* no/500 m^2

As can be noticed in the above table, the plant density of *A.marina* varied from 20 - 130 plants/100 m^2 with a frequency of occurrence of 100% at Narara. The species like *Ceriops tagal* (7 plants/500 m^2) and *Rhizophora mucronata* (2 plants/500 m^2 - 3 plants/100 m^2) were rarely noticed. The locations N2 (85 plants/100 m^2) and N4 (80 plants/100 m^2) revealed better average density of *A.marina* as compared to the rest. The height of *A.marina* varied from 0.5 to 4 m with N2 and N4 locations indicating better plant height than the rest. The DBH varied from <1.5 to 12 cm at the monitoring locations. The seedling density ranged from 0 - 85 no/m^2 with N1 and N3 locations sustained better seedling density than the rest. Few new plants (30 - 45 cm in height) of *C.tagal* and *R.mucronata* were noticed at the EOL pipeline corridor during the present monitoring.

Sand dune vegetation

The narrow beach of ~ 5 m width around HTL along Narara Bet is marked with berm of ~ 1.5-2 m width, followed by back shore sandy zone. Occasional shrubs of *Salicornia brachiata* and *Suaeda maritima* are observed on the backshore sandy zone. The sand dune flora is more predominant on berm and immediate back shore zone of ~5 m width. Sand dune flora is represented by seven species viz; *Crassa sp, Cyperus arenarius, Launea sp, Suaeda maritima, Salicornia brachiata,* unidentified *Poaceae* member and unidentified *Fabaceae* member.

Seaweeds and Seagrasses

Seaweeds, which are known as a source of food, fodder and manure, are mostly found attached to various substrata like sandy, muddy and coralline sediments as well as rocky areas and play a significant role in enriching the sea by adding dissolved organic matter, nutrients and detritus besides serving as nursery areas for the larvae and juveniles of innumerable marine organisms. Some green Seaweeds are edible, red algae are the important source of agar and some of the brown algae are used for manufacturing algin and alginic acid. Seaweeds are also used to produce some bioactive compounds.

The algal zone of Narara Bet is confined to 1.2-2.5 km width. A total of 62 species of algae and 3 species of sea grasses are recorded from this region. Among them *Lyngbya*, *Caulerpa*, *Cladophora*, *Ulva*, *Cystoceira*, *Dictyota*, *Hydroclathrus*, *Padina*, *Sargassum*, *Acanthopora*, *Amphiroa*, *Champia*, *Centraceros*, *Gracilaria*, *Hypnea* and *Polysiphonia* were common with the dominance of *Padina* and *Gracilaria* at the lower reef flat. The open mudflats of Narara Bet are dominated by algae like *Enteromorpha*, *Ulva*, *Lyngbya* and *Polysiphonia*, while, the upper sandy shore and mangrove areas are associated with *Enteromorpha* and *Ulva*. Seagrasses such as *Halophila ovata* and *Halodule uninervis* are common in patches on sandy regions of the reef, while, *Halophila beccarii* occasionally occurred on mudflats along the tidal channels.

Open mudflats near Dargah and Narara pipeline corridor supported growth of twelve marine algae dominated by Enteromorpha spp (Table 8.7). The biomass of Enteromorpha estimated at ~ 4 kg/m2.

Table 8.7: Marine algal flora along Narara/Vadinar

Sr. No.	Species	% FO*	ES*
1	*Enteromorpha clathrata*	100	D
2	*Enteromorpha intestinalis*	100	D
3	*Caulerpa racemosa*	50	C
4	*Ulva fasciata*	100	D
5	*Ulva lactuta*	100	D
6	*Ulva reticulate*	90	D
7	*Codium elongatum*	30	O
8	*Sargassum ilicifolium*	45	C
9	*Sargassum tenerimmum*	60	CD
10	*Gracilaria corticata*	55	C
11	*Gracillaria verrucosa*	85	C
12	*Polysiphonia platycarpa*	20	O

*%FO: Percentage Frequency Occurrence, ES: Ecological Status, D: Dominant (% FO = 80-100), CD: Co-dominant (% FO = 60-79), C: Common (% FO = 40-59), O: Occasional (% FO = 20-39).

The intertidal zone of Kalubhar Tapu harbours 47 species of marine algae and three species of seagrasses. The reef areas of this island are dominated by *Dictyota*, *Gracilaria*, *Padina*, *Hydroclathrus*, *Ulva* and *Hypnea*. The open mudflats and sandy areas at the upper intertidal are preferred by *Enteromorpha*, *Ulva*, *Lyngbya* and *Polysiphonia*. The sandy region of the reef flat supported seagrasses like *Halophila* and *Halodule*.

Zooplankton

The zooplankton standing stock in terms of biomass and population density during April 2010 (Table 8.8) varied from 0.2 to 121.2 ml/100m^3 (av 3.3 ml/100m^3) and 2.2-722.7 x 10^3/100m^3 (av 39 x 10^3/100m^3), respectively while during October 2010 the zooplankton biomass and abundance ranged from 0.2 to 12.0 ml/100m^3 (av 3.5 ml/100m^3) and 2.5-157.8 x 10^3/100m^3 (av 48.4 x 10^3/100m^3) respectively suggesting normal secondary production off Vadinar during the monitoring period.

The average zooplankton biomass (ml/100m^3), population density (nox10^3/100m^3) and total groups (no) off Vadinar during the monitoring period varied in accordance with the data presented in Table 8.8.

Table 8.8: Average values of zooplankton (A) biomass (ml/100m$^{3)}$ (B) Population density (nox10^3/100m^3) and (c) total groups (no) off Vadinar (April 2010 – October 2010)

Area		Pathfinder	Nearshore	ESSAR DP	IOC SPM	Essar SPM	Salaya Creek	Gulf
April 2010	A	8.3	1.1	1.1	0.9	1.4	2.5	3.5
	B	89.9	24.6	14.4	22.7	12.7	20.4	37.4
	C	17	15	12	16	13	16	17
Oct 2010	A	4	3.9	1.5	3	5.7	-	2.1
	B	57.4	55.9	23.5	30.5	83.1	-	32.8
	C	13	11	10	10	9	-	7

The overall zooplankton standing stock was low and highly variable off Vadinar which could be due to high patchiness and seasonal variability in their distribution apart from high grazing pressure at higher trophic levels.

During April 2010, 24 faunal groups were identified in the coastal waters off Vadinar during the monitoring period while 17 faunal groups were present in the samples of October 2010. The most common faunal groups were copepods (40.5%), decapod larvae (19%), gastropods (22.5%), lamellibranchs (10.7%), and foraminiferans (2.1%) in April 2010. In addition to the above, groups like chaetognaths, siphonophores, *Lucifer* sp, polychaetes, ctenophores, medusae, amphipods, ostracods, mysids, heteropods, isopods, stomatopod larvae, appendicularians and fish larvae were also frequently noticed but in less numbers during April 2010. During October 2010, the dominant groups were copepods (93.6%) and decapod larvae (4.8%). In general, the coastal waters off Vadinar revealed a moderate production of zooplankton associated with random fluctuations and seasonal changes.

Macro benthos

The organisms inhabiting the sediment are referred as benthos. Depending upon their size, benthic animals are divided into three categories, macrofauna, microfauna and meiofauna and macrofauna. Benthic community responses to environmental perturbations are useful in assessing the impact of anthropogenic perturbations on environmental quality. Macrobenthic organisms which are considered for the present study are animals with body size larger than 0.5 mm. The presence of benthic species in a given assemblage and its population density depend on numerous factors, both biotic and abiotic.

Intertidal macrofauna

During April 2010, Intertidal macrofauna was studied along 5 transects viz. 1 transect (Transect I) at Kalubhar Island and 4 transects at Narara Bet. Several locations were sampled along each transect between the HTL and the LTL viz; High Water (HW), Mid Water (MW) and Low Water (LW). The intertidal macrofaunal standing stock in terms of population density (50-7800 no/m^2, av 2292 no/m^2) and biomass (0.1-37.2 g/m^2; wet wt, av. 9.2 g/m^2; wet wt) varied widely During the post monsoon, only the first three transects were sampled. In October 2010, the intertidal macrofaunal standing stock in terms of population density ranged from 0-3625 no/m^2 (av 1185 no/m^2) and biomass from 0-67.8 g/m^2; wet wt (av. 14.6 g/m^2; wet wt). These results are compared with historical data in Table 8.9.

Table 8.9 Average of intertidal macro benthos off Vadinar during April 2010 to October 2010, (A) Biomass (g/m^2) (B) Population density (no/m^2) and (C) Total groups

Transect		I	II	III	IV	V
April 2010	A	11.2	4.2	13.7	10.7	6.1
	B	3983	1172	1292	2401	2614
	C	5	3	6	6	3
Oct 2010	A	11.9	16.8	15.1	-	-
	B	1495	904	1156	-	-
	C	5	7	5	-	-

Overall, the intertidal region sustained good faunal standing stock and diversity and the contribution of major faunal components are comparable over the past many years at Narara Bet/Kalubhar.

Subtidal macrofauna

Subtidal macrofauna was studied at 13 stations in the coastal system off Vadinar during April 2010 and at 10 stations during October 2010. The distribution of subtidal faunal standing stock in terms of biomass (0.3 - 41.0 g/m^2; av 8.0 g/m^2 wet wt) and population density (150-8925 no/m^2; av 1902 no/m^2) during April 2010. In October 2010 the biomass ranged from 0.3 – 23.9 g/m^2 (av 7.1 g/m^2; wet wt) and population density ranged from 125-14975 no/m^2 (av 2282 no/m^2) The current data is listed (April 2010 – Oct 2010) in Table 8.10.

Table 8.10 Average of subtidal macrobenthos off Vadinar during April 2010 to October 2010, (A) Biomass (g/m^2) (B) Population density (no/m^2) and (C) Total groups

Area		Pathfinder	Nearshore	ESSAR DP	IOC SPM	ESSAR SPM	Salaya Creek	Gulf
April 2010	A	11.2	2.9	2.0	6.1	1.3	15.5	6.4
	B	3833	338	388	694	2375	1553	1865.5
	C	7	3	4	6	5	6	4
Oct 2010	A	12.1	7.7	1.9	4.9	1.8	-	10.6
	B	5019	2967	400	1169	181	-	1652
	C	8	5	4	4	2	-	7

The macrobenthic population was dominated by polychaetes (50.1%), amphipods (18.5%), pelecypods (8.2%), decapod larvae (7.4%), tanaids (3.6%) and foraminiferans (3.2%) during April and by polychaetes (76.3%), amphipods (12.3%) and pelecypods (5%) during October 2010.

Corals and associated biota

Live corals at the Narara and Kalubhar reefs are mainly confined to the lower littoral (reef flat) and shallow subtidal zones (< 8 m). They are absent at the upper reef flat probably because of high rate of sedimentation and long exposure during low tide.

Narara Bet

The eastern segment of Narara Bet represents a formation of vast mud flat, which resulted in significant negative influence on the live coral population. Many regions along the reef flat on the western side are exposed during low tide for prolonged periods because of which the distribution of live corals was poor. In all 30 and 22 Scleractinian species have been identified in the intertidal and subtidal zones respectively of Narara Bet with *Montipora*, *Goniopora*, *Porites*, *Favia*, *Favites*, *Goniastrea*, *Platygyra*, *Cyphastrea*, *Pseudosiderastrea*, *Turbinaria*, *Leptastrea* and *Symphyllia* as the dominant genera.

In general, the live coral density decreased with depth. The live corals were absent beyond 8 m (CD). However, the subtidal area at Narara sustained good coral populations within 5 m (CD). Distance-wise corals were rich within 250 m towards the sea from the LTL. The corals of the genera *Montipora, Porites*, *Favites*, *Goniastrea*, *Goniopora*, *Cyphastrea*, *Leptastrea*, *Favia* and *Turbinaria* dominated the subtidal area.

Kalubhar

In general, Kalubhar reef sustained relatively healthy live corals at the lower intertidal and subtidal (<7 m depth) zones as compared to the population at the Narara reef. The north and north-west regions of Kalubhar had better coral density and diversity as compared to the east and south-east regions because of high sedimentation of the reef flat and the subtidal zones. Overall, 30 and 7 species of Scleractinians in the intertidal and subtidal zones respectively at Kalubhar have been identified. The corals at Kalubhar were mainly represented by genera *Montipora*, *Favia*, *Favites*, *Porites*, *Goniastrea*, *Goniopora*, *Cyphastrea*, *Platygyra,* and *Symphyllia* and *Turbinaria.* The live corals were absent at the reef edge of 50 m width due to total exposure for longer period whereas their coverage increased (90 to 100%) at the reef slope below 1 m depth.

A rich reef associated flora and fauna was noticed at Kalubhar. The common and dominant seaweed genera were *Sargassum*, *Gelidiella*, *Acanthophora*, *Ulva*, *Caulerpa*, *Codium*, *Dictyota*, *Padina*, *Halymenia*, *Enteromorpha*, and *Gracillaria*. Varieties of sponges were associated with coral boulders. The fauna consisted of coelenterates (*Zoanthus* sp., *Discosoma* sp., *Stoichactis*, *giganteum*, *Cerianthus* sp. and variety of corals), annelids (various polychaetes), echiuroid (*Ikedella misakiensis*), crustaceans (amphipods, isopods, *Acetes* sp., shrimps and crabs), molluscs (*Octopus* sp., *Sepia* sp., *Loligo* sp., gastropods, bivalves, nudibranchs etc.) echinoderms and variety of reef fishes.

Fishery

Gujarat ranks number one position in marine fish production in India. The Gulf contributes about 22% to the fish production of the state. The share of the Jamnagar District is between 5 and 14% (av 10%) to the State's total marine fish landings. The important fish landing centres in the vicinity of IOCL SPM area which falls under Khambalia zone are Vadinar, Bharana, Nana Amla and Salaya which together contributed about 6823 t, 8253 t and 5330 t of fish landings in 2006-07, 2007-08 and 2008-09 respectively to the total landings of the Jamnagar District. Similarly, the important fish landing centres in the vicinity of Sikka which falls under Jamnagar zone are Sachana, Baid, Sarmat, Bedi and Sikka which together contributed about 4768 t, 5122 t and 5848 t of fish landings in 2006-07, 2007-08 and 2008-09 respectively. Within the Jamnagar zone, the major landings (98%) were from Sachana (32%), Baid (27%), Sikka (19.7%) and Bedi (18.9%) during the last 3 years. Within the Khambalia zone, the major landings (81-89%) were at Salaya during the period 2006-09. On an average the Khambalia zone (56.5%) contributed to about 13% higher fish landings than Jamnagar zone (43.5%) for the last 3 years. However, the landings at Sikka (1.3%) and Vadinar (0.5%) to the total landings of the district were negligible during the period 2006-2009.

Reptiles and mammals

The reptiles are mainly represented by marine turtles Chelonia mydas and Lepidochelys olivacea which breed and spawn on the sandy beach along the Sikka-Vadinar coast as well as on the islands.

Dolphin (*Dolphinus delphis*) and whale (*Balanoptera* sp) are common in the Gulf. Though occurrence of Dugong (*Dugong dugon*) in the Gulf particularly along the Jamnagar coast has been reported, there are no recent sightings.

The resources discussed above likely to be threatened are tidal flats, Phytoplankton, Phytopigments, Mangroves, seaweeds and seagrasses, Zooplankton, Macrobenthos, Corals and associated biota, salt works fishing activities and other vocational related to marine sensitive areas in the coast of Vadinar and Sikka.

It has been observed from the modeling study that during pre-monsoon season, the spills occurring at the APSEZL marine facilities move towards the southern / southwestern part of the Gulf of Kutch nearer to the facilities depending on tide phase.

The spills taking place at the APSEZL marine facilities move towards northern coast of Gulf of Kutch during monsoon season and affect the coast near Mundra, Kandla etc.

During post - monsoon season, the spills taking place at the APSEZL marine facilities move towards south / southwest and affect the islands /coast on southern side of the Gulf of Kutch.

2.7 Special local considerations

Considering the distant proximity of various other installations with the port of Mundra, in case of a tier 1 spill, no other special considerations are deemed to be required apart from an active spill response close to the port facility itself.

3 Response strategy

3.1 Philosophy and objectives

This plan is intended to assist APSEZL in dealing with an accidental release or discharge of oil. Its primary purpose is to set in motion the necessary actions to stop or minimize the discharge and to mitigate its effects. Effective planning ensures that the necessary actions are taken in a structured, logical and timely manner.

This plan guides the HOD– Marine and his Duty Staff through the decisions which will be required in an incident response. The tables, figures and checklists provide a visible form of information, thus reducing the chance of oversight or error during the early stages of dealing with an emergency situation.

For this plan to be effective, it must be:

- familiar to those APSEZL staff with key response functions;
- regularly exercised; and,
- Reviewed and updated on a regular basis.

This plan uses a tiered response to oil and chemical pollution incidents. The plan is designed to deal with Tier One spillage. The products handled are likely to pose a greater fire and safety, rather than an environmental risk; there may thus be additional factors involving the safety of personnel, which will take precedence over the pollution response. In this case, reference must be made to the APSEZL Emergency Procedures Manual. The salvage and casualty management of any vessel that poses a threat of pollution is priority considerations.

During oil spill response activities, account must be taken of the following:

- site hazard information
- adherence to permit procedures
- spill site pre-entry briefing
- boat safety
- APSEZL safety manual and material safety data sheets
- Personal protective equipment needs
- heat stress
- decontamination

3.2 Limiting and adverse conditions

APSEZL is situated in natural protected Gulf of Kutch and there are less incidences of heavy wind or any other factor affecting operation.

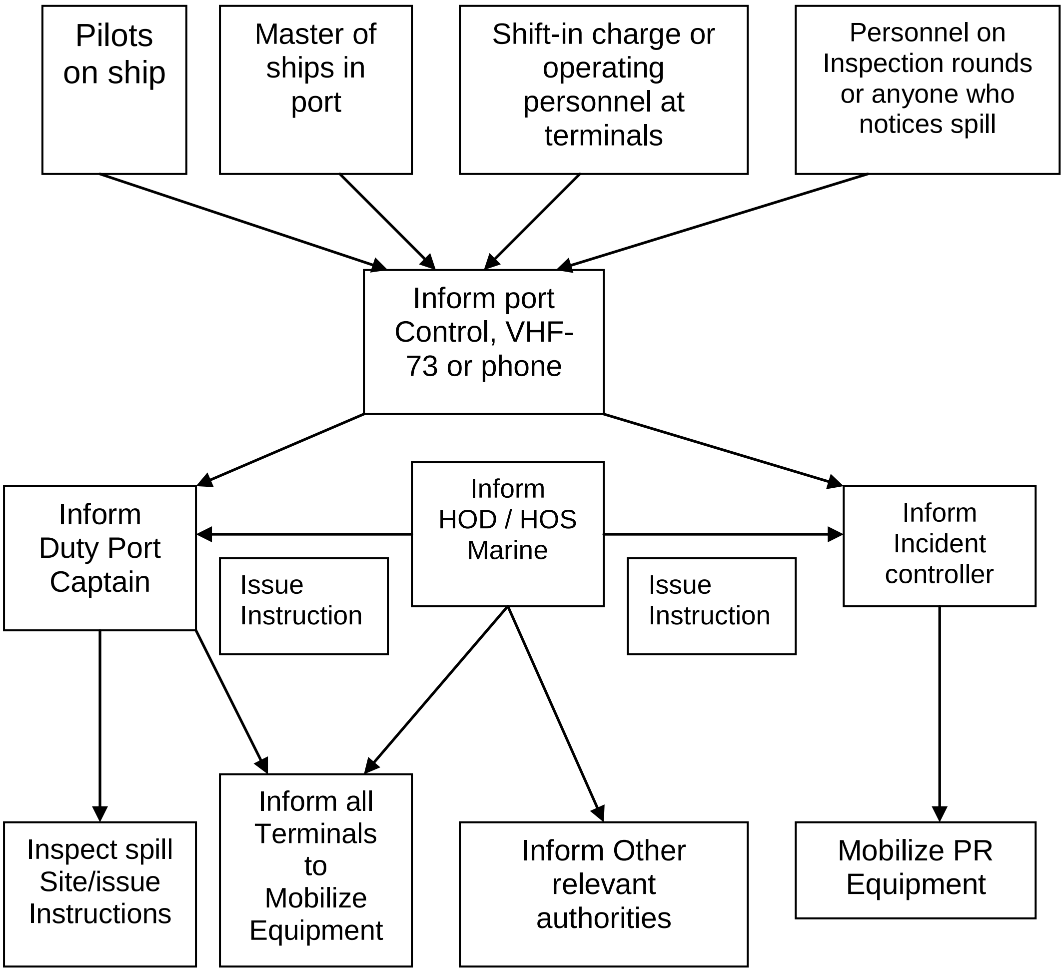
3.3 Oil spill response in offshore zones

SPM handles (unloading) crude oil and pumps it to shore tank farm area through sub-sea pipeline. The impact of such spills on marine environment is on the higher side. Hence, oil spill equipments are required for combating oil in case of such spills at the marine facilities at Mundra.

