

SOUTH WEST PORT LTD.

Regd. Office : 1st Floor. Port Users Complex Marmugao Harbour, Goa - 403 803. India. Bandra (East), Mumbai - 400 051

CIN. : U45203GA1997PLC002369 Phone : 0832 - 252 3000 Fax : 0832 - 252 3006 Website : www.jsw.in

Date: 21.09.2017

To,

The Director (IA-III)

Infrastructure and Miscellaneous Projects & CRZ (Infra-2) Ministry of Environment, Forests & Climate Change (MoEF & CC) Indira Paryavaran Bhavan, Jor Bagh Road, New Delhi- 110 003

Sub: EIA Report Submission for Environmental and CRZ Clearance for proposed Terminal Capacity Enhancement at Berth 5A-6A of Mormugao Port by M/s South West Port Ltd., Goa [F. No. 10-5/2015-IA.III]

Ref: Minutes of 21st meeting of Expert Appraisal Committee (EAC) dated 04.09.2017.

Dear Sir,

This is with reference to the proposed project, and as desired by the expert appraisal committee, we are herewith submitting the following additional documents for your kind consideration and further appraisal.

- i. Certified compliance report issued by MoEFCC RO, Bangalore
- ii. Reply to the comments made by Conservation Action Trust (CAT)
- iii. Documents as per para 4.2 (i) of CRZ Notification, 2011.
 - a. Form I
 - b. Rapid EIA report (study report prepared as per the additional ToR and finalized after Public Consultation process)
 - c. Risk Assessment & Disaster Management Plan (as in the Rapid EIA Report)
 - d. CRZ map indicating HTL and LTL demarcation, CRZ-I, II, IV areas and Project Layout superimposed in 1:4000 scale prepared by IRS, Anna University Chennai
 - e. CRZ Landuse map covering 7km radius around the project site
 - f. No Objection Certificate from Goa State Pollution Control Board (GSPCB) *vide* consent no. 5/6013/13-PCB/11466

In this regard, we request that our proposal may kindly be appraised for the crz and environmental clearance and included in the forthcoming meeting of EAC.

Your kind consideration in this regard is solicited and highly obliged.

Thanking You. Sincerely Yours, for South West Port Ltd., Goa

Rashmi Ranjan Patra Vice President- Strategy & Planning

Corporate Office : JSW Centre. Bandra Kurla Complex, Bandra (East), Mumbai - 400 051

Phone : +91 22 4286 1000 Fax : +91 22 4286 3000 i. Certified Compliance Report issued by MoEFCC RO, Bangalore

GOVERNMENT OF INDIA Ministry of Environment and Forests (Regional Office, Southern Zone) Bangalore-34

MONITORING REPORT

F. No. EP/12.1/49/GOA

1	Name of the project	Const. of two multipurpose cargo berths (5-A & 6- A) in Mormugao Port on BOOT basis by M/s. South West Port Ltd (formerly ABG Goa Port Ltd)
2	Clearance letter No.& date	PD-26018/2/2000-PDZ (CRZ) dt.24.1.2001
3	Location: District & State / UT	Mormugoa port, Goa
4	Address for correspondence:	Mr Anthony Fernandes, Unit In-Charge South West Port Limited. 1st Floor, Port Users Complex Mormugao Harbour, Goa-403 803 Phone: 0832-2523000/002 Fax: 0832-2523006
5	Date of site visit for this report	01.06.2017
6	Date of previous visit(s) if any	23.01.2007 & 03.07.2008
7	Present status of the project	

The site visit was made to this port project along with Shri Anthony Fernandes, Unit In-Charge, Shri Patra and Jadhav, Manager (EHS) of South West Port Limited (SWPL) (formerly ABG Goa Port Ltd.).

Environmental Clearance: Environmental clearance for the development of berths Nos 5A & 6A were granted by the Ministry of Shipping (Port Wing) in the year 2001 (when it was with delegated power to grant EC). It was operational under Mormugao Port Trust subsequently taken over by South West Port Ltd (SWPL) on BOOT basis in 2004 and the commercial operations are started since February 2005.

Coal Handling: SWPL has developed fully mechanized cargo handling system along with state of the art dust suppression system, for handling the imported coking coal which included unloading of coal into hoppers, closed conveyors for coal transport, water sprinklers for dust suppression, cover for coal storage, auto loading in to the wagons etc. The house keeping is good. The compliance to different conditions of the environmental clearance is satisfactory.

Continuous Air Quality Monitoring: A continuous air quality monitoring station as per guidelines of Goa State Pollution Control Board has been installed and the data are sent to SPCB through MPT.

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Environment Cell: PA informed that MPT has set a separate Environmental Cell with person qualified in the filed of Environment. An Environmental person from SWPL is also part of the Cell.

The detailed point wise compliance status is given in this report. The Compliance is Satisfactory.

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(E.Thirunavukkarasu) Scientist 'D'

PART-II - Compliance Status in brief

Status of compliance to the Environmental clearance issued by the Ministry of Shipping (Ports Wing) for the Construction of two multipurpose cargo berths (5-A & 6-A) in Mormugao Port on BOOT basis by M/s. ABG Goa Port Ltd, issued vide Ref: No. PD-26018/2/2000-PDZ (CRZ) dt.24.1.2001

<u>No</u>	SPECIFIC CONDITIONS	<u>COMPLIANCE</u>
1	All constructions as per approval	Complied
2	Adequate infrastructure to labourers	Complied
3	Dredging operations with out adverse impact	Complied
4	Disposal site not to interfere with natural drainage	Complied
5	Adequate fire fighting system in place	Complied
. 6	Staff to be trained in crisis management	Complied
7	Development of green belt	Complied
8	Liquid waste management	Complied
9	Adequate noise control measures	Complied
10	Quality of treated effluents to confirm standards	Complied
11	Environment cell to be set up	Complied
12	Necessary leakage detection system be provided	No Liquid handled
13	Standby DG sets for fire fighting system	Complied
14	Third party inspection during construction	Complied
15	Full support to RO scientists for inspection	Complied
16	Adequate funds for safeguards	Complied
17	Implement the environment management plan	Complied



Part -III - Detailed Compliance status of specific conditions

All constructions & drawings must have the approval of the competent authority.

Construction activities have been completed and operational. PA produced the approval of Port authorities and consent order of SPCB.

ii Adequate infrastructure facilities to the workers during construction.

PA informed that adequate infrastructure facilities were provided to the workers during the construction.

iii Dredging operations to be restricted to the minimum without affecting water quality & marine environment.

PA informed that only maintenance dredging in Port is being done by Mormugao Port Trust as and when required and the dredged materials is disposed at the identified dump site.

iv Disposal sites for excavated material to be done in such a way it do not interfere with natural drainage.

The dredge material was disposed a the designated dump site in consultation with NIO Goa.

v Adequate fire fighting system should be in place.

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Fire fighting equipment including fire extinguishers have been installed at strategic locations and PA informed that they are getting support firefighting system from MPT fire Station and Goa Fire Brigade.

vi The staff posted in the sensitive zone to be properly trained in the implementation of Crisis management Plan prepared by the authorities.

The project authorities have informed that their staffs are periodically trained for safety precautions and crisis management. As per crisis management plans mock drills are conducted periodically. In the year 20016, mock drills were conducted on 16.02.2016 and 21.08.2016.

vii Development of green buffer with necessary species of plants.

PA has developed green belt within the available space and also informed that green belt developed in Dabolim airport road, Vasco road, and Vasco city.



viii Provision for collection, treatment and disposal of liquid waste from the ships.

PA informed that the collection, treatment and disposal of liquid waste from the ships is being done by Mormugao Port Trust. As per the information provided, the Mormugao Port Trust is having necessary facilities for the collection, treatment and disposal of liquid wastes from ships. These terminals handle only solid cargo. One settling tank is provided in the coal handling area to take care of the surface runoffs. PA has plan to provide covered shed for coal storage in near feature.

ix Adequate noise control measures to be in place

It was noted that personal noise control equipment like ear muffs are provided to the staff. PA informed that Mufflers, exhaust manifolds of Port equipment are regularly serviced. Noise level surveys are also conducted through competent agencies and readings revealed that the levels are within the limits.

x Quality of the treated effluents to confirm standards.

The project authorities are handling only coal and as such no effluents are generated.

xi An environmental cell to be set up with lab facilities for monitoring.

PA informed that MPT has set a separate Environmental Cell with person qualified in the filed of Environment. An Environmental person from SWPL is also part of the Cell.

PA has installed a continuous air monitoring station as per guidelines of Goa State Pollution Control Board and the data are sent to SPCB through MPT.

xii Necessary leakage detection devices with early warning system to be provided.

The project authorities have informed that this condition is not applicable as they are not handling any hazardous chemicals or fluids.

xiii Standby DG sets must be provided to ensure uninterrupted power supply to pump house and fire fighting systems.

Standby DG sets are in place

xiv Third party inspection during construction & operational phase with adequate insurance cover.

PA informed that Port assets are covered under General Insurance Port Package Policy



xv Full support to RO scientists for inspection.

Necessary assistance for monitoring was provided.

xvi Adequate fund provision for environmental safeguards

The project authorities allocated necessary funds to implement the environmental safeguards.

xvii Project authorities to follow mitigative measures as per the plans prepared and submitted

The project authorities have provided mitigative measures such as closed conveyors for coal transport, water sprinklers for dust suppression, cover for coal storage, auto loading in to the wagons etc.

(E.Thirunavukkarasu) Scientist 'D'

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ii. Reply to the comments made by Conservation Action Trust (CAT)

Point wise reply to the comments made by Conservation Action Trust, Mumbai

Project	Proposed Terminal Capacity Enhancement at Berth 5A-6A of Mormugao Port for Handling Coal And Coal Products, Iron Ore and Limestone including Unitised and Steel Products at Mormugao Port Trust, Mormugao, Goa		
Project No.	File No. 10-5/2015-IA-III, Proposal No. IA/GA/MIS/26758/2015		
Reference	Agenda item No. 21.2.23, Minutes of 21 st Meeting of Expert Appraisal Committee (Infra-2) for Projects related to All Ship Breaking Yard including Ship Breaking Unit, Airport, Common Hazardous Waste Treatment, Storage and Disposal Facilities, Ports and Harbours, Aerial Ropeways, CETPs, Common Municipal Solid Waste Management Facility, Building/Construction Projects, Townships and Area Development Projects held on 21-24 August, 2017 in the Ministry of Environment, Forest and Climate Change Indira Paryavaran Bhawan New Delhi 110 003 21 st August, 2017		

Sr.	Comments	Proponent's submissions
1.	The proposed project location should be mapped on the approved CZMP.	The proposed project is located within an operational, notified Major Port since 2004. No change in the waterfront component of the existing terminal is proposed.
		Tideline demarcation for the project has been carried out by M/s IRS, Anna University, Chennai in September, 2016. The same has been duly submitted as part of the CRZ Clearance process to the Goa CZMA and to the MoEFCC. CRZ NOC from GCZMA is obtained <i>vide</i> letter dated 18.08.2017.
2.	It is not clear if all the previous conditions granted to the facilities at Mormugao Port Trust have been complied or not. All the compliance and monitoring reports should be made available in the public domain.	M/s South west Port operates a Terminal inside the MPT premises under tenancy basis. The EC conditions granted to the Terminal (<i>vide'</i> letter dated 24 January, 2001) have been certified by the Regional Office, MoEFCC, Bangalore (<i>vide'</i> letter dated 13 June, 2017) and have been duly submitted to the MoEFCC for scrutiny.
3.	The Cumulative impact assessment of proposed project along with all the other existing and proposed projects in Mormugao should be carried out. All the reports should be made available in the public domain.	Environmental Impact Assessment for the proposed Terminal capacity enhancement by modernization has been carried out based on ToRs issued by the MoEFCC <i>vide'</i> their letter dated 19 th June, 2015. The project has completed Public Consultation process in April, 2017 following due procedure, <i>inter alia</i> , making the EIA Paports public as

		prescribed in the EIA Notification, 2006 (amended).
4.	The project proponent should furnish a copy of the Disaster Management Plan and the Maximum Credible Accident Scenario.	Risk Analysis and Disaster Management Plan is part of the EIA Report, Chapter 6.
5.	All the copies of consent to establish and consent to operate given by the Goa State Pollution Control Board should be provided with the Compliance and monitoring reports for the same.	Copies of Consent to Operate issued by Goa State Pollution Control Board and their respective compliances is being made available to the MoEFC.
6.	We would like to bring to your notice that the public hearing for the proposed project was held on 20 th March 2017 at Vasco Residency, Main Hall, Vasco. More than a thousand locals turned up for the public hearing to oppose the project. Due to space constraints, the public hearing was postponed.	No reply is solicited from the Project proponent.
7.	The public hearing was again conducted on 26 th April 2017 at Tilak Maidan, Vasco-da-Gama. We had submitted our written suggestions, questions, and comments via email on 18 th March 2017 and 24 th April 2017. We had also submitted a hard copy of our representations to the GSPCB authorities during the public hearing conducted on 26 th April 2017.	Replies to all written representations were duly submitted to the GSPCB on 10.06.2017, and is hoisted in GSPCB website. Replies to written representations received from Conservation Action Trust were covered in the replies at sr. no. 110.
8.	The copies of our comments and copy of our written submission acknowledged by GSPCB is attached for your ready reference.	No reply is solicited from the Project proponent.
9.	Despite this, our representations are not considered in the public hearing proceedings and we have not received response to our submissions. We have pointed this out via email dated 10 th August 2017. A copy of the same is also attached herewith.	Replies to all written representations were duly submitted to the GSPCB on 10.06.2017, and is hoisted in GSPCB website. Replies to written representations received from Conservation Action Trust were covered in the replies at sr. no. 110. The submissions is available for verification.
10.	The concerns raised by us during the public hearing have also apparently not been addressed.	Replies to all written representations were duly submitted to the GSPCB on 10.06.2017, and is hoisted in GSPCB website. Replies to written representations received from Conservation Action Trust were covered in the replies at sr. no. 110. The submissions is available for verification.
11.	There was a strong opposition to the proposed project during the public hearing. Please find a link to news article highlighting the major concerns raised by the locals during the public hearing. (http://timesofindia.indiatimes.com/city/goa/43- speakers-hundreds-of-voices-oppose-mpt- plans/articleshow/58388641.cms)	No reply is solicited from the Project proponent.

12.	We would like to request the committed to direct the project proponent to give a response to our comments and incorporate the same into the public hearing proceedings pursuant to which we will be able to send our submissions for the proposed project.	The EIA Report has been finalised after addressing all the material environmental concerns expressed during Public Consultation process, and by making appropriate changes in the draft EIA Report per procedure provided in the EIA Notification, 2006 (amended)
13.	Till then the project should be deferred.	No reply is solicited from the Project proponent.

iii. CRZ related documents as per para 4.2 (i) of CRZ Notification, 2011





FORM I

PROPOSED CONCEQUENTIAL TERMINAL CAPACITY ENHANCEMENT AT BERTH 5A-6A OF MORMUGAO PORT, MORMUGAO, GOA



Prepared for

GOA COASTAL ZONE MANAGEMENT AUTHORITY (GCZMA), GOA

Submitted By

M/s South West Port Ltd.





Form-I for seeking clearance for project attracting CRZ notification

BASIC INFORMATION:

Name of the Project:- Proposed Terminal Capacity Enhancement at Berth 5A-6A of Mormugao Port for Handling Coal and Coal Products, Iron Ore and Limestone including Unitised and Steel Products

Location or site alternatives under consideration:- This is a modernisation project of the existing port facility. Hence, site alternative study is not required

Size of the project (in terms of total area):- Mordenisation of existing cargo handling capacity from 7.5 mmtpa to Bulk handling to 13 mmtpa and multiple unitised cargo and Steel product at about 2 mmtpa.

> 13 MTPA of bulk (consisting of coal, iron ore, lime stone, dolomite, bauxite, mineral ores, fertiliser and other misc. cargo), and about 2 MTPA of unitised cargo (consisting of steel bars, coils, flats and plates, and other steel products)

CRZ classification of the area: The project area belongs to CRZ-IB, CRZ-II, CRZ-IV

Expected cost of the project: 210 Crores

Contact Information: Mr. Rashmiranjan Patra Vice President- Strategy & Planning 1st Floor, Port Users Complex Mormugao Port, Goa Mail: <u>rashmiranjan.patra@jsw.in</u>

> Phone: +91 832-2523000 Fax. +91 832-2523006





II. ACTIVITY

1. Construction, operation or decommissioning of the Project involving actions, which will cause physical changes in the locality (topography, land use, changes in water bodies, etc.)

			Details thereof (with approximate
C N-	Information/Checklist	NZ /NI -	quantities /rates, wherever
5. 1NO.	confirmation	r es/ino	possible) with source of
			information data
1 1	Permanent or temporary change	No	The berths are operational and the
1.1	in land use, land cover or		proposed project is enhancement of
	topography including increase in		the cargo handling capacity.
	intensity of land use (with		
	respect to local land use plan)		
1.0	Details of CRZ classification as	Yes	CRZ IB, CRZ-II, CRZ-IV
1.2	per the approved Coastal Zone		
	Management Plan?		
1.3	Whether located in CRZ-I area?	Yes	CRZ IB
1.4	The distance from the CRZ-I	Yes	Berths lies in the inter-tidal zone
1.7	areas.		CRZ IB
15	Whether located within the	NO	No
1.5	hazard zone as mapped by		
	Ministry of Environment and		
	Forests/National Disaster		
	Whather the grap is prope to	No	
1.6	cyclone tsunami tidal surge	INO	There is no record of occurrence of
	subduction, earthquake etc.?		floods, landslides and cloud bursts
	······································		in the area.
			The project site is seismically not
			active zone.
1.7	Whether the area is prone for	No	No
	Clearance of existing land		
1.8	vegetation and buildings?	No	Not Applicable
1.9	Creation of new land uses?	No	Not Applicable
		No	Not Applicable
1.10	Pre-construction investigations	110	
	e.g. bore holes, soil testing?		
1 11	Construction works?	No	Not Applicable
1,11	Construction works:	110	
1.12	Demolition works?	No	Not Applicable
	Temporary sites used for	No	Local labourers shall be deployed
1.13	construction works or housing of		for any development works at the
	construction workers?		site.





			Details thereof (with approximate
C No	Information/Checklist	Vag/Na	quantities /rates, wherever
5.INO.	confirmation	Y es/INO	possible) with source of
			information data
	Above ground buildings,	No	Not Applicable
	structures or earthworks		
1.14	including linear structures, cut		
	and fill or excavations		
	Underground works including		
1.15	mining or tunneling?	No	Not Applicable
1 16	Reclamation works?	No	Not Applicable
1.10	Dredging?	No	Not Applicable
1.17	Offshore structures?	No	Not Applicable
1.10	Distore structures:	INU	Not Applicable
1.19	processes?	No	Not Applicable
	Eacilities for storage of goods or		Covered bulk cargo storage with
1.20	materials?	Yes	wind shields.
			Covered shed steel products
1.21	Facilities for treatment or disposal of solid waste or liquid effluents?	Yes	The activity does not produce any industrial effluent. The domestic waste water will be treated in a septic tank and soak pit as is done at present.
			The solid waste shall be segregated and disposed as per the norms.
1.22	Facilities for long term housing of operational workers?	No	Not envisaged
1.23	New road, rail or sea traffic during construction or operation?	No	Not envisaged
1.24	New road, rail, air waterborne or other transport infrastructure including new or altered routes and stations, ports, airports etc?	No	Not envisaged
1.25	Closure or diversion of existing transport routes or infrastructure leading to changes in traffic movements?	No	Not envisaged
1.26	New or diverted transmission lines or pipelines?	No	Not envisaged
1.27	Impoundment, damming, culverting, realignment or other	No	Not applicable





			Details thereof (with approximate
S No	Information/Checklist	Voc/No	quantities /rates, wherever
5.1 (0.	confirmation	1 05/110	possible) with source of
			information data
	changes to the hydrology of		
	watercourses or aquifers?		
1.28	Stream crossings?	No	Not applicable
1.29	Abstraction or transfer of water from ground or surface water?	No	Not applicable
1.30	Changes in water bodies or the land surface affecting drainage or run-off	No	There are no alterations in the existing drainage network. The drainage facility, if required for the enhancement project shall be merged with the existing facilities.
1.31	Transport of personnel or materials for construction, operation or decommissioning?	Yes	No major construction activities are involved. During the operational there shall be transportation of cargo to the port. Also the personnel involved in operational activities shall be transported to the region.
1.32	Long-term dismantling or decommissioning or restoration works?	No	Not envisaged
1.33	Ongoing activity during decommissioning which could have an impact on the environment?	No	Not envisaged
1.34	Influx of people to an area in either temporarily or permanently?	Yes	Only the operators, technical staff would be coming to the site
1.35	Introduction of alien species?	No	Not applicable
1.36	Loss of native species or genetic diversity?	No	Not applicable
1.37	Any other actions?	No	Not applicable





2. Use of Natural resources for construction or operation of the Project (such as land, water, materials or energy, especially any resources that are non-renewable or in short supply):

S.No.	Information/checklist confirmation	Yes/No	Details thereof (with approximate quantities /rates, wherever possible) with source of information data
2.1	Land specially undeveloped or agricultural land (ha)	No	Not applicable
2.2	Water (expected source and competing users)	Yes	The requirement shall be met from existing allocation of Goa PWD for existing operations. About 500 KLD of water would be required for full operation.
2.3	Minerals (MT)	No	Not envisaged
2.4	Construction material – stone, aggregates, and/ soil (expected source-MT)	No	Not envisaged
2.5	Forests and timber (source-MT)	No	No use of timber is envisaged in the proposed expansion of Jetty
2.6	Energy including electricity and fuels (source, competing users) Unit: fuel (MT), energy (MW)	Yes	The power will be drawn from the Goa State Electricity Board. Approximately 7 MVA of power shall be required when the entire project is in operation.
2.7	Any other natural resources (use appropriate standard units)	No	Not envisaged

3. Use, storage, transport, handling or production of substances or materials, which could be harmful to human health or the environment or raise concerns about actual or perceived risks to human health.