Based on the oil spill modeling study, it has been observed that crude oil spill of 700 tons (Tier-I) will spread over an area having radius of around 400 m within 4hr. APSEZL has already having facilities for combating a Tier-1 spill.

3.4 Oil spill response in coastal zones

Contingency Chart to deal with Oil Spill



On-site Crisis Management Group – Action Group

In an emergency, the personnel available at or near the incident site play vital role. This concept is made use of in nominating the Key Persons. It is necessary to nominate a functionary as the Incident Controller who is invariably a shift-in-charge of the facility. The Incident Controller tackling the emergency in real times requires the support from various other services i.e. Fire & Safety, Medical Services covering communication, transport and personal functions etc. A key person for each of these services therefore, is nominated.

Overall in charge of these activities is **Chief Operating Officer – Mundra Port.** The different functional coordinators, designated, will co-ordinate with Chief Controller in their respective functional areas. It is suggested that key personal chart be developed, giving the names, designation, telephone nos. of top level personnel who will act as coordinators in different disciplines/services. The duties and the responsibilities of various Key Persons and Coordinators need to be written down on a chart and should be made available across the organization at the site / location.

Roles & Responsibilities

Incident Control Officer – (HOS – Marine / Duty Port Captain)

- Directs and co-ordinates all field operations at the scene of the accident
- Assess incident/crisis at site, nature, location, severity, casualties, resource requirement
- Classifies incident - Advises Exe. Controller, Civil Defence, Dy. Conservator, Traffic Manager - regarding crisis severity status and emergency level, wind direction, temperature, casualties and resource requirements.
- **Conducts initial briefing to Chairman**
- Activates elements of the terminal emergency plan/ site response actions
- Protect port personnel and the public
- Directs security/fire fighting/oil spillage/gas leakage/vessel accidents/natural calamities, cargo operations shutdown
- Search for casualties and arrange first aid and hospitalization
- Brief or designate a person to brief, personnel at the incident scene
- Determine information needs and inform Crisis Management Group
- Coordinates all functional heads in field operations group to take action
- Manages incident operations to mitigate for re-entry and recovery
- Coordinate search and rescue operations
- Arrange evacuation of non-essential workers to assembly points –outside port
- Arranges tugs, mooring boats and pilot(s) for sailing vessel(s)
- Co-ordinates actions, requests for additional resources and periodic tactical and logistical briefings with Site Emergency Coordinator
- Coordinate incident termination and cleanup activities
- Instructs various emergency squads as necessary

Site Emergency Coordinator – (Senior Pilot and Duty Radio Officer)

- Direct operations from the emergency control center with assistance from Crisis Management Group
- Take over central responsibility from the Site incident controller (SIC)
- Decide level of crisis and whether to activate off site emergency plan
- Instruct SIC to sound appropriate alarm
- Direct the shutting down, evacuation and other operations at the port
- Monitor on site and off site personal protection, safety and accountability

- Monitor that causalities if any are given medical aid and relatives informed
- Exercise direct operational control of the works outside the affected works
- Monitor control of traffic movements within the port
- Coordinate with the senior operating staff of the fire, police and statutory authorities
- Issue authorized statements to the news media
- Review and assess possible developments to determine the most probable course of events
- Authorize the termination of the emergency situation by sounding the all clear siren-continuous long single tone siren for one minute
- Control rehabilitation of affected areas after emergency
- Arrange for a log of the emergency

Fire Coordinator – (HOS - Fire / HOS -Safety)
(Under the direction of the Incident Control Officer)

- Announces fire incident point over the public address system and evacuates workers to the assembly points
- Informs fire station immediately and leads fire fighting team to the incident location
- Informs SIC if external fire tender / fire-fighting equipment / materials/mutual aid is required
- If necessary, arranges and activates other fire-fighting equipment
- Arranges safety equipment e.g. fire suits, protective gloves and goggles, breathing apparatus
- In liaison with Civil Engineering Department, ensures that adequate water pressure is maintained in the fire hydrant system/at the area supply
- Maintains adequate records

HOS - Security / Duty Security Officer

- Directs, gate security and facilitates evacuation, transport, first aid, rescue
- Controls the entry of unauthorized persons and vehicles-disperses crowd
- Permits the entry of authorized personnel and outside agencies for rescues operations without delay. Liaises with State police
- Allows the entry of emergency vehicles such as ambulances without hindrances
- Ensures that residents within port area are notified about disaster and instructs to evacuate if necessary
- Ensure that all people are aware of the assembly points, where the transportation vehicles are available
- Ensure that the people are as per the head count available with the assembly point section of that area
- Liaise with the Chief Medical Officer to ensure first aid is available at the assembly points
- Carry out a reconnaissance of the evacuated area before declaring the same as evacuated and report to SIC.

Medical Superintendent

- Direct medical team
- Set up casualty collection centre arrange first aid posts
- Arrange for adequate medicine, antidotes, oxygen, stretchers etc
- Contact and cooperate with local hospitals and ensure that the most likely injuries can be adequately treated at these facilities e.g. burns
- Advise Chief Emergency Controller on industrial hygiene and make sure that the facility personnel are not exposed to unacceptable levels of toxic compounds

- Make arrangements for transporting and treating the injured
- Inform the hospitals of the situation in case of a toxic release and appraise them of the antidotes necessary for the treatment
- Maintain a list of blood groups of each employee with special reference to rare blood groups
- Liaise with Govt. Hospitals/Red Cross

Marine Pollution Coordinator – Manager (Marine / pollution control)

- Minimizes the impact of an accident on the environment for which it would develop methodologies to control hazardous spills

- Monitors cooperation with emergency response squads to conduct the actual cleanup work during and after the emergency.
- In case of fire and specially if the fire involves toxic/flammable materials, to ensure responsible actions for containing the run off fire water and other water from the damaged units
- Determines the level of contamination of the site as a result of the accident
- During cyclones/floods arranges sand bags and transfers important plans and documents to higher levels

Traffic Coordinator – Duty Port Captain

- Directs operation staff
- Prepares vessels to vacate from berth
- Arranges to protect cargo in vicinity from damage
- Arranges to segregate and shift cargo in sheds
- Submits consolidated list of dangerous goods in port including tankers in port and tank farms in port area
- Coordinates with ship owners / agents/C & F agents/stevedores

Communications Officer – (Duty Port Captain / Marine Control In-charge)

- Ensure telephone operator/signal room advises entire emergency team
- On receipt of instructions from the chief Incident controller, notifies the fire brigade/police/hospitals/district collector/mutual aid partners
- Keep the switchboard open for emergency calls and transmit the same to the concerned personnel effectively
- Refrain from exchanging any information with authorized persons unless authorized to do so by the Chief Incident Controller
- Maintains contact with other vessels through VTMS

Chief Emergency Controller – (Head - HSE)

- Inform district emergency authorities-District Collector, Medical officer-Coast Guard Pollution control -Inspector of factories-Inspector of Dock Safety & Health,
- Activate the off site plan if necessary
- Liaise with Jt. Secy./Director MOST (Ministry of Shipping) or relevant Govt. authority
- Inform the media

Civil Coordinator – (HOS – Environment cell / HOS - Estate)

- Inform Gujarat Pollution Control Board and other environmental agencies about the incident for getting necessary guidance
- Instruct the contractors to carry out urgent civil works if required
- Hire the barges for collecting the spilled oil, if required

Marine Engineering Coordinator – (HOS – SPM / Diving Team in-charge)

- Organise the tugs for combating the pollution
- Start the rigging of pollution combating equipment on tugs/launches
- Hire additional crafts if required

HOD- Corporate affairs:

- Collect detailed information periodically and liaise with press about the incident
- Arrange transport facilities, if required
- Inform local authorities/District Collector about the incident (as per EAP)

HOS - Legal & HOD - Estate:

- Issue notice under Major Port Trusts Act, Indian Ports Act(Prevention & Control of Pollution) Rules, etc; to the defaulting master/owner/agent
- Arrange for settlement of claims related to the pollution(as per EAP)

3.5 Shoreline oil spill response

Most oil spills reach the shorelines and cause visible oil pollution which is particularly sensitive to public opinion. The selection and correct application of clean up techniques are therefore essential. When an oil spill occurs on open water the optimal solution is to intercept and recover the oil before it reaches the shoreline. This is because:-

- The environmental damage is normally less critical in the open water environment
- The logistics of oil removal becomes more complex in the varied natural environment of coastlines compared with the open sea.
- The costs of oil recovery increases dramatically when oil reaches sensitive shorelines compared with open water operations.

Experience has shown that it is very difficult to avoid some oil reaching the shorelines. Mechanical equipment and chemical treatment at sea are often insufficient to recover all oil spilled at sea. When the oil reaches the shoreline, a number of different parameters specific for this particular situation have to be taken into consideration:-

- Quantity of oil
- Characteristics of the oil (for instance, toxicity and viscosity)
- Prevailing on-site conditions (weather, season, tides, temperature)
- Shoreline type or combination of types (cliffs, pebble, sand, marsh)
- Special Considerations

The four main steps in a shoreline clean-up operation are:

Step 1: Assessment

- Determine the need to clean, setting priorities in line with this contingency plan
- Determine required degree of clean-up for each area in accordance with priorities
- Attain agreement between clean-up team, ecological experts, government authorities

Step 2: Select Clean-up Method

- Choose method appropriate to type of shoreline, access, degree of oiling
- Minimize damage caused by choice of clean-up technique, degree of clean-up
- Address conflicts of interest (e.g. needs of amenity use versus environment or response speed versus aggressiveness)

Step 3: Clean-up Operations

- Monitor clean-up, confirm choices made above, re-evaluate if necessary
- Minimize disturbance of shoreline features
- Minimize collection of un-oiled debris, sediments

Step 4: Termination / Monitoring

- Ongoing assessment of clean-up operations
- Determine when clean-up objectives have been met
- Post-spill monitoring to confirm recovery of shoreline features, biota

The four main methods for shoreline clean-up are as follows:-

A. Pumping and Skimming Techniques

- Applicable to shorelines that are heavily oiled.
- Often the first step in cleaning a heavily contaminated shoreline.
- Preferred option because it results in fluid wastes that are relatively free of sediments and debris, which are more easily dealt with in disposal.
- Pumping and skimming techniques can also be used in conjunction with flushing techniques.

B. Flushing Techniques

- Use water or steam to flush oil from the beach, and direct it to a recovery location.
- Applicable to heavily contaminated beaches, and substrates that are relatively impermeable (e.g., mud and saturated beaches, boulders, and man-made structures) that will not allow the flushed oil to penetrate the beach surface.
- Typically carried out in conjunction with a skimming operation. The flushed oil is directed down-slope to skimmers positioned at the water's edge, with booms deployed around the skimmers to prevent any loss of the water.
- Options of using low or high pressure water, and of using ambient temperature water versus warm water or steam.
- Low pressure, cold water is generally the least effective, particularly with sticky oils and emulsions, but is least harmful on the environment.
- High pressure water and heated water and steam are more effective, but may remove and/or kill beach-dwelling organisms.

C. Sediment Removal Techniques

- Applicable to a variety of shoreline types, and in particular, when the shoreline is heavily contaminated, though likely to cause the greatest environmental impact
- The requirements are access for the heavy equipment required for transporting away oily debris and sediments for disposal and a surface which is able to support heavy equipment
- An important factor to consider is the depth of oil penetration
- Important to limit the depth of material removed in order to minimise disturbance to the beach, and to minimise disposal requirements
- The best option is to use manual labour to pick up the oily sediment and mechanical means to transport it away

D. Biodegradation Techniques

- Generally refers to "active" bioremediation, where nutrients and/or microorganisms are applied to enhance natural degradation
- Generally suitable for areas that are lightly oiled, especially lightly oiled salt marshes and tidal flats where the use of equipment could increase the environmental effects by forcing oil into the substrate
- It can also be used as a final clean-up step following more active efforts

The shoreline clean-up operation is normally not an emergency operation as is the case with an oil spill on open water. A clean-up project can last many weeks or months depending on the amount of oil spilled. Many wrong decisions can be made in planning and carrying out a shoreline clean-up operation. The contingency plan must be used in combination with consulting experts with experience of shoreline clean up. The agencies such as NIO, NEERI, Ports and Oil companies have experts with experience which is relevant for the specific oil spill situation and they should be consulted prior undertaking shoreline clean-up.

3.6 Storage and disposal of oil and oily waste

After the natural degradation by coagulation and evaporation of oil on water, residual oil and waste material collected during a Tier 1 response will be disposed off by in-situ or terrestrial burning.

	Type of material	Separation methods	Disposal methods
LIQUIDS	Non-emulsified oils	Gravity separation of free water	Use of recovered oil as fuel or refinery feedstock
	Emulsified oils	Emulsion broken to release water by ; - Heat treatment - Emulsion breaking chemicals - Mixing with sand	Use of recovered oil as fuel or refinery feedstock. Burning Return of separated sand to source.
SOLIDS	Oil mixed with sand	Collection of liquid oil leaching from sand during temporary storage Extraction of oil from sand by washing with water or solvent Removal of solid oil by sieving	Use of recovered oil as fuel or refinery feedstock. Direct disposal Stabilization with inorganic material. Degradation through land farming or composting. Burning
	Oil mixed with cobbles, pebbles or shingle	Collection of liquid oil leaching from beach material during temporary storage Extraction of oil from beach material by washing with water or solvents	Direct disposal. Burning
	Oil mixed with wood, plastics, sea weeds, sorbents	Collection of liquids leaching from debris during temporary storage Flushing of oil from debris with water	Direct disposal. Burning. Degradation through land farming or composting for oil mixed with sea weeds or natural sorbents.
	Tar balls	Separation from sand by sieving	Direct disposal Burning

Location for Dug Pond for temporary storage of oily water:

To store the contaminated oily water, temporary dug pond will be excavated for storage of oily water. It is expected that 20 times volume of oil & water mixture will be generated if oil spill happen in the sea. Storage capacity of dug pond of volume 14000 m3 considering spill of level 1 (Tier-1) is required.

Location Identified for Dug Pond behind Maruti Yard (Lat. 22° 45.252'N , Long. 69° 41.093'E) is roposed.

- Size of Dug Pond to be provided : 100 mtr X 100mtr X 1.5mtr
- Total storage capacity (m3) : considering 20 times oily water @ 700 m3 = 14000 m3

Once the contaminated mixture of oil and water is stored, the same will be transferred via tanker to following location. Following are the steps require to be followed.

1. Oil Water Separator: Capacity 25 m3/hr.
2. Effluent Treatment Plant: Capacity 120 KLD
3. Parallely oil recyclers will be approached for the collection and transportation of the oily water.
4. Contaminated Soil / Sediments will be directly sent to the Treatment Storage and Disposal Facility (TSDF) site. List of Oil recyclers and TSDF sites are shown in Annexure – 15
5. Different types of equipment & manpower require for creating dug pond:

Name of Equipment	**Quantity**	**Primary Responsibility of Equipment & Material**	**Secondary Responsibility**
Excavator	10 Nos.	Marine Dept.	MHS section (Dry Cargo) / Asset Department / Procurement
JCB Machines	10 Nos.	Marine Dept.	ES Civil / Asset Department / Procurement
Material			
HDPE Liners for dug pond	10600 Sq. mtr.	Marine Dept.	Stores & Procurement

In phase wise manner stored oily water will be treated at both the above facility to separate oil from water to the possible extent. Whereas, after recovery of oil from water, water confirming to the effluent discharge limit of oil (< 10 ppm) will be discharged in to sea.

Whereas in case oily water will not capable of treat at OWS & ETP will be dispose through sending it to registered recyclers, for which APSEZL have already done tie up with the registered recyclers as mentioned in **Annexure – 15**.

APSEZL have also done necessary tie up with various institutes/agency/NGO as mentioned in **Annexure – 16** for providing service for rescue & rehabilitation of oil socked birds as well as restoration of mangroves, when oil reaches to the sea shore and mangrove areas during oil spill. Mobile van / vehicle require for rescue of oil socked birds to transfer from affected area to treatment facility center.

4 Equipment

4.1 Marine oil spill response equipment

Detailed in Annexure 3

4.2 Inspection, maintenance and testing

The equipments are being kept in working condition. Routine inspection, maintenance and testing performed as per the stipulated requirements.

4.3 Shoreline equipment, supplies and services

The shoreline clean-up equipment which are essential for the oil removal operations at beaches are as follows:-

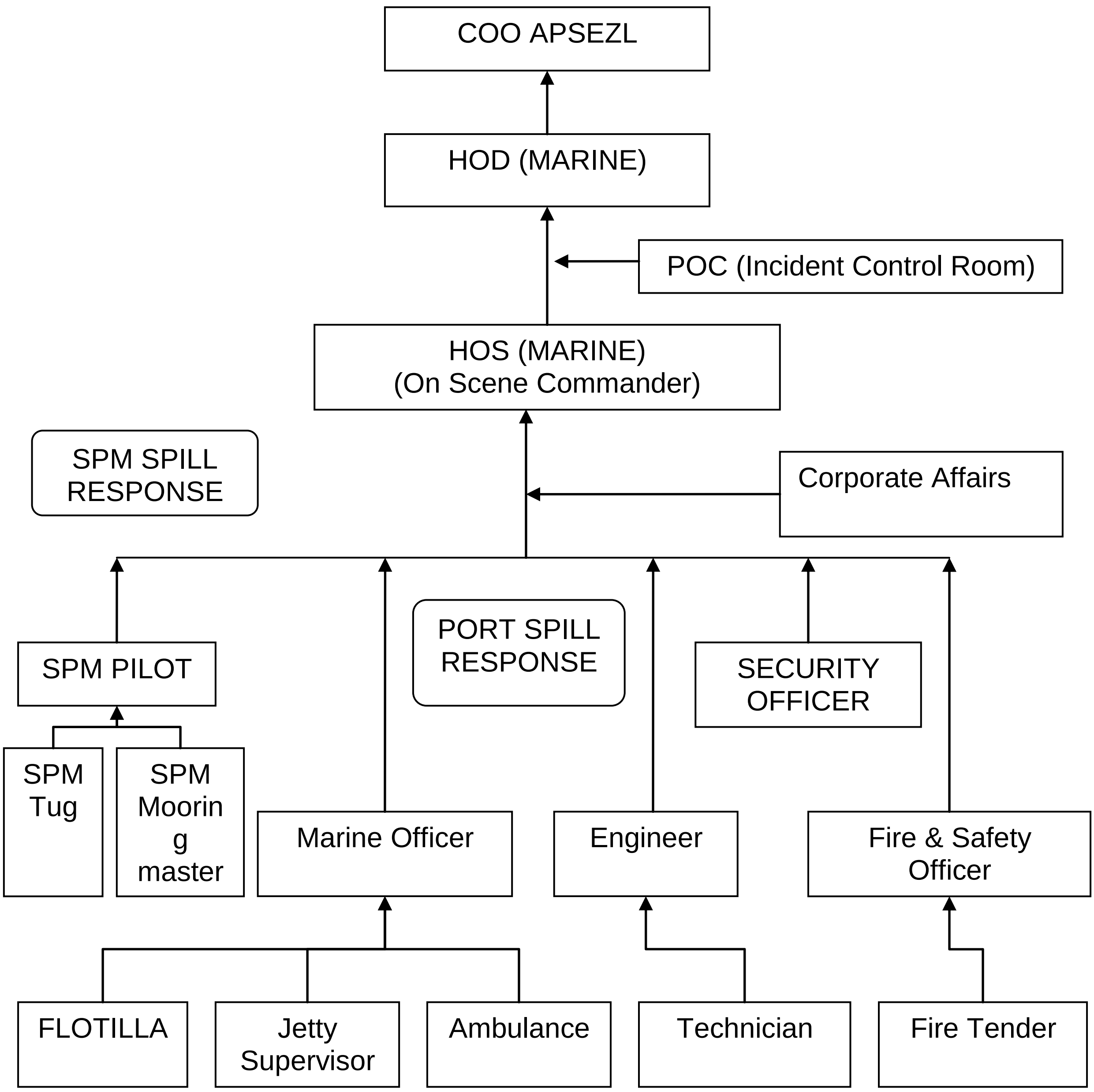
- Protective clothing for everybody (including boots and gloves), spare clothing.
- Cleaning material, rags, soap, detergents, and brushes.
- Equipment to clean clothes, machinery, etc., with jets of hot water.
- Plastic bags (heavy duty) for collecting oily debris.
- Heavy duty plastic sheets for storage areas especially for the lining of temporary storage pits.
- Spades, shovels, scrapers, buckets, rakes
- Ropes and lines
- Anchors, buoys
- Lamps and portable generators
- Whistles
- First Aid material.

5 Management

5.1 Crisis manager and financial authorities

The COO of APSEZL is the final authority of the oil spill response in case of a Tier 1 scenario. He is responsible for raising the level of the response if required and summoning additional help. The authority of all financial decisions rest with him.

5.2 Incident organization chart



5.3 Manpower availability (on-site, on call)

In an event of incident Kandla Port Trust, Gujarat Maritime Board, Gulf of Kutch Ports, District and Regional plans are deemed to have been implemented. Adani Ports and Special Economic Zone Limited (APSEZL) manpower and resources will be put at the disposal and will be deployed as required, provided APSEZL is the polluter and spill is within the Port Limits.

In the event of APSEZL not being the polluter and any event outside the port limit of Adani Port, APSEZL equipment will be subject to mutual assistance plan and it will be the responsibility of the above forum.

5.4 Availability of additional manpower

Similarly in the event of APSEZL being the polluter, additional manpower and supplies can be requested from the resources which are part of this forum.

A numbers of private parties have their labor force working round the clock in the port and on call these can be available.

5.5 Advisors and experts – spill response, wildlife and marine environment

APSEZL, being the nodal agency in this LOS-DCP, will function as the main agency. In the event of the emergency getting raised to higher tier, i.e. in case the incidence becomes a national disaster, the help and advice of Indian Coast Guard will be taken.

5.6 Training / safety schedules and drill / exercise programme

Training of all APSEZL staff who may get involved in implementing this plan is acknowledged. In house and external facilities (of ICG) are used periodically to impart training as per matrix below. Marine Manager has been appointed as training coordinator and custodian of oil pollution equipment. He shall organize training, drills and inspection of equipment as per the plan in force.

Training Module	Duration	Frequency	Participants	Remarks
IMO Model Course	2-5 days	Once	Key persons	By Maritime Training Institute
Oil Spill	1-5 days	Once every 5 years	Key persons	Coast Guard
Oil spill equipment	1-5 days	Once every Year	Managers	In house
Oil spillManagement course	1 day	Once every year	Managers & junior staff	In house for in-depth knowledge
Notification exercise	1-2 hours	6 months	Operational staff	Check systems & communication
Table top	2-6 hours	12 months	Managers	Interactive discussions
Incident	6-8 hours	12 months with others	All	Mock drill

Number of IMO Level-1 and IMO Level-2 qualified staff available with Adani Ports and SEZ Ltd, Mundra:

IMO Level-1 - 30
IMO Level-2 - 03

6 Communications

6.1 Incident control room facilities

Detailed in Annexure 3

6.2 Field communication equipment

Detailed in Annexure 3

6.3 Reports, manuals, maps, charts and incident logs

A copy of the relevant manual is kept with HOD – Marine. Maps/ Charts of APSEZL are kept in Marine Control Tower and attached in Annexures

Action and operations

7 Initial procedures

7.1 Notification of oil spill to concerned authorities

The emergency (due to spill) should be initiated by the first person noticing it by activating the fire alarm from the nearest call-point or by contacting the fire control room immediately on the internal telephone or through mobile phone or through VHF Channel.

The SPM Pilot or On Scene Commander will report the spill to the Marine Control Room.

7.2 Preliminary estimate of response tier

The first few minutes after the incident / accident are invariably the most critical period in prevention of escalation. Therefore the person available at or near the incident site (and often responsible for carrying out that particular activity) on round the clock basis play a vital role in an emergency. The SPM Pilot or On Scene Commander will report the spill to the control room along with his estimate of the response tier.

7.3 Notifying key team members and authorities

Statutory First Information Report (FIR - given in annexure 1) is to be communicated by fastest means possible to President, GMB port and CG at Porbandar followed by full Pollution Report (POLREP – given in annexure 2). The report is to be updated, should the oil spill not be contained and likely to increase to Tier 2

7.4 Manning Control Room

Auxiliary control center is located at Port Operation Centre. Escalation of emergency if any is monitored here. Statutory reporting procedures of FIR and POLREP of developing situation and action taken are also sent from this center. The detail of the contacts to whom the information is to be given is placed at Annexure 4.

7.5 Collecting information (oil type, sea / wind forecasts, aerial surveillance, beach reports)

Marine Manager has the responsibility of arranging the collection of the relevant information which will help in mitigating the emergency

7.6 Estimating fate of slick (24, 48, 72 hours)

Considering the prevalent tidal stream, wind and weather conditions, section 8.3 is to be used in estimating the fate of the slick

7.7 Identifying resources immediately at risk, informing parties

Depending on the quantity of fluid spilled and the prevalent wind & weather conditions, the resources / facilities immediately at risk have to be identified by the On scene commander and the concerned parties informed.

8 Operations planning

8.1 Assembling full response team

On being appraised of the spill, the duty marine officer will inform the marine manager, who will, in turn initiate the assembly of the complete response team which essentially involves relaying information to all relevant personnel, parties and authorities and informing them of the initial response requirements.

8.2 Identifying immediate response priorities

Depending on the initial estimated response tier and the prevalent weather conditions, the marine manager, in consultation with the on scene SPM pilot / marine officer will identify the immediate resources at risk and the response priorities.

8.3 Mobilizing immediate response

The Manager - Marine will initiate the mobilization procedure of the spill equipment, resources and personnel depending on the scale of emergency at hand.

8.4 Media briefing

No other person is authorized to communicate with any external party by any means whatsoever unless expressly permitted by the HOD – Marine or COO, APSEZL.

8.5 Planning medium-term operations (24, 48 and 72 hour)

The HOD – Marine will plan the subsequent action to be taken in response to the tier 1 spill after the initial response is well under way and its consequences / effectiveness are duly evaluated.

8.6 Deciding to escalate response to higher tier

After carefully assessing the scenario and appraising the efficiency of the initial response in the prevalent conditions, the HOD – Marine will decide whether or not to escalate the response.

8.7 Mobilizing or placing on standby resources required

It is recommended that in case of a doubt (as the exact estimate of the quantity of oil spilled is quite difficult and the boundaries between the tiers will inevitably be blurred) it is important to be prepared to involve the next higher tier from the earliest moments. It is easier to stand down an alerted system than to try to escalate a response by calling up unprepared reserves at a late stage.

8.8 Establishing field command post communications

Communications between the Emergency Response Center/ Marine Control room and marine personnel during the response to any oil spillage will be primarily by VHF marine band radio on Channel 73 or 77

Communications between the Marine Control Room and other vessels will be established on VHF radio Channel 16 and will thereafter be conducted on Channel 73 / 77.

Use of cellular telephones will be minimized.

Communications between the Emergency Response Center/ Marine Control Room and external authorities and organizations will be undertaken by telephone and facsimile.

9 Control of operations

9.1 Establishing a Management team with experts and advisors

Detailed in Annexure **4**

9.2 Updating information (sea, wind, weather forecasts, aerial surveillance, beach reports)

The Marine Control Room is well equipped in assimilating data on weather and its forecasts. In case of a Tier 1 response, aerial surveillance and beach reports are not deemed to be essential

9.3 Reviewing and planning operations

Ongoing response and its influence in mitigating the situation will have to be constantly under review in order to contain the spill at the earliest.

9.4 Obtaining additional equipment, supplies, manpower

While deciding not to elevate the tier of the response the HOD- marine may still request additional resources from nearby port facilities which are essentially members of the common forum and are obliged to assist.

9.5 Preparing daily incident log and management reports

A complete report will be submitted by the Marine Manager to the HOD (Marine) every morning (in case the response extends to more than 1 day).
Format for the above report in Annexure 9

9.6 Preparing operations accounting and financial reports

The Port's accounting department will assess the expenditure incurred in the ongoing operation and submit a report to the President's office.

9.7 Preparing releases for public and press conferences

The COO's office, HOD – Marine and the Corporate communications cell will formulate the requisite press releases from time to time and hold press conferences.

9.8 Briefing local and government officials

The COO's office, HOD – Marine and the Corporate communications cell will formulate the requisite reports to brief local and government officials..

10 Termination of operations

10.1 Deciding final and optimal levels of beach clean-up

If at all a distant beach is affected, the COO APSEZL office will decide the optimal levels of cleanup in consultation with the conservator of the port – Gujarat Maritime Board Port Officer.

10.2 Standing down equipment, cleaning, maintaining, replacing

Considering the natural disintegration of the residual oil on water after the cleanup of the bulk amount, The HOD – Marine will decide when to stand down the response. The resources which have been used will have to be re-instated to the original condition by elaborate cleanup or replacement.

10.3 Preparing formal detailed report

The COO's office, HOD – Marine and the Corporate communications cell will formulate the requisite reports to brief local and government officials and media.

10.4 Reviewing plans and procedures from lessons learnt

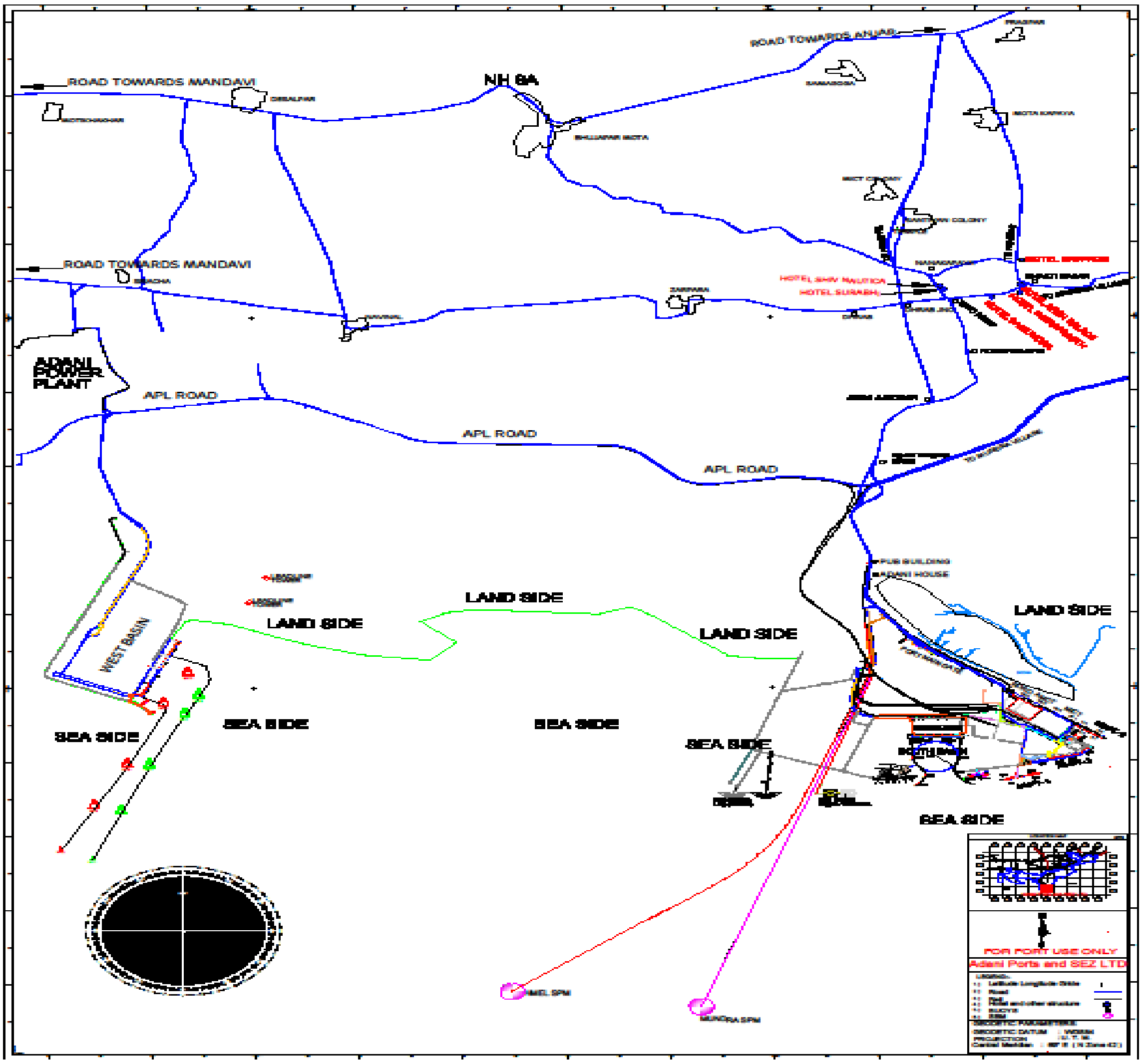
A complete spill response report will be produced by the Marine manager providing comprehensive and all-inclusive details of the circumstances leading to the spill, initial response and consequent affect of the same, subsequent follow up, effect of prevailing weather, adverse situations, safety issues, difficulties faced and lessons learnt.
Requisite changes will be affected to this plan on basis of such report.

Such a report will also be prepared by the marine manager after each drill or training session and requisite modification(s) incorporated to the plan in order to enhance the overall efficacy of the same.

Data Directory

Maps / Charts

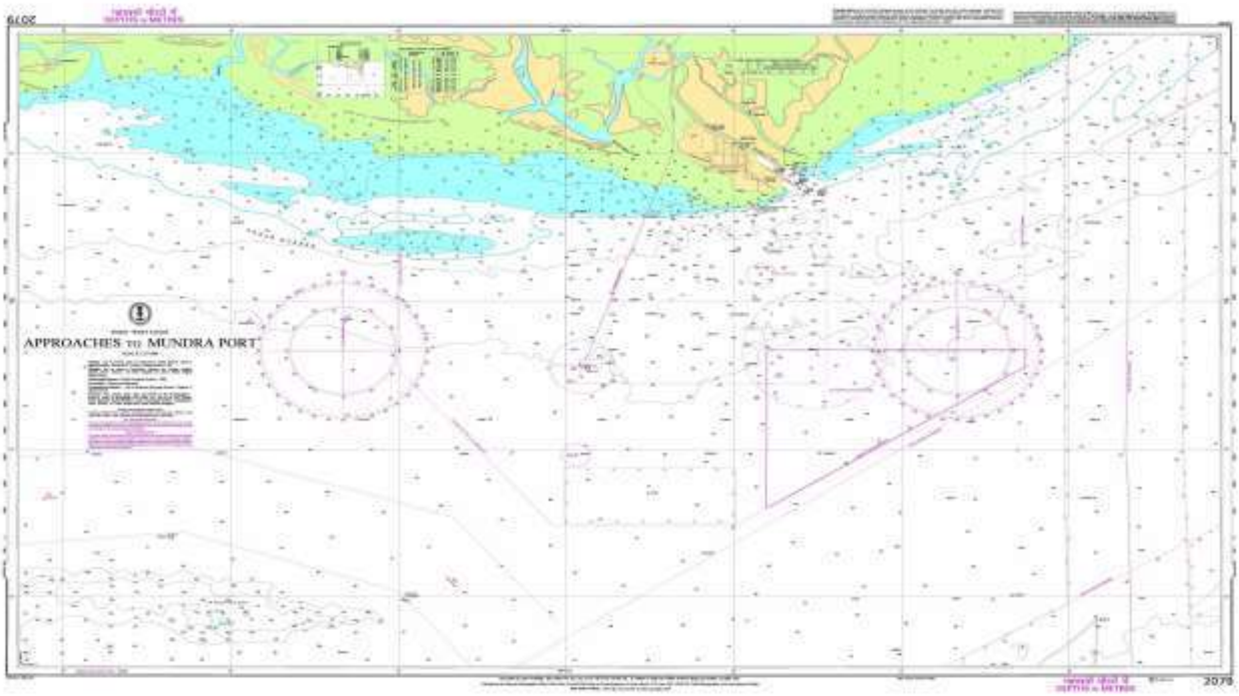
1. Coastal facilities, access roads, hotels etc.

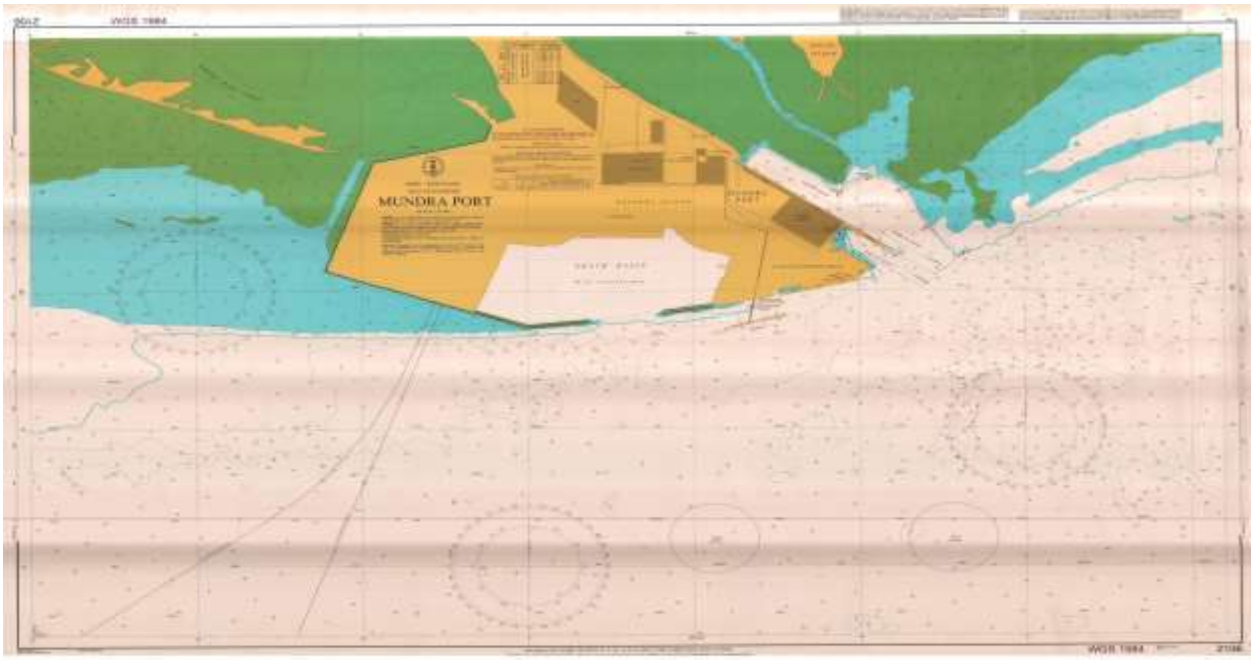


Telephones: Detailed in Annexure **4**

2. Coastal charts, currents, tidal information (ranges and streams), prevailing winds

Currents, tidal information (ranges and streams) : Detailed in Annexure- II, Annexure- III and Annexure- IV (Volume 2) of Oil Spill Risk Assessment






WGS 1984
MUNDRA PORT
WEST BASIN
WGS 1984
2107

3. Risk locations and probable fate of oil

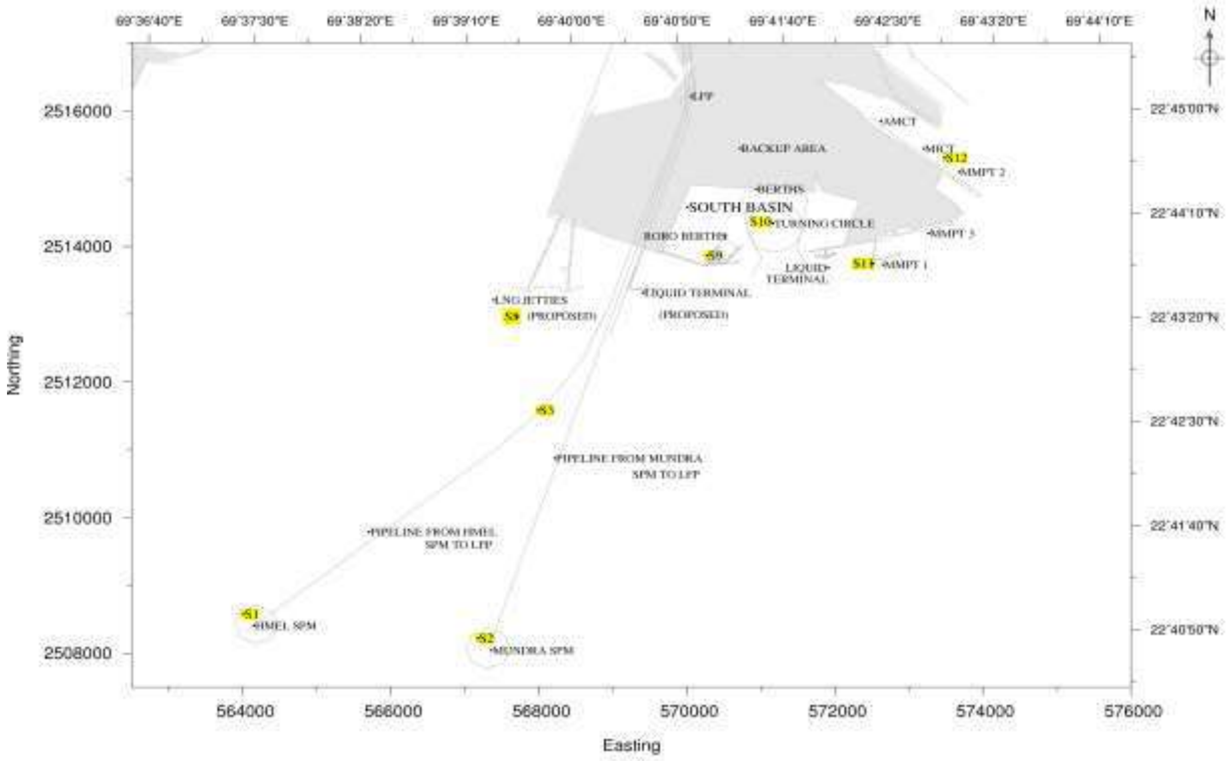


Fig.1: General layout of the Mundra port facilities of APSEZL showing the location of Spill Points for SPMs, South Basin berths, LNG jetty and existing berths