S.No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities /rates, wherever possible) with source of information data
3.1	Use of substances or materials, which are hazardous (as per MSIHC rules) to human health or the environment (flora, fauna, and water supplies)	No	Not envisaged
3.2	Changes in occurrence of disease or affect disease vectors (e.g. insect or water borne diseases)	No	Not envisaged





S.No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities /rates, wherever possible) with source of information data
3.3	Affect the welfare of people e.g. by changing living conditions?	No	Not envisaged
3.4	Vulnerable groups of people who could be affected by the project e.g. hospital patients, children, the elderly etc.,	No	Not envisaged
3.5	Any other causes	No	Not applicable

4. Production of solid wastes during construction or operation or decommissioning (MT/month).

			Details thereof (with approximate
S No	Information/Checklist	Ves/No	quantities /rates, wherever
5.110.	confirmation	103/110	possible) with source of
			information data
4.1	Spoil, overburden or mine wastes	Yes	A very little amount of solid waste is envisaged during the development phase. The waste shall be segregated and disposed through CPCB authorised vendors.
4.2	Municipal waste (domestic and	Yes	All municipal solid waste generated
	or commercial wastes)		from the sewage treatment will be
			used within the jetty site for
			plantation as manure.
4.3	Hazardous wastes (as per Hazardous Waste Management Rules)	Yes	The spent oil will be given to the recycler authorised by SPCB. Other wastes like soiled packaging material, discarded batteries, etc. will be sent to the authorised agency for incineration.
4.4	Other industrial process wastes	Yes	Not envisaged
4.5	Surplus product	No	Not envisaged
4.6	Sewage sludge or other sludge from effluent treatment	Yes	Biological sludge generated shall be mixed with the vermi-composed manure and used for horticulture.
4.7	Construction or demolition wastes	Yes	Small quantity of metallic scrap waste is expected to be generated during installation activities. This scrap will be used as melting scrap in steel making.





S.No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities /rates, wherever possible) with source of information data
4.8	Redundant machinery or equipment	No	Not envisaged
4.9	Contaminated soils or other materials	No	Not envisaged
4.10	Agricultural wastes	No	Not envisaged
4.11	Other solid wastes	No	Not envisaged

5. Release of pollutants or any hazardous, toxic or noxious substances to air (Kg/hr)

	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities /rates, wherever possible) with source of information data
5.1	Emissions from combustion of fossil fuels from stationary or mobile sources	Yes	The emissions like smoke are expected from ships carrying cargo and the vehicles carrying cargo in and from the port area. Proper mitigation measures would be implemented to minimize the impacts.
5.2	Emission from production processes	No	The proposed project caters to services for loading / unloading of raw materials and product from ships. Dust emissions from loading unloading activities, transfer operations etc. can be expected.
5.3	Emissions from materials handling including storage or transport	Yes	Fugitive dust will be generated from the material handling activities. Dust suppression systems with water sprinklers/dry fog system will be provided to prevent the fugitive dust emissions. Further, the development of Greenbelt would prevent the fugitive dust emissions.
5.4	Emissions from construction activities including plant and equipment	Yes	Fugitive Dust only.





5.5	Dust or odours from handling of materials including construction materials, sewage and waste	Yes	Dust emissions from raw material handling will be generated. Suitable dust suppression and dust extraction equipments will be installed for dust suppression. There is no possibility of any odour generation as there are no organic solvents / processes involved.
5.6	Emissions from incineration of waste	No	Not envisaged
5.7	Emissions from burning of waste in open air (e.g. slash materials, construction debris)	No	Not envisaged
5.8	Emissions from any other sources	No	Not envisaged

6. Generation of Noise and Vibration, and Emissions of Light and Heat.

S.No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities /rates, wherever possible) with source of information data
6.1	From operation of equipment e.g. engines, ventilation plant, crushers	Yes	During construction phase i.e. upgradation of facilities noise will be generated from activities and equipments.
			During operational phase noise will be generated from loading /unloading activities. Proper mitigation measures shall be deployed to attenuate the noise generated.
6.2	From industrial or similar processes	No	Not envisaged
6.3	From construction or demolition	No	No major construction activities are envisaged in the project
6.4	From blasting or piling	No	Not envisaged
6.5	From construction or operational traffic	Yes	Proper mitigation measures shall be deployed to attenuate the noise generated.
6.6	From lighting or cooling systems	No	Not envisaged
6.7	From any other sources	No	Not envisaged



7. Risks of contamination of land or water from releases of pollutants into the ground or into sewers, surface waters, groundwater, coastal waters or the sea.

S.No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities /rates, wherever possible) with source of information data
7.1	From handling, storage, use or spillage of hazardous materials	No	Not envisaged
7.2	From discharge of sewage or other effluents to water or the land (expected mode and place of discharge)	Yes	The sewage water will be treated in septic tanks and soak pit. Treated sewage will be used for horticulture within the port area.
7.3	By deposition of pollutants emitted to air, onto the land or into water	No	Not envisaged
7.4	From any other sources	No	Not envisaged
7.5	Is there a risk of long term build-up of pollutants in the environment from these sources?	No	Not envisaged

8. Risk of accidents during construction or operation of the Project, which could affect human health or the environment

S.No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities /rates, wherever possible) with source of information data
8.1	From explosions, spillages, fires etc from storage, handling, use or production of hazardous substances	No	Not envisaged
8.2	From any other causes	No	Not envisaged
8.3	Could the project be affected by natural disasters causing environmental damage (e.g. floods, earthquakes, landslides, cloudburst etc)?	Yes	During the design stage, the possible effects of natural disasters will be considered and necessary precautionary measures would be built-in and implemented.





9. Factors which should be considered (such as consequential development) which could lead to environmental effects or the potential for cumulative impacts with other existing or planned activities in the locality

Sr. No.	Information/Checklist Confirmation	Yes/ No	Details thereof (with approximate quantities/ rates, wherever possible) with source of information data
9.1	Lead to development of supporting, facilities, ancillary development or development stimulated by the project which could have impact on the environment	Yes	Existing and ancillary facilities will improve.
	Supporting infrastructure (roads, power supply, waste or waste water treatment, etc)	Yes	Existing infrastructure facilities will be expanded / extended to take care of the project.
	Housing development	No	-
	Extractive industries	No	-
	Supply industries	Yes	The material is sent by Indian Railways at present and the mode will continue to be the same.
	Other		-
9.2	Lead to after use of the site, which could have an impact on the environment	No	-
9.3	Set a precedent for later developments	No	This facility is inside a major port and is for receiving stacking and despatching to the intended industries. No ancillary industries are envisaged.
9.4	Have cumulative effects due to proximity to other existing or planned projects with similar effects	No	-





III ENVIRONMENTAL SENSITIVITY

S No	Arons	Name/	Aerial distance (within 15 km)
5.110.	Altas	Identity	Proposed project location boundary
1	Areas protected under	No	The project is in the existing
	international conventions,		operational facility. There are no
	national or local legislation for		ecological, landscapes, cultural or other
	their ecological, landscape,		sensitive areas around the project site.
	cultural or other related value		
2	Areas which are important or	No	The project is in the existing
	sensitive of ecological reasons –		operational facility.
	wetlands, water courses or other		
	water bodies, coastal zone,		
	biospheres, mountains, forests		
3	Areas used by protected,	No	There are no protected for sensitive
	important or sensitive species of		flora and fauna near the site.
	flora or fauna for breeding,		
	nesting, foraging, resting, over		
	wintering, migration		
4	Inland, coastal, marine or	Yes	The facilities are in the coastal marine
	underground waters		areas of Mandovi - Zuari estuary,
			located inside a Major Port.
5	State, national boundaries	No	-
6	Routes or facilities used by the	No	Not applicable
	public for access to recreation or		
	other tourist, pilgrim areas		
7	Defence installations	No	Not applicable
8	Densely populated or built-up	No	Capacity enhancement of the existing
	area		facility by increased mechanisation
			and associated operational efficiency.
9	Areas occupied by sensitive	No	Not applicable
	man made land uses (hospitals,		
	schools, places of worship,		
	community facilities)		
10	Areas containing important.	No	No scarce resources are present around
	high quality or scarce resources		the site.
	(ground water resource, surface		
	resources, forestry, agriculture,		
	fisheries, tourism, minerals)		
11	Areas already subjected to	No	The proposed activity is in the
	pollution or environmental		operational berths.
	damage. (those where existing		





S No	A #000	Name/	Aerial distance (within 15 km)
5.110.	Areas	Identity	Proposed project location boundary
	legal environmental standards		
	are exceeded)		
12	Areas susceptible to natural hazard which could cause the project to present environmental problems <i>(earthquakes, subsidence, landslides, erosion,</i> <i>flooding or extreme or adverse</i> <i>climatic conditions)</i>	No	There is no record of occurrence of floods, landslides and cloud bursts in the area. The project site is seismically not active zone.

Signature: Name: Rashmi Ranjan Patra Designation: Vice President

Date: 01.02.207 Place: Mumbai Environmental Impact Assessment Study for Proposed Terminal Capacity Enhancement at Berth 5A-6A of Mormugao Port, Mormugao, Goa





FINAL REPORT¹



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September, 2017

¹ Prepared after addressing all the material environmental concerns expressed during Public Consultation process, and by making appropriate changes in the draft EIA Report as per procedure provided in the EIA Notification, 2006 (amended).





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Chapter 1.0 INTRODUCTION

1.0 BACK GROUND

Mormugao Port is a Major Port on the west coast of India in service to the nation's maritime trade for a longer period. It is located at latitude 15° 25' N and longitude 73° 47' E between two Major Ports of New Mangalore in south and Mumbai in north. It is located at the mouth of the river Zuari. The location of Mormugao Port on the west coast of India is depicted in the Figures 1.1 and 1.2. The Port serves the geographical regions of Goa, Karnataka and parts of Maharashtra and Andhra Pradesh. Major commodities being handled at the Port are Coal, Iron Ore, POL and general cargo items. Because of the proximity of the Port with various mining regions in Goa, the Port assumed the role of a premier Iron Ore exporting port of the country. However, the requirements of coal from various steel industries and power generating units have made it an attractive and cost effective destination for coal imports and steel exports.



Figure 1.1: Location of Mormugao Port







Figure 1.2: Google Image showing Berth 5A & 6A at Mormugao Port

The Port has 7 cargo handling berths of which two are dedicated coal berths, one dedicated iron ore berth and a dedicated POL berth and the remaining general cargo berths. Apart from these 7 berths, there is also a dedicated berth for cruise vessels and a non-cargo berth which is proposed to be earmarked for the exclusive use of Navy and Coast Guard and 6 nos Mooring Dolphins. There is 7.5 km of entrance channel with the depth of outer channel being 14.4 m and that of the inner channel being 14.1 m. The Port has a total land area of 530 acres (approx.).

South West Port Ltd. (SWPL), a JSW group company operates two berths, namely berth no. 5A & 6A in the Mormugao Port on BOOT basis to handle its group cargo.

1.2 JSW GROUP Profile

JSW Group is one of the fastest growing business conglomerates with a strong presence in the core economic sector. This enterprise has grown from a steel





rolling mill in 1982 to a multi business conglomerate worth US \$ 11.0 billion within a short span of time. As part of the US \$ 16.5 billion O. P. Jindal Group, JSW Group has diversified interests in Steel, Energy, Minerals and Mining, Infrastructure, Cement and Information Technology.

JSW Steel Limited (JSWSL), the flag ship company of JSW group is one of the largest steel producers of the Country. The company has manufacturing facilities located at Vijayanagar in Karnataka, Salem in Tamil Nadu, and Vasind, Tarapur, Dolvi, & Kalmeshwar in Maharashtra. JSW Steel has present capacity to produce steel of 18.0 million tonnes per annum (MTPA). The group presently engaged in the fields of steel, cement and aluminum production, power generation and Infrastructure development.

JSW Steel at Vijayanagar is one of the India's largest integrated steel company with an annual capacity of about 14.3 MTPA. The company has manufacturing facilities located at Vijayanagar in Karnataka, Salem in Tamil Nadu, Vasind, Tarapur and Dolvi in Maharashtra. The product range includes Pellets, Slabs, HRC, HR Plates / Sheets, CR Coils, GP/GC and Colour Coated Coils/Sheets, Bars, Rounds and Reinforcement bars.

JSW Energy Ltd. (JSWEL) is the first Independent Power Producer (IPP) set up in the state of Karnataka. The company has set up 2 units of 130 MW each and two units of 300 MW each and all these units are generating power using Corex gas and coal. JSWEL supply power to JSW Steel Ltd., and to Power Trading Corporation. JSWEL would require 4 MTPA of coal for its 1200 MW power plant at Vijayanagar.

Another subsidiary, JSW Energy (Ratnagiri) Ltd, is operating a 1200 MW Coal fired power plant at Jaigarh, Dist, Ratnagiri, Maharashtra. Another unit is functional at Barmer, Rajasthan producing about 1080 MW lignite fired power.

The JSW Infrastructure Ltd (JSWIL) is a JSW Group company which is presently into development of ports, rail/road and inland water connectivity, development of





port based SEZ and other related infrastructure developments works along with terminal handling operations and port management. Buoyed by the Group's cargo support, experience in marine infrastructure development and operations, JSW Infrastructure Ltd. ventured into development of Greenfield ports across the coast of India.

South West Port Ltd, a JSWIL group company, has developed two berths, namely berth no. 5A & 6A in Murmugao Port, Goa on BOOT basis.

JSW Jaigarh Port Ltd. (JSWJPL), a subsidiary of JSW Infrastructure Ltd. developed as Greenfield all weather Port facility at Jaigarh in Ratnagiri Dist. by entering a 50-year concession agreement with the Maharashtra Maritime Board (MMB). Presently, Jaigarh Port is undergoing a major expansion plan in its second phase.

In the initial Phase, the Port has an installed capacity of about 10 MTPA of dry and liquid cargo. JSWJPL is meeting the coal requirements of the operational 1200 MW power plant of JSW Energy in its first phase. In the second phase expansion, the port has planned to handle other cargoes like bauxite, raw sugar, fly ash, cement, iron ore, fertilizers, fertilizer raw materials, edible oil, molasses and chemicals, containerized cargoes, POL and LNG. Rail, road and inland waterway connectivity projects for the port are also being taken up simultaneously to propel the growth further by connecting the port seamlessly with the hinterland. The LNG facility is being developed by H-Energy Gateway Private Limited (HEGPL), Mumbai.

JSW Dharamtar Port Ltd., another subsidiary of JSW Infrastructure Ltd.at Dolvi in Raigad District of Maharashtra, is an existing port and terminal facility, located in Amba River about 23 Nautical Miles away from Mumbai Harbour by sea route. The port has 331.5 m jetty with a depth of 4.5 metres, capacity to handle about 8.0 million tonnes per annum of cargo. The port facility is being expanded with construction of additional jetty length upto 1750 m in phases to handle various cargoes about 35.0 million tonnes per annum.





JSW Dharamtar Port can handle bulk and break-bulk cargo. The Port currently handle entire import & part of export requirement of JSW Steel Plant at Dolvi in Maharashtra. The cargo handled includes limestone pellets and lumps, dolomite, hot briquette iron, sponge iron, PCI coal, scrap, and iron ore lumps, fines and pellets. Dharamtar Port currently looks after JSW Group's Dolvi and Kalmeshwar Steel Plants' export-import (EXIM) requirements.

1.3 **PROJECT Profile**

Mormugao Port Trust (MPT) is strategically located to cater to the needs of the coal requirement of steel and power plants of its hinterland in Karnataka and elsewhere. Although MPT is ideally located to serve the industries in the hinterlands, a lot of cargo including coal is imported through some of the ports situated in eastern coast of India despite the fact that the rail distance from these port to the industries are much more compared to Mormugao Port. Apart from the fact that the South Western Railway network is heavily congested, the industries prefer the eastern coast ports viz. Gangavaram, due to their ability to handle larger cape size vessels resulting in saving the sea freight. Imports/Exports through Capesize vis-à-vis Panamax vessels will result in freight advantage and thereby the industries stand to benefit. This will also make imports cheaper and exports more competitive leading to overall economic growth and employment creation.

SWPL is presently handling coal, limestone and steel products at berth 5A & 6A by using a mix of multipurpose and specialized material handling cranes depending on availability and ship cargo. The entire unloading and evacuation chain of bulk cargo right from unloading from ships to conveyance to stacks, reclamation and rail wagon loading is mechanized. The Terminal does not handle any bulk cargo in non-mechanized manner (jetty dumping, loading of trucks by pay-loaders, high-heaping of coal stockpiles, loading of cargo on trucks by pay loaders) and does not evacuate any cargo by road route.

The SWPL Terminal mainly caters to the 14 MTPA Steel Plant of JSW Steel Vijayanagar plant at Torangallu, Sandur Taluk of Bellary District, North





Karnataka. JSW Steel Vijaynagar works is the first integrated steel plant to reach 14 MTPA capacity at a single location in India and being expanded to 16 MTPA. It is the first plant in India to use the Corex technology for hot metal production. The rail distance from Vasco da Gama to Torangallu by South Western Railway is about 385 km. The almost west to east rail alignment, the shortest Port to Steel Plant route encounters Londa, Dharwad, Hubli and Gadag along the way.

Ships calling at the berth are generally up to Panamax (80,000 – 90,000 DWT) in size and throughput of about 7.5 MTPA is being achieved presently. SWPL is proposing to modernize and optimize the operation though installation of more efficient and environmental friendly equipments. In addition, increase efficiency of the rake turnarounds would make the evacuation and dispatch more efficient. Consequentially the total cargo to be handled is expected to go up to 12 to 13 MTPA of bulk (consisting of coal, iron ore, lime stone, dolomite, bauxite, mineral ores and other miscellaneous cargo), and about 2 MTPA of unitised cargo (consisting of steel bars, coils, flats and plates, and other steel products). The total cargo handling capacity hence is expected to increase to about 14 to 15 MTPA. The higher efficiency is also likely to be achieved by serving larger Capesize vessels (upto 180,000 DWT) once they begin to call at the Port after the proposed capital dredging project of the MPT is completed. However, in this scenario the capacity enhancement can also be achieved without the Capesize vessels by calling in Panamax ships at more regular intervals than at present, taking advantage of the spare capacity of the navigational channel.

In general, the consequential capacity enhancement would be achieved by deploying highly mechanized and more efficient environment friendly material handling systems, enhancing the existing conveyor speed, and improving the rake loading turnaround time through operational efficiency.

No additional land or water front/berth area is required for the project. The project does not include any additional marine structures or fore-shore work. The dust barrierisation and pollution prevention-control of the existing facility will also be





brought to the level of state-of-art protection to ensure lesser total pollution from the proposed facility.

1.4 CONNECTIVITY

1.4.1 Air Connectivity

Goa International Airport is a civil enclave at INS Hansa, a Naval airfield located at Dabolim near Vasco da Gama. The airport caters to scheduled domestic and international air services.

1.4.2 Road Connectivity

Goa has four National Highways passing through it. NH-66 (ex NH-17) runs along India's west coast and links Goa to Mumbai in the north and Mangalore to the south. NH-4A running across the state connects the capital Panjim to Belgaum in east, linking Goa to cities in the Deccan. The NH-366 (ex NH-17A) connects NH-66 to Mormugao Port from Cortalim. The new NH-566 (ex NH-17B) is a four-lane highway connecting Mormugao Port to NH-66 at Verna via Dabolim Airport, primarily built to ease pressure on the NH-366 for traffic to Dabolim Airport and Vasco da Gama. NH-768 (ex NH-4A) links Panjim and Ponda to Belgaum and NH-4. Goa has a total of 224 km (139 mi) of national highways, 232 km (144 mi) of state highway and 815 km of district highway. However, the proposed project does not use or envisaged to any road transport for cargo transportation in future.

1.4.3 Rail Connectivity

Goa has two rail lines, one run by the South Western Railway and the other by the Konkan Railway. The line run by the South Western Railway was built during the colonial era linking the port town of Vasco da Gama, Goa with Belgaum, Hubli, Karnataka via Margao. The Konkan Railway line, which was built during the 1990s, runs parallel to the coast connecting major cities on western coast. At present, cargo transport is generally being carried out through south western railways and continue to do so in future. The existing rail is adequate for the envisaged capacity enhancement and proposed expansion of railways is not required for the purpose.





1.5 NEED FOR THE EIA STUDY

The proposed projects require CRZ clearance under Coastal Regulation Zone (CRZ) Notification (January 2011) and Environmental clearance as per the clause No. 7 (e) of the schedule of EIA notification of September 2006 and subsequent amendments. Environmental Impact Assessment (EIA) study needs to be conducted as per the guidelines stipulated in the EIA notification of September 2006 and CRZ Notification of January 2011. It is proposed to conduct an EIA study to assess the impacts likely to accrue as a result of various activities of the proposed projects. A suitable Environmental Management Plan (EMP) will then be suggested to ameliorate the adverse impacts. Based on this, an Environmental Monitoring Programme (EMOP) shall be delineated as part of the EIA study to ensure proper implementation of EMP.

1.6 OBJECTIVES OF THE EIA STUDY

The major thrust of the EIA study shall be to assess the impacts of various activities of proposed project on various components of the environment. The study shall cover the impacts on water quality, noise, air quality, terrestrial ecology, wildlife, aquatic ecology including fisheries, etc. The study will include collection of baseline data, prediction of impacts and formulation of Environmental Management Plan (EMP) for amelioration of the adverse impacts. The study area is the area within 10 km radius of the project with proposed site as centre. The objectives of the Environment Impact Assessment study are to:

- determine the baseline status of the marine ecology, terrestrial environmental conditions, Ambient Air Quality, Land use, Noise levels, Socioeconomic aspects of the study area.
- identify and assess the probable impacts of the project activity on marine and terrestrial environment in the study area.
- suggest adequate mitigation measures to minimize the impacts during operational phases of the project.
- recommend Environment Management Plan to ensure that the project implementation does not impact the environment adversely.





• preparation of Risk assessment and Disaster Management Plan considering the project activity.

1.7 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

The Terminal obtained CRZ and Environmental Clearance (EC) from Ministry of Shipping (Port Wing) *vide* letter no PD-26018/2/200-PDZ(CRZ) dated 24th January, 2001. Half yearly compliance reports of the EC are sent to the regional office of MoEFCC, Bangalore regularly. Certified copy of the EC compliance report obtained from the MoEFCC RO, Bangalore is given in Annexure III. The Terminal also operates under valid Consent to Operate issued by the Goa State Pollution Control Board, consent no. 5/2580/04-PCB/CI-36 dated 10th April, 2015 and renewed.