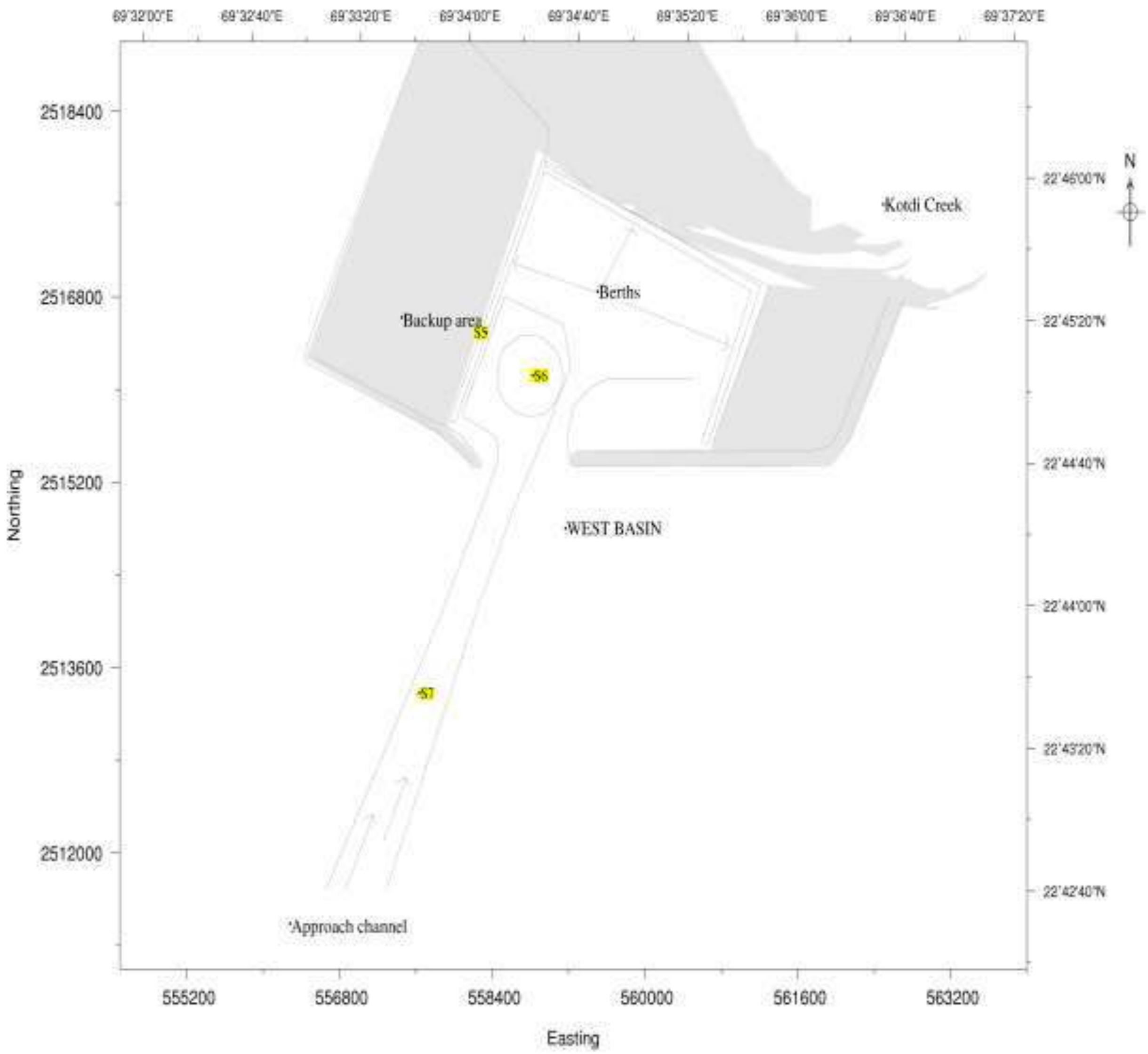


Fig.2: Zoomed up portion of Mundra port facilities of APSEZL showing the location of Spill Points for West Basin

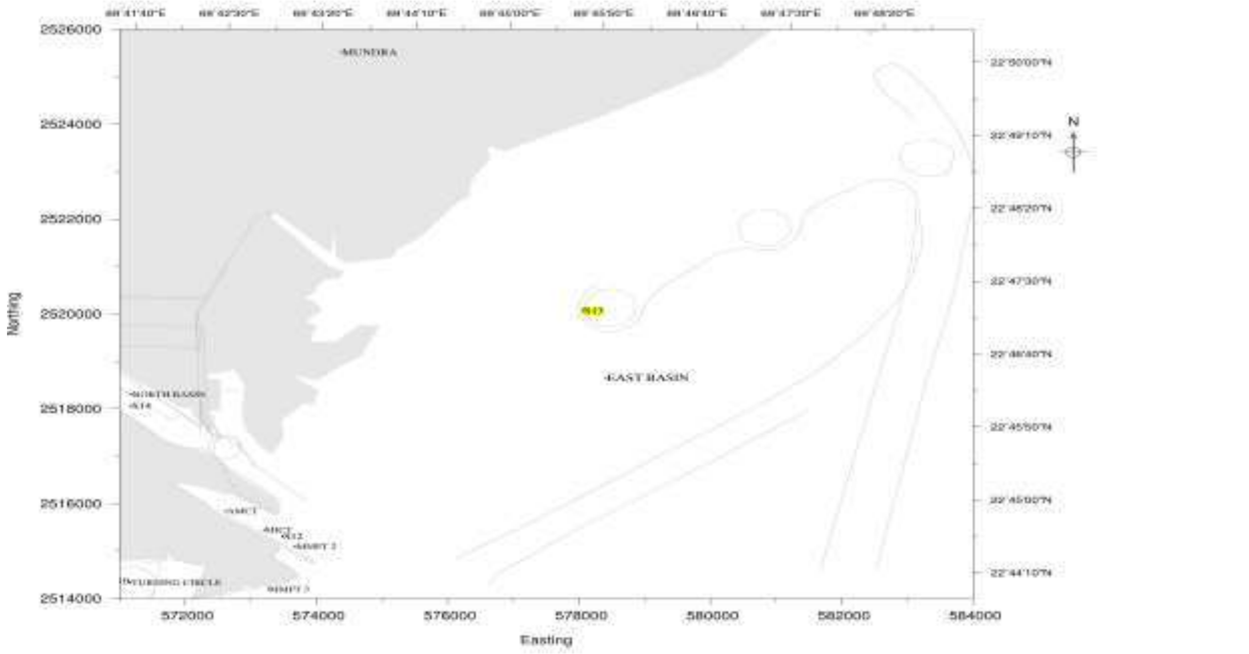
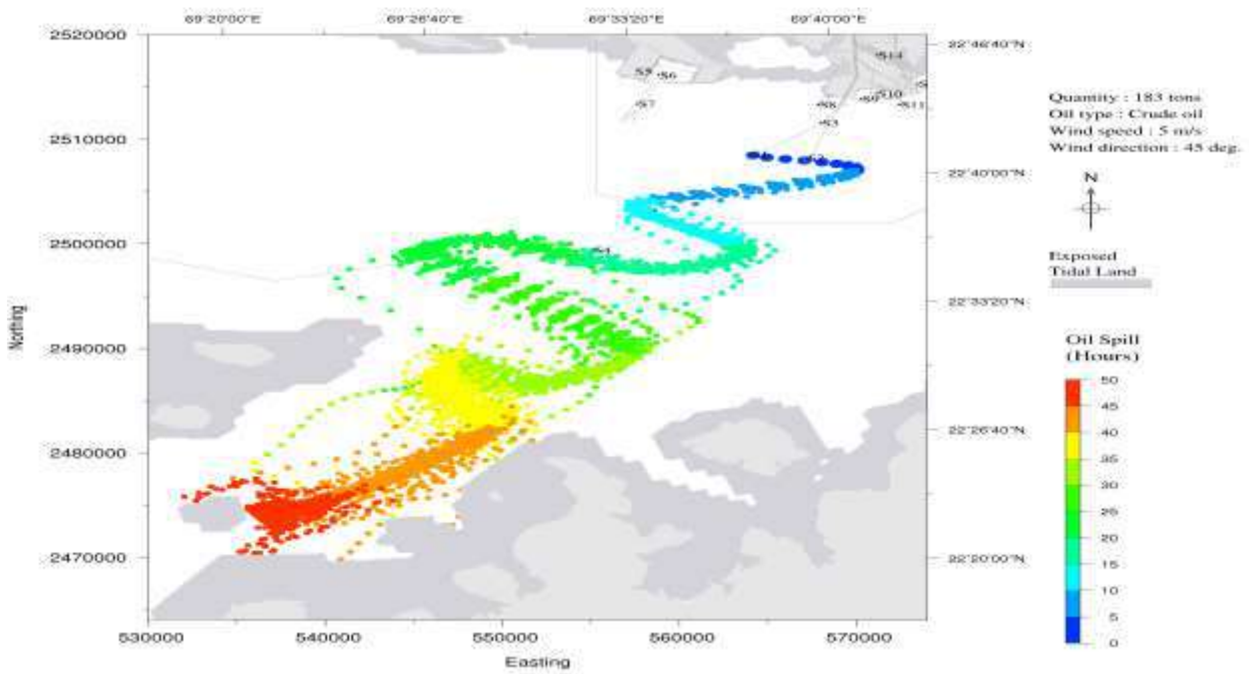
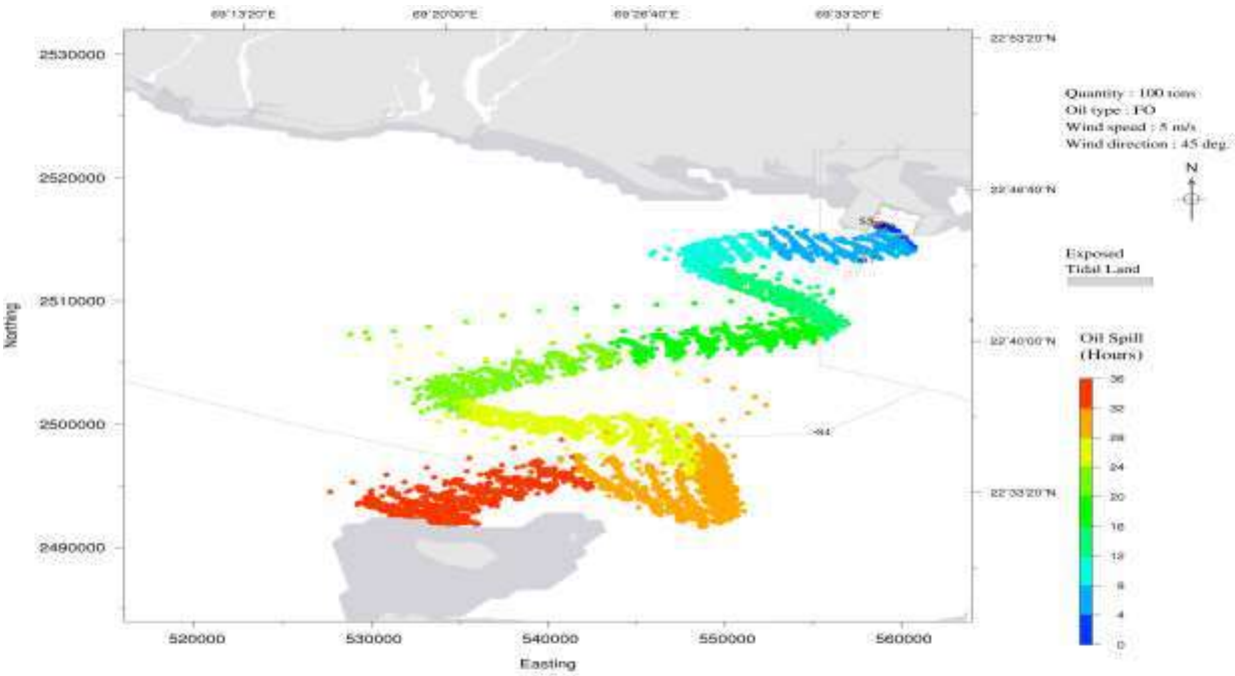


Fig.3: Zoomed up portion of Mundra port facilities of APSEZL showing the location of Spill Points for North Basin & East Basin



Oil Spill trajectory due to instantaneous crude oil leakage of 700 t (due to collision) at spill point S1 (HMEL SPM) after 50 hours during flood condition of the neap tide



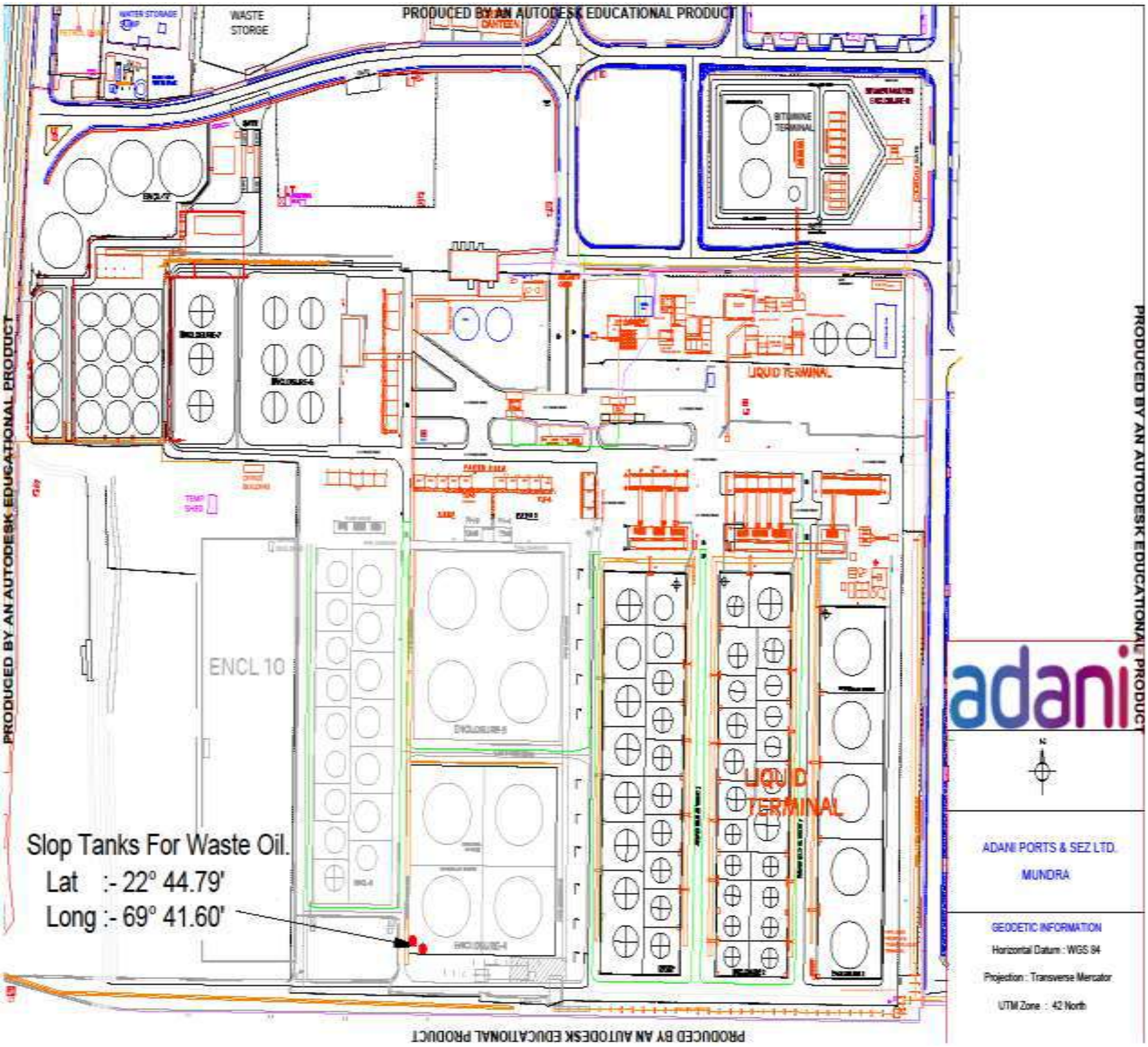
Oil Spill trajectory due to instantaneous FO leakage of 700 t (due to hull failure/ fire / explosion) at typical berth location in the West Basin

For Risk locations and probable fate of oil refer Annexure- V (Volume 2) of Oil Spill Risk Assessment.

Shoreline resources for priority protection

Oil and Waste Storage / Disposal sites

Oil and Waste storage / Disposal tank No. 46, 109 and 110 are available within Liquid Tank farm.



Sensitivity Maps/ Atlas

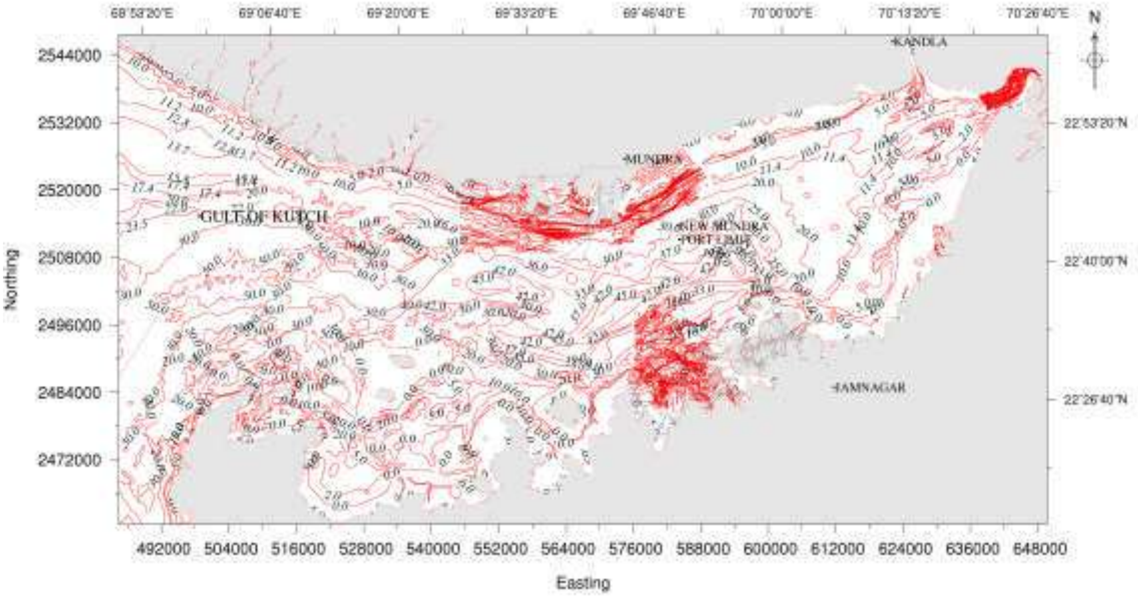


Fig.A1.1 Terrain features of study domain.

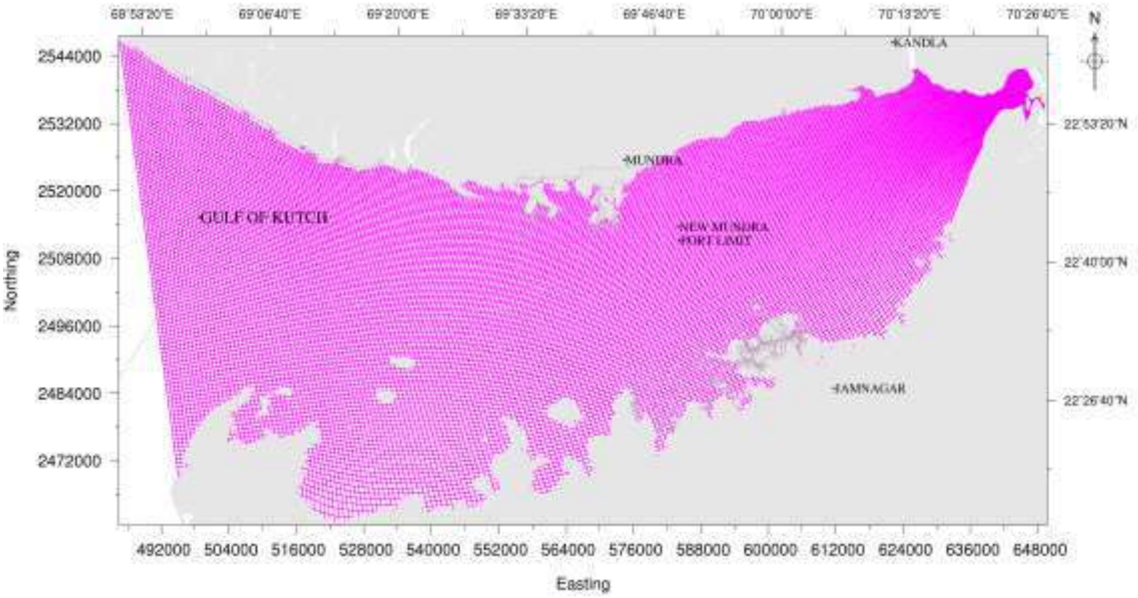


Fig.A1.2 Computational grid

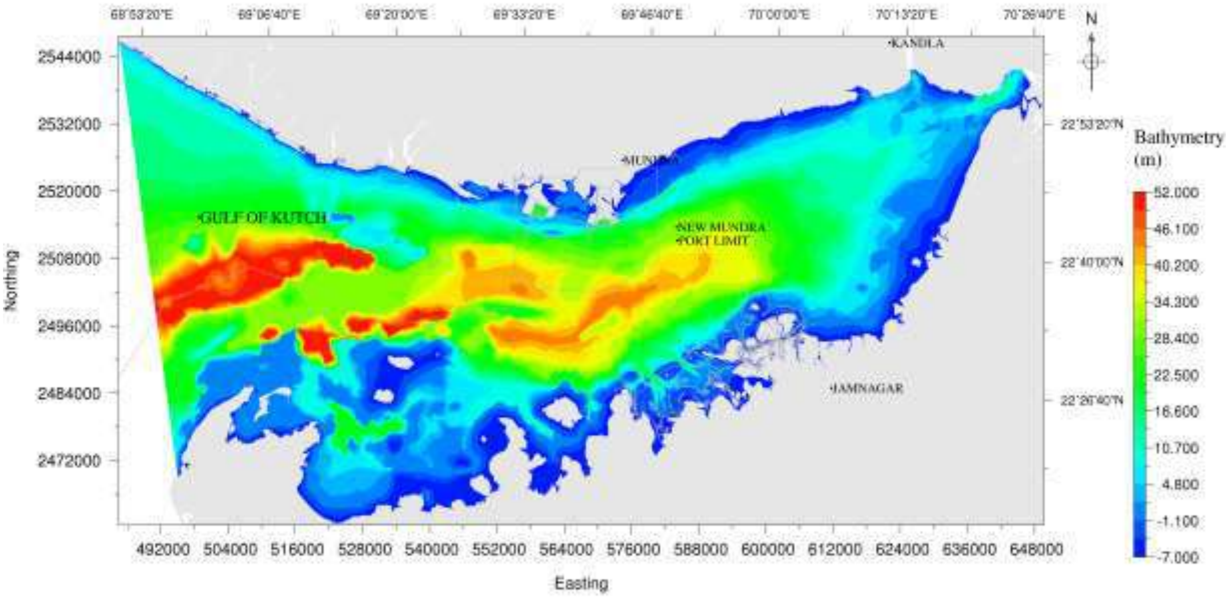


Fig.A1.3 Interpolated depth contours

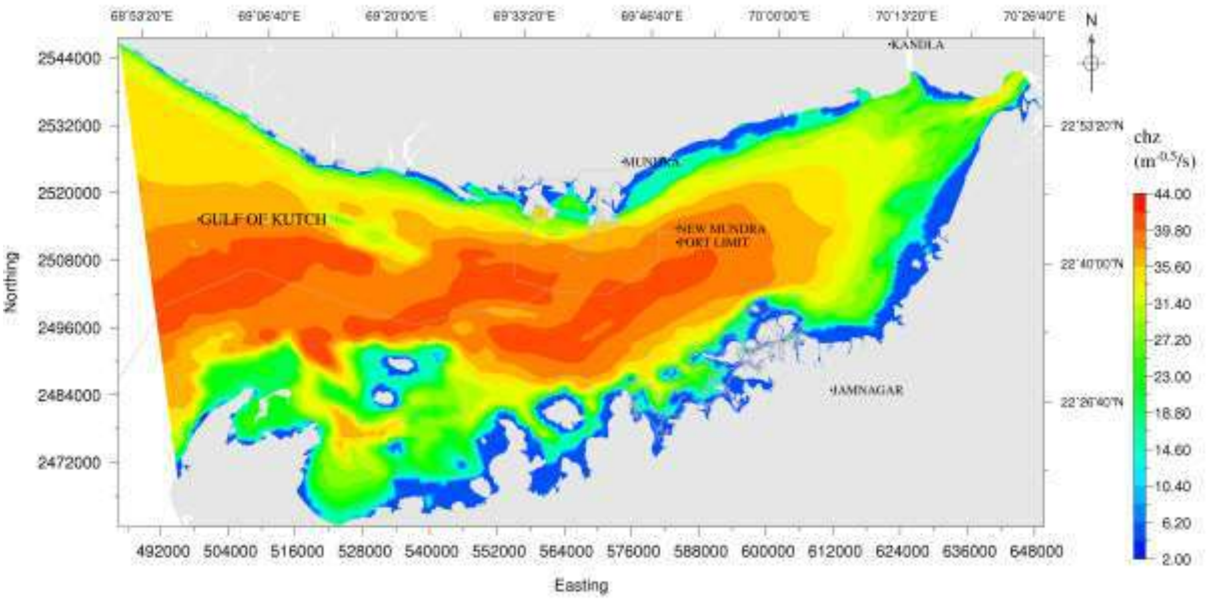


Fig.A1.4 Chezy's coefficient

Lists

1. **Primary Oil spill Equipment:** booms, skimmers, spray equipment, dispersant, absorbents, oil storage, Radio communications etc.

   Detailed in Annexure **3**

2. **Auxiliary Equipment:** Tugs and work boats, aircraft, vacuum trucks, tanks and barges, loaders and graders, plastic bags, tools, protective clothing, communication equipment etc.

   Detailed in Annexure **3**

3. **Support Equipment:** Aircraft, communications, catering, housing, transport, field sanitation and shelter etc. (Availability, contact, cost and conditions)

   Not applicable

4. **Sources of Manpower:** Contractors, local authorities, caterers, security firms (Availability, numbers, skills, contact, cost and conditions)

   Refer Para 5.3

5. **Experts and Advisors:** Environment, safety, auditing (Availability, contact, cost and conditions)

   Detailed in Annexure **4**

6. **Local and National Government contacts:** Name, rank and responsibility, address, telephone, fax, telex.

   Detailed in Annexure **4**

Data

1. **Specification of Oils commonly traded**

At the liquid berth, the representative products that would be handled are petroleum products like FO/ HSD / SKO / MS / CBFS / CPO / Naphtha etc. Vessels calling at the port will be having FO and HSD for their propulsion requirements.. The products like MS, Naphtha etc are oils of non – persistent nature; they tend to evaporate fast and will not stay long on the surface of the sea waters. Hence spill studies have been carried out for FO and HSD spills at the berths.

At the SPMs, Crude oil unloading takes place.

Physical and Chemical Properties of products handled at the SPMs, Berths and of the propulsion fuels of the ships / tankers

Data on the properties for the hydrocarbons / products handled at the jetty is required for quantitative hazard identification and consequence calculations. The properties of the FO and HSD, the petroleum hydrocarbons likely to be spilled due to the operations at the jetty are given in Table-3.1.

Table-3.1: Properties of Crude Oil, FO and Diesel

Sl. No	Chemical	Boiling Range (^oC)	Specific Heat of Liquid (J/Kg ^oK)	Heat of Evaporation (x 10^5 J/Kg)	Heat of Combustion (x 10^5 J/Kg)
1	Crude Oil	IBP - 700+	2385	3.4	425
2	HSD	200 - 350	2889	4.65	448
3	Fuel Oil	180 - 450	2500	3.4	452

The following characteristics of oil are used for modelling study:

(a) Crude Oil
Sp. Gr = 0.82 to 0.88
Surface Tension =3.0 e-03
Molar Volume =0.002
Viscosity: 275 CST at 37.8 deg C
Wax content: 12 – 19 %
Pour point of untreated crude: 30 deg C
Pour point of treated crude: 18 deg C

(b) FO
Sp. Gr = 0.92
Boiling point = > 260^0 C
Vapor pressure = < 0.1 psia at 21^0 C

(c) HSD
Sp. Gr = 0.86
Pour point = 6^0 C - 18^0 C
Vapor pressure = 2.12 to 26 mm Hg at 21^0 C

2. Wind and weather

Meteorological and Oceanographic Conditions

The met-ocean conditions have been previously ascertained at several stages in the course of various studies conducted in past in respect of Mundra port projects. Flow modeling for the Mundra port location has been covered in the model developed by Environ, India, who have developed the model for whole of Gulf as relevant to Mundra region. It has been observed during model studies that flow regime does not have significant changes due to the proposed developments. The following are the main hydo-meteorological parameters for planning and designing of the marine facilities described below.

Rainfall and Temperature

The Kutch is a semi-arid region with weak and erratic rainfall confined largely to June-October period. With a few rainfall days, the climate is hot and humid from April till October and pleasant during brief winter from December to February. Although the monthly mean maximum temperature recorded is 37^oC during 2005, it occasionally exceeds 40^oC. Rainfall alone forms the ultimate source of freshwater resource to the region. The average rainfall at Mundra is about 400 mm/year.

Cyclones

Cyclonic disturbances strike North-Gujarat, particularly the Kachchh and Saurashtra regions, periodically. These disturbances generally originate over the Arabian Sea and sometimes the Bay of Bengal. Generally during June, the storms are confined to the area North of 15^{o}N and East of 65^{o}E. In August, the initial stages, they move along the northwest course and show a large latitudinal scatter. West of 80^{o}E, the tracks tend to curve towards North. During October the direction of movement of a storm is to the West in the Arabian Sea. However, East of 70E some of the storms move North-Northwest and later recurves North East to strike Gujarat-North Mekran coast.

Wind

There are strong winds at times at Mundra Port. The month wise wind rose diagrams for the year 2012 and for the months of January and February of the year 2013 are given below. In the period lasting over months March to May the wind direction is generally SWW (225˚ - 250˚) and velocity varies from 20 to 25 Knots. From June through August, the wind direction is predominantly SW and velocity varies from 25 to 30 Knots with short gusts going up to 35 to 40 Knots. Towards end of September and through October wind direction changes to NE with velocities ranging from 7 to 10 Knots. Direction remaining same the velocity varies 10 knots to 25 Knots in the period November to January. February is the calm period when wind direction is Southerly with velocity in the range of 7 Knots. Stormy weather may generate winds having velocity up to 100 Knots which should be taken as the worst case scenario for design of tall structures and heavy duty cranes.