The proposed projects *inter alia*, require Environmental Clearance under clause No. 7 (e) of the schedule of EIA Notification of September 2006 and subsequent amendments, and CRZ clearance under Coastal Regulation Zone (CRZ) Notification (January 2011). Application for EC was made in Form I and PFR to the Ministry of Environment and Forests, New Delhi on 09th February, 2015. The proposal was discussed in the 148th meeting of the EAC, Infra-2. ToR for EIA study was issued by the MoEFCC *vide* its letter no. F.No.10-5/2015-IA.III, dated 19th June, 2015 as given in Annexure IV.

Environmental Impact Assessment (EIA) study has been conducted by M/s WAPCOS Ltd. a Govt. of India Undertaking (Mini Ratna), an organization under the Ministry of Water Resources, River Development and Ganga Rejuvenation. WAPCOS Ltd. holds QCI NABET Accreditation, Category "A" in the Ports and Harbour sector.

The EIA study was based on one season environmental baseline monitoring conducted in Summer, 2016 (4th March to 28th May, 2016 for air & noise monitoring, and 9th to 10th May, 2016 for terrestrial and marine ecology). The draft EIA Report was submitted to the Goa State Pollution Control Board on date 16th September, 2016. It was published by GSPCB to initiate the Public





Consultation process on 16th January, 2017. Public hearing for the project was announced on 17th February, 2017 following the due process of advertising in newspapers and other means as provided for in the EIA Notification, 2006 (amended) but was postponed by the Dist. Collector, North Goa on law and order grounds. The Public Hearing was announced again on 20th March, 2017 at Vasco Residency, Main Hall, Vasco, Goa. Before the proceedings of the Public Hearing could begin, a section of the attendees objected to the arrangements made for the Public Hearing stating that the Public Hearing venue was too small to accommodate the local people who were willing to voice their concerns for and against the project. Considering the demand of the local people sympathetically, the Additional Deputy Magistrate presiding over the Public Hearing announced that the Hearing will be postponed and will be reconvened at a larger venue.

The Public Hearing was re-arranged on 26th April, 2017 at Tilak Maidan Football Stadium, Vasco, Goa following the due process of advertising in newspapers and other means as provided for in the EIA Notification, 2006 (amended). Details of the Public Hearing (e.g. GSPCB/Newspaper Notifications, Minutes of Meeting, SWPL's response to the MoM and to the written representations received for the project, passed on by the GSPCB, and other relevant documents and correspondences etc.) is presented in Chapter 11 and reported separately. The present EIA Report is finalised based on the comments and observations recorded during the Public Consultation process.

Mormugao Port Trust, the BOOT concessioner Port of JSW South West Port Ltd. (SWPL) is proposing to expand the overall cargo handling capacity of the Mormugao Port by capital dredging of the navigational channel and harbour from the present about - 14.1 m CD to about - 19.5 m CD by thereby debottlenecking the Port from draft limitation and making the Port cape-compliant.

The MPT has also proposed to redevelop its presently unutilised Berths 8 and 9 and barge berths west of SWPL Terminal. Both the above-mentioned projects have obtained ToR for EIA from the MoEFCC, have carried out the EIA and have





carried out Public Hearing together along with the JSW South West Port Ltd. at the same venue one day after the JSPL Public hearing.

The EIA Consultant for both the proposed MPT projects is M/s WAPCOS Ltd. By virtue of the projects being few meters away from each-other, the EIA Report prepared by WAPCOS Ltd. has congruent impact boundary and share few common baseline environmental monitoring stations. A list of sensitive elements present within 15 km of the SWPL site has been updated in Chapter 3.

The present EIA Report is finalised based on the comments and observations recorded during the Public Consultation process, and further improved after the 21st expert appraisal committee (EAC) meeting.

Application to the Goa Coastal Zone Management Authority (GCZMA) for CRZ Clearance has been made *inter alia* in the prescribed Form I, EIA Report and project-specific CRZ Map prepared in 1:4000 scale by Institute of Remote Sensing (IRS), Chennai, one of the agencies authorised by the MoEFCC under the CRZ Notification, 2011 (amended) to demarcate HTL, LTL and preparation of CRZ map. The CRZ map is annexed to this report as Annexure V. CRZ recommendation from GCZMA is obtained *vide* their letter dated 18.08.2017 (Annexure VI).

1.8 EIA STUDY METHODOLOGY

As per the Ministry of Environment, Forests & Climate Change (MOEFCC) guideline, the study area for the EIA study has been considered as 10 km radius as project influence area (PIA) from the proposed project site at the centre.

Adherence of the ToRs issued for the EIA study by the MoEFCC on 19th June, 2015 for the capacity enhancement project is given in Annexure VII.

In addition to the above, the EIA Report also follows the EIA Report format as given in the Appendix III of EIA Notification, 2006 with relevant modifications, and the Standard ToR for the Port and Harbour published by MoEFCC in April, 2015.





1.9 STAGES IN AN EIA STUDY

The purpose of this section is to enumerate the steps involved in an Environmental Impact Assessment (EIA) Study. The same are given in following paragraphs.

Scoping: An exhaustive list of all likely impacts drawing information from as many sources as possible shall be prepared to assess the impacts due to various activities of proposed port. The next step shall be to select a manageable number of attributes, which are likely to be affected as a result of the proposed project. Various criteria applied for selection of the important impacts which are as follows:

- magnitude
- extent
- significance
- special sensitivity

Baseline study: Before the start of the project, it is essential to ascertain the baseline levels of appropriate environmental parameters, which could be significantly affected by the implementation of the project. The planning of baseline survey shall emanate from shortlisting of impacts prepared during identification. The baseline study involves both field work and review of existing documents, which is necessary for identification of data which may already have been collected for other purposes.

Impact Assessment: is essentially a process to forecast the future environmental conditions of the project area that might be expected to occur as a result of the proposed project. An attempt is generally made to forecast future environmental conditions quantitatively to the extent possible. But for certain parameters which cannot be quantified, the general approach is to discuss such intangible impacts in quantitative terms so that planners and decision-makers are aware of their existence as well as their possible implications.





Environmental Monitoring Programme: An Environmental Monitoring Programme shall be delineated for implementation to oversee the environmental safeguards, and to ascertain the agreement between prediction and reality and to suggest remedial measures not foreseen during the planning stage which may arise during the operation.

Risk Assessment and Disaster Management Plan: Suitable Risk Assessment outline Disaster Management Plan (DMP) is prepared considering the proposed project activities.

Environmental Management Plan: For the proposed coastal development projects an Environmental Management Plan (EMP) is formulated to maximize the positive environmental impacts and minimize the negative ones. After selection of suitable environmental mitigation measures, the cost required for implementation of various management measures is estimated, to have an idea of their cost-effectiveness.

2.0 OUTLINE OF THE REPORT

The contents of the EIA report are as follows:

Chapter 1: The chapter gives an overview of the need for the project, objectives and need for EIA study etc. The methodology adopted for conducting the EIA study for the proposed project is described in this chapter.

Chapter 2: A brief write-up on various project components, infrastructure available at the port, etc. has been covered in this chapter.

Chapter 3: Baseline environmental conditions including physical, biological and socio-economic parameters, resource base and infrastructure have been described in this Chapter. The baseline study involved both field work and review of existing documents, which is necessary for identification of data which may already have been collected for other purposes.





Chapter 4: Prediction is essentially a process to forecast the future environmental conditions of the project area that might be expected to occur as a result of the proposed project activity.

Chapter 5: Environmental Management Plan (EMP) for amelioration of anticipated adverse impacts likely to occur as a result of the project is presented in this chapter.

Chapter 6: Risk Assessment demonstrates the preparation of Disaster Management Plan (DMP) that will be executed to handle the situation, if any emergency occurs.

Chapter 7: This chapter depicts the SWPL contribution towards the socioeconomic and aesthetic development of the local people and region.

Chapter 8: Environmental Monitoring Program (EMoP) for implementation during the construction and operational phase of the project.

Chapter 09: This chapter indicates the cost estimation towards implementing the environmental management plan and monitoring program.

Chapter 10: This chapter specifies the consultants engaged and the resources deployed for preparation of the environmental impact assessment report.

Chapter 11: This chapter depicts proceeding of the Public Hearing conducted for the proposed project as per the EIA Notification, 2006 (amended).





Chapter 2.0 PROJECT DESCRIPTION

2.1 PROJECT BACKGROUND

Mormugao Port Trust (MPT) is strategically located to cater the needs of the coal requirement of steel and power plants of its hinterland in Karnataka. The main user for MPT is currently JSW steel Limited. JSW steel Limited, Vijayanagar imports about 5.5 million tons of coal/coking coal, 1 million ton of lime stone, and exports about 1 million ton of finished steel products through MPT. However, the coal requirement of JSW is in excess of 15 million tons and thus, has to depend on ports on the Eastern Coast like Krishnapatnam for part of its coal imports despite the fact that MPT is closer to the steel plant situated at Vijayanagar. Utilization of other port infrastructure on the east as well as west coast for receipt of raw material and despatch of finished cargoes depends on several factors, such as distance from the port from the Steel Plant, capacity availability in the ports, availability of stock holding in the port backup, rate of evacuation of cargo from the port, congestion in the rail network and steaming distance of the raw material and finished cargoes from the points of origin and destination respectively. The choice between utilising a new point of maritime entry and dispatch vis-a-vis expansion in an existing maritime facility is carried out based on techno-economic feasibility.

Coal imports for JSW at MPT are carried out at Berth No. 5A and 6A which is operated by South West Port Ltd. (SWPL), a group company of JSW Infrastructure Ltd. (JSWIL). Cargo is evacuated by the South Western Railways using their rolling stock through the existing Vasco-Belgaum-Hubli network.

SWPL is proposing to deploy highly mechanised and efficient environment friendly material handling systems so that the cargo handling capacity at the berth is increased consequentially to meet its demand, and in the process reducing environmental pollution by retrofitting state of art latest dust entrapment systems. SWPL is presently handling cargos like coal, limestone and steel





products at berth 5A & 6A by cranes, ship unloaders and wagon loading system. Ships calling at the berth are generally up to Panamax (80,000 – 90,000 DWT) in size and throughput of about 7.5 MTPA is being achieved presently. MPT has proposed dredging of the approach channel and port area for permitting navigation of Cape Size Vessels of up to 180,000 DWT.

MPT has proposed to deepen the approach channel to suit the navigational requirements of Capesize vessels. The outer channel which is presently dredged to -14.4 m is to be deepened to -19.8 m and the inner Channel from -14.1 m to -19.5 m. This will facilitate navigation of Capesize Vessels at any state of the tide. The proposal is presently in the Environmental Clearance (EC) process.

SWPL is proposing to modernise and optimise the operation though installation of more efficient and environmental friendly equipments of higher capacity. The higher efficiency is also likely to be achieved by servicing larger Capesize vessels (up to 180,000 DWT) as and when they call on to the Terminal after dredging is completed by MPT. However, the higher efficiency and capacity enhancement can also be achieved without the Capesize vessels by calling Panamax type ships at more frequent intervals than at present using the spare capacity of the approach channel.

In addition to the increased efficiency of the rake turnarounds after deployment of in-motion wagon loading system and further implementing Engine On Load (EOL) scheme which would make the evacuation faster. Consequentially the total cargo to be handled is expected to go up to 13 to 14 MTPA of bulk (consisting of coal, iron ore, lime stone, dolomite, bauxite, mineral ores and other misc. cargo), and about 2 MTPA of unitised cargo (consisting of steel bars, coils, flats and plates, and other steel products). The total cargo handling capacity at the terminal, hence is expected to increase to about 15 to 16 MTPA.

This consequential capacity enhancement shall be achieved by deploying highly mechanised and efficient handling systems to achieve shorter dwell time of cargo in the Terminal coupled with faster evacuation.





2.2 NEED FOR THE PROJECT

SWPL currently operates two berths (Berth 5A and 6A) in the Mormugao Port, Goa, and is handling coal, lime stone and steel products. Ships presently calling at the berths are generally up to 80,000 – 90,000 DWT (Panamax size vessels). Consequent upon the completion of dredging for the draft depth of 19.8 m by Mormugao Port, the port would be able to handle Capesize vessels up to 180,000 DWT capacities. Accordingly, to support this Government initiative, SWPL has proposed to modify the existing material handling equipment and enhance the port handling facility to handle larger vessels thereby helping the country to save the valuable foreign exchange by reducing the logistics cost through the economies of scale. The cargo handling equipment are about 13 years old and needs replacement. Hence, selecting suitable equipment for handling up to Capesize vessels are done, though the deepening and bringing Capesize vessels are not central to the capacity enhancement plan. Therefore, with or without Capesize vessels, the proposed capacity enhancement can proceed for replacing the aging equipment with better and more environment friendly equipments.

The consequential capacity enhancement shall be achieved by deploying highly mechanised and efficient environment friendly material handling system, enhancing the existing conveyor speed, and improving the rake loading turnaround time through operational efficiency. The proposed modernization will lead to shorter dwell time of cargo in the Terminal and faster evacuation. The systems proposed under modernization are also more environment friendly.

The proposed project does not involve any increase in the Terminal Land Area and Water Front. No additional land or any kind of land acquisition will be required to carry out the proposed modernization activity, no construction of new berths or lengthening of existing berths or any kind of civil engineering intervention will be required. Hence the proposed increased capacity is the direct result of the better and more efficient equipment and handling methods. The implementation of the project will lead to increase in port efficiency, better





utilization of existing resources and overall net reduction in pollution level due to retrofitting material handling systems with latest dust entrapment systems and barriers.

Since the increase in productivity is due implementation of better and more efficient equipment which are new and fitted with state of the art dust control systems, thereby result in reduction in the overall pollution load. This is consequent upon the fact that the increase in productivity at the berths shall be achieved without disturbing its local environment. The salient features of the project are given below;

- i. Located inside the Port premises
- ii. No additional land area or waterfront is involved
- iii. Increase in productivity is due to better equipments
- iv. The pollution load reduces due to consequential implication of environmental safeguards by deploying eco-friendly material handling systems

Port conservancy operations including maintenance of navigation depths in the channel and harbour, and all water side operations such piloting, navigation, tug assistance for berthing, ensuring adherence of ISPS codes, MARPOL, bilge and ballast water, etc. are vested with MPT. Scope of the Terminal is removal of cargo from the vessels, in-terminal storage and evacuation by railway route. The Terminal does not handle any bulk cargo in non-mechanized manner (jetty dumping, loading of trucks by pay-loaders, high-heaping of coal stockpiles, loading of cargo on trucks by pay loaders) and does not evacuate any cargo by road route.

2.3 LOCATION OF THE PROJECT

The location of the berth 5A, 6A is in the existing port facilities of Mormugao Port, Goa. The port is located at the mouth of the Zuari estuary. The imagery showing berth 5A, 6A at Mormugao Port is shown in Figure 2.1. The port is well





connected by road, rail and air. The nearest railway station Vasco is about 4 km on Southern railways and Madgaon is about 35 km on Konkan railways. The nearest airport is Dabolim located at about 6 km from the location. Nearest town Vasco is at about 6 km from the Terminal.

Mormugao is an open type natural harbour and has a natural promontory known as Mormugao Headland. The harbour is protected by a breakwater of 550 m long and a mole of 270 m long. The approach channel is about 6 km long. The port was envisaged using the protruding headland which provides partial shelter from the SW winds and monsoonal waves. The Harbour is fairly well protected and tranquil.



Figure 2.1: Location of Berth 5A, 6A at Mormugao Port

The Terminal is bordered in the west by Western India Shipyard owned by ABG Shipyard Ltd., and in the east at Berth 7 by Adani Mormugao Port Terminal Pvt. Ltd. (AMPTPL). The AMPTPL is a common user/trade cargo Terminal handling coal to the tune of 05 MTPA. The AMPTPL terminal evacuates coal by road and





rarely by rail route. Other industrial activities and operations in the MPT and nearby area are given in Chapter III.

2.4 EXISTING NAVIGATION FACILITIES

The Port of Mormugao has a 250 m wide channel that is 5.2 km long in the Outer Channel and 2.3 km long in the Inner Channel. Channel depths range from 14.1 m in the Inner Channel to 14.4 m in the Outer Channel. Navigation chart of MPT area with the channel demarcated is shown in Figure 2.2.

The maximum fully laden vessel draft that can be accommodated within the harbour at all stages of the tide is 13.4 m allowing for under-keel clearances. However, vessels are sometimes loaded up to 14.1 m draft, departing only on the high tide.



Figure 2.2: MPT Navigation Chart

2.5 EXISTING & PROPOSED CARGO CAPACITY

SWPL is having two mechanized berths (namely 5A, 6A) in MPT handles both Break Bulk and Dry Bulk with present capacity of 7.5 MMTPA, and proposed to





enhance its handling capacity capable to handle about 15 MMPTA. The existing and proposed cargo details are given in the following Table 2.1.

S. No.	Cargo details	Capacity (MMTPA)
	Existing	7.5
01	Coal /Coke/ Coking coal, Lime Stone	6.5
02	Steel Slab /Coil/Steel products	1.0
	Proposed	15.0
01	Coal /Coke/ Coking coal/Lime stone/Iron Ore/Dolomite/Bauxite, & other natural Mineral Ore	13.0
02	Steel Slab /Coil/ Unitised Steel products	2.0

Table 2.1: Existing and proposed cargo handling capacity at SWPL

2.6 FACILITIES AT THE TERMINAL

SWPL in its berth 5A, 6A are handling various dry bulk and break bulk cargo for export and import of group cargoes for its hinterland industries. The existing berthing facility and discharge capacity of various cargoes are given in Table 2.2.

Table 2.2: Existi	ng berth fa	cility at SWPL
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Berth No.	Use	Cargo handled	Vessel capacity	Draught	Average Discharge
5A	Export	Steel Slabs & Coils	Handymax	13.5	8000 tons
6A	Import	Coal & Flux	Panamax	14.5	35000 tons

The salient features of the existing terminal and cargo handling facilities are given which are as follows;

A. Berth

- Existing berths is about 450 m long (combined 5A and 6A) and 26 m wide and is designed for large size vessels

EIA Study for capacity enhancement at berth 5A, 6A of Mormugao Port EIA Report, September, 2017





B. Conveyor System

From Berth to Stackyard

- Capacity (TPH)
- o Belt Speed

From Stackyard to Despatch

- Capacity (TPH)
- o Belt Speed
- Pipe Conveyor

- 2400 (Rated); 3280 (Design)
- 3.4 m/sec
- 1500 (Rated); 1800 (Design)
- 3.4 m/sec
- 1800 TPH (Rated) & 2200 TPH (Design);
 550 mm nominal dia; 4.5m/sec speed

C. Stackyard Capacity

Coal

- ~180,000 tonnes (in 3 stockpiles)
- ~280 m long

D. Stacker / Reclaimers (2 Nos.)

Stacking Capacity

Reclaiming Capacity

- 2880 TPH (Max.)

- 2400 TPH (Nominal)

- 1500 TPH (Nominal)
- 1800 TPH (Max.)

E. Wagon Loading

- > Wagon Loading arrangement (Travelling Type)
 - Wagon loading rate
 1800 TPH
 - Rake length can be loaded at Half Rake a time

F. In Motion Wagon Loading Silo

System loading rate - 3600 TPH One full rake can be loaded at a time

Some upgradation of the Terminal such as installation of In-motion Wagon Loading System and Grab Ship Unloaders has been carried out in order to switch to cleaner sources of energy, increase operational efficiency, achieve better environmental and safety compliance and update the material handling to the recent vintage since the Terminal was commissioned. The above have also





been done as part of our working philosophy of continuously investing in newer technology. Some of the earlier material handling equipment were more than 12 years old and were driven by diesel engines for ensuring mobility and lift. Therefore, the current electrically driven equipments are more environment friendly compared to conventional loading/unloading equipment and wagon loading system. Other existing equipment such as Stacker cum Reclaimer, Pipe Conveyor, Mobile Harbour Cranes, etc. will be deployed to achieve the desired cargo handling target of 15 MTPA based on the peaking loads and operational flexibility. The installed and proposed equipment will realize their full capacity potential after the other physical bottlenecks in the system are removed and Environmental Clearance from MoEFCC and other statutory clearances, and applicable NOC's from concerned regulatory agencies are obtained.

Project specific tideline in cadastral scale with the layout of the Terminal has been prepared by IRS, Anna University, Chennai in September, 2016 for CRZ clearance procedure of the project. The CRZ map is given in Annexure V. The high tide line corresponding to the Terminal is a solid strata and is not likely to have any shoreline change, erosion or shore collapse due to implementation of the capacity enhancement project.

The Layout of the Terminal is given in Figure 2.3. As modernization activity will involve replacement of the present material handling system by faster drives and higher capacity conveyance systems, no significant change in the layout is envisaged.







Figure 2.3: Layout of the Terminal

2.7 CARGO HANDLING, STORAGE & TRANSPORTATION

2.7.1 Break Bulk Cargo (Import Cargo)

(Coal, Coke, Coking Coal, Limestone, Iron Ore, Bauxite, Dolomite etc.)

Modernization of the Terminal will continue the material handling philosophy, and pollution and safety safeguards as used in the present operation. The cargo would be discharged from the vessel by using Grab Ship Un-loaders into their inbuilt hoppers Mobile Harbour Crane into the Mobile Hopper/GSU chutes. They will feed to a Stacker Reclaimer through the conveyors system for stacking in the stack yard as per the operational requirement.

For transportation, the second Stacker Reclaimer will reclaim cargo and feed to the Wagon Loader / Silo through the reclaiming stream conveyors and load the empty rakes. During rake loading through the Wagon Loader, wagons will be stationary and the wagon loader will be mobile whereas through the In-motion





Wagon Loading/Silo system, the wagons will be mobile. The cargoes would be handled and transported through a fully mechanized system and hence there is no spillage. Also, all the stack yards are barricaded by GI barricades and RCC wall to avoid any over spillage.

2.7.2 Steel Slab / Coil, Steel Finished Products (Export Cargo)

Steel slab, coal and steel finished products handling at the Terminal is a significantly low pollution potential activity by virtue of nature of the cargo. The steel slabs / coils, finished steel products, etc. would be received by wagons at SWPL Railway siding and the cargo would be unloaded by using Gantry Cranes and loaded onto trucks/trailers and taken to the storage yards (piled concrete platforms and paved/concreted areas) and to the special purpose covered steel sheds.

The steel is loaded on the export vessel using Forklifts & Trailers, to transport it alongside the Jetty and Vessel gears/ Mobile Harbour Cranes will be used to load into the vessel holds.