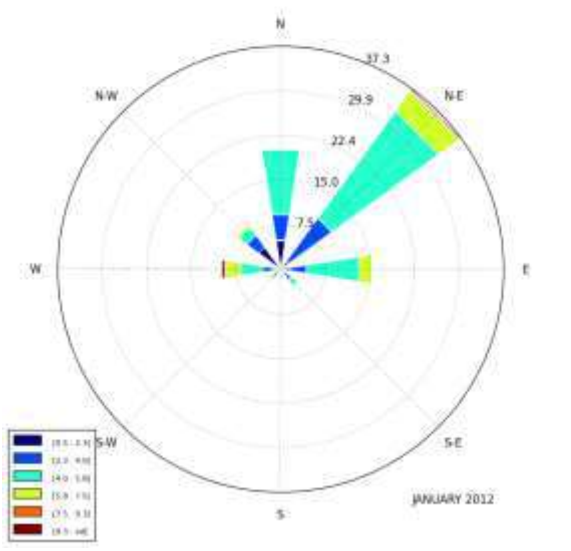


Fig.1.5 January 2012 winds

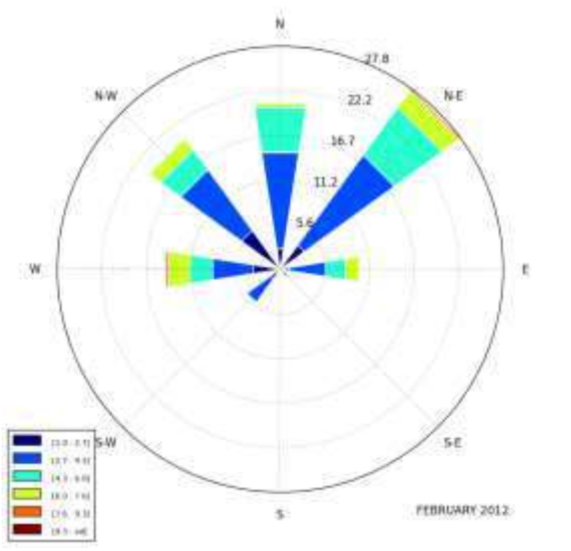


Fig.1.6 February 2012 winds

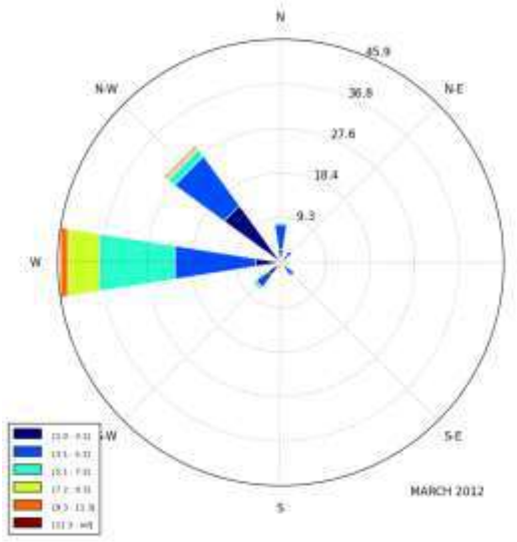


Fig.1.7 March 2012 winds

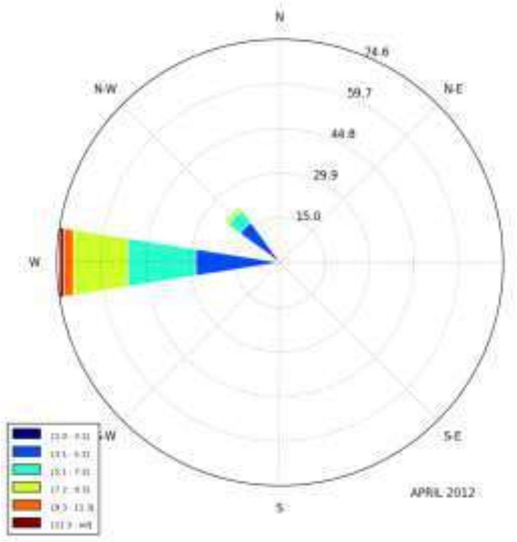


Fig.1.8 April 2012 winds

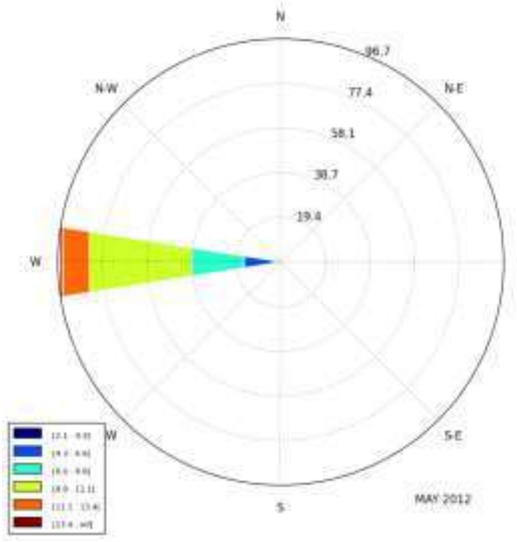


Fig.1.9 May 2012 winds

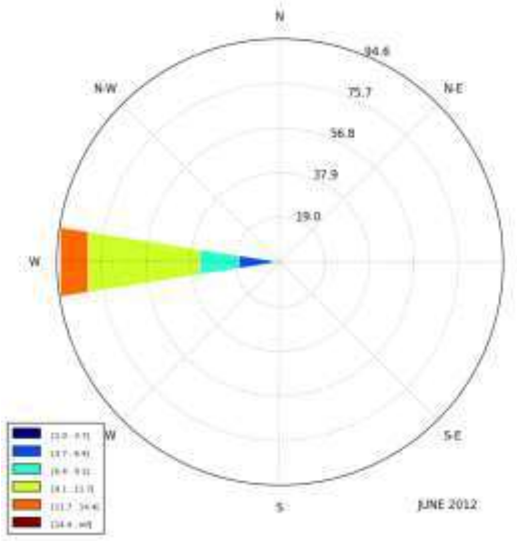


Fig.1.10 June 2012 winds

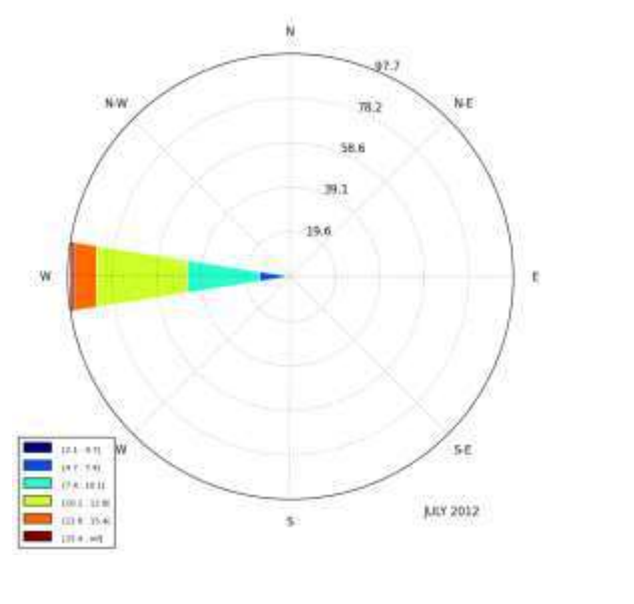


Fig.1.11 July 2012 winds

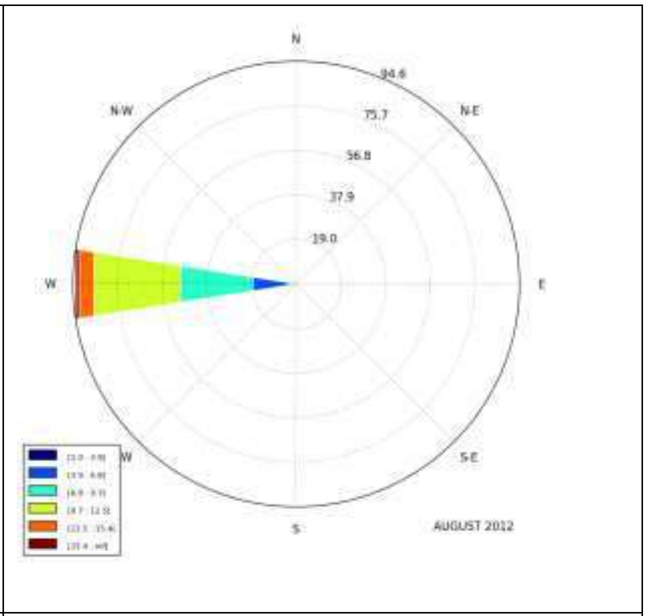


Fig.1.12 August 2012 winds

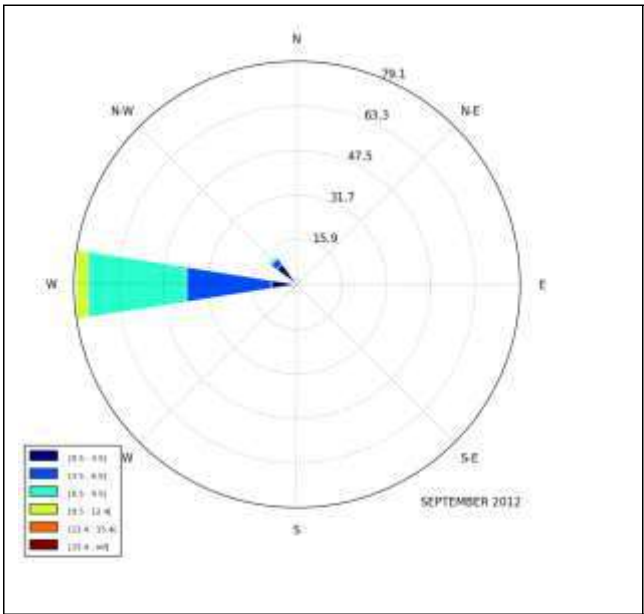


Fig.1.13 September 2012 winds

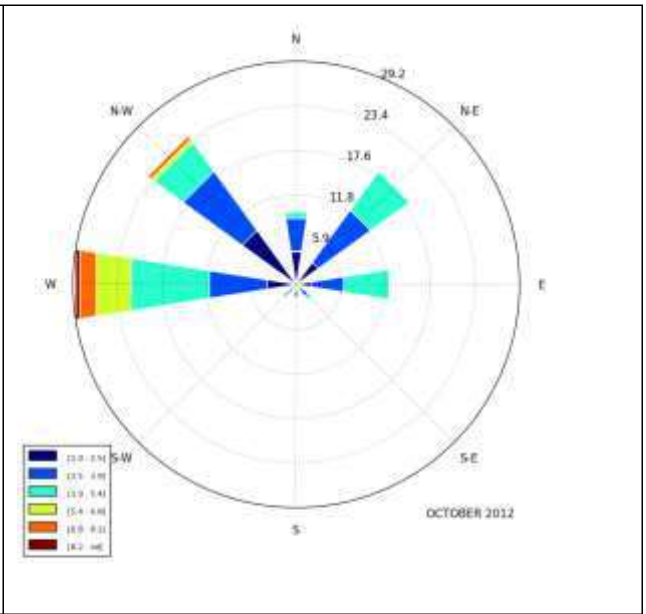


Fig.1.14 October 2012 winds

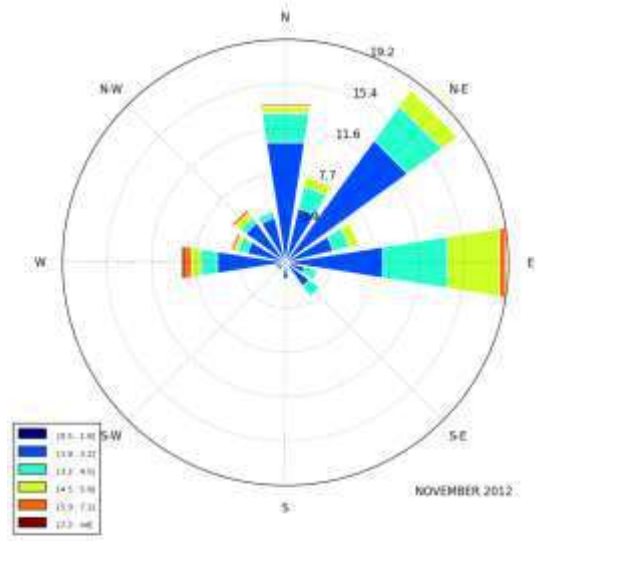


Fig.1.15 November 2012 winds

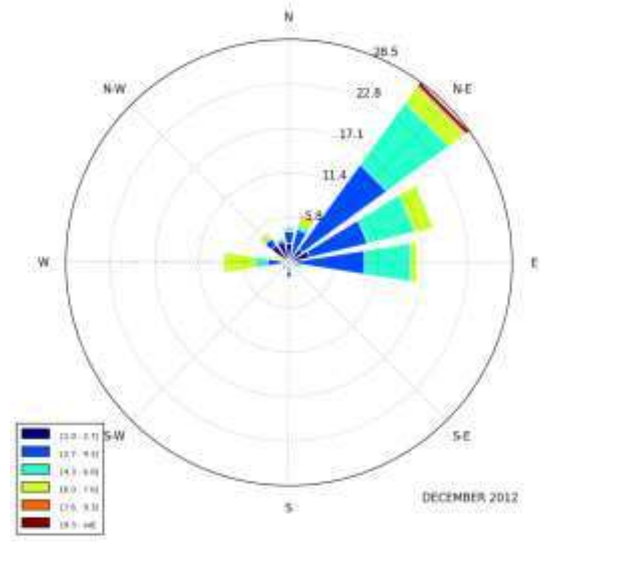


Fig.1.16 December 2012 winds

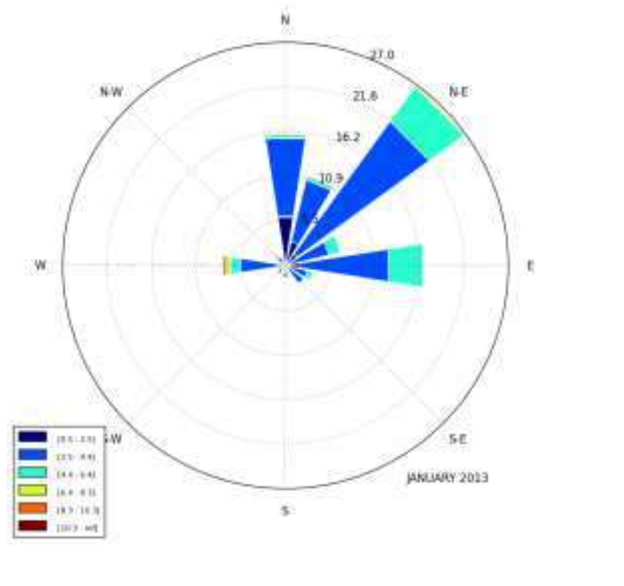


Fig.1.17 January 2013 winds

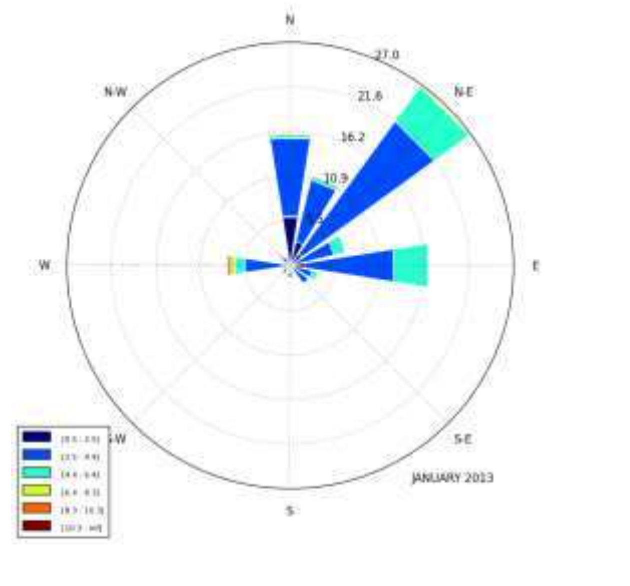


Fig.1.18 February 2013 winds

(Readings till Feb 18,2013)

Tides

The tidal planes were assessed in 1998 and are as shown in Table below.
The Highest Astronomical Tide (HAT) is estimated to be about +6.4 m above chart datum (CD), and the Lowest Astronomical Tide (LAT) to be at 0.0 m CD.

Tide	Height (m) above CD
Mean High Water Springs	5.8
Mean High Water Neaps	4.6
Mean Low Water Neaps	2.1
Mean Low Water Springs	1.0

Currents

Currents in the approaches to the port are dominated by the tidal flows, with predictable variations over diurnal, monthly and annual time scales. Currents in this part of the Gulf flow parallel to the natural sea-bed contours. Currents can be relatively strong, with speeds in excess of 3.0 Knots reported at sometimes of the year. The Admiralty Chart shows currents off Navinal point to be 3.0 Knots East & West bound. It is observed that the currents are usually aligned with the bed contours and are stronger in deeper waters off the coast. The impact of future development over the existing coast-line can be determined by the change in current speed resulting from the proposed developments.

Waves

In past HR Wallingford (HRW) has studied the wave climate considering wave energy from locally generated waves and swell propagating in to the Gulf of Kutch from the Arabian Sea. The results of the study carried out by HRW are presented in the Table below.

Design Waves at Mundra

Direction Sector (ºN)	**Return Period (years)**	**Inshore Direction (ºN)**	**Hs (m)**	**T2 (sec)**
210	1	222	1.2	5.0
	5	222	1.4	5.3
	20	221	1.6	5.8
	100	221	1.8	6.1
240	1	226	1.5	5.4
	5	226	1.7	5.8
	20	225	1.8	6.1
	100	225	2.0	6.5
270	1	239	1.4	5.5
	5	236	1.7	6.3
	20	236	1.8	6.7
	100	235	2.0	7.4
300	1	240	0.8	5.2
	5	240	0.9	5.6
	20	239	1.0	6.2
	100	238	1.2	6.7

Atmospheric stability is an important factor for predicting the dispersion characteristics of gases/vapours into the surrounding environment. Change in atmospheric stability is a direct consequence of the vertical temperature structure. The stability effects are mathematically represented through Pasqual parameters. The following stability classification is employed:

Stability Class	Atmospheric Condition
A	Very Unstable
B	Unstable
C	Slightly Unstable
D	Neutral
E	Stable
F	Very Stable

Condition of atmospheric stability is estimated by a suitable method that uses dispersion parameters viz., vertical temperature gradient, profile of the winds and roughness factor. The roughness factor for the Mundra area is small since it mainly comprises of plain land.

The following meteorological information has been taken in the calculations for the Mundra area (GMB-2010):

Average ambient temperature	: $30^{o}C$
Average wind speed	: Wind data for the whole year 2012 is available and is used
Stability condition	: F (Very Stable)

3 Information sources

This plan is prepared in accordance with:

a) Marine Environmental Impact Assessment of SPMs, COTs and connecting pipelines of APSEZL at Mundra dated February 2001, prepared by National Institute of Oceanography, Mumbai.

b) Report on Risk assessment study and On-site disaster management Plan for SPMs, COTs and connecting Pipelines of Adani Ports and Special Economic Zone Limited, by TATA AIG Risk Management Services Limited, dated February 2001.

c) HAZOP study report of SPM Terminal pipeline project by Intec Engineering, dated 26/02/2004.

d) IPIECA guide to Contingency planning for oil spills on water.

e) Oil spill risk assessment and contingency plan study done by M/s Environ Software Pvt. Ltd. (Copy enclosed)

ANNEXURES

INITIAL OIL SPILL REPORT		**ANNEXURE 1**
Particulars of person, office reporting		
Tel No.		
Date & time of incident		
Spill location		
Likely cause of spill		Witness
Initial response action		By
Any other information		

This FIR is to be sent to Marine Manager by fastest means of communication possible. It is an offence not to report oil pollution incident.

This FIR is to be followed by company's incident report also.

Following POLREP report to the Government through nearest CG information will also be required:

Identity of informant	
Time of FIR	
Source of spill	
Cause of spill	
Type of spill	
Colour code information (from CG)	
Radius of slick	
Tail	
Volume	
Quantity	
Weather	
Tide / current	
Density	
Layer thickness	
Air / Sea temp.	
Predicted slick movement	
Size of spill classification (Tier 1, 2 or 3)	

POLREP **ANNEXURE 2**

In case of an oil spill, APSEZ will provide information to Commandant Coast Guard District 1 Porbandar COMDIS 1 and Coast Guard Station Mundra in the following format:

SN.	Parameter	Data
1.	Identity of the informant	
2.	Time of information receipt	
3.	Source of Spill	
4.	Cause of Spill	
5.	Type of oil	
6.	Colour code information	
7.	Configuration	
8.	Radius	
9.	Tail	
10.	Volume	
11.	Quantity	
12.	Weathered or Fresh	
13.	Density	
14.	Viscosity	
15.	Wind	
16.	Wave Height	
17.	Current	
18.	Layer Thickness	
19.	Ambient air temperature	
20.	Ambient sea temperature	
21.	Predicted slick movement	
22.	Confirm Classification of spill size	

Additional Information :

LIST OF RESOURCES AVAILABLE **ANNEXURE 3**

Tugs Available for Oil Spill Containment

Name of Tug	Type	BHP	OSD	AFFF	Capacity (cubm/Hr)	BP
Dolphin No. 6	ASD	2200 X 2	3000 ltr	2000 ltr	1200	55
Dolphin No. 7	ASD	2200 X 2	3000 ltr	2000 ltr	1200	55
Dolphin No. 8	ASD	2200 X 2	3000 ltr	2000 ltr	1200	55
Dolphin No. 10	ASD	3000 X 2	3000 ltr	-	-	70
Dolphin No. 11	ASD (DSV)	2200 X 2	3000 ltr	2000 ltr	1200	55
Dolphin No. 12	ASD	3000 X 2	3000 ltr	2000 ltr	1200	70
Dolphin No. 14	ASD	3000 X 2	3000 ltr	2000 ltr	1200	70
Dolphin No. 15	ASD	3000 X 2	3000 ltr	2000 ltr	1200	70
Dolphin No. 16	ASD	3000 X 2	3000 ltr	2000 ltr	1200	70
Dolphin No. 17	ASD	3000 X 2	3000 ltr	-	-	70
Dolphin No. 18	ASD	3000 X 2	3000 ltr	2000 ltr	1200	70
Khushboo	Fixed screw	401 X 2	-	-	-	10

Dolphin No. 6, 7, 8, 10, 11, 12, 14,15,16 ,17& 18 are fitted with Oil Spill Dispersant boom and proportionate pump to mix OSD and Sea water as required. Dolphin No.2, 6, 7, 8, 11, 12, 14, 15, 16, 17 & 18 are fitted with a fire curtain and remote controlled fire monitors.

All above twelve Tugs have class notation as Harbour Tugs and are certified to work within the Harbour limits only.
Reception Facility : 12” pipe line, connected to a slop tank at chemical tank farm.

Dolphin 11 has fire fighting system of 1200 m3/hr along with 20 ton lifting “A” frame and diving support facility.

Location of Oil Spill Equipment: The Oil Spill Equipments are stored in SPM Store.

Resources / Equipment Available with APSEZL, Mundra

Item	Quantity
Canadyne Fence Boom (Reel model 7296/8496 with Power Pack, Towing bridles and Tow lines - 235 meter	1 no
Power pack with boom reel with hydraulic hoses	2 nos.
Power pack - 20 KV with boom reel with hydraulic hoses	2 nos.
Lamor Side Collector system (Recovery Capacity 123 m^3/ hr) (Side collector LSC-3C/2300(01CO2-P536). Oil transfer pump OT A 50 with oil transfer hose set	2 nos. 2 sets
Lamor Minimax 12 m^3 skimmer	2 sets
Power pack for skimmers with hydraulic hoses	4 nos.
Power pack - 20 KV for skimmers with hydraulic hoses	1 no.
Floating tank (25 m^3)	1 nos.
Foot pumps for floating tank	6 nos
Oil Spill Dispersants	5000 ltr
Portable dispersant storage tank: 1000 ltr capacity	1 no.
Portable pumps	2 nos.
Two – way hydraulic maneuvering panel	2 nos
Oil Containment Boom-Length 2000 metres, Height -1500 mm, Draft-900mm, Free Board-600mm	2000 mtr
Current Buster Boom-Fasflo -75 (for response in fast current)	2 Nos
Skimmer-KOMARA 15 Duplex Skimmer System with floating IMP 6 Pump.	4 Nos
12.5T Flexible Floating Storage Tank (PUA).	3 Nos
Diesel Driven Transfer Pump for Flex Barge	2 Nos
Site Hose Kit for the transfer Pump for the Flex Barge	2 Nos
3" & 2"Hose Adaptor for Transfer Pump and Hose	2 Nos
Shoreline Cleanup Equipment	
Mini Vac System	5 Nos
OSD Applicator- Oil Dispersant Spry Unit(20 Ltr) for use on Beach and Inter Tidal Zones	2 Nos
Startank with Capacity 10000 liter(10m^3)	2 Nos
Sorbent Boom Pack(12.5cm x4 M)	500 mtr
Sorbent pad	2000 Nos

Facilities in the Marine Control room:

1. Tidal stream gauge: This can accurately read the prevalent rate of flow and direction of current.
2. Tide gauge: For accurately calculating the height of tide at any given time.
3. Wind gauge: For direction and speed of wind.
4. VHF sets (fixed and portable) with complete range of marine frequencies to be used for field operations.

LIST OF TELEPHONE NUMBERS OF EXPERT ADVISORS **ANNEXURE 4**

List of Important Telephone Numbers of Govt. Officials and other neighboring Organisations (Expert and Advisors) related to Spill Combating Plan

SN.	Company	Name and Designation	Telephone Numbers
1.	APSEZL, Mundra	Chief Executive Officer Head Marine Pollution Response Officer Port Control	02838-61115 02838-255727 02838-255727 02838-255761 / 289170 (Fax)
2.	Kandla Port Trust	Chairman Dy. Conservator Harbor Master Signal Station	02836-233001 / 234601 02836-223585 / 220235 02836-270201 02836-270194 / 549
3	Indian Oil Corporation, Mundra	CM (Ops) Manager (Ops) Control Room	02838- 222194 02838- 222197 02838- 224444
4	Indian Oil Corporation, Vadinar	DGM (Ops) Manager Tech Services Port Control	02833-256527 02833-256464 02833-256555
5	Reliance Petroleum Ltd Jamnagar	Marine Chief Senior Port Captain Port Control	0288-4013607 0288-4013750 0288-4012600 / 4012610
6	The Commanding Officer Indian Coast Guard Station, Mundra	ICGS, Mundra Station Ops Officer	02838 - 271402 & 03 (Tel) 02838 – 271404 (Fax)
7	The Commander Coast Guard Region (North West), Gandhinagar	COMCG (NW) Regional Ops & Plans Officer	079-23243241 (Tel) 079-23243283 (Fax)
8	The Commander No.1 Coast Guard District (Guj), Porbandar	COMDIS-1 District Ops & Plans Officer	0286-2214422 (Tel) 0286-2210559 (Fax)
9	The Commander Coast Guard Region (West) Mumbai	COMCG (W) Regional Ops & Plans Officer	022-24376133 (Tel) 022-24333727 (Fax)
10	The Officer-in-Charge Coast Guard Pollution Response Team (West), Mumbai	PRT (W) Officer-in-Charge	022-23722438 (Tel) 022-23728867 (Fax)
11	Gujarat Maritime Board	Vice Chairman & CEO Chief Nautical Officer	079-23238346 / 23238363 079-23234716

12	Ministry of Environment Govt. of Gujarat	Director (Environment)	079-23252154 / 23251062 079-23252156 (Fax)
13	Gujarat Pollution Control Board	Environmental Engineer	079-232 22756 079-232 22784 (Fax)

List Of Important Telephone Numbers Of Adani Group Personnel

S.No.	Description / contact person / designation	Telephone Nos.	
		Landline	Mobile
01	Capt. Sansar Chaube, Head – Marine & PFSO, APSEZL	02838 - 255727	91 9925223674
02	Mr.Cherian Abraham, Dy. PFSO - (AICTPL)	91-2838 - 255733	9189800 48850
03	Capt. Kumar Paritosh, Dy. PFSO, ACMACGM	02838 – 255733	91 9879104839
04	Mr. Vilsan Kurian, Dy.PFSO, MICT	02838 – 252015	91 9879104805
05	Marine control, APSEZL	02838 – 255333 / 255761	91 9825228673
06	Port Operation center, APSEZL	02838 –255762	91 9825000949
07	Port security Control, APSEZL	02838 – 289322	91 9825000933
08	Head - Security, APSEZL	02838 – 289947	91 90999 99262
09	Head - Health, safety & Environment, APSEZL	02838 - 255777	91 7574894383
10	Head - Fire Dept. APSEZL	02838 – 255857	91 7069083035
11	Occupational Health Centre	02838 - 255710	91 8980015070

	Marine Officer/ SPM Mooring master	ANNEXURE 5
Responsibilities	• Observe or receive report of oil or chemical spill incident • Initiate measures to prevent/ reduce further spillage • Maintain communication with other all vessels	

Step	**Actions**	**Additional Information**
Alert	☐ (Marine Manager / On Scene Commander / SPM Pilot ☐ Tugs and other support/ response craft	*VHF Channel 73 / 77*
Initial Actions	☐ Stop all cargo operations ☐ Ensure all safety precautions taken/observed ☐ Verify incident details ☐ Advise all relevant information to (Marine Manager / On Scene Commander / or SPM Pilot ☐ Initiate personal log ☐ Place tugs/other response craft on stand-by	*Liaise with Terminal Shift Engineer*
Further Actions	☐ Brief (Marine Manager / On Scene Commander / SPM Pilot as necessary ☐ Mobilize response equipment/ personnel as directed by (Marine Manager / On Scene Commander / ☐ Maintain personal log of communications and events ☐ Act as instructed by (Marine Manager / On Scene Commander / SPM Pilot	
Final Actions	☐ Submit personal log to HOD – Marine ☐ Attend debrief	

	MARINE MANAGER / On Scene Commander	**ANNEXURE 6**
Responsibilities	• Initially assess situation • Verify classification • Verify fate of spill • Verify resources immediately at risk, inform parties • Provide accurate situation reports to Radio Room/ HOD – Marine • Collect evidence and/ or statements • Liaise with HOD-Health, Safety, Environment & Fire • Liaise with incident vessel regarding status of oil spill (if applicable)	