The cargo would be received / dispatched from Receipt & Despatch yard of MPT. The haulage from R&D yard upto SWPL boundary will be done by MPT. SWPL has its own Railway yard within its boundary wherein four rail lines are connected to the interfacing rail lines laid by MoPT up to SWPL boundary. Engine-on-Load Scheme, announced by Indian Railways is under implementation, wherein SWPL will get a dedicated engine for the placement and removal of rakes from Vasco to SWPL rail siding and vice versa during loading of rakes through Silo.

Evacuation of Terminal cargo by Indian Railways is an ongoing operation. No expansion of the railway line by the Indian Railways is necessary to accommodate additional cargo proposed to be handled as part of the capacity enhancement project, as the existing rail infrastructure is sufficient to handle additional cargo envisaged due to proposed capacity enhancement of the terminal.





2.7.3 Environment Regulatory Mechanisation

SWPL has developed fully mechanized cargo handling system along with state of the art dust suppression system, for handling imported coal and other commodities. The facility would be developed ensuring that pollution is controlled through effective mechanized systems supplemented with automatic water based Dust Suppression System (DSS), while achieving maximum operational efficiency of throughput and faster evacuation through efficient mechanized modern wagon Loading system.

Throughout the year, cargo is also covered with tarpaulins to avoid emissions through wind during summer and rain water not to ingress in the cargo during Monsoon. Additionally, constructed wind breaking wall of 12 m high towards eastern side of stack yard and are covering filled railway wagons the tarpaulin to avoid emission / spillage in the transit. Water sprinklers installed around cargo stockpiles and nozzles at all the cargo discharge points so that the dust particles are not allowed to be airborne

In addition to the atomized water sprinkling and AQUADYNE system, one 12 KL capacity water tanker with sprinkling, firefighting and road sprinkling arrangement is provided. Also one highly efficient rotary boom type road sweeping machine is in place for sweeping the berths, roads and paved area to mitigate any dust emissions from rare spillage and vehicular movements. Detailed spillage control and dust suppression mechanism is described in chapter 5 (Environmental Management Plan).

The coal stockpiles are covered with geotextile sheets at all time, except at the location of reclaiming and stacking, where handling is carried out under continuous sprinkling of water. A wind breaking wall of 12 m height is also provided towards eastern side of stack yard. In order to further reduce opportunities of wind borne dusting, technical feasibility study and engineering design for a longitudinal storage shed to enclose the coal stockpiles is underway and is given in chapter 5.





2.8 CONSEQUENTIAL CAPACITY ENHANCEMENT

Break bulk cargo is unloaded from the vessels by using Harbour Cranes/Ship Unloaders on the berth having higher capacities. For the ship size under consideration, 2 Unloaders of at least 2500 TPH is the minimum unloading rate for the Iron ore shipment trade. For unloading of coking coal maximum unloading rate per unloader is limited to 2000 TPH because of disadvantage of large grab size required to handle coal and relatively lighter cargo. Initially the Unloaders may operate at 1500 TPH for Iron Ore/Coal till the downstream system is upgraded.

Since SWPL is an operating Terminal, the unloading efficiency of about 65-70% of the rated capacity could be achieved with the skilled operators. Moreover, it will be able to monitor the ship arrival so that there will not be undue waiting at the Port even at 75% berth occupancy.

Due to capacity enhancement at the terminal due to better mechanisation, assessment of the terminal capacity of the existing berth is analysed to establish the requirement of downstream facilities such as stackyard, receiving/stacking conveyors etc. The existing and proposed upgradation at the back up facility is given in Table 2.3.

Parameter	Existing Facility	Proposed Upgradation
Conveyor Belt speed	3.4 m/s	4.6 m/s
SCR: Stacking	2800 TPH	3000 TPH
Reclaiming	1800 TPH	2200 TPH
Rake loading Time	Wagon Loader	In-motion Wagon Loading
	2:30 – 3:00 hrs.	System
		1:00 – 1:30 hrs.
Rake Unloading Time	10-13 hrs.	6-8 hrs.
(Break Bulk)		
Rakes handled (per day)	6-8 nos.	12-15 nos.
Vasco to Vasco Rake	18 hr	6 hr
turnaround time		

Table 2.3: Existing and proposed backup facility

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Upon the increase in unloading and dispatch efficiencies through conveyor speed enhancement, decrease in rake turnaround time at the Terminal, the cargo handling volume consequently increase from present 7.5 MTPA to 15 MTPA. Also, ships presently calling at the terminal are generally upto about 90,000 DWT. In iron ore and coal trade, higher size vessels are being used world over and with the facility being enhanced to handle upto 180,000 DWT, it is anticipated that, on an average, higher vessels (say 120,000 to 130,000 DWT) will call at the terminal which would increase the capacity because of the lesser vessel trips and saving time due to peripheral activities of about 6 hours per trip. However, the Terminal is proposing to debottleneck its materials handling and evacuation mechanism in the Terminal backup side and improving rail loading time to increase the turnaround time in the Terminal. This capacity enhancement is possible with the present ship sizes and is achievable irrespective of the MPT harbour becoming cape-compliant as proposed by the MPT. This is further explained in the following sections.

2.9 STACKYARD CAPACITY

Stackyard is a critical interface between receipt of cargo from ship and dispatch by wagons which absorbs the mismatch between the inflow and outflow of cargo during operations and it is desirable the same to be sized adequately for smooth functioning of the terminal as well as achieving the targeted throughput.

Existing stackyard capacity is adequate and can be maintained by faster evacuation and on-line direct loading from vessel to the Silo for loading on to the Rakes.

2.10 WAGON LOADING SYSTEM

The Silo in the Wagon Loading Station will be filled prior to commencement of wagon loading operation and reclaiming system will continue to operate during wagon loading to ensure supply of balance material to fill the rake. Silo of 4000 tonnes is adequate if effective reclaiming rate is 2200 TPH (i.e. rated 1800 TPH





@ 70% efficiency) for loading a rake of 3800 tonne in one hour, i.e. when a rake moves at 0.65 - 0.80 km/hour.

Equipment will be sized to receive material from conveyors at the rated load for continuous wagon loading while the rake is in motion. The performance of the Terminal is critically dependent on the performance of the dispatch system.

The capacity of single track In-motion Wagon Loading Station depends on;

- Actual train loading time,
- Minimum gap required between two consecutive loading cycles due to various reasons not related to cargo handling operation.

For instance, a silo with 4000 tonne capacity will be adequate to load a rake of 3800 tonnes in one hour if the effective reclaiming rate is 2200 TPH and will be ready to load the next rake in 45 minutes, i.e. frequency could be minimum 1 hour 30 min.

Even if the frequency of rake loading is 2 hours, the Facility will have the capability to load 15 to 18 rakes per day. Hence, key factor is reclaiming rate, higher the reclaiming capacity (dispatch capacity) lower is the silo size and time gap between two Rakes loading cycles.

2.11 STACKER/RECLAIMERS IN STACKYARD

2.11.1 Capacity

2 nos. existing Stacker/Reclaimers are rated for stacking and reclaiming at 2400 TPH and 1800 TPH respectively for Coal. It will be necessary to change stacking capacity of the machine to 4000 TPH (rated) for Coal, and 5000 TPH (rated) for Iron Ore in order to match the ship unloading capacity at the berth.

Similarly, the reclaiming capacity (dispatch capacity) shall be increased to enable the Wagon Loading Station to have 1.30 hours loading cycle, i.e. capability to commence wagon loading on two consecutive rakes in 1.30 hours.





Reclaiming Capacity

Hence the effective reclaiming capacity of the Stacker/ Reclaimer is expected to be in the range of 2200 TPH (both for Iron Ore and Coal), where the corresponding silo capacity requirement is about 4000 tonnes (both for Iron Ore and Coal). Considering reclaiming efficiency as 75%, the rated reclaiming capacity shall be about 2800 TPH, say 3000 TPH.

2.11.2 New Stacker/Reclaimer

Because of the necessity of capacity increase, the existing equipment shall be replaced with new equipment for building the system capability of sustained dispatch of rakes upto 15 to 18 per day. Changing the track centre required for stability of the Stacker / Reclaimer with extended boom and higher capacity can be provided using the existing piles at the stackyard. A track centre of 9 m is envisaged.

Alternatively, if capability of sustained daily despatch in the order of 10 to 12 rakes are not required, existing Stacker / Reclaimer may be examined for modification for handling of Iron Ore and increased in capacity assuming boom extension is not feasible.

If capacity increase of the existing Stacker / Reclaimer is not at all feasible, effective dispatch rate to silo can possibly be maintained at the level of 2200 TPH, the rated capacity of the existing Pipe Conveyor instead of 1800 TPH (reclaiming capacity @ 1800 TPH with 70% efficiency) by combining reclaiming output with direct loading from berth.

2.12 BELT CONVEYOR SYSTEM

2.12.1 Receiving Conveyor

The existing receiving belt conveyor has to be upgraded by increasing their speeds to match the ship unloading capacity.





Receiving and Stacking Conveyors as existing:

- a) Belt Width
- 1600 mm
- b) Trough 35 deg.
- c) Speed 3.6 m/sec.
- d) Rated Capacity 3000 TPH (for Coal)

Iron Ore being of higher density than Coal, existing belt width of 1600 mm will have enough reserve cross-sections to carry Iron Ore even at higher capacity than 5000 TPH. However, Coal, with lower density than Iron Ore, will require wider belt than 1600 mm to carry 4000 TPH matching the Unloader capacity at berth.

Following changes would be done in the receiving conveyors if these are to be enhanced to convey Coal and Iron Ore at 4000 TPH and 5000 TPH respectively.

Material	Belt		Remarks
	Width/Trough	Speed	
Coal			
a) 4000 TPH (rated)	1800 mm / 35 deg.	~4.6 m/sec.	With existing belt width of 1600 mm, 35 deg trough, the speed required will be about 5.4 m/s. which is high for such relative short conveyor length.
	1600 mm /45 deg.	4.9 m/sec.	Fill factor as 91% and 100% at rated and design capacity respectively.
b) 3500 TPH (rated)	1600 mm /45 deg.	4.6 m/sec.	Changing 35 deg trough to 45 deg of the existing belt will convey upto 3500 TPH Coal.
Iron Ore	a)1600 mm / 35	~2.8 m/sec.	
(5000 TPH –	deg.	Actual speed	
rated)	-	required	Even existing belt width/ trough/
	 1600 mm /45 deg. 	~2.6 m/sec. Actual speed required	speed are suitable.

If the receiving conveyor system is to be designed for 4000 TPH Coal, it will require either;

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- a) change of belt width from the existing 1600 mm to 1800 mm along with other associated components, like stringer frame, wider pulleys, chutes, etc., which will involve more cost and time for implementation, or
- b) increase in belt speed to ~5.4 m/s of the existing conveyor operating Coal with more than 4.6 m/sec is not desirable.
- c) increase of belt speed to 4.9 m/s is a feasible option

Hence, it is proposed to operate the system at capacity of 4000 TPH for Coal with belt width of 1600 mm but changing the trough from 35 deg to 45 deg by changing the brackets of idlers and enhancing the speed from 3.6 upto 4.9 m/s.

2.12.2 Despatch Conveyors

Existing despatch conveyors comprise the following:

a) Conveyors

- Belt Width
- Trough

- 1400 mm - 35 dea.

3.6m/sec.

Rated : 1800 TPH (Coal)

550 mm (2100 mm wide belt)

Design: 2200 TPH

- Trougn
- Belt Speed
- Capacity -

b) Pipe Conveyor

Pipe Dia

Drive

- Belt Speed
- Capacity Rated : 1800 TPH (Coal)
 - Design : 2200 TPH
 - With VFD Control

4.5 m/sec.

The dispatch conveyors, since they work in conjunction with the Stacker/ Reclaimer, are governed by the existing reclaiming capacity (1800 TPH), if the same Stacker/Reclaimers are retained. These conveyors will be common for handling Iron Ore and Coal.

Iron Ore being heavier material, it will have lower fill factor on troughed belts and also in the pipe conveyor for the required capacity. However, no advantage





would be derived due to limitations in handling number of rakes/day, by increasing the capacity of conveyors unless reclaiming capacity is enhanced.

Pipe Conveyor needs to be modified or preferably replaced with matching capacity of reclaiming system if new Stacker/Reclaimer, as recommended is adopted to achieve sustained enhancement of the Terminal capacity.

2.12.3 Bypass Conveyor for direct Despatch

It has been proposed to provide connectivity of receiving conveyors with the despatch conveyors for direct despatch of cargo unloaded at berth. A new bypass conveyor, via a new belt feeder, will discharge on existing conveyor, which has been extended to feed the pipe conveyor.

The capacity of bypass system has been planned with matching capacity of the dispatch conveyors, i.e. 1800 TPH. Part cargo will be diverted to stockyard, when unloading rate at berth is higher than 1800 TPH. A belt weigher on conveyor will be installed to control the feed rate at the bypass conveyor. The planned drive units will be replaced with hydraulic motors for speed variation.

2.13 TRAFFIC POTENTIAL

Coking coal is mainly imported by JSW steel plants located in the hinterland of the port. The traffic volume in respect of this cargo is dependent upon the capacity of steel plants, their production program and policy with regard to using imported coal. During last 3 years, there has been a steady increase in coal imports. In the recent years the International price for Iron Ore has gone down appreciably. This has made import of the Iron Ore at low prices to the Indian Sub-continent affordable. The Western Australian and Brazilian Iron Ore with higher Iron content has made the life of steel makers' lot easier. Accordingly, berth 5A and 6A is likely to see an increase in the import capacity of coal. Iron ore is another probable cargo which could be handled at the berths. Since both are similar type of cargo, handling them with the same material handling systems





would not be difficult. The coal imported through MPT in the years 2009-10 to 2013-14 is given in the Table 2.4.

Year	Quantity (Million Tonnes)
2009-10	4.71
2010-11	6.56
2011-12	6.83
2012-13	7.38
2013-14	7.52

Table 2.4: Coal Imported through Mormugao Port

The main importer of coal through MPT is JSW Steel located at Vijayanagar, Karnataka. Most of the steel companies are poised for major expansion and the demand for coal is set to go up in the near future. In addition to steel plants, coal imports can also serve power plants which will come up in the hinterlands. At present coal meant for JSW are brought in gearless vessels of about 75,000 DWT. Coal importers/nation stand to gain substantial freight advantage by deploying Capesize vessels in the event of proposed capital dredging by MPT.




Chapter 3.0 ENVIRONMENTAL BASELINE STATUS

3.0 GENERAL

Assessment of baseline environment of the project area is an important component of the EIA study. As a part of the study, a Scoping Matrix was prepared, based on which, various parameters to be anaysed for assessment of baseline environmental were identified. The assessment of environmental impacts due to construction and commissioning of proposed cargo capacity enhancement at the berths requires a complete and scientific consideration of various environmental aspects and their interaction with the natural resources, namely, physico-chemical parameters i.e. meteorology, geology, soil, land use and water quality, biological parameters i.e. terrestrial flora and fauna, marine flora and fauna, fish species, etc in the study area. It also includes the socio-economic parameters i.e. demography, occupational profile, etc. As a part of the EIA study, a large quantum of related data available with various departments including Forest Department, Fisheries Department, and Directorate of Economics & Statistics were collected and analysed. Field studies for primary data collection on various parameters were also carried out as part of the EIA study.

As a part of the EIA study, the baseline status has been ascertained on the following environmental aspects:

- Meteorology
- Bathymetry
- Cyclones
- Sediment Transport
- Topography
- Tides
- Waves
- Currents
- Grownd Water Quality
- Soil Quality
- Landuse Pattern
- Shoreline Change Status
- Ambient Air Quality
- Noise Level
- Marine Ecology





- Terrestrial Ecology
- Fisheries
- Socio Economic Status

3.2 STUDY AREA

The study area considered for EIA study is the area within 10 km radius, keeping project site at the centre. The study area map is shown as Figure 3.1.



Figure 3.1: Study area map





3.3 METEOROLOGY

Goa experiences a tropical monsoon climate under the Köppen climate classification. Goa, being in the tropical zone and near the Arabian Sea, has a hot and humid climate for most of the year. The calendar year in the project area can be divided into four main seasons. The winter season lasts from December to February followed by premonsoon or summer season from March to May. The monsoon season begins in June and continues upto mid-October. The period from mid-October to November constitutes the post-monsoon season.

The average meteorological conditions of the Marmugao as per observation of IMD from 1981-2010 are summarized given in Table 3.1.

Month	Temperature (°C)		Rainfall	Relative	e Humidity	Mean Wind
	Maximum	Minimum	(mm)	08.30	17.30	Speed (kmph)
January	31.8	21.9	0.4	72	64	7.1
February	31.3	22.3	0	75	67	8.4
March	31.9	24.2	0.2	78	71	9
April	32.8	26.2	3.7	76	71	9.4
Мау	33.2	27.1	90.6	76	73	9.9
June	30.7	25.2	831.5	87	84	13.4
July	29.2	24.5	824.5	89	86	14.9
August	28.9	24.2	550.2	90	87	11.7
September	29.9	24.3	256.3	88	83	7.4
October	31.6	24.6	136	82	78	6
November	33.1	23.8	19.7	70	67	5.4
December	32.7	22.5	5	67	63	5.9
Total			2718			
Average	31.4	24.2		79	74	9.0

Source: IMD, Mormugao

Temperature: Slight variation in the daily maximum temperatures is observed throughout the year, as it ranges from 28.9 °C to 33.2 °C. The minimum temperatures, however show greater variations, ranging from 21.9 °C to 27.1 °C. Goa has a short winter season between mid-December and February. The monthwise temperature variations in the project area is shown in Figure 3.2.



Figure 3.2: Temperature variations in the project area

Rainfall: The total annual rainfall in the project area district is 2718 mm. Majority of the rainfall is received in the months from June to September. Usually maximum average monthly rainfall of 831 mm occurs in June. There is practically no rainfall from December to April. The average rainy days in a year are about 94. The monthwise rainfall received in Mormugao is depicted in Figure 3.3.



Figure 3.3: Rainfall variations in the project area





Winds: The mean sea wind varies from 2 on the Beaufort scale in November to 4 in July. The annual mean sea wind speed is of the order of 13.6 kmph. In an average year, there are 316 days with wind speed varying between 0 to 3 on the Beaufort scale and 48 days with winds varying between 4 to 7 on the Beaufort scale.

The predominant wind direction changes with the time of the year. During the period from June–September, wind blows from the west and south-west. During the remaining period, the wind direction is from NE, ESE during the evening. The highest speed of 105 km/hr was recorded in June 1994. Winds of force more than 10 on the Beaufort scale are not expected. The wind speed ranged from 5.4 kmph to 14.9 kmph. The monthwise variations in mean wind speed in the project area are shown in the Figure 3.4. Wind rose diagram for the period from March to May, 2015 is shown in Figure 3.5.



Figure 3.4: Mean wind speed variations in the project area







Figure 3.5 : Wind rose diagram for the month of March to May, 2015

Relative Humidity

Mean yearly relative humidity at 0830 hours is 79% and 74% at 1730 hours. The monthly average humidity is lowest in December (63%) and highest in monsoon months from July to September (85%).

Visibility

Sometimes mist develops during sunrise on the west coast, above latitude 16° N, but disperses thereafter. Smog hangs over the land at Goa from November to March obscuring everything in view mostly after sunrise and occasionally in the evenings. However, the smog lasts only for short durations. Visibility is generally good for most part of the year.





3.4 BATHYMETRY

The current bathymetry chart shows that in the outer channel the proposed dredge level of 19.8 m is available at a distance of 10 km away from the inner channel. Depth of the order of 14 m exists at the entrance of the inner channel and towards the harbour basin and turning circle area the depth is reducing up to 13.1 m.

Seabed Features

The sea bed exhibits an even low to medium level of reflectivity, indicative of silty clays and sands, with a few patches of higher reflectivity indicating the presence of isolated highly weathered bed rock. In the outer channel, highly weathered bed rock patches are also seen above the dredging limit of 19.8m.

3.5 CYCLONES

In general West Coast of India is less prone to cyclonic storms compared to the east coast. From the information reported by India Meteorological Department (IMD), a total of 1034 disturbances occurred in the Bay of Bengal during the period from 1891 to 1970 of which 363 intensified to cyclonic storms, the rest being 'depressions'. On an average the number of cyclonic disturbances per year during this period was about 13. However, if the data is updated to 1990, the number of cyclonic events per annum works out to be 16, varying from a minimum of 8 to a maximum of 18.

The above cyclones may be divided into two broad categories. The first group consists of cyclones that originate in the Bay of Bengal and cross the East coast at certain locations. These storms pass over the Indian landmass and lose their strength before crossing the West coast. The second group consists of cyclones that cross over to the Arabian Sea at the southern tip of the Indian Peninsula and veer northwards towards Saurashtra. These cyclones are much stronger and more dangerous for the west coast and normally occur during the transition months of May and November. Tracks of the cyclones in the Arabian Sea from 1877 to 1992 are presented in Figure 3.6.



Figure 3.6: Storm tracks applicable for the region (Source IMD)

3.6 SEDIMENT TRANSPORT

Unlike the East coast, West coast exhibits very low rates of "Littoral Drift". This is primarily due to the high tidal range, where the waves act on different parts of the flat offshore lower beach and the action on the beach above the high tide level are restricted to a very short time interval. Under such circumstances, it is difficult to discern the direction of the net drift as this is likely to change with local shoreline configuration.

3.7 TOPOGRAPHY AND GEOLOGY

The region is generally hilly including a portion of the Western Ghat rising to 1200 m above Mean Sea Level. The Mormugao head land adjoining the Harbour is hilly; the height varies from 20 m to 60 m. As the area is flanked by hills, back land is limited for development of Port.





The State of Goa is located on the Western Dharwar craton. It constitutes the northwesterly extension of the greenstone-granitoid terrain of Karnataka, comprising rocks of the Peninsular Gneissic Complex (PGC) and Dharwar Supergroup of Precambrian age. The PGC is well exposed along the Western Ghats in North Goa and around Chauri and Quepem in the South Goa. The rocks of the Dharwar Supergroup are represented by the northern extension of the Shimoga schist belt locally classified as 'Goa Group' (Gokul et al, 1985). The rocks of the PGC and the Goa Group are intruded by mafic-ultramafic complexes, younger granites and mafic intrusives. A narrow strip in the north eastern corner of the State is covered by Deccan Traps of late Cretaceouslower Eocene age. Most of these rocks are often hidden below a thick weathered lateritic cap and/or a soil cover varying thickness. As per IS 1893, the site falls under Seismic Zone III.