Step	**Actions**	**Additional Information**
Alert	HOD – Marine	
Initial Actions	☐ Proceed to incident location, assume role of On-Scene Coordinator ☐ Ensure all safety precautions have been taken ☐ Initiate response / ☐ Investigate cause/ source of spill ☐ Communicate all information to HOD – Marine ☐ Ensure samples of spilled oil taken ☐ Initiate personal log ☐ Take photographic evidence ☐ Collect evidence and take statements	*Stopped or ongoing*
Further Actions	☐ Ensure resources are being deployed as required ☐ Provide co-ordination at-sea response ☐ Provide detailed situation reports to HOD- Marine ☐ Liaise with -Health, Safety Environment & Fire Department.	
Final Actions	☐ Submit personal log to HOD – Marine ☐ Attend debrief	

	SPM Pilot	**ANNEXURE 7**
Responsibilities	• Initially assess situation • Verify classification • Provide accurate situation reports to Radio Room/ OSC • Collect evidence and/ or statements • Liaise with incident vessel regarding status of oil spill (if applicable)	

Step	**Actions**	**Additional Information**
Alert	☐ Marine Control Room ☐ OSC ☐ Tugs and other support / response crafts	*VHF Channel 73 / 77*
Initial Actions	☐ Assume role of On-Scene Coordinator ☐ Investigate cause/ source of spill ☐ Communicate all information to Marine Control Room ☐ Ensure samples of spilled oil taken ☐ Initiate personal log ☐ Take photographic evidence ☐ Collect evidence and take statements	*Stopped or ongoing*
Further Actions	☐ Ensure resources are being deployed as required ☐ Provide co-ordination of the at-sea response ☐ Provide detailed situation reports to HOD – Marine	
Final Actions	☐ Submit personal log to HOD – Marine ☐ Attend debrief	

	HOD – Marine	**ANNEXURE 8**
Responsibilities	• Confirm/ amend initial classification • Manage the APSEZL response • Authorize expenditure after consultation with COO APSEZL • Brief COO, APSEZL • Liaise with Coast Guard • Approve press statements for release	

Step	**Actions**	**Additional Information**
Alert	☐ Coast Guard ☐ External organizations	
Initial Actions	☐ Verify/ amend spill classification ☐ Ensure all safety precaution have been taken ☐ Confirm external organizations have been alerted ☐ Convene Emergency Response Team ☐ Predict slick movement ☐ Liaise with vessel Agents/ Owners as appropriate	
Further Actions	☐ Chair the Emergency Response Team meetings ☐ Constantly review the strategy being employed and advise of changes where necessary ☐ Approve all expenditure commitments ☐ Brief President APSEZ ☐ Agree press statements with Corporate Relations Chief ☐ Confirm formal samples have been taken ☐ Advise Coast Guard if oil migrates outside of Local Area	
Final Actions **Final Actions (contd.)**	☐ Terminate the clean-up ☐ Collate personal logs. ☐ Prepare the incident report. ☐ Hold full de-brief involving all members. ☐ Amend contingency plan as required. ☐ General Report to President	

OIL SPILL PROGRESS REPORT	**ANNEXURE 9**
Incident Name:	
Updated by:	
Date:	**Time (local):**
Summary of Incident Response Operations:	
Summary of Incident Response Resource Utilization:	
Number of Aircraft:	Number of Vessels:
Dispersant Used: Liters	Length of Booms in Use: m
Number of Recovery Devices:	Number of Storage Devices:
Sorbent Used: kg	Bio-remediation Used: kg
Number of Personnel:	Number of Vehicles:
Specialist Equipment:	
Oil Spill Balance Sheet:	
Total amount of oil spilled:	Tons
Total amount of oil recovered:	Tons
Outstanding amount of spilled oil:	Tons
Mass balance:	
Estimated Natural Weathering:	Tons
Mechanically agitated:	Tons
Chemically dispersed:	Tons
Skimmer recovered:	Tons
Sorbent recovered:	Tons
Manually recovered:	Tons
Bio-remediated:	Tons
Other:	Tons

Emergency Response Log	**ANNEXURE 10**
Page Number:	**Date:**
Name:	**Position:**
Contact Number	**Signature:**

Time	Activity Completed:

Control Room Officer **HOD – Marine**

Classification of Oil	**ANNEXURE 11**

Group 1 oils

A: °API > 45 (Specific gravity < 0.8)
B: Pour point °C
C: Viscosity @ 10–20°C: less than 3 CSt
D: % boiling below 200°C: greater than 50%
E: % boiling above 370°C: between 20 and 0%

	A	B	C	D	E
Aasgard	49	-28	2 @ 10°C	58	14
Arabian Super Light	51	-39	2 @ 20°C		
Cossack	48	-18	2 @ 20°C	51	18
Curlew	47	-13	2 @ 20°C	57	17
F3 Condensate	54	<-63	1 @ 10°C	81	0
Gippsland	52	-13	1.5 @ 20°C	63	8
Hidra	52	-62	2.5 @ 10°C	60	11
Terengganu condensate	73	-36	0.5 @ 20°C	>95	0
Wollybutt	49	-53	2@ 20°C	55	4
Gasoline	58		0.5 @ 15°C	100	0
Kerosene	45	-55	2 @ 15°C	50	0
Naptha	55		0.5 @ 15°C	100	0

Group 2 oils

A: °API 35–45 (Specific gravity 0.8–0.85)
B: Pour point °C
C: Viscosity @ 10–20°C: between 4 Cst and semi-solid
D: % boiling below 200°C: between 20 and 50%
E: % boiling above 370°C: between 15 and 50%

Low pour point <6°C	A	B	C	D	E
Arabian Extra Light	38	-30	3 @ 15°C	26	39
Azeri	37	-3	8 @ 20°C	29	46
Brent	38	-3	7 @ 10°C	37	33
Draugen	40	-15	4 @ 20°C	37	32
Dukhan	41	-49	9 @ 15°C	36	33
Liverpool Bay	45	-21	4 @ 20°C	42	28
Sokol (Sakhalin)	37	-27	4 @ 20°C	45	21
Rio Negro	35	-5	23 @ 10°C	29	41
Umm Shaif	37	-24	10 @ 10°C	34	31
Zakum	40	-24	6@ 10°C	36	33
Marine Gas oil (MGO)	37	-3	5 @ 15°C		
High pour point >5°C					
Amna	36	19	Semi–solid	25	30
Beatrice	38	18	32 @ 15°C	25	35
Bintulu	37	19	Semi–solid	24	34
Escravos	34	10	9 @ 15°C	35	15
Sarir	38	24	Semi–solid	24	39
Statfjord	40	6	7 @ 10°C	38	32

Group 3 oils

A: °API 17.5–35 (Specific gravity 0.85–0.95)
B: Pour point °C
C: Viscosity @ 10–20°C: between 8 CSt and semi solid
D: % boiling below 200°C: between 10 and 35%
E: % boiling above 370°C: between 30 and 65%

Low pour point <6°C	A	B	C	D	E
Alaska North Slope	28	-18	32 @ 15°C	32	41
Arabian Heavy	28	-40	55 @ 15°C	21	56
Arabian Medium	30	-21	25 @ 15°C	22	51
Arabian Light	33	-40	14 @ 15°C	25	45
Bonny Light	35	-11	25 @ 15°C	26	30
Iranian Heavy	31	-36	25 @ 15°C	24	48
Iranian Light	34	-32	15 @ 15°C	26	43
Khafji	28	-57	80 @ 15°C	21	55
Sirri	33	-12	18 @ 10°C	32	38
Thunder Horse	35	-27	10 @ 10°C	32	39
Tia Juana Light	32	-42	500 @ 15°C	24	45
Troll	33	-9	14 @ 10°C	24	35
IFO 180	18–20	10–30	1,500–3,000 @ 15°C		-
High pour point >5°C					
Cabinda	33	12	Semi–solid	18	56
Coco	32	21	Semi–solid	21	46
Gamba	31	23	Semi–solid	11	54
Mandji	30	9	70 @ 15°C	21	53
Minas	35	18	Semi–solid	15	58

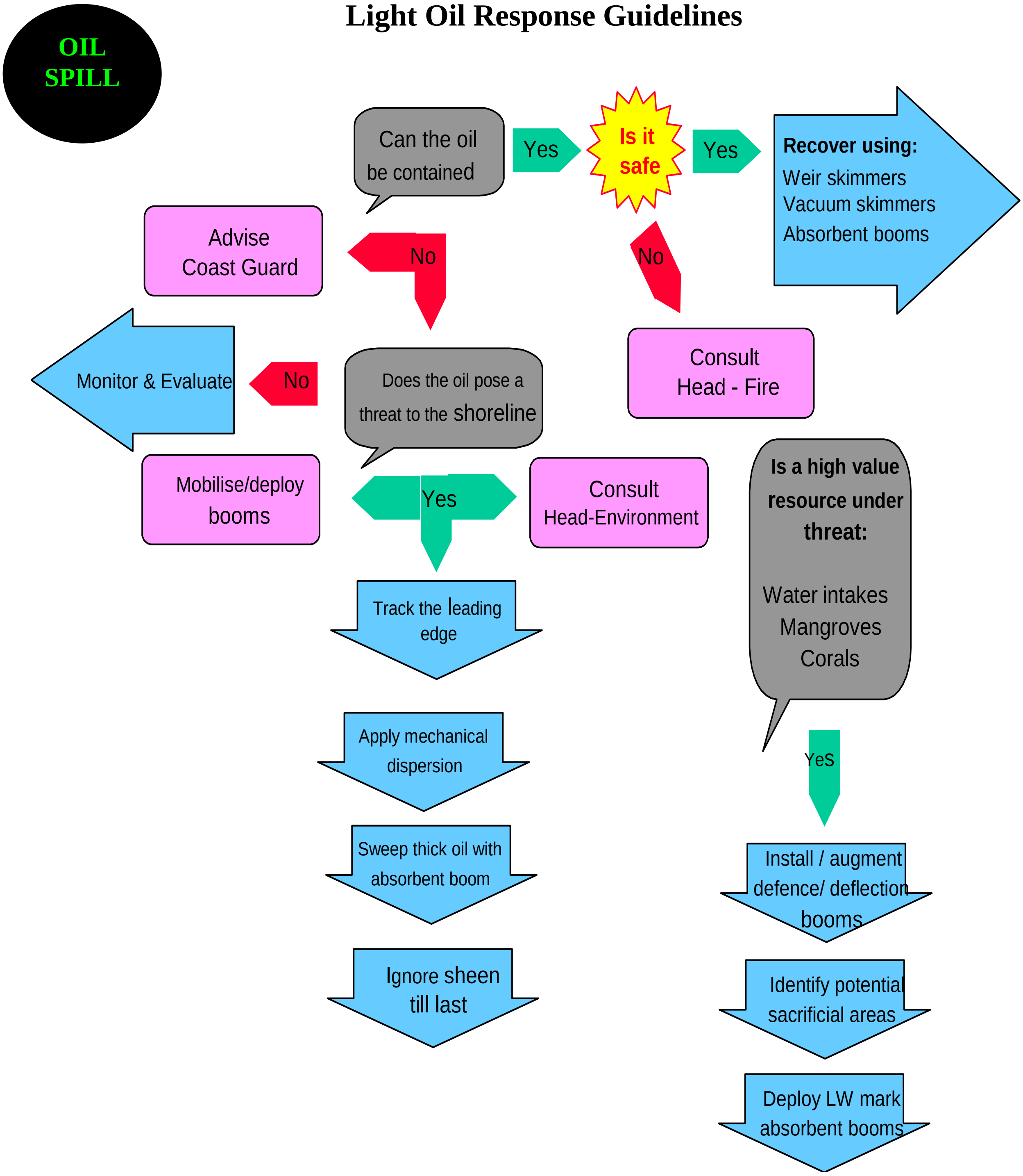
Group 4 oils

A: °API <17.5 (Specific gravity >0.95) or
B: Pour point >30°C
C: Viscosity @ 10–20°C: between 1500 CSt and semi-solid
D: % boiling below 200°C: less than 25%
E: % boiling above 370°C: greater than 30%

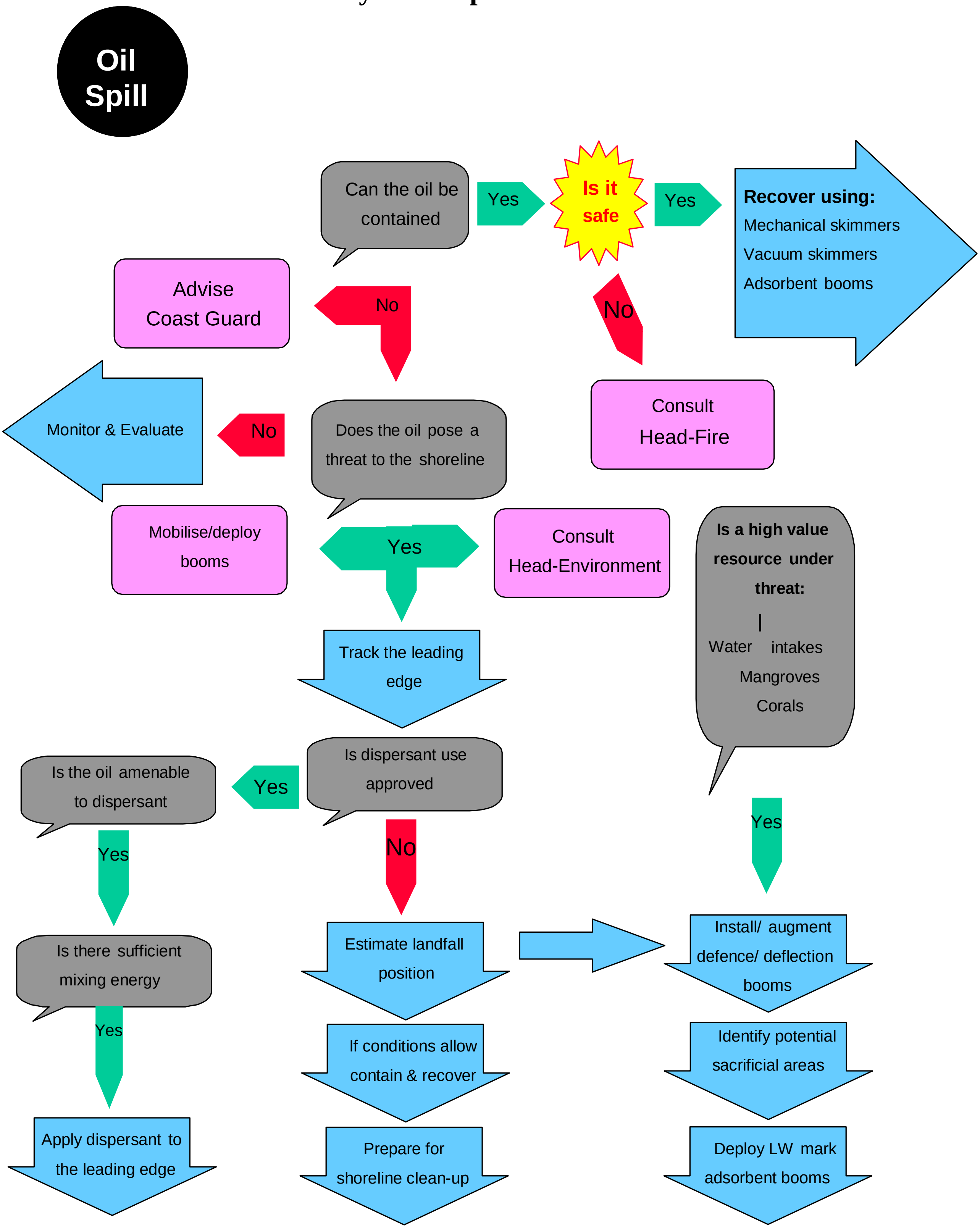
	A	B	C	D	E
Bachaquero 17	16	-29	5,000 @ 15°C	10	60
Boscan	10	15	Semi –solid	4	80
Cinta	33	43	Semi –solid	10	54
Handil	33	35	Semi –solid	23	33
Merey	17	-21	7,000 @ 15°C	7	70
Nile Blend	34	33	Semi–solid	13	59
Pilon	14	-3	Semi–solid	2	92
Shengli	24	21	Semi–solid	9	70
Taching	31	35	Semi–solid	12	49
Tia Juana Pesado	12	-1	Semi–solid	3	78
Widuri	33	46	Semi–solid	7	70
IFO 380	11–15	10–30	5,000–30,000 @ 15°C		

Response Guidelines	ANNEXURE 12

Light Oil Response Guidelines



Heavy Oil Response Guidelines



Site Specific Health and Safety Plan **ANNEXURE 13**

Assessment Form

1. APPLIES TO SITE :					
2. DATE :		**3. TIME :**		**4. INCIDENT :**	
5. PRODUCT(S) :				(Attach MSDS)	
6. Site Characterization					
6a. Area	☐ Open water	☐ Inshore water	☐ River / Creek	☐ Salt marsh	☐ Mudflats
	☐ Shoreline	☐ Sand	☐ Shingle	☐ Intake Channel	
6b. Use	☐ Commercial	☐ Industrial	☐ Public	☐ Government	☐ Recreational
	☐ Residential	☐ Other			

7. Site Hazards			
	☐ Boat safety	☐ Fire, explosion, in-situ burn	☐ Slips, trips and falls
	☐ Chemical hazards	☐ Heat stress	☐ Steam and hot water
	☐ Drum handling	☐ Helicopter operations	☐ Tides
	☐ Equipment operations	☐ Lifting	☐ Trenches, excavations
	☐ Electrical hazards	☐ Motor vehicles	☐ Visibility
	☐ Fatigue	☐ Noise	☐ Weather
	☐ Others	☐ Overhead/buried utilities	☐ Work near water
	☐	☐ Pumps and hoses	

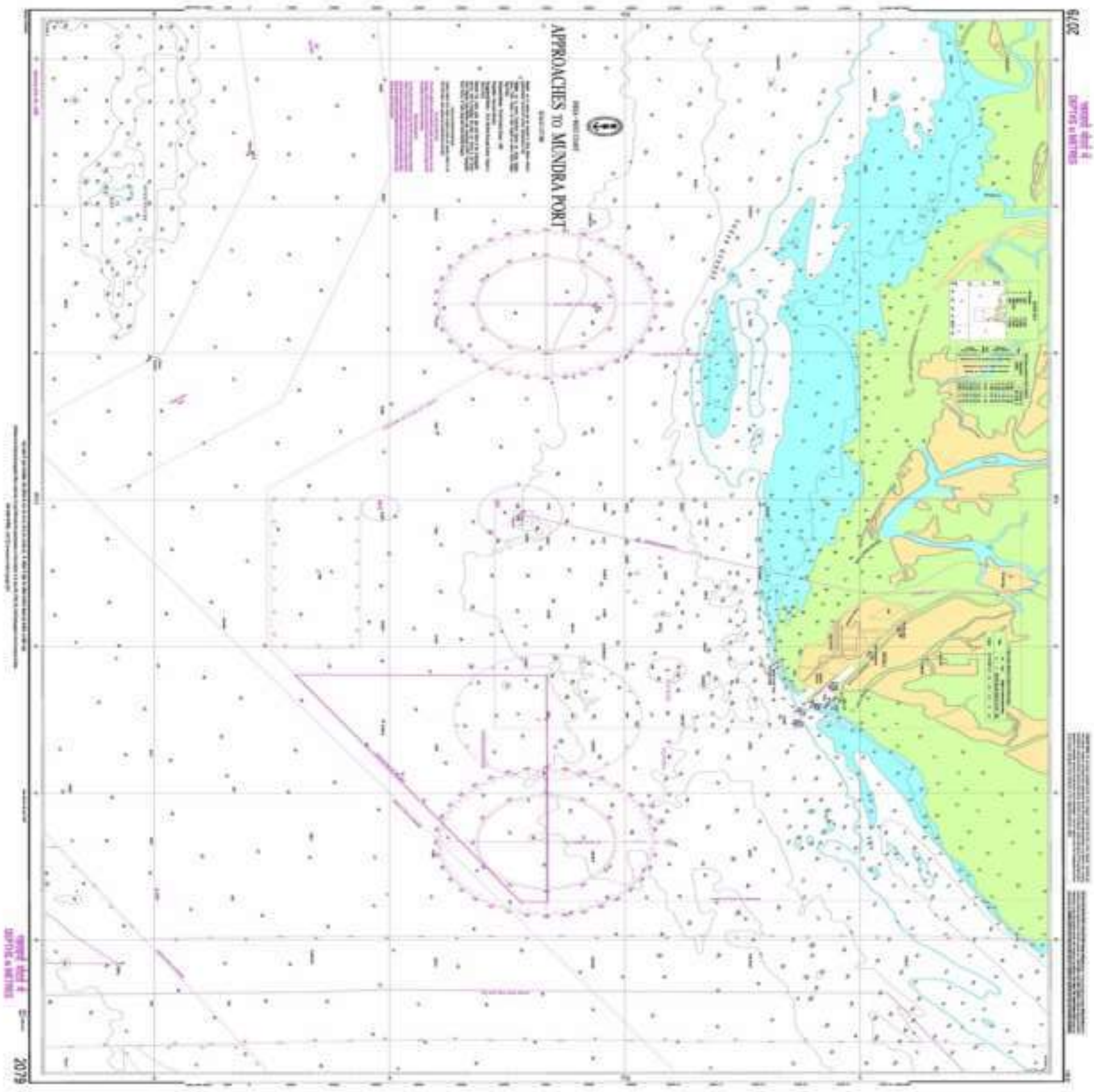
8. Air Monitoring										
	☐ O_2		☐ LEL		☐ Benzene		☐ H_2S		☐ Other	