3.8 TIDES

The nature of tide prevailing at Mormugao is mainly semi-diurnal exhibiting two high and two low waters in a tidal day. The mean tidal variation is of the order of 1.6 m at spring tide and around 0.7 m at neap tides. Based on Indian Naval Hydrographic Chart No. 2020, the tide levels with respect to chart datum at Mormugao Harbour are given in Table 3.2.

Higher High water at Spring	+2.3 m
Mean Higher High Water (MHHW)	+1.9 m
Mean Lower High Water (MLHW)	+1.8 m
Mean Higher Low Water (MHLW)	+1 m
Mean Lower Low Water (MLLW)	+0.5 m
Mean Sea Level (MSL)	+1.3 m

Table 3.2: Tide levels with respect to Chart Datum (CD)

3.9 WAVES

Mormugao harbour on the southern side where berths are located is protected by a breakwater and mole and generally it is the waves from directions between SW and NW that could affect the tranquillity in the harbour. The deep water waves from NW





generally have a small % probability exceedence and do not affect harbour tranquillity significantly since their heights get reduced by the time they reach the harbour. Wave periods during the monsoons tend to be longer than during the rest of the year when NW winds prevail.

As part of the master plan study by MPT, HOWE India constructed the wave rose diagram from the visually observed wave heights during the period 1949 to 1962, from the area bounded by Latitude 10°N to 20°N and Longitude 70°E to 80°E. These wave analysis indicated that the yearly average probability of exceedence of the wave height of 2 m for the Westerly direction would be;

Direction	Exc. Hs = 2 m
SW	4.7 %
W	4.5%
NW	0.4 %

The deep water wave climate is summarized in Table 3.3.

 Table 3.3:
 Deep water wave climate (Probability of exceedance in % of time)

HS =	1.0 m	2.0 m	3.0 m	4.0 m
SW	12.2	8.7	4.7	2.2
W	21.6	13.6	7.4	3.0
NW	8.4	2.0	0.6	0.2

Due to refraction, shoaling and breaking, the wave direction and wave height will change while travelling from deep water to the harbour entrance. Generally by refraction the waves from NW turn to WNW. Waves from W and NW reduce in height. All wave conditions higher than Hs = 4 m are reduced by wave breaking. The operational wave climate at the harbour entrance is presented in Table 3.4.

Table 3.4: Operational wave climate	(Probability of	exceedance in	n % of time	?)
-------------------------------------	-----------------	---------------	-------------	----

HS =	1.0 m	2.0 m	3.0 m	4.0 m
SW	12.2	8.7	4.7	2.2
W	21.6	13.6	7.4	3.0
NW	8.4	2.0	0.6	0.2

The extreme wave climate at the harbour entrance is as follows:





Frequency of occurrence	Hs
4.7 m	10/year
5.0 m	1/year
5.4 m	1/10 years
5.8 m	1/100 years

Extreme wave conditions at harbour entrance will occur mainly during the monsoon. The period of the extreme waves varies between T = 7 S and 13 S.

3.10 CURRENTS

The currents in the region outside the sheltered harbour have been found to be generally less than one knot, during fair season and are mainly caused by tidal ebb and flow. Within the sheltered harbour, indicated current strengths are of the order of 30 to 40 cm/sec. During heavy monsoon rains, current pattern is altered during the fair season but the current strength does not get appreciably altered.

As a part of the field observations in Vasco bay, current observations were earlier taken at two locations (CM1 - 15° 26' 00"N, 73° 48' 18" E , CM2 - 15°24' 21"N, 73° 48' 42" E). A summary of the current measurements is given in Table 3.5.

	CM1	CM2 (Water depth, 3.5 m)		
	Near surface	Mid depth	Near bottom	Near bottom
Maximum	68	31	29	57
Speed (cm/s)				
Minimum	0	0	0	0
Speed (cm/s)				
Predominant	ESE- WNW	ESE-WNW	ESE - WNW	ESE
Direction				

Table 3.5:	Current measurements at Vasco B	ay
I able 3.J.		ay

Measurements at open location (CM1) indicate that the predominant flow is in the ESE-WNW direction, while at the location (CM2) close to the shore, the predominant direction is ESE. The flow of currents is predominantly due to the tidal currents. During flood water, flow is towards Zuari River while during the ebbing, the reversal of flow takes place. The maximum current velocity was observed as 68 cm /sec.





3.11 GROUND WATER QUALITY

As a part of the field studies, water samples were collected at various locations in the study area. Sampling Locations are listed below:

- GW1- ST Harbour Gate No.1
- GW2- ST Harbour Gate No. 2
- GW3- V3 SET Workshop Baina Goa
- GW4- Sasmolem Baina Goa
- GW5- Vasco near Railway Station

The results of the water quality analysis is given Tables 3.6, and the sampling locations are shown in Figure 3.7.



Figure 3.7: Sampling location map





Table 3.6: Ground water	^r quality in t	the study area
-------------------------	---------------------------	----------------

Parameters		Locations				BIS Stds-
	GW-1	GW-2	GW-3	GW-4	GW-5	IS:10500-1991
рН	4.60	5.10	4.90	5.60	5.50	6.5-8.5
Temperature, °C	33.4	33.7	33.5	33.4	33.5	-
Electrical	184	191	452	444	124	-
Conductivity at						
25°C, μS/cm						
Total Alkalinity (as	29.6	29.9	124	188	18.6	200
HCO ₃), mg/l						
Chlorides (as	17.6	15.5	42.3	43.3	9.79	250
CI),mg/I						
Total Hardness (as	84.0	80.0	248	256	72	200
CaCO ₃), mg/l						
Calcium (as	11.2	25.6	56.1	80.2	17.6	75
CaCO ₃), mg/l						
Magnesium (as	13.6	13.9	19.4	33.6	6.8	30
CaCO ₃),mg/l	0.07	1.07				
Nitrate (as NO ₃),	0.07	4.07	0.08	7.78	1.41	45
mg/l	40.0	40.0	4.07	44.4	5.44	000
Sulphate (as SO ₄),	13.8	13.2	4.37	14.4	5.41	200
Mg/I	10.04	10.04	10.04	10.04	10.04	
Phosphate (as	<0.04	<0.04	<0.04	<0.04	<0.04	-
PO4), Mg/I	10.2	2.5	10	0.2	2.0	
	19.2	3.5	4.2	0.3	2.9	-
BOD (2 dove of	0.5	<0.1	<0.1	<0.1	<0.1	
$27^{\circ}C$ mays at	0.5	~ 0.1	~ 0.1	~ 0.1	~ 0.1	-
COD ma/l	1/1	<10	<10	<10	<10	_
Oil & Grease mall	<20	<2.0	<2.0	<2.0	<2.0	
Sodium (as Na)	<u>~2.0</u> 56.8	30.7	<u>~2.0</u>	34.1	25.0	
ma/l	50.0	50.7	5.5	54.1	20.0	
Potassium (as K)	25	55	14	83	44	
ma/l	20	0.0	1.7	0.0	7.7	
Phenolic	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Compounds (as	-0.001	0.001	0.001	0.001	0.001	0.001
C_6H_5OH), mg/l						
Iron (as Fe), mg/l	0.4	0.4	0.3	0.02	0.2	0.3
Arsenic (as As).	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.05
ma/l		0.01	0.01		0.01	0100
Total Chromium (as	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.05
Cr), mg/l						
Mercury (as Hg).	<0.01	<0.01	<0.01	<0.01	<0.01	0.001
mg/l	_	-	-	-	-	-
Copper (as Cu),	<0.01	<0.01	<0.01	<0.01	<0.01	0.05
mg/l						





Parameters		L	ocation	6		BIS Stds-
	GW-1	GW-2	GW-3	GW-4	GW-5	IS:10500-1991
Zinc (as Zn), mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	5.0
Cadmium (as Cd), mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Lead (as Pb), mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	0.05
Fluorides (as F), mg/l	<0.01	<0.01	0.11	0.21	0.11	1.0
Coliform Organisms/ 100 ml, (MPN)	10	Absent	Absent	12	Absent	10

The pH level in various groundwater samples is observed to be slightly acidic side (4.60-5.60). The total hardness in various water samples ranged from 80 to 256 mg/l. The total hardness level in two out of five groundwater samples were higher than the permissible limit of 200 mg/l, specified for meeting drinking water requirement. The principal hardness causing cations are calcium, magnesium, strontium and ferrous and iron. The concentration of calcium and magnesium are mainly responsible for the hardness level in water.

Chlorides occur in all natural waters in widely varying concentrations, chlorides is available in natural water, mainly through solvent power of water, which dissolves chlorides from top soil and deeper formations. Sulphates ion is one of the major anions occurring in natural water. It is an important parameter because of its cathartic affect, when it is present in higher concentration. The chlorides and sulphates level was found to be below the permissible but below the cause of rejection limit specified for drinking water purposes in some of the ground water samples.

The concentration of various heavy metals was observed to be below detectable limit. This is expected in an area, where heavy metals loading is not from geogenic sources and there are no anthropogenic sources as well. Presence of coliform oranisms in two out of five samples indicates anthropogenic source of pollution.





3.12 SOIL QUALITY

As a part of field studies, soil sample was collected at at various locations in the study area. Sampling Locations are listed below.

- S1- ST Harbour Gate No.1
- S2- ST Harbour Gate No. 2
- S3- V3 SET Workshop Baina Goa
- S4- Sasmolem Baina Goa
- S5- Vasco near Railway Station

The results of soil quality analysis are shown in Table 3.7.

 Table 3.7: Soil quality in the study area

S.No.	Parameters			Stations		
		S1	S2	S3	S4	S5
1.	pH	8.02	8.06	8.19	7.94	8.02
2.	Bulk Density, g/cm ³	1.33	1.30	1.45	1.42	1.36
3.	Total Kjeldahl	0.19	0.06	0.03	0.08	0.11
	Nitrogen, % w/w					
4.	Phosphorous (as P), mg/kg	60.8	64.6	72.3	104	127
5.	Phosphate (as P), mg/kg	64.1	66.3	77.9	110	130
6.	Organic Matter, %	2.92	1.53	0.81	2.05	1.80
7.	Sodium Absorption Ratio	0.62	0.55	0.60	0.76	0.76
8.	Sodium (as Na), mg/kg	181	185	188	257	212
9.	Potassium (as K), mg/kg	672	557	217	478	780
10.	Texture	Sandy	Sandy	Sandy	Sandy	Sandy
		Clay	Clay	Clay	Clay	Clay
		Loam	Loam		Loam	Loam
11.	Particle Size Distribution					
	• Very Coarse Sand (<2000-	22.7	24.1	28.1	24.6	24.0
	 Coarse sand (<1000-500μ) Medium Sand (<500-250μ) Fine Sand (<250-100μ) Very Fine Sand (<100-50μ) Silt (<50 - 2μ) Clay (<2μ) 	18.6 24.4 0.73 7.95 14.7 10.7	18.1 23.9 0.29 7.33 15.9 10.1	17.1 20.0 0.82 8.49 16.0 9.28	19.7 22.1 0.72 7.68 14.5 10.4	20.1 22.8 0.44 8.11 14.6 9.76

The pH of soil at various sites lies within neutral range. The levels of NPK indicates moderate to high soil productivity.





3.13 LANDUSE PATTERN

The landuse pattern of the study area has also been assessed using satellite data. The Resources at-2 LISS-IV, Path 096, Row 062, sub-scene-A, dated 15.12.2014, digital satellite was procured from National Remote Sensing Agency (NRSA), Hyderabad for assessing the landuse pattern of the study area. The FCC of the study area is shown in Figure 3.8, and the classified imagery of the study area is enclosed as Figure 3.9. The landuse pattern is summarized in the Table 3.8.



Figure 3.8: FCC of the study area







Figure 3.9: Land use pattern of the study area

Table 3.8 : Landuse	pattern of the	study area
---------------------	----------------	------------

S. No.	Category	Area (ha)	Area (%)
1	Dense Vegetation	2056	4.92
2	Open Vegetation	2664	6.38
3	Open Land/Barren Land	3721	8.91
4	Sand	259	0.62
5	Water Body	31434	75.24
6	Agricultural Land	1057	2.53
7	Builtup Area	589	1.41
	Total	41780	100.00

The major landuse category is water body accounting for about 75.24% of the total study area. The area under dense and open vegetation in the study area is 4.92% and 6.38% respectively. The agricultural area accounts for about 2.53% of the Study Area, while built-up area accounts for 1.41% of the total Study Area.





3.14 SHORELINE CHANGE STATUS

West coast exhibits very low rates of littoral drift, primarily due to the high tidal range, where the waves act on different parts of the flat offshore lower beach and the action on the beach above the high tide level are restricted to a very short time interval. As it is difficult to distinguish the direction of the net drift, its effect on the local shoreline remains unchanged.

Apart from this, the operating berths are erosion protected with under deck pitching, so no shoreline change corresponding to the waterfront is likely to happen. Therefore, the existing shoreline along the Mormugao Port trust is quite stable without any significant changes in the shoreline along its coast. This can be substantiated from the study report on "Use of Satellite data for detection of violation of land use along the Coastal Regulation Zone and Impact of Port structures on Shoreline Changes" by Ministry of Earth Sciences (MoES), prepared for the Ministry of Environment and Forests (MoEF), New Delhi. The shoreline change is reported along the coast off South Goa, other than the coast of Mormugao Port.

Sametime, the "National Assessment of Shoreline change, Goa coast" maps are also prepared by National Centre for Sustainable Coastal Management (NCSCM), Chennai, an institute under MoEFCC. The map indicates no change in the shoreline in the port berth area, but a small stretch of the coast towards north of the port is accreding and stable. However, most of the sholeline along the zuari river is rocky coast and is devoid of any shoreline change. The shoreline change map of the project area prepared by NCSCM is shown in Figure 3.10.







Source: GCZMA, Goa



3.15 AMBIENT AIR QUALITY

As a part of field studies, ambient air quality monitored at various locations in the study area by WAPCOS from 4th March 2016 to 28th May 2016. The ambient air quality monitoring was carried out with a frequency of two samples per week for twelve consecutive weeks at four locations in the study period. The parameters monitored as a part of the study are listed as below:

- Particulate Matter less than 2.5 microns (PM_{2.5})
- Particulate Matter less than 10 microns (PM₁₀)
- Sulphur dioxide (SO₂)
- Nitrogen dioxide (NO₂)
- Carbon Monoxide (as CO)
- Ozone (as O₃)
- Lead (as Pb)





- Ammonia (as NH₃)
- Benzene (as C₆H₆)
- Benzo (O) Pyrene (as BaP)
- Arsenic (as As)
- Nickel (as Ni)

The location of ambient air quality monitoring stations is given in Table 3.9. The results of ambient air quality survey conducted during the study period are given in Table 3.10. The summary of ambient air quality monitoring is given in the Table 3.11. The ambient air quality standards specified by Central Pollution Control Board (CPCB) are enclosed as Annexure-II. The location of ambient air quality monitoring stations is shown in the Figure 3.7.

S. No.	Station Code	Location	Latitude	Longitude
1	AAQ-1	SWPL Project site	15°24'47.71"N	73°47'37.19"E
2	AAQ-2	Port User's complex	15°24'46.03''N	73°47'22.64''E
3	AAQ-3	MPT Guest House	15 ⁰ 24'38.62"N	73 ⁰ 47'26.32"E
4	AAQ-4	Headland Sada	15°24'27.28''N	73°47'28.21''E
5	AAQ-5	Near Sub Jail	15°24'25.13''N	73°47'44.72"E

Table 3.9: Loca	ation detail of	ambient air o	auality monite	oring stations
			1441107 11101110	sing olationo





Table 3.10: Results of ambient air quality status

S.	Date of	PM _{2.5}	PM ₁₀	SO ₂	NO ₂	CO	O ₃	Pb	NH₃	C ₆ H ₆	BaP	As	Ni
No.	Sampling	µg/m³	µg/m³	µg/m³	µg/m³	mg/m³	µg/m³	µg/m³	µg/m³	µg/m³	ng/m ³	ng/m³	ng/m ³
Samp	oling Location-1 –	SWPL Pr	oject site	9									
01	04-05/03/2016	36.2	79.5	23.5	38.4	0.5	57	ND	13	0.2	ND	ND	ND
02	07-08/03/2016	35.5	76.8	25.3	46.7	0.5	41.2	ND	11.5	0.7	ND	ND	ND
03	10-11/03/2016	37.5	82.2	24.8	54.5	0.7	46.2	ND	14.6	0.6	ND	ND	ND
04	14-15/03/2016	42.0	98.0	27.5	44.6	0.7	48.4	ND	13.6	0.8	ND	ND	ND
05	17-18/03/2016	47.5	95.2	26.8	46.5	0.8	45	ND	15.6	0.6	ND	ND	ND
06	21-22/03/2016	37.2	78.1	26.6	42.5	0.7	48.1	ND	14.5	0.4	ND	ND	ND
07	24-25/03/2016	36.0	78.5	22.6	55.7	0.7	54.6	ND	13	0.3	ND	ND	ND
08	28-29/03/2016	48.5	99.2	24.7	51.4	0.8	41.6	ND	15.3	0.5	ND	ND	ND
01	04-05/04/2016	47.5	99.4	23.5	38.7	0.6	57	ND	13	0.2	ND	ND	ND
02	07-08/04/2016	38.8	85.6	24.8	46.2	0.6	51	ND	15.7	0.4	ND	ND	ND
03	11-12/04/2016	45.0	92.2	28.8	51.3	0.6	51	ND	14.3	0.3	ND	ND	ND
04	15-16/04/2016	34.5	85.2	24.5	36.4	0.6	43	ND	14.1	0.3	ND	ND	ND
05	18-19/04/2016	34.7	82.5	27.4	49.9	0.6	43	ND	15.1	0.4	ND	ND	ND
06	22-23/04/2016	33.0	79.5	27.0	49.6	0.9	48	ND	14.4	0.3	ND	ND	ND
07	25-26/04/2016	44.3	98.5	26.9	56.7	0.8	56	ND	13	0.3	ND	ND	ND
08	29-30/04/2016	34.2	75.0	25.8	56.8	0.7	43	ND	15.1	0.2	ND	ND	ND
01	02-03/05/2016	40.2	85.2	27.4	45.7	0.5	53	ND	14.6	0.5	ND	ND	ND
02	06-07/05/2016	35.5	72.2	27.3	45.3	0.8	47	ND	14.3	0.6	ND	ND	ND
03	09-10/05/2016	34.5	80.2	25.6	46.5	0.7	56	ND	14.2	0.5	ND	ND	ND
04	13-14/05/2016	33.2	76.5	31.5	50.4	0.6	53	ND	14.5	0.5	ND	ND	ND
05	16-17/05/2016	30.5	69.5	29.5	49.0	0.6	50	ND	15.2	0.7	ND	ND	ND
06	20-21/05/2016	30.5	72.5	28.4	46.0	0.6	55	ND	11.7	0.4	ND	ND	ND
07	23-24/05/2016	32.0	72.2	29.8	44.3	0.6	56	ND	11.5	0.5	ND	ND	ND
08	27-28/05/2016	30.5	64.5	26.5	51.0	0.7	64	ND	11.7	0.6	ND	ND	ND





S.	Date of	PM _{2.5}	PM ₁₀	SO ₂	NO ₂	CO	O ₃	Pb	NH₃	C ₆ H ₆	BaP	As	Ni
No.	Sampling	µg/m³	µg/m³	µg/m³	µg/m³	mg/m ³	µg/m³	µg/m³	µg/m³	µg/m³	ng/m ³	ng/m ³	ng/m³
Samp	ling Location-2 -	Port User	's Comp	lex									
01	04-05/03/2016	32.3	80.2	26.6	42.5	0.9	38	ND	9.5	0.2	ND	ND	ND
02	07-08/03/2016	34.5	73.4	26.8	41.2	0.6	39	ND	9.9	0.6	ND	ND	ND
03	10-11/03/2016	36.5	78.5	29	55.2	0.9	51	ND	14.1	0.5	ND	ND	ND
04	14-15/03/2016	33.5	70.8	25.9	60.4	0.7	50.4	ND	13	0.5	ND	ND	ND
05	17-18/03/2016	32.7	75.2	28.3	47.3	0.9	45.6	ND	10.6	0.7	ND	ND	ND
06	21-22/03/2016	31.2	75.0	26.1	62.8	0.8	52	ND	13	0.2	ND	ND	ND
07	24-25/03/2016	33.5	68.5	28.5	60.6	0.8	52	ND	8.5	0.2	ND	ND	ND
08	28-29/03/2016	36.5	80.2	27.9	42.5	0.8	38	ND	10.3	0.4	ND	ND	ND
01	04-05/04/2016	37.4	92.5	24.8	40.6	0.7	52	ND	17.1	0.4	ND	ND	ND
02	07-08/04/2016	34.8	86.6	25.7	49.9	0.7	50	ND	16.4	0.3	ND	ND	ND
03	11-12/04/2016	38.0	99.0	29.3	52.2	0.9	42	ND	15.5	0.3	ND	ND	ND
04	15-16/04/2016	36.3	90.2	27.3	39.2	0.7	42	ND	17.8	0.4	ND	ND	ND
05	18-19/04/2016	34.7	82.5	25.5	51	0.7	48	ND	14.6	0.3	ND	ND	ND
06	22-23/04/2016	36.0	78.5	25.4	51.4	0.6	42	ND	14.2	0.6	ND	ND	ND
07	25-26/04/2016	42.3	98.5	26.4	59.4	0.8	52	ND	17.1	0.5	ND	ND	ND
08	29-30/04/2016	36.0	85.0	29.6	59.2	0.8	42	ND	16.7	0.4	ND	ND	ND
01	02-03/05/2016	34.2	82.2	25.6	49.6	0.8	50	ND	14.5	0.6	ND	ND	ND
02	06-07/05/2016	42.0	98.0	25.7	48.7	0.7	52	ND	14.2	0.5	ND	ND	ND
03	09-10/05/2016	36.5	85.2	30.6	50	0.8	55	ND	11.7	0.7	ND	ND	ND
04	13-14/05/2016	32.2	76.5	29.5	55.9	0.9	64	ND	16.4	0.5	ND	ND	ND
05	16-17/05/2016	30.5	72.5	30.5	52.8	0.8	52	ND	13.8	0.6	ND	ND	ND
06	20-21/05/2016	31.5	70.5	27.6	48.7	0.8	51	ND	12.8	0.6	ND	ND	ND
07	23-24/05/2016	32.0	72.2	34.8	48.6	0.5	52	ND	10.5	0.4	ND	ND	ND
08	27-28/05/2016	33.5	79.0	27	53.2	0.8	59	ND	14.6	0.6	ND	ND	ND
Samp	oling Location-3 –	MPT Gue	est House	•									
01	04-05/03/2016	33.2	72.5	26.4	39.6	0.8	62	ND	17.1	0.4	ND	ND	ND
02	07-08/03/2016	31.2	70.2	27.4	49.7	0.7	44.6	ND	17.3	0.9	ND	ND	ND
03	10-11/03/2016	27.4	68.5	27.3	56	0.9	53.7	ND	10.7	0.8	ND	ND	ND





S.	Date of	PM _{2.5}	PM ₁₀	SO ₂	NO ₂	CO	O ₃	Pb	NH₃	C ₆ H ₆	BaP	As	Ni
No.	Sampling	µg/m³	µg/m³	µg/m³	µg/m³	mg/m ³	µg/m³	µg/m³	µg/m³	µg/m³	ng/m ³	ng/m ³	ng/m ³
04	14-15/03/2016	31.5	76.5	27.3	58.2	0.8	64.3	ND	9.6	0.4	ND	ND	ND
05	17-18/03/2016	31.2	65.0	27.2	56.3	0.8	37.9	ND	16.5	0.6	ND	ND	ND
06	21-22/03/2016	26.5	68.7	27.5	59.7	0.7	47.3	ND	14.5	0.4	ND	ND	ND
07	24-25/03/2016	33.5	75.0	26.2	51.7	0.9	45	ND	13.7	0.3	ND	ND	ND
08	28-29/03/2016	49.2	75.2	37.3	54	0.9	61	ND	16.7	0.6	ND	ND	ND
01	04-05/04/2016	34.3	82.5	27.8	41.4	0.6	41	ND	12.4	0.3	ND	ND	ND
02	07-08/04/2016	32.8	75.0	27.8	51	0.7	47	ND	12.4	0.1	ND	ND	ND
03	11-12/04/2016	32.3	69.8	30.2	49.7	0.7	45	ND	14.3	0.4	ND	ND	ND
04	15-16/04/2016	37.3	88.0	24.9	38	0.7	42	ND	13.7	0.5	ND	ND	ND
05	18-19/04/2016	33.7	75.2	26.3	49.8	0.7	40	ND	12	0.4	ND	ND	ND
06	22-23/04/2016	33.0	76.5	25.9	49.9	0.5	43	ND	11.8	0.5	ND	ND	ND
07	25-26/04/2016	30.6	65.4	27.5	53.2	0.7	49	ND	12.4	0.4	ND	ND	ND
08	29-30/04/2016	28.2	68.2	25.3	48.7	0.6	40	ND	13.5	0.3	ND	ND	ND
01	02-03/05/2016	31.2	66.5	28.3	44.5	0.7	51	ND	11.3	0.7	ND	ND	ND
02	06-07/05/2016	34.2	65.0	26.5	50.4	0.6	49	ND	13	0.5	ND	ND	ND
03	09-10/05/2016	32.5	72.2	28.3	51.5	0.7	49	ND	13.6	0.5	ND	ND	ND
04	13-14/05/2016	33.2	74.5	27.5	51.2	0.8	47	ND	14.5	0.6	ND	ND	ND
05	16-17/05/2016	31.5	64.5	29.7	55.2	0.8	46	ND	11.7	0.7	ND	ND	ND
06	20-21/05/2016	35.3	58.0	32.4	51.6	0.5	48	ND	12.5	0.7	ND	ND	ND
07	23-24/05/2016	34.8	70.2	30.4	51	0.6	49	ND	11.7	0.5	ND	ND	ND
08	27-28/05/2016	33.2	72.5	26.5	46	0.6	63	ND	11	0.5	ND	ND	ND
Samp	ling Location-4 –	Headland	d Sada ar	ea	-	-							
01	04-05/03/2016	36.2	79.5	23.5	38.4	0.5	57	ND	13	0.2	ND	ND	ND
02	07-08/03/2016	35.5	76.8	25.3	46.7	0.5	41.2	ND	11.5	0.7	ND	ND	ND
03	10-11/03/2016	37.5	82.2	24.8	54.5	0.7	46.2	ND	14.6	0.6	ND	ND	ND
04	14-15/03/2016	34.5	72.0	27.5	44.6	0.7	48.4	ND	13.6	0.8	ND	ND	ND
05	17-18/03/2016	32.7	75.2	26.8	46.5	0.8	45	ND	15.6	0.6	ND	ND	ND
06	21-22/03/2016	35.8	78.0	26.6	42.5	0.7	48.1	ND	14.5	0.4	ND	ND	ND
07	24-25/03/2016	36	78.5	22.6	55.7	0.7	54.6	ND	13	0.3	ND	ND	ND





S.	Date of	PM _{2.5}	PM ₁₀	SO ₂	NO ₂	CO	O ₃	Pb	NH₃	C ₆ H ₆	BaP	As	Ni
No.	Sampling	µg/m³	µg/m³	µg/m³	µg/m³	mg/m ³	µg/m³	µg/m³	µg/m³	µg/m³	ng/m ³	ng/m ³	ng/m³
08	28-29/03/2016	34.5	81.2	24.7	51.4	0.8	41.6	ND	15.3	0.5	ND	ND	ND
01	04-05/04/2016	37.4	88.6	23.5	38.7	0.6	57	ND	13	0.2	ND	ND	ND
02	07-08/04/2016	32.8	85.6	24.8	46.2	0.6	51	ND	15.7	0.4	ND	ND	ND
03	11-12/04/2016	36	78.4	28.8	51.3	0.6	51	ND	14.3	0.3	ND	ND	ND
04	15-16/04/2016	34.5	85.2	24.5	36.4	0.6	43	ND	14.1	0.3	ND	ND	ND
05	18-19/04/2016	34.7	82.5	27.4	49.9	0.6	43	ND	15.1	0.4	ND	ND	ND
06	22-23/04/2016	33	79.5	27	49.6	0.9	48	ND	14.4	0.3	ND	ND	ND
07	25-26/04/2016	44.3	84.5	26.9	56.7	0.8	56	ND	13	0.3	ND	ND	ND
08	29-30/04/2016	34.2	75.0	25.8	56.8	0.7	43	ND	15.1	0.2	ND	ND	ND
01	02-03/05/2016	40.2	85.2	27.4	45.7	0.5	53	ND	14.6	0.5	ND	ND	ND
02	06-07/05/2016	35.5	72.0	27.3	45.3	0.8	47	ND	14.3	0.6	ND	ND	ND
03	09-10/05/2016	31.7	72.5	25.6	46.5	0.7	56	ND	14.2	0.5	ND	ND	ND
04	13-14/05/2016	33.2	76.5	31.5	50.4	0.6	53	ND	14.5	0.5	ND	ND	ND
05	16-17/05/2016	30.5	59.5	29.5	49	0.6	50	ND	15.2	0.7	ND	ND	ND
06	20-21/05/2016	30.5	72.5	28.4	46	0.6	55	ND	11.7	0.4	ND	ND	ND
07	23-24/05/2016	32	72.2	29.8	44.3	0.6	56	ND	11.5	0.5	ND	ND	ND
08	27-28/05/2016	30.5	77.0	26.5	51	0.7	64	ND	11.7	0.6	ND	ND	ND
Samp	ling Location-5 –	Near Sub	o Jail			-				-			-
01	04-05/03/2016	33.3	76.5	26.9	46.7	0.8	53	ND	13	0.2	ND	ND	ND
02	07-08/03/2016	34.2	68.6	34	55.3	0.6	42.1	ND	10.2	0.7	ND	ND	ND
03	10-11/03/2016	35	63.5	31	58.3	0.9	58	ND	13.2	0.7	ND	ND	ND
04	14-15/03/2016	32.5	71.8	27.1	51.7	0.9	52	ND	10.3	0.6	ND	ND	ND
05	17-18/03/2016	34.7	74.2	31	49	0.7	44.1	ND	14.4	0.6	ND	ND	ND
06	21-22/03/2016	32.2	76.4	37.2	64.5	0.9	44.1	ND	17.2	0.2	ND	ND	ND
07	24-25/03/2016	33.5	69.5	29.7	58.2	0.9	51.7	ND	11	0.7	ND	ND	ND
08	28-29/03/2016	38.5	81.2	28.7	57.7	0.9	49.7	ND	18.2	0.2	ND	ND	ND
01	04-05/04/2016	39.3	96.5	29.3	56.2	0.8	43	ND	22.6	0.3	ND	ND	ND
02	07-08/04/2016	35.8	85.5	27.3	48.2	0.9	49	ND	18.2	0.2	ND	ND	ND
03	11-12/04/2016	42.9	99.0	34.2	50.3	0.7	49	ND	13.7	0.3	ND	ND	ND





S.	Date of	PM _{2.5}	PM ₁₀	SO ₂	NO ₂	CO	O 3	Pb	NH₃	C ₆ H ₆	BaP	As	Ni
No.	Sampling	µg/m³	µg/m³	µg/m³	µg/m³	mg/m ³	µg/m³	µg/m³	µg/m³	µg/m³	ng/m³	ng/m³	ng/m³
04	15-16/04/2016	37.3	91.2	29.3	35.1	0.6	47	ND	14.5	0.5	ND	ND	ND
05	18-19/04/2016	34.7	82.2	29.2	51.2	0.6	51	ND	13.7	0.5	ND	ND	ND
06	22-23/04/2016	36.8	74.5	27.4	48.5	0.7	47	ND	13.5	0.5	ND	ND	ND
07	25-26/04/2016	32.3	98.5	29.5	57.4	0.6	51	ND	14.2	0.3	ND	ND	ND
08	29-30/04/2016	32.5	75.2	27.3	58.3	0.8	45	ND	14.2	0.4	ND	ND	ND
01	02-03/05/2016	36.2	99.1	22.3	52.1	0.7	49	ND	16.8	0.5	ND	ND	ND
02	06-07/05/2016	39.5	99.2	25.8	54.2	0.7	51	ND	15.4	0.6	ND	ND	ND
03	09-10/05/2016	36.5	86.2	31.3	48.5	0.4	53	ND	14.6	0.5	ND	ND	ND
04	13-14/05/2016	34.2	78.5	28.3	49.8	0.8	51	ND	13.1	0.7	ND	ND	ND
05	16-17/05/2016	31.0	74.5	26.3	49.7	0.5	50	ND	16.4	0.6	ND	ND	ND
06	20-21/05/2016	32.5	69.5	30.6	50.6	0.5	48	ND	14.7	0.6	ND	ND	ND
07	23-24/05/2016	32.0	72.2	33.7	52.5	0.7	51	ND	13.4	0.4	ND	ND	ND
08	27-28/05/2016	34.5	80.0	28.3	49.8	0.8	58	ND	10.8	0.7	ND	ND	ND





Table 3.11: Summary of	ambient air quality status
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Station	Maximum	Minimum	Average			
Particulate Matter _{2.5} (PM _{2.5}) (Unit: µg/m ³)						
Project site	48.5	30.5	37.5			
Port User's complex	42.3	30.5	35.9			
MPT Guest House	49.2	26.5	33.0			
Headland Sada area	44.3	13.5	34.6			
Near Sub Jail	42.9	31.0	35.0			
Particulate Matter10 (PM10) (Unit: µg/	⁷ m ³)		·			
Project site	99.4	64.5	82.4			
Port User's complex	99.0	68.5	81.3			
MPT Guest House	88.0	58.0	71.5			
Headland Sada area	88.6	59.5	77.7			
Near Sub Jail	99.2	63.5	81.0			
Sulphur Dioxide (SO ₂) (Unit: µg/m ³)						
Project site	31.5	22.6	26.5			
Port User's complex	34.8	24.8	27.7			
MPT Guest House	37.3	24.9	28.0			
Headland Sada area	31.5	22.6	26.5			
Near Sub Jail	37.2	22.3	29.4			
Nitrogen Dioxide (No ₂) (Unit: µg/m ³)						
Project site	56.8	36.4	47.7			
Port User's complex	62.8	37.2	50.9			
MPT Guest House	59.7	38.0	50.3			
Headland Sada area	56.8	36.4	47.7			
Near Sub Jail	64.5	35.1	52.2			
Carbon Monoxide (CO) (Unit: mg/m	3)					
Project site	0.9	0.5	0.7			
Port User's complex	0.9	0.5	0.8			
MPT Guest House	0.9	0.5	0.7			
Headland Sada area	0.9	0.5	0.7			
Near Sub Jail	0.9	0.4	0.7			
Ozone (O ₃) (Unit: μg/m ³)						
Project site	64.0	41.2	50.3			
Port User's complex	64.0	38.0	48.8			
MPT Guest House	64.3	37.9	48.5			
Headland Sada area	64.0	41.2	50.8			
Near Sub Jail	58.0	42.1	49.5			
Ammonia (NH ₃) (Unit: μg/m ³)						
Project site	15.7	11.5	13.9			
Port User's complex	17.8	8.5	13.6			
MPT Guest House	17.3	9.6	13.2			
Headland Sada area	15.7	11.5	13.8			
Near Sub Jail	22.6	10.2	14.5			
Benzene (C ₆ H ₆) (Unit: µg/m ³)						
Project site	0.8	0.2	0.4			





Station	Maximum	Minimum	Average
Port User's complex	0.7	0.2	0.5
MPT Guest House	0.9	0.1	0.5
Headland Sada area	0.8	0.2	0.5
Near Sub Jail	0.7	0.2	0.5

Observations on PM2.5 levels

The average concentration of PM_{2.5} at various stations monitored ranged from 33.0 to 37.5 μ g/m³. The highest PM_{2.5} value was recorded as 49.2 μ g/m³ near MPT Guest House and lowest values of 13.5 μ g/m³ was recorded near Sada Area. The PM_{2.5} values monitored during the field survey were within the permissible limit of 60 μ g/m³ for industrial, residential, rural and other areas (Refer Annexure-III).

Observations on ambient PM10 levels

It is observed from Table 3.11 that aveage concentration of PM_{10} at various stations ranged from 71.5 to 82.4 μ g/m³. The highest PM_{10} value was recorded as 99.4 μ g/m³ near project site and lowest values of 58.0 μ g/m³ was recorded near MPT Guest House. The average PM_{10} values monitored during the field survey were generally within the permissible of 100 μ g/m³ for industrial, residential, rural and other areas.

Observations on ambient SO₂ levels

The summary of ambient SO₂ level as monitored during field studies is given in the Table 3.11. The average concentration of SO₂ at various stations in the study area was well below the prescribed limit of 80 μ g/m³ specified for industrial, residential, rural and other areas (Refer Annexure-III). The average concentration of SO₂ at various stations monitored ranged from 26.5 to 29.4 μ g/m³. The highest SO₂ value was recorded as 37.3 μ g/m³ near MPT Guest House and is below detectable limit in all the locations.

Observations on ambient NO₂ levels

It can be seen from Table 3.11 that during the study period, average NO₂ concentration at various sampling stations ranged from 47.7 to 52.2 μ g/m³. The highest NO₂ value was recorded as 64.5 μ g/m³ near Sub Jail and lowest value of 35.1 μ g/m³ was also recorded at the same station.. The average concentration of NO₂ at various stations





in the study area was observed to be well below the prescribed limit of 80 μ g/m³ specified for industrial, residential, rural and other areas.

Observations on ambient CO levels

The average concentration of CO at various stations monitored ranged from 0.7 to 0.8 mg/m³. The highest CO value was recorded as 0.9 mg/m³ and lowest values of 0.4 mg/m³ were recorded near Sub Jail Area. The CO values monitored during the field survey were below permissible limit of 2 mg/m³ for industrial, residential, rural and other areas.

Observations on ambient O3 levels

It is observed from Table 3.11 that average concentration of Ozone (O₃) at various stations ranged from 48.5 to 50.8 μ g/m³. The highest Ozone value was recorded as 64.3 μ g/m³ near MPT Guest house and lowest values of 37.9 μ g/m³ were also recorded at the same station. The Ozone values monitored during the field survey were below the permissible limit of 100 μ g/m³ for industrial, residential, rural and other areas.

Observations on ambient NH3 levels

The average concentration of Ammonia (NH₃) at various stations monitored are ranged from 13.2 to 14.5 μ g/m³. The highest NH₃value was recorded as 22.6 μ g/m³ near Sub Jail, and lowest values of 8.5 μ g/m³ was recorded near Port User's Complex. The NH₃ values monitored during the field survey were below permissible limit of 400 μ g/m³ for industrial, residential, rural and other areas.

Observations on ambient C₆H₆ levels

It is observed from Table 3.11, that the average concentration of C_6H_6 at various stations ranged from 0.4 to 0.5 μ g/m³. The highest C_6H_6 value was recorded as 0.9 μ g/m³ near MPT Guest House and lowest values of 0.1 μ g/m³ were also recorded in the same station. The C_6H_6 values monitored during the field survey were below the permissible limit of 5 μ g/m³ for industrial, residential, rural and other areas.





3.16 NOISE LEVELS

Baseline noise data has been measured using a weighted sound pressure level meter. The survey was carried out in calm surroundings. Sound Pressure Level (SPL) measurement in the outside environment was made using sound pressure level meter. Hourly noise meter readings were taken at each site, and equivalent day time and night time noise levels were estimated. The ambient noise levels were recorded at 7 locations and details are listed Table 3.12. The hourly ambient noise levels recorded at various locations are listed in Table 3.13. The day time and night time noise levels are presented in Table 3.14. The ambient noise standards are enclosed as Annexure-III. The sampling stations of the noise monitoring are shown in Figure 3.6.

S.No.	Noise monitoring station
1	Near Project site
2	D- Type Quarters ST colony
3	D Type Quarter Near Sub Jail ST
4	ST Guest House
5	JSW Office Port Complex Building
6	A Type Quarters, Bogda Bharat Line
7	Vasco- Hotel Westend

Table 3.12: Location details	s of noise	monitoring	stations
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Table 3.13: Ambient Noise Level in the stu	udy area [Unit: dB(A)]]
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Time	Stations						
	S1	S2	S 3	S4	S5	S6	S7
6AM-7AM	42.3	47.1	46.4	45.7	49.8	51.7	46.9
7AM-8AM	44.3	50.2	47.9	46.9	52.7	54.0	49.9
8AM-9AM	45.6	51.5	51.4	47.8	53.9	54.9	52.2
9AM-10AM	47.5	51.2	53.6	48.8	54.9	55.2	50.9
10AM-11AM	47.6	51.4	54.9	50.9	57.3	56.9	50.1
11AM-12PM	48.5	52.7	56.4	52.8	58.4	54.1	48.4
12PM-1PM	50.3	53.2	57.4	53.7	59.8	54.9	50.9
1PM-2PM	51.6	53.7	58.0	52.8	60.8	55.0	47.9
2PM-3PM	51.6	52.5	57.2	54.8	61.0	58.4	52.1
3PM-4PM	52.6	53.5	57.4	52.9	60.3	59.4	53.1
4PM-5PM	53.2	54.1	57.2	50.9	61.1	60.0	51.4
5PM-6PM	54.6	54.8	59.0	53.2	61.4	61.2	49.7
6PM-7PM	55.6	53.1	56.9	52.7	58.2	58.0	52.2
7PM-8PM	53.2	51	55.0	51.8	56.1	56.0	48.2
8PM-9PM	50.2	47.1	53.0	49.8	51.8	56.9	49.9





Time	Stations						
	S1	S2	S3	S4	S5	S6	S7
9PM-10PM	47.6	43.2	50.4	47.2	47.7	52.2	45.2
10PM-11PM	45.6	41.1	46.2	45.1	46.2	50.2	41.7
11PM-12AM	43.2	40.1	43.2	41.9	43.0	46.7	40.1
12AM-1AM	40.2	39.5	41.2	39.8	40.1	43.3	37.8
1AM-2AM	37.2	37.2	40.2	38.2	38.0	40.1	34.2
2AM-3AM	36.1	38.2	39.5	38.8	38.7	38.5	37.4
3AM-4AM	38.2	40.5	41.6	41.2	40.2	42.5	39.8
4AM-5AM	39.2	42.1	43.5	42.2	41.1	45.4	31.4
5AM-6AM	41.6	43.5	45.7	45.1	44.2	47.4	42.9

Table 3.14: Equivalent noise levels in the Study Area

S. No.	Noise monitoring station	Leq(day)	Leq(night)
1	Near Project site	51.28	40.39
2	D- Type Quarters ST colony	52.29	38.83
3	D- Type Quarter near Sub Jail ST	55.87	42.69
4	ST Guest House	51.70	40.94
5	Port User's Complex	58.24	41.12
6	A Type Quarters, Bogda Bharat Line	57.16	44.90
7	Vasco- Hotel Westend	50.59	38.36

It may be seen from the Table 3.14, that the day time equivalent noise level ranged from a minimum of 50.59 dB (A) to a maximum of 58.24 dB (A). The night time equivalent noise level ranged from a minimum of 38.36 dB (A) to a maximum of 44.90 dB (A). The day and night time equivalent noise level at various sites located close to residential areas and commercial area were compared with Ambient Noise Standards (Refer Annexure-III) and were observed to be well below the permissible limit specified.

3.17 MARINE ECOLOGY

The prime objective of ecological survey is to study the baseline status of marine biodiversity, physiochemical and biological charecteristics of marine water and sediments in the study area. Anticipated impacts on marine ecology during construction and operation phases of the proposed modernization of the terminal have been evaluated based on the baseline status of various parameters of marine environment in the study area. These impacts will be ascertained by superimposing





the impacts due to the planned activities on the baseline environmental status. Mitigation measures in the form of an Environmental Management Plan (EMP) have also been outlined as a part of the EIA report. To accomplish this task, Experts from the Centre of Advanced Study (CAS) in Marine Biology of Annamalai University, Tamilnadu during 9th and 10th May 2016. During the survey marine water and sediment were collected across two different depths (surface and subsurface) from 7 different stations. Samples for biological parameters i.e. phytoplankton, zooplankton, macrobenthos, meio-benthos and microbial samples besides sea weeds, sea grasses, and fishery resources were also collected from various stations. The geographical location of the each sampling stations are given in Table 3.15 and shown in Figure 3.11.