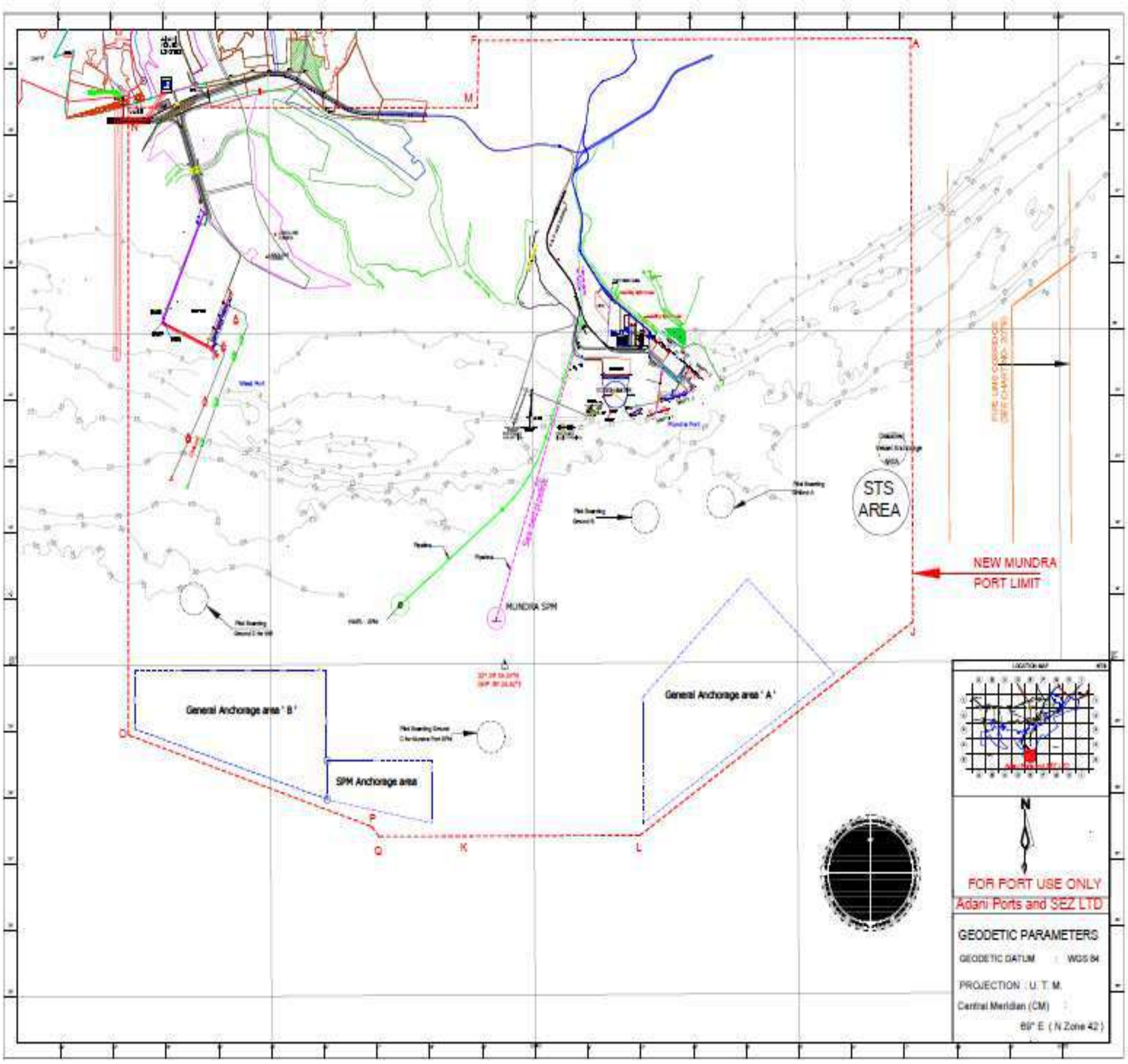
9. Personal Protective Equipment			
☐ Foot Protection		☐ Coveralls	
☐ Head Protection		☐ Impervious suits	
☐ Eye Protection		☐ Personal Floatation	
☐ Ear Protection		☐ Respirators	
☐ Hand Protection		☐ Other	

10. Site Facilities		
☐ Sanitation	☐ First Aid	☐ Decontamination

11. Contact details :			
☐ Doctor		Phone	
☐ Hospital		Phone	
☐ Fire		Phone	
☐ Police		Phone	
☐ Other		Phone	
12. Date Plan Completed			
13. Plan Completed by			

Indian Chart 2079	**ANNEXURE 14**




STS
AREA
NEW MUNDRA
PORT LIMIT
MUNDRA SPM
General Anchorage area ' B '
General Anchorage area ' A '
SPM Anchorage area
FOR PORT USE ONLY
Adani Ports and SEZ LTD
GEODETIC PARAMETERS
GEODETIC DATUM : WGS 84
PROJECTION : U. T. M.
Central Meridian (CM) :
69° E (N Zone 42)

List of recycler approved by state of Gujarat	ANNEXURE 15

LIST OF APPROVED VENDOR FOR COLLECTION & DISPOSAL OF OIL SPILL WASTE WATER AND OILY SOIL

Sr No.	Name of the party & Contact Detail	Date of Issue of Passbook alongwith validity	Capacity
1	M/s Jawrawala Petroleum, Plot No: 200/33, B/H Kashiram Textile Mill, Narol, Ahmedabad – 382405 Contact Detail - (079) - 25358099 (M) +91 9824045726	18/09/2012 to 17/09/2017	1. 4800 KLPA - Used Oil 2. 9000 KLPA – Waste Oil
2	M/s Reliance Barrel Supply co., 200/34, B/H-Kashiram Mill, Narol, Ahmedabad-382405 Contact Detail - (079) - 25356629 (M) +91 9824090021	03/09/2014 to 02/09/2019	1. 8280 KLA - Used Oil 2. 9000 KLA – Waste Oil
3	M/s Western India Petrochem Industry, Plot No-50, 51, GIDC Estate, Village Gozaria, Dist-Mehsana. Contact Detail - Tel:+91- 278- 420941 Fax:+91- 278- 429503	25/07/2014 to 24/07/2019	1. 3660 KLPA – Used oil 2. 11100 KLPA – waste oil
4	M/s Saurashtra Enviro Projects Pvt. Ltd.(SEPPL) 3rd Floor,K.G.Chambers, Udhana Darwaja, Ring Road, Surat, Gujarat, India-395002 Contact Detail - +91 261 2351248	TSDF Site	3,95,000 MT (Landfilling) + 7.50 Million Kcal/Hr. (Incineration)
5	M/s Bharuch Enviro Infrastructure Ltd, Ankleshwar Contact Detail - Phone 91-2646-253135 Fax 91-2646-222849	TSDF Site	23,00,000 MT (Landfilling) + 120 MT/Day (Incineration)
6	M/s Nandesari Environment Control Ltd. Nandesari, Vadodara, Contact Detail – Phone 265 – 2840818 Fax 265 – 2841017	TSDF Site	3,00,000 MT (Landfilling) + 700 Kg/Hr. (Incineration)

LIST OF AGENCY FOR SUPPORT & GUIDANCE FOR RESCUE & REHABILITATION OF OILED BIRD & MANGROVES MANAGEMENT DURING OIL SPILL	ANNEXURE 16

Sr No.	Name of the party & Contact Detail	Contact Person	Contact Detail	Activity
1	Gujarat Institute of Desert Ecology P.O Box No. #83, Opp. Changleshwar Temple, Mundra Road Bhuj - 370001 Gujarat – India.	Dr. Thivakaran	EMAIL: desert_ecology@yahoo.com FAX: 02832-235027 02832-235025	Restoration of Mangroves
2	Kalapoornasuri Karunadham Karunadham Hospital, At – Shedata, Bhuj, Kucth		(M) 9925020776	Rescue of oil socked birds / animals and medical treatment facility
3	Anchorwala Ahinshadham Bhagwan Mahavir Pashu Raksha Kendra, Pragpar, Mundra, Kutch.		Phone (02838) 22352	Rescue of oil socked birds / animals and medical treatment facility
4	**ASHA Foundation** C/182, Ashoknagar, Opposite ISRO Satellite, Ahmedabad – 380015, Gujrat, India.	Lalubhai	Phone: 09824037521 ,09879877281 Email: ashahmedabad@yahoo.co.in Website: www.ashafoundationindia.org	Rescue of oil socked birds / animals and medical treatment facility

Terms, definitions and abbreviations used in this plan

APSEZL	Adani Ports and Special Economic Zone Ltd.
COO	Chief Operating Officer
DGM	Deputy General Manager
DGS	Directorate General of Shipping
ENGR.	Engineer
ESD	Emergency Shut Down
FIR	First Information Report
FO	Furnace Oil
GMB	Gujarat Maritime Board
GPCB	Gujarat Pollution Control Board
HOD	Head Of Department
HQ	Head Quarters
HSD	High Speed Diesel
ICG	Indian Coast Guard
IMO	International Maritime Organization
IPMS	Integrated Port Management System
KPT	Kandla Port Trust
LWS	Low Water State
MCLS	Maximum Credible loss scenario
MMD	Mercantile Maritime Deptt.
MOEF	Ministry of Environment & Forest
MSDS	Material Safety Data Sheets
NOS DCP	National Oil Spill Disaster Contingency Plan
OSC	On Scene Commander
PLEM	Pipe line end manifold
POLREP	Pollution Report
PPE	Personal Protective Equipment
PR	Public Relations Officer
R/O	Radio Officer
SKO	Super Kerosene Oil

Certificate of Endorsement

(To be certified personally by an officer not below the post of Deputy Conservator of a port facility or the Installation Manager of an oil installation, or offshore installation, or equivalent legally responsible authority)

I hereby certify that:

1 The oil spill contingency plan for the facility under my charge has been prepared with due regard to the relevant international best practices, international conventions, and domestic legislation.

2. The nature and size of the possible threat including the worst case scenario, and the resources consequently at risk have been realistically assessed bearing in mind the probable movement of any oil spill and clearly stated.

3. The priorities for protection have been agreed, taking into account the viability of the various protection and clean-up options and clearly spelt out.

4. The strategy for protecting and cleaning the various areas have been agreed and clearly explained.

5. The necessary organization has been outlined, the responsibilities of all those involved have been clearly stated, and all those who have a task to perform are aware of what is expected of them.

6. The levels of equipment, materials and manpower are sufficient to deal with the anticipated size of spill. If not, back-up resources been identified and, where necessary, mechanisms for obtaining their release and entry to the country have been established.

7. Temporary storage sites and final disposal routes for collected oil and debris have been identified.

8. The alerting and initial evaluation procedures are fully explained as well as arrangement for continual review of the progress and effectiveness of the clean-up operation.

9. The arrangements for ensuring effective communication between shore, sea and air have been described.

10. All aspects of plan have been tested and nothing significant found lacking.

11. The plan is compatible with plans for adjacent areas and other activities.

12. The above is true to the best of my knowledge and belief.

13. I undertake to keep the plan updated at all times and keep the Indian Coast Guard informed of any changes through submission of a fresh certificate of endorsement.

Seal:

Signature:

Name: Capt. Sansar Chaube

Designation: Head - Marine

Organisation: Adani Ports and SEZ Ltd, Mundra

Place: Mundra

Date: 29 Aug 2017

Appendix E5 to NOS DCP 2015

(Para 4.5 refers)

Contingency Planning Compliance Checklist

Name of the Port/ Oil Handling Agency	Adani Ports and SEZ Limited, Mundra

	DESCRIPTION	Complied Yes/No	Remarks
Risk Assessment			
1.	Whether the facility produces / handles / uses / imports / stores any type of petroleum product.	Yes	**(Ref. OSCRP 2.2)**
2,	Whether risk assessment is done	Yes	**(Ref. OSCRP 2.0)**
3.	Who did the risk assessment	Yes	Environ Software (P) Ltd. & APSEZ
4.	Whether maximum volume of oil spill that can occur in the worst case scenario is considered.	Yes	**(Ref. OSCRP 2.4)**
5.	Whether relative measures of the probability and consequences of various oil spills including worst case scenario are taken into account.	Yes	**(Ref. OSCRP 2.4)**
6.	Whether all types of spills possible in the facility are considered including grounding, collision, fire, explosion, Rupture of hoses.	Yes	**(Ref. OSCRP 2.3 & 2.4)**
7	Please specify the list of oils considered for risk assessment	Yes	**(Ref. OSCRP 2.2)**
8	Whether the vulnerable areas are estimated by considering maximum loss scenario and weather condition	Yes	**(Ref OSCRP 2.1 Computational Scenarios)**
9	Whether impacts on the vulnerable areas are made after considering the marine protected areas ,population ,fishermen ,saltpans ,mangroves ,corals, and other resources within that area	Yes	**(Ref. OSCRP 2.6)**
10	Whether measures for reduction of identified high risk are included by reducing the consequences through spill mitigation measures	Yes	**(Ref. OSCRP 1.4, 2.3, 2.6. 3 & 5)**
11	Whether steps have been considered to reduce risks to the exposed population by increasing safe distances by acquiring property around the facility ,if possible	NA	All facilities developed within SEZ keeping safe distances from the exposed population.
12	Whether risk levels are established for each month after considering the probability with tide and current and consequences of each such spill	Yes	**(Ref. OSCRP 2.1 computational scenarios & 2.3)**
13	Whether prevention and mitigation measures are included in the plan	YES	**(Ref. OSCRP 4.0, 7.0, 8.0 & 9.0)**
14	Whether the spill may affect the shoreline.(length of the shoreline with coordinated)	Yes	**Ref. OSCRP 2.3 & 2.6)**
15	Whether time taken the oil spill to reach ashore in each quantity of spill in various month are mentioned in the plan	Yes	**(Ref. OSCRP 2.3)**
16	Whether sensitivity mapping has been carried out	Yes	**(Ref. OSCRP 2.5)**
17	Does the sensitivity mapping clearly identify the vulnerable areas along with MPAs, corals fishermen community, saltpans, mangroves and other socio-economic elements in the area	Yes	**(Ref. OSCRP 2.5 & 2.6)**

18	Do the sensitivity maps indicate area to be protected on priority	Yes	**(Ref. OSCRP 2.6)**
19	Does the maps indicate boom deployment locations	NA	Booms not deployed permanently
20	Whether any marine protected area will be affected	YES	**(Ref. OSCRP 2.5 & 2.6)**
21	Whether total number of fishermen likely to affected is mentioned in the plan	Yes	**(Ref. OSCRP 2.6)**
22	Whether any saltpan in the area is going to be affected	Yes	**(Ref. OSCRP 2.6)**
23	Whether any mangroves in the area will be affected by a spill	Yes	**(Ref. OSCRP 2.6)**
Preparedness			
24	whether any containment equipment is available	Yes	**(Ref. OSCRP Annex 3)**
25	Whether any recovery equipment is available	Yes	**(Ref. OSCRP Annex 3)**
26	Whether the facility is having any temporary storage capacity	Yes	**(Ref. OSCRP Annex 3)**
27	Whether location of the oil spill response equipment is mentioned in the plan	Yes	Has been included in Annex 3
28	Whether suitable vessels available for deploying the boom skimmer etc.	Yes	**(Ref. OSCRP Annex 3)**
29	Whether OSD held with facility	Yes	**(Ref. OSCRP Annex 3)**
30	Whether the OSD held with the facility is approved for use in Indian waters	Yes	
31	Whether the facility has MoU with other operator for tier -1 preparedness	Yes	**(Ref. OSCRP 1.4)**
32	Whether the list of oil spill response equipment available with each agency in deliberation	Yes	MoU document
33	Whether the facility has any MoU with private OSRO	NA	Port itself is equipped to deal with oil spill emergencies
34	Whether the procedure for evoking the mutual aid is clearly described in the plan	Yes	**(Ref. OSCRP 1.4)**
35	Whether additional manpower is available	Yes	**(Ref. OSCRP 5.4)**
36	Whether list of approved recyclers is mentioned in the plan	Yes	List of recycler approved by state of Gujarat is included in Annexure 15.
37	Whether NEBA (net environmental Benefit Analysis) has been undertaken	Yes	Before commissioning of any new project, various environmental aspects with their positive or adverse impact is considered under EIA Environment Impact Assessment stage.
38	**Whether the areas from priority protection have identify in the plan**	YES	**(Ref. OSCRP 2.5 & 2.6)**
39	Whether relevant authorities and stakeholder were consulted for NEBA and during the areas for property protection	Yes	Before commissioning of any new project Environment Impact Assessment & Public consultation is carried out, in which relevant authorities & stakeholders

			were consulted.
40	Whether district administration has been appraised of the risk impact of oil spills?	Yes	District Level Disaster Management Plan is prepared and regularly updated at district level by District Collector of Kutchh. Under DMP Oil spillage contingency is identified as risk. During preparation & updating of disaster management plan, District Level Authority organises & compiles information from various industries of kutchh. APSEZL is regularly participating in the same & providing necessary information to district level administration.
Action Plan			
41	Whether the plan outlines procedure for reporting of oil spill to coast guard	Yes	**(Ref. OSCRP 7.3)**
42	Whether the oil spill response action is clearly mentioned	Yes	**(Ref .OSCRP 3.1 to 3.6)**
43	Whether the action plan include all duties to be attended in connection with an oil spill	Yes	**(Ref. OSCRP 3.4)**
44	Whether the action plan includes key personnel by their name and designation viz. C/C, S/C	Yes	**Ref. OSCRP Annexure-4**
45	Whether alternate coverage is planned to take care of the absence of a particular person [in cases where action plan is developed basic names]	Yes	**(Ref. OSCRP 5)**
46	Whether the plan includes assignment of all key coordinators viz.the communication controller ,safety coordinator ,Emergency management team, Administration and communication coordinator and safety coordinator	Yes	**(Ref. OSCRP 3.4)**
47	Whether contact directory containing numbers of key response and management personnel is intimated in the plan	Yes	Ref. OSCRP Annexture-4
48	Whether approved recyclers are identified for processing recovered oil and oily debris	Yes	List of approved recycler of Gujarat state is included in annexure 15. Membership of common disposal facility for disposal of oily debris is also attached annexure 16.
49	Whether the shoreline likely to be affected is identified	Yes	**(Ref. OSCRP 2.5 & 2.6)**
50	Whether final report on the incident is submitted to CGHQ as per NOS-DCP 2014	NA	**No incident**
51	Whether the spill incident and its consequences	NA	**No incident**

	are informed to fishermen and other NGOs for environment protection through media		
	Training and exercises		
52	Whether mock fire /emergency response drills are specified in the plan	Yes	**(Ref. OSCRP 5.6)**
53	Whether the mock drills cover all types of probable oil spill	Yes	
54	Whether the plan mentions list of trained manpower	Yes	**(Ref. OSCRP 5.6)**
55	Whether record for periodic mock drill are maintained in a well-defined format	Yes	
56	Whether the plan updated according to the finding in mock-drills and exercises	Yes	
	DESCRIPTION		
57	What is the frequency of updation /review of contingency plan?	Yes	As Per NOSDCP 2015
58	Periodicity of joint exercises with mutual aid partner	Yes	
59	Frequency of mock-drills for practice	Yes	**(Ref. OSCRP 5.6)**
60	Whether the records for periodic mock drills are maintained in a well-defined format	Yes	**(Ref. OSCRP 5.6)**
61	Whether the plan is updated according to the finding of mock-drills and exercises	Yes	
62	Frequency of updation /review of contingency plan	Yes	As Per NOSDCP 2015

I, hereby ,declare that the all information appended above and true and correct to my knowledge of belier

Date: 29 Aug 2017 Chief conservator /Installation manager

VERIFIED

Date: (District commander ICG)
or his representative

Date: (Regional commander ICG)
or his representative

Annexure – 10

Organogram of Environment Management Cell, APSEZ, Mundra