S. No.	Station Code	Latitude (N)	Longitude (E)
1	ST-1	15°25'31.51"N	73°48'54.87"E
2	ST-2	15°26'8.47"N	73°47'14.30"E
3	ST-3	15°25'14.31"N	73°45'48.10"E
4	ST-4	15°24'46.15"N	73°46'53.04"E
5	ST-5	15°25'9.87"N	73°47'34.58"E
6	ST-6	15°24'54.20"N	73°47'50.96"E
7	ST-7	15°24'15.90"N	73°46'50.06"E

Table 3.15: Marine sampling	locations and its	geographical	coordinates
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3.17.1 Methodology adopted for Analyses Water and Sediment Sampling

Water samples were collected at the surface and sub-surface level using Universal water sampler and transferred to the pre-cleaned polypropylene and glass containers. Sediment samples were collected using Van veen grab transferred to clean polythene bags and transported to the shore. The samples were air-dried and the plant root and other debris were removed and stored for further analysis.

In-situ Analysis

The physical parameters such as temperature, salinity and pH were measured *in-situ* in the field. The sub-surface temperature was measured with a mercury thermometer (±0.02 °C accuracy) and the pH was measured by a calibrated pH pen (pH ep-3 model). Salinity was estimated using a Hand Refractometer (Atago, Japan). Turbidity was measured with the help of Nephelometer. Water samples collected for dissolved oxygen estimation were transferred carefully to BOD bottles. The DO was immediately fixed and brought to the shore for further analysis.

Preservation and Laboratory Analysis

After collection, the samples were immediately cooled to 4°C and then brought to the laboratory in insulated thermocool boxes. For dissolved heavy metals, the water samples were acidified immediately after the collection. On reaching laboratory, water samples were filtered through Whatman GF/C filter paper and analysed for organic matter and other nutrients. Unfiltered samples were used for the estimation of total nitrogen and total phosphorus. All the analyses were carried out by adopting Standard procedures for samples of aquatic origin. The methodology for each analysis is briefly given below:

Total Suspended Solids (TSS)

The total suspended solid is measusred as the difference in the filter paper weight (dried filter paper before filteration and after filteration) and the volume of water filtered. The TSS valuess are expresses as mg/l.





Dissolved Oxygen (DO) and Biochemical Oxygem Demand (BOD)

The modified Winkler's method as described by Strickland and Parsons (1972) was adopted for the estimation of dissolved oxygen fixed at the field. The BOD was computed simply as the difference between the 1st day DO and 5th day DO after incubation at 20 °C. The values are expressed in mg/l.

Nitrate and Nitrite

The nitrate and nitrite content of samples were analysed by following the method described by Strickland and Parsons (1972). The nitrite was estimated from highly coloured azo dye formed by the addition of N (1-Napthyl) ethylene diaminedihydro-chloride and sulfanilamide into the solution was then measured at 543 nm in a spectrophotometer. The same procedure was followed for the estimation of nitrate. For this, nitrate was reduced to nitrite by passing the sample through copper coated cadmium column. The calculated values are expressed in μ mol of Nitrogen/I.

Ammonical Nitrogen

Ammonium (NH₄) was determined by indophenol blue method. The NH₄ in the sample is allowed to react in a moderately alkaline solution with hypochlorite to give monochloramine which in presence of phenol, with catalytic amounts of nitroprusside ions and excess of hypochlorite produces the indophenol blue. The blue color was then measured at 630 nm wavelength using spectrophotometer.

Inorganic Phosphate

The single solution mixed reagent procedure developed by Murphy and Riley (1962) was followed for the estimation of dissolved inorganic phosphate levels in water samples. This involves the conversion of phosphate into phosphomolybdic acid, which was then reduced to molybdenum blue color complexes and then the intensity of colour was measured at 882 nm in a spectrophotometer. The calculated values are expressed in µmol of Phosphate/I.

Total Phosphorus (TP)

The Total Phosphorus in water samples was estimated by adopting the method described by Menzel and Corwin (1964). This procedure involves the conversion of



organically bound phosphate into inorganic phosphate by wet oxidation of samples with potassium persulphate in an autoclave for 30 min at 15 lbs pressure. The converted inorganic phosphate was then estimated by using the method described by Murphy and Riley (1962). The calculated value is expressed in µmol of Phosphorus/I.

Total Nitrogen (TN)

The Total Nitrogen in water samples was estimated by adopting the method described by Strickland and Parsons (1972). This procedure involves the conversion of organically bound nitrogen into inorganic nitrogen by wet oxidation of samples with potassium persulphate in an autoclave for 30 min at 15 lbs pressure. The converted inorganic nitrogen was then estimated by using the method described by Strickland and Parsons (1972). The calculated value is expressed in µmol of Nitrogen/I.

Reactive Silicate

The reactive silicate content of water was estimated by following the method of Strickland and Parsons (1972). In this method, the intensity of blue color formed by silico-molybdate complex was measured at 810 nm in a spectrophotometer and the calculated values are expressed in µmol of Silica/I.

Dissolved Organic Carbon (DOC)

The DOC in the water sample was measured using a TOC analyser (Shimadzu TOC-VCPH) by following high temperature catalytic oxidation method. The accuracy and precision of the DOC measurements were checked once in every five samples with Certified Reference Material (CMR) and the accuracies were found to be within the \pm 1% level. For instrument calibration internal standards of 2, 5, 10, 15 and 20 mg l⁻¹ were prepared using potassium hydrogen phthalate (KHC₈H₄O₄). The accuracy and precision was checked by analyzing one known standard equivalent to concentration of sample, once in every ten sample and found to be within the \pm 1% level.

Petroleum Hydrocarbon (PHc)

The PHc in the water sample was determined with the help Spectrofluorometer after solvent extraction of the water samples.





Heavy Metals & Major Ions

For the determination of dissolved heavy metals, the acidified water sample was solvent extracted using APDC-MIBK solution. Hexavalent Chromium (Cr⁶⁺) was anlysed after extraction with APDC-NaDDC solution. The solution extracts were analysed through Atomic Absorption Spectrophotometer (Perkin Elmer 4100). Mercury was analysed through Cold Vapor Technique using AAS. The major ions like calcium, magnesium, sodium, potassium were analyzed using Flame Photometer by following the standard methods for the examination of water and wastewater manual APHA, 2006. Similarly, the Chloride and Fluoride were also analysed titrametrically by following the manual APHA, 2006.

Sediment Analysis

For the analysis of soil textural composition and pH, the air-dried sediment samples were used as such. For all other analyses, sediment samples were ground to fine powder and dried in an oven at 110°C to constant weight for an hour.

Total Organic Carbon

The estimation of total organic carbon in sediment was performed by adopting the method of El Wakeel and Riley (1956). The procedure involves chromic acid digestion and subsequent titration against Ferrous ammonium sulphate solution in the presence of 1-10 phenonthroline indicator. The values calculated are expressed in mg C/g of sediment.

Heavy Metals

The heavy metals in sediment samples were analysed after acid digestion of the sapmes with aqua regia. The solution extracts were analysed through Atomic Absorption Spectrophotometer (Perkin Elmer 4100). Mercury was analysed through Cold Vapor Technique using AAS.

Petroleum Hydrocarbon (PHc)

The PHc in the sediemt sample was determined using a Spectrofluorometer after the solvent extraction.





Bacteriological analysis methods Collection of samples

Surface water samples were collected in 30ml sterile screw capped bottles for bacteriological assessment. Enough air space was left in the bottles to allow thorough mixing. Precautionary measures were taken to avoid contamination through handling. For microbial assessment in sediment samples, a known quantity of samples was collected from the grab samples using sterilised spatula. The central portion of the collected sediment was aseptically transferred into sterile polyethylene bags. All the samples were brought to the laboratory in portable ice box soon after collection and bacteriological analyses were carried out with necessary dilution.

Enumeration of Total Viable Counts (TVC)

TVC was enumerated by adopting the spread plate method using Zobell's Marine Agar medium (EA123, Hi-Media, Mumbai). The samples (water and sediment) were diluted using the sterile sea water and 0.1 ml of the diluted sample was pippeted into the petriplates containing Zobell's Marine Agar and it was spread using a 'L' shaped glass spreader. The plates after inoculation were incubated in an inverted position at a temperature of 28+2°C for 24 to 48 h. The colonies were counted and the population density expressed as Colony Forming Unit (CFU) per ml or g of the sample. The bacterial colonies were picked up from the pertidishes and re-streaked in appropriate nutrient agar plates thrice before a pure culture was established in agar slants.

Enumeration of Total Coliforms

Macconkey agar with 0.15% bile salt, crystal violet and NaCI has been recommended in accordance with USP/Nfxi (1) for the detection, isolation and enumeration of coliforms and intestinal pathogens in water, dairy products, pharmaceutical preparations, etc. The agar weighing 51.5 g in 1000 ml distilled water was heated up to the boiling point to dissolve the medium completely and sterilized by autoclaving at 15 lbs pressure (121°C) for 15 min. suitably diluted samples were inoculated in the petriplates containing medium and were incubated for 48 h. After incubation, the colonies of *E. coli* appeared with pink color.




M-FC agar was employed for detection and enumeration Faecal Coliforms by the membrane filter technique at higher temperature (44.5°C). The agar weighing 52 g was suspended in 1000 ml of distilled water and heated up to the boiling point to dissolve the medium completely, 10ml of Rosolic acid (dissolved in 0.2 N NaOH) was added, heated with frequent agitation and boiled for 1 min. Then the medium was cooled to 50°C. Finally, the medium was poured into small 60mm plates. Samples filtered by Millipore apparatus using 0.45µm Whatman filter papers were impregnated in the petriplates. After 48 h of incubation, the colonies of *E. coli* appeared with blue colour.

Chlorophyll Pigments

The samples were filtered through Whatman GF/C filter papers and the chlorophyll was extracted into 90% acetone. The resulting colored acetone extract was measured in a spectrophotometer at different wave lengths and the same acetone extracts were acidified and measured for the phaeo-pigments. The detailed methodology as described in APHA manual (1989) was followed.

Phytoplankton

Phytoplankton samples were collected from the surface waters of the study area by towing a plankton net (mouth diameter 0.35 m) made of bolting silk [No.30 mesh size 48 μ m) for half an hour. These samples were preserved in 5% neutralized formalin and used for qualitative analysis. For the quantitative analysis of phytoplankton, the settling method as described by Sukhanovo (1978) was adopted. Numerical plankton analysis was carried out using Utermohl's inverted plankton microscope.

Phytoplankton species was identified using the standard works of Hustedt (1930-1966), Venkataraman (1939), Cupp (1943), Subramanian (1946), Prescott (1954), Desikachary (1959 and 1987), Hendey (1964), Steidinger and Williams (1970) and Taylor (1976) and Anand*et al.* (1986).

Zooplankton

Zooplankton samples were collected from the surface waters of the study area by horizontal towing of plankton net with mouth diameter of 0.35 m, made of bolting silk





(No. 70 mesh size 200 μ m) for half an hour. After collection, the samples were preserved in 5% neutralized formalin and used for quantitative analysis. The zooplankton collected were identified to the species level using the classical works of Dakin and Colefax (1940), Davis (1955), Kasthurirangan (1963) and Wickstead (1965) and Damodara Naidu (1981). For the quantitative analysis of zooplankton, a known quantity of water (100 L) was filtered through a bag net (0.33 mm mesh size) and filtrate was made up to 1 litre in a wide mouthed bottle and then enumerated using Utermohl's inverted plankton microscope. The plankton density is expressed as number of organisms/m³.

Benthic Community

For studying the benthic organisms, sediment samples were collected using *Van Veen* grab which covered an area of $0.1m^2$. The wet sediment was sieved with varying mesh sizes (0.5 mm - macrofauna and 0.062 mm - meiofauna) for segregating the organisms. The organisms retained in the sieve were fixed in 5-7% formalin and stained further with Rose Bengal solution for easy spotting at the time of sorting. After a day or two, the organisms were sorted into various groups. The number of organisms in each grab sample was expressed as number per meter square. All the species were sorted, enumerated and identified to the advanced taxonomic level possible with the consultation of available literature. The works of Fauvel (1953), Day (1967) were referred for polychaetes; Barnes (1980) and Lyla *et al.* (1999) for crustaceans; Subba Rao *et al.* (1991) and Ramakrishna (2003) for molluscs.

3.17.2 Marine Water Quality

The water quality parameters analysed in the Mormugao coastal water is given in Table 3.16 and 3.17 respectively. The range of physico-chemical parameters was found to be within the permissible range. Similarly, other chemical parameters such as DO, BOD, nutrients were also at the optimal concentration with a few exceptions which might be owing to the prevailing seasonal variation.





Station	Water Temp. (°C)	EC (µC/cm)	Salinity (psu)	рН	DO (mg/l)	BOD (mg/l)	TSS (mg/l)	Turbidity (NTU)
ST-1S	29.7	71.9	34.5	8.3	4.7	2.3	15.2	6.3
ST-1B	26.3	56.7	34.9	7.9	5.5	2.5	18.9	6.7
ST-2S	31.3	73.9	35.7	8.6	3.7	2.8	14.8	6.2
ST-2B	30.4	69.0	35.2	8.4	4.4	2.3	19.3	6.9
ST-3S	31.9	59.6	35.0	8.7	4.3	2.0	19.6	6.9
ST-3B	30.2	47.5	34.2	8.2	5.0	2.3	22.6	7.7
ST-4S	30.2	58.8	35.9	8.7	5.2	1.3	23.2	8.0
ST-4B	29.4	49.0	34.7	8.3	5.9	1.5	28.5	8.4
ST-5S	29.1	57.5	35.3	8.5	6.4	1.8	24.8	7.8
ST-5B	28.5	49.8	34.6	8.1	5.9	2.3	29.2	8.9
ST-6S	29.7	60.8	35.7	8.6	5.0	2.0	21.7	8.1
ST-6B	28.3	55.1	35.2	8.2	5.4	2.3	26.5	8.6
ST-7S	30.9	73.8	35.7	8.4	4.8	2.2	18.8	7.3
ST-7B	30.5	61.0	34.9	8.0	5.6	2.6	19.9	7.8

Table 3.16: Physico-chemical characteristics of marine water in the study area

Table 3.17: Nutrients in the water samples analysed from study area

Station	NO ₂	NO ₃	NH ₄	TN	TP	IP	SiO ₄	TOC	PHc
				(µmol/l)			(µgC/I)	(µg/l)
ST-1S	0.93	3.41	0.49	14.48	2.00	1.78	31.77	109.0	1.690
ST-1B	0.82	3.90	0.70	19.93	2.90	0.98	35.93	113.5	1.325
ST-2S	1.05	3.55	0.49	23.90	2.89	1.29	27.35	119.6	1.523
ST-2B	0.98	4.08	0.67	28.55	3.75	1.56	34.81	121.3	1.722
ST-3S	0.92	4.15	0.60	30.43	3.67	1.71	29.55	123.9	1.590
ST-3B	1.45	4.63	0.84	35.73	4.07	2.09	32.34	118.6	1.642
ST-4S	0.94	4.11	0.69	33.68	3.89	2.17	30.45	124.4	1.809
ST-4B	1.00	5.21	0.75	30.97	4.11	2.87	35.82	126.7	1.960
ST-5S	1.37	4.67	0.81	32.49	3.77	2.00	32.67	117.1	1.857
ST-5B	1.65	5.00	0.91	37.89	4.01	2.64	39.10	127.7	1.973
ST-6S	1.05	3.36	0.77	32.31	3.37	1.89	36.78	120.9	1.902
ST-6B	1.26	4.09	0.83	34.84	3.87	2.31	43.78	123.2	1.963
ST-7S	0.83	3.05	0.57	25.25	3.50	1.67	31.04	118.7	1.723
ST-7B	1.09	3.77	0.69	29.08	3.93	1.96	37.97	120.6	1.823

Water Temperature

Temperature affects the ability of water to hold the oxygen. The water temperature in the water column ranged between 26.3 to 31.9°C. The maximum water temperature was at ST-3 and minimum was recorded at ST-1.





Electrical Conductivity (EC)

The Electrical Conductivity varied from 47.5 to 73.9 (μ S/cm). The lowest value was recorded at ST-3 and the highest value was recorded at station ST-2.

Salinity

The water salinity varied from 34.5 to 35.9 PSU. The salinity was found to be lower at ST-1 and higher at ST-4.

pН

pH is an important indicator of chemical change in water, it is affected by temperature, pressure, chemical contaminants, photosynthetic and microorganisms activities. Pollution can change the pH of water, which in turn can harm living organisms in water. Sea water pH values ranges from 6.5 to 9.0, as per the water quality criteria for class SW-IV waters (Harbour Waters). The pH value varied between 7.9 and 8.7 with minimum value recorded at ST-1 and maximum was recorded at ST-4.

Total Suspended Solids (TSS)

The total suspended solids values ranged between 14.8 and 29.2 mg/l. The minimum value was recorded at ST-2 and maximum was recorded at ST-5.

Turbidity

The turbidity values were varied between 6.0 and 8.9 NTU. The lower value was at ST-2 and the maximum level was at ST-5.

Dissolved oxygen (DO)

The Dissolved Oxygen level as per the water quality criteria for class SW-IV waters (Haebour Waters) should be 3 mg/l or 40% saturation value, considering the biodegradation of oil and inhibition to oxygen production through photosynthesis. The dissolved oxygen level in the water column varied between 3.7 and 6.4 mg/l which indicates good quality of water in the study area. The lower value was at ST-2 and higher level was at ST-5.

Biological Oxygen Demand (BOD)

BOD levels to maintain the water quality relatively free from pollution caused by swage amd other decomposable wastes ,as per the water quality criteria for class SW-IV waters





(Haebour Waters) is 3 mg/l. However BOD values observed in the water samples collected from the study area The BOD values varied between 1.3 and 2.8 mg/l with minimum value at ST-4 and the maximum value was recorded at ST-2.

Nutrients

The life supporting processes in the sea requires a range of inorganic substances, of which, the role of nitrogen, phosphorus and silicate are considered to be immense in marine ecosystem. Among the nitrogenous compounds, nitrite, nitrate and ammonia are the major constituents, which play a key role in the growth and proliferation of primary producers like phytoplankton, which in turn in the distribution of secondary and tertiary consumers. The results of various parameters recorded are given in the following paragraphs.

Nitrite (NO₂)

The nitrite level varied from 0.82 to 1.65 μ mol/l with maximum was recorded at ST-5 and the minimum was recorded at ST-1.

Nitrate (NO₃)

Nitrate concentration ranged between 3.05 and 5.21 µmol/l with minimum concentration at ST-7 and the maximum value was recorded at ST-4.

Ammonical Nitrogen (NH₄)

The ammonia concentration varied from 0.49 to 0.91 μ mol/l. The maximum concentration was recorded at ST-5 and the minimum was at ST-1 & 2.

Total Nitrogen (TN)

Total nitrogen values ranged from 14.48 to 37.89 µmol/l. The minimum value was at ST-1 and the maximum value was recorded at ST-5.

Total Phosphorus (TP)

Total Phosphorus ranged from 2.00 to 4.11 µmol/l with minimum value was recorded at ST-1 and the maximum value was at ST-4.





Inorganic Phosphate (IP)

The inorganic phosphate values ranged between 0.98 and 2.87 µmol/l with maximum value was recorded at ST-4 and the minimum was at ST-1.

Reactive Silicate (SiO₄)

The silicate values ranged between 27.35 and 43.78 μ mol/l. The minimum (27.35 μ mol/l) and the maximum (43.78 μ mol/l) values were recorded at ST-2 and ST-6 respectively.

Total Organic Carbon (TOC)

The dissolved organic carbon level ranged between 109 and 127 μ gc/l with minimum value (109 μ gc/l) was recorded at ST-1 and the maximum (127 μ gc/l) at ST-5.

Petroleum Hydrocarbon (PHc)

PHc level in the water column fluctuated between 1.325 and 1.973 μ g/l. The maximum was recorded at ST-5 and the minimum was recorded at ST-1.

HEAVY METALS

The heavy metal present in the water sample is given in Table 3.18.

Station	Fe	Zn	Mn	Cd	Ni	Cr	Pb	Cu	Hg			
	(µg/I)											
ST-1S	12.67	14.64	29.00	1.12	1.30	2.00	1.79	3.72	0.30			
ST-1B	19.20	10.23	30.56	1.03	1.03	2.39	2.00	4.23	0.35			
ST-2S	24.71	20.90	28.03	0.95	0.55	2.08	3.36	4.98	0.37			
ST-2B	20.01	23.87	31.93	1.20	0.89	2.38	3.09	3.91	0.41			
ST-3S	22.03	23.67	28.89	0.94	0.56	2.88	3.24	4.98	0.36			
ST-3B	21.61	19.81	30.30	0.88	0.79	3.03	3.89	4.75	0.38			
ST-4S	22.83	21.56	30.67	1.09	0.99	3.10	3.65	5.04	0.39			
ST-4B	25.35	23.89	31.87	1.37	1.13	3.47	3.98	5.43	0.47			
ST-5S	20.76	20.44	34.57	1.05	1.05	3.00	3.66	5.19	0.32			
ST-5B	24.53	22.36	36.72	1.23	1.35	3.27	4.78	6.86	0.37			
ST-6S	19.25	19.93	30.78	0.98	1.03	2.58	3.00	4.58	0.34			
ST-6B	21.04	21.18	33.12	1.11	1.17	2.79	3.34	5.84	0.38			
ST-7S	16.83	17.31	29.67	0.81	0.73	2.12	3.23	5.06	0.31			
ST-7B	19.54	19.90	31.57	0.96	0.90	2.39	3.65	5.43	0.34			





Iron (Fe)

The iron level varied from 12.67 to 25.97 μ g/l. The maximum was recorded at ST-4 and the minimum was recorded at ST-1 during this survey.

Zinc (Zn)

Zinc is an essential trace element which is required in minimum quantity for the wellbeing of the aquatic animals. The zinc level varied from 10.23 to 23.89 μ g/l. The maximum was recorded at ST-4 and the minimum was recorded at ST-1.

Manganese (Mn)

The Manganese level varied from 28.03 to 36.72 μ g/l. The maximum was recorded at ST-5 and the minimum was recorded at ST-2 during this survey.

Cadmium (Cd)

The Cadmium level varied from 0.81 to 1.37 μ g/l. The maximum was recorded at ST-4 and the minimum was recorded at ST-7.

Nickel (Ni)

The Nickel level varied from 0.55 to 1.35 μ g/l. The maximum level was recorded at ST-5 and the minimum was recorded at ST-2.

Chromium (Cr)

The chromium level varied from 2.00 to 3.47 μ g/l. The maximum value was recorded at ST-4 and the minimum was recorded at ST-1.

Lead (Pb)

The Lead level ranged from 1.79 to 4.78 μ g/l with maximum value was recorded at ST-5 and the minimum was recorded at ST-1.

Copper (Cu)

The copper level varied from 3.72 to 6.86 μ g/l. The maximum was recorded at ST-5 and the minimum was recorded at ST-1.





Mercury (Hg)

The mercury level varied from 0.28 to 0.47 μ g/l. The maximum value was recorded at ST-4 and the minimum was recorded at ST-1.

3.17.3 Marine Sediment Quality

As regards soil texture, the sand, silt and clay fraction at each station along with their textural classification indicated that the sand and silt composition was higher when compared to clay during this survey. Sediment analysis result is given in Table 3.19.

Station	рН	Sand (%)	Silt (%)	Clay (%)	TOC (mgC/g)	PHc (µg/g)
ST-1	8.0	56.6	34.2	9.11	4.73	0.62
ST-2	8.5	76.3	22.0	1.61	6.52	0.59
ST-3	8.7	71.5	23.2	5.31	5.79	0.63
ST-4	8.6	80.2	12.2	7.63	6.17	0.74
ST-5	8.8	31.2	60.0	8.76	5.52	0.80
ST-6	8.4	13.2	66.7	20.1	4.59	0.71
ST-7	8.6	70.4	21.6	8.01	5.79	0.66

 Table 3.19: Results of sediment samples analysed from the study area

Sediment pH

The soil pH varied from maximum of 8.8 at ST-5 and minimum of 8.0 at station ST-1.

Texture

Sand content varied from 13.2 to 80.2 % with maximum value at ST-4 and the minimum at ST-6; maximum silt content (66.7 %) was found at ST-6 and the minimum (12.2 %) at ST-4 and the maximum clay (20.1 %) was found at ST-6 and the minimum (1.61 %) at ST-2.

Total organic Carbon (TOC)

The total organic carbon level ranged between 4.59 and 6.52 mgC/g. The maximum level (6.52 mgC/g) was found at ST-2 and the minimum (4.59 mgC/g) at ST-6.

Sediment PHc

The sediment PHc level varied from 0.59 to 0.80 μ g/g. The maximum was recorded at ST-5 and the minimum was recorded at ST-2.





HEAVY METALS

The concentration of heavy metals in sediment samples indicates that it is well within the ERM (Effective Range Median) which means there are no possibilities of heavy metal contamination in the region. The analysis results of heavy metals in the sediment sample are given in Table 3.20.

Station	Fe	Zn	Mn	Cd	Ni	Cr	Pb	Cu	Hg			
	(µg/g)											
ST-1	40.23	26.6	227	4.67	13.5	6.73	3.81	13.9	0.41			
ST-2	43.90	18.3	373	2.50	17.7	8.00	4.34	20.8	0.35			
ST-3	48.72	20.7	398	4.03	15.0	6.67	6.73	21.7	0.58			
ST-4	53.01	30.3	402	6.39	11.7	8.18	5.16	22.2	0.68			
ST-5	67.84	23.9	362	5.38	19.8	6.05	8.37	28.3	0.49			
ST-6	50.81	27.4	528	4.73	15.8	7.38	6.75	25.6	0.55			
ST-7	49.32	19.4	277	3.47	13.7	5.07	5.43	19.3	0.39			

Table 3.20: Heavy metals in sediment samples analysed from study area

Iron (Fe)

The Iron level varied from 40.23 to 67.84 μ g/g. The maximum was recorded at ST-5 and the minimum was recorded at ST-1 during this survey.

Zinc (Zn)

Zinc level varied from 18.3 to 30.3 μ g/g. The maximum value was recorded at ST-4 and the minimum was recorded at ST-2 during this survey.

Manganese (Mn)

The Manganese level varied from 227 to 528 μ g/g. The maximum value was recorded at ST-6 and the minimum was recorded at ST-1.

Cadmium (Cd)

The Cadmium level varied from 2.50 to 6.39 μ g/g. The maximum was recorded at ST-4 and the minimum was recorded at ST-2.

Nickel (Ni)

The nickel level varied from 11.7 to 19.8 μ g/g. The maximum was recorded at ST-5 and the minimum was recorded at ST-4 during this survey.





Chromium (Cr)

The Chromium level varied from 5.07 to 8.18 μ g/g. The maximum was recorded at ST-4 and the minimum was recorded at ST-7.

Lead (Pb)

The lead level varied from 3.81 to 8.37 μ g/g. The maximum was recorded at ST-5 and the minimum was recorded at ST-1 during this survey.

Copper (Cu)

The copper level varied from 13.9 to 28.3. The maximum value was recorded at ST-5 and the minimum was recorded at ST-1 during this survey.

Mercury (Hg)

The mercury level varied from 0.35 to 0.68 μ g/g. The maximum was recorded at ST-4 and the minimum was recorded at ST-2 during this survey.

3.17.4 Marine Microbiology

Marine Water

The total viable count (TVC) in water samples ranged from $27x10^2$ to $24x10^4$ CFU/ml. The maximum count was found at ST-5 and the minimum at ST-1. The Total coliform (TC) count is varied from $20x10^2$ to $22x10^4$ CFU/ml with high colony count observed at ST-5 and low count at ST-1. The *E. coli* (EC) count ranged from $16x10^2$ to $12x10^4$ CFU/ml with a maximum value found at ST-6 and the low value at ST-1. The *Faecal coliform* (FC) count is varied from $20x10^2$ to $13x10^4$ CFU/ml with the high values at ST-6 & 7 and low value at ST-1. The *Streptococcus faecalis* (SF) count ranged from $11x10^2$ to $10x10^4$ CFU/ml. The highest value was recorded at ST-5 and the lowest was at ST-1. The *Shigella* count (SH) varied from $18x10^2$ to $13x10^4$ CFU/ml with the high values at ST-6 and the low value at ST-1. The *Shigella* count (SL) colony count varied from $18x10^2$ to $12x10^4$ CFU/ml with the high values at ST-1. The *Salmonella* (SL) colony count varied from $18x10^2$ to $12x10^4$ CFU/ml with the high values at ST-1. The *Vibrio parahaemolyticus* (*VP*) colony count varied from $12x10^2$ to $13x10^4$ CFU/ml with the high value at ST-4 and the low value at ST-1. The *Vibrio cholera* (VC) colony was found to be varied from





22x10² to 20x10⁴ CFU/ml. The high colony count was observed at ST-4 and the low count was recorded at ST-1 (Table-3.21).

Marine Sediment

In sediment samples, the total viable count (TVC) varied between 32x10⁴ to 28x10⁴ CFU/g. The maximum value was found at ST-7 and the minimum at ST-1. The Total coliform (TC) count varied from 25x10⁴ to 18x10⁶ CFU/g with high colony count at ST-6 and the low count at ST-1. The E. coli (EC) count ranged from 09x10⁴ to 16x10⁶ CFU/g with the high value at ST-6 and the low value at ST-1. The Faecal coliform (FC) count was found to be varied from 23x10⁴ to 18x10⁶ CFU/g with the high value at ST-5 and the low value at ST-1. The Streptococcus faecalis (SF) count ranged between 11x10⁴ to 13x10⁶ CFU/g. The high value was recorded at ST-6 and the low value was recorded at ST-1. The Shigella counts (SH) varied from 21x10⁴ to 19x10⁶ CFU/g with the high values at ST-4 and the low values at ST-1. The Pseudomonas aeurginosa (PA) count ranged from 09x10⁴ to 11x10⁶ CFU/g with the high values found at ST-6 and the low values at ST-1. The Salmonella (SL) colony count varied from 13x10⁴ to 14x10⁶ CFU/g with the high value found at ST-6 and the low value at ST-1. The Vibrio parahaemolyticus (VP) colony count varied from 13x10⁴ to 23x10⁶ CFU/g with the high values found at ST-7 and low values at ST-1. The other species Vibrio cholerae (VC) colony was found to be varied from 22x10⁴ to 17x10⁶ CFU/g with the high colony count at ST-7 and low count at ST-1 (Table-3.22).





Station	тс	VP	VC	SL	FC	EC	SH	PA	SF	TVC
ST-1	20x10 ²	12 x10 ²	22 x10 ²	18 x10 ²	20 x10 ²	16x10 ²	18x10 ²	16 x10 ²	11 x10 ²	27 x10 ²
ST-2	15 x10 ³	24 x10 ³	19 x10 ³	20 x10 ³	13x10 ³	10x10 ³	23x10 ³	14 x10 ³	10 x10 ³	22 x10 ³
ST-3	24 x10 ³	18 x10 ³	22 x10 ³	23 x10 ³	16x10 ³	13x10 ³	17x10 ³	11x10 ³	16 x10 ³	28 x10 ³
ST-4	18x10 ⁴	13 x10 ⁴	20 x10 ⁴	08 x10 ⁴	10x10 ⁴	08x10 ⁴	12x10 ⁴	08 x10 ⁴	08x10 ⁴	16 x10 ⁴
ST-5	22x10 ⁴	10 x10 ⁴	16 x10 ⁴	12 x10 ⁴	07 x10 ⁴	06x10 ⁴	09 x10 ⁴	06 x10 ⁴	10 x10 ⁴	24 x10 ⁴
ST-6	16x10 ⁴	08 x10 ⁴	19 x10 ⁴	07 x10 ⁴	13 x10 ⁴	12x10 ⁴	13x10 ⁴	12x10 ⁴	08 x10 ⁴	18 x10 ⁴
ST-7	20 x10 ⁴	05 x10 ⁴	07 x10 ⁴	10 x10 ⁴	13x10 ⁴	11x10 ⁴	08x10 ⁴	04x10 ⁴	09 x10 ⁴	23 x10 ⁴

Table 3.21: Bacterial population in marine water analysed from study area

Table 3.22:	Bacterial population in sedim	nents analysed from study area
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Stations	TC	VP	VC	SL	FC	EC	SH	PA	SF	TVC
ST-1	25 x10 ⁴	13 x10 ⁴	22 x10 ⁴	13 x10 ⁴	23 x10 ⁴	09x10 ⁴	21x10 ⁴	09x10 ⁴	11 x10 ⁴	32 x10 ⁴
ST-2	22 x10⁵	12 x10⁵	18 x10 ⁵	23 x10 ⁵	24x10 ⁵	20x10 ⁵	06x10 ⁵	15x10⁵	12 x10 ⁵	28 x10 ⁵
ST-3	20 x10 ⁵	12 x10⁵	16 x10⁵	21x10 ⁵	13x10 ⁵	16x10 ⁵	07x10 ⁵	10x10 ⁵	16x10⁵	29 x10 ⁵
ST-4	11x10 ⁶	16 x10 ⁶	13 x10 ⁶	11 x10 ⁶	16 x10 ⁶	13x10 ⁶	19x10 ⁶	09x10 ⁶	09 x10 ⁶	25 x10 ⁶
ST-5	15 x10 ⁶	15 x10 ⁶	11 x10 ⁶	09 x10 ⁶	18x10 ⁶	10x10 ⁶	16x10 ⁶	10x10 ⁶	11 x10 ⁶	20 x10 ⁶
ST-6	18 x10 ⁶	18 x10 ⁶	11 x10 ⁶	14x10 ⁶	16x10 ⁶	16x10 ⁶	17x10 ⁶	11x10 ⁶	13 x10 ⁶	27 x10 ⁶
ST-7	17 x10 ⁶	23 x10 ⁶	17 x10 ⁶	10 x10 ⁶	13x10 ⁶	15x10 ⁶	12x10 ⁶	09x10 ⁶	08 x10 ⁶	28 x10 ⁶





3.17.5 Chlorophyll Pigments

Chlorophyll *a* (mg/m³), Phaeopigments (mg/m³), and Total biomass

In the present study, chlorophyll *a* in the water sample varied from 0.42 to 2.55 mg/m³ with maximum value at ST-3 and the minimum at ST-5. The Phaeopigments varied from 0.33 to 1.96 mg/m³ with maximum value at ST-7 and the minimum value at ST-4. Total biomass varied from 17.9 to 42.5 ml/100 m³ with maximum value at ST-3 and minimum at ST-5 (Table 3.23).

Stations	Chlorophyll <i>a</i> (mg/m³)	Phaeopigments (mg/m ³)	Total biomass (ml/100 m ³)		
ST-1	0.65	0.94	25.9		
ST-2	1.17	0.42	25.6		
ST-3	2.55	1.34	42.5		
ST-4	0.98	0.33	27.9		
ST-5	0.42	0.43	17.9		
ST-6	1.27	0.44	23.4		
ST-7	2.23	1.96	33.9		

Table 3.23: Chlorophyll a, Phaeopigments and Total biomass in marine water

3.17.6 Phytoplankton

In the present study period, species belonging to three groups namely diatoms, dinoflagellates and blue greens were recorded. Of these, diatoms were found to be the dominant group with 40 species. Dinoflagellates formed next group with 5 species and blue greens came last in the order with 4 species in all the stations.

Among the diatoms, Bellerochea malleus, Cerataulina orientalis, Coscinodiscus centralis, C. granii, Chaetoceros affinis, C. curvisetus, Leptocylindrus danicus, Skeletonema costatum, Diatoma anceps, Thalassionema nitzschioides, Triceratium favus, Cyclotella sp. Nitzschia sp. Planktonella sol, Odentella mobilensis, O. sinensis, Pleurosigma normani, Rhizosolenia alata, R. styliformis and Streptotheca sp were found to be the commonly occurring species in the samples collected in various stations. Coming to dinoflagellates, Ceratium furca, C. trichoceros, Prorocentrum micans and Protoperidinium oceanicum and blue green Anabeana sp. and Spirulina sp. Tricodesmium erythraeum showed consistency in their occurrence in the samples





collected from the study area. The abundance and density of phytoplankton at various sampling stations are given in Table 3.24.

Phytoplanktons	ST-1	ST-2	ST-3	ST-4	ST-5	ST-6	ST-7
				Cells/ltr)			
Blue greens							
Oscillatoria sp.	0	60	90	0	0	120	75
<i>Lyngbya</i> sp	40	0	85	180	135	0	60
Spirulina sp.	440	120	132	0	0	60	60
Tricodesmium	50	255	180	0	90	30	0
erythraeum							
Diatoms							
Bacteriastrum	60	60	150	90	0	60	320
hyalinum							
Bellerochea	135	135	0	128	0	30	140
malleus							
Cerataulina	0	0	0	90	90	0	90
orientalis							
Chaetoceros	0	0	60	125	30	30	0
curvisetus							
C. diversus	90	90	0	30	0	255	0
Coscinodiscus	0	0	60	150	120	0	105
perferatus							
C. centralis	0	210	125	90	75	0	0
C. gigas	60	0	120	0	75	90	0
C. granii	310	440	0	30	0	115	0
Coscinodiscus sp	125	15	60	30	0	0	230
Cyclotella sp.	225	105	30	75	90	125	0
Dinophysis sp	0	0	60	0	135		40
Ditylum brightwelli	0	0	90	0	60	35	0
Diatoma anceps	150	125	120	105	0	0	120
Eucampia	0	0	66	0	90	210	30
zoodicus							
<i>Fragilaria</i> sp.	175	90	125	110	0	60	120
Grammatophora	0	0	120	45	0	30	60
marina							
Gyrosigma	0	90	90	135	75	105	0
balticum							
Leptocylindrus	200	0	60	75	90	45	190
danicus							
Lithodesmium	885	120	520	410	120	0	290
undulatum							
Navicula granulata	0	0	0	0	90	39	0

 Table 3.24: Abundance and density of Phytoplankton in marine water





Phytoplanktons	ST-1	ST-2	ST-3	ST-4	ST-5	ST-6	ST-7
Nitzschia	330	135	60	60	0	90	175
closterium							
N. longisima	110	60	75	0	0	45	415
Odontella aurita	30	0	450	125	145	30	120
O. mobiliensis	120	75	90	30	15	330	0
O. sinensis	100	0	450	30	90	220	45
Planktonella sol	0	0	90	0	125	220	120
Pleurosigma	130	0	180	185	*0	110	45
elongatum							
Pleurosigma	415	165	150	90	45	0	550
normanii							
Rhizosolenia alata	0	135	120	60	0	220	845
R. imbricate	243	0	30	0	0	133	30
R. styliformis	0	0	330	0	0	640	0
Skeletonema	75	80	125	120	0	85	450
costatum							
Stephanophysis	155	0	0	0	120	135	0
palmeriana							
Streptotheca sp	0	450	0	330	0	120	135
Thalassionema	220	220	330	330	60	45	0
nitzschioides							
Thalassiosira	10	0	120	0	0	0	243
subtilis							
Thalassiothrix	0	0	120	0	55	120	0
frauenfeldii							
Triceratium favus	155	65	330	330	0	45	0
T. reticulatum	10	410	0	220	210	210	345
Dinoflagellates							
Ceratium furca	0	65	220	220	120	0	210
C. tripos	0	220	350	0	0	127	455
C. trichoceros	450	60	225	350	455	135	220
Prorocentrum	145	0	85	225	133	0	120
micans							
Potoperidinium	90	0	225	0	0	510	0
oceanicum							
Total	5733	4055	6498	4603	2938	5009	6453

Population density

Density of phytoplankton varied from 2,938 to 6,498 Cells/I with maximum at ST-3 and minimum at ST-5 (Figure 3.12).



Figure 3.12: Population density of Phytoplankton recorded from study area

ST-5

ST-6

ST-7

ST-4

ST-3

Percentage composition

ST-1

ST-2

When the results of percentage composition of phytoplankton were viewed, diatoms constituted the maximum with 75% to the total followed by dinoflagellates with 16% and blue greens with 9% of the total (Figure 3.13).



Figure 3.13: Percentage composition of Phytoplankton recorded from study area





Diversity Indices

In Marmugao port waters, the data collected on phytoplankton species were subjected to various diversity indices. The species diversity (H') varied from 3.540 to 4.940 with maximum in ST-2 and minimum in ST-4. The species richness (d) ranged between 3.163 and 4.321 with maximum in ST-5 and minimum in ST-3. The species evenness varied from 0.814 to 0.943 with maximum in ST-6 and minimum in ST-4 (Table 3.25).

Station	H' (diversity)	d (richness)	J' (evenness)
ST-1	4.475	3.557	0.895
ST-2	4.940	3.939	0.863
ST-3	4.024	3.163	0.828
ST-4	3.540	3.368	0.814
ST-5	3.772	4.321	0.909
ST-6	4.469	3.428	0.943
ST-7	3.914	4.104	0.902

Table 3.25: Diversity indices, *a*-Shannon diversity (H'); b-Margalef richness (d) and c-Pielou's evenness (J') calculated for Phytoplankton

3.17.7 Zooplankton

During the study period, three groups of macro zooplankton namely, calanoida, cyclopoida, and harpacticoida and 2 groups of micro zooplankton namely, spirotricha and larval forms and group "others" of zooplankton were recorded. Among these, calanoida were found to be the dominant group with 11 species. Larval forms came as next dominant group with 7 species. Cyclopoida and harpacticdoia came next in the order with 5 species each and spirotricha with 4 species. While group "Others" showed only meager contributions in the collection.

Among the calanoida, Acartia danae, Acrocalanus gibber, A. gracilis, Labidocera sp. Nannocalanus minor, Paracalanus parvus, Temora discaudata and cyclopoida, Oithona rigida, O.brevicornis, O. similis, Corycaeus danae and larval forms, gastropod veliger, bivalve veliger, barnacle nauplii and harpacticoida, *Macrosetella aculata, Microsetella norvegica* were found to be the frequenters in the collections. In the case of spirotricha *Tintinnopsis cylindrica, T. uruguayensis* Sagitta sp. Oikopleura parva showed consistency in their occurrence in the





samples collected in various stations. The abundance and density of zooplanktons at various sampling stations is given in Table 3.26.

(ir	n Nos/m ³	?)					
Zooplankton	ST-1	ST-2	ST-3	ST-4	ST-5	ST-6	ST-7
Acartia danae	0	0	0	0	225	0	110
A. spinicauda	245	135	0	0	120	280	0
Acrocalanus	350	225	120	75	0	0	50
giber							
A. gracilis	325	0	125	450	120	350	0
Calanopia	35	0	0	0	130	0	185
minor							
Centropages	0	110	110	125	235	65	225
furcatus							
Labidocera	125	0	210	120	0	46	50
pavo							
Nannocalanus	54	125	315	650	0	150	20
minor							
Paracalanus	320	145	20	0	85	0	375
parvus							
Pontella sp.	80	0	0	410	350	40	50
Temora	350	350	175	0	250	25	350
discaudata							
Cyclopoida							
Oithona	0	225	210	25	0	350	120
brevicornis							
O. rigida	540	350	0	540	0	540	0
O. similis	50	110	840	40	80	0	250
Corycaeus	0	140	540	350	240	145	0
danae							
C. catus	65	0	350	20	90	95	350
Harpacticoida							
Macrosetella	350	350	220	110	0	0	237
aculata							
M. gracilis	0	0	0	450	230	120	225
Microsetella	345	160	350	0	0	0	150
norvegica							
M. rosea	145	350	0	120	115	0	140
Euterpina	350	0	0	0	350	650	0
acutiforns							
Spirotricha					-		
Favella brevis	350	350	60	350	0	45	125
Tintinnopsis cylindrical	540	350	120	250	125	0	210

Table 3.26: Abundance and density of Zooplankton in marine water (in Nos/m³)





Zooplankton	ST-1	ST-2	ST-3	ST-4	ST-5	ST-6	ST-7
T.uruguayensis	225	0	350	85	0	0	320
Oikopleura	0	420	0	225	320	420	0
parva							
Larval forms							
Barnacle	255	705	50	30	125	325	320
naupilii							
Bivalve veliger	0	0	350	0	150	540	0
Copepod	0	325	0	225	225	100	0
nauplius							
Crustacean	150	0	350	120	0	350	60
nauplius							
Gastropod	0	350	60	0	45	225	220
veliger							
Mysis larva	875	515	0	850	85	0	120
Polychaete	0	0	745	0	195	0	180
larva							
Others							
Lucifer	0	0	0	125	0	350	135
hanseni							
Sagitta sp	0	465	120	20	120	20	0
Total	6124	6255	5790	5765	4010	5231	4577

Population density

Unlike phytoplankton, zooplankton density varied from 4,010 to 6,255 Nos/m³ with maximum value at ST-2 and minimum at ST-5 (Figure 3.14).



Figure 3.14: Population density of Zooplankton recorded from study area





Percentage composition

In zooplankton, calanoida emerged as the dominant group by constituting 27%, followed by larval forms with 23%, cyclopoida and Harpacticoida with 16% each, spirotricha with 12% of the total percentage composition, and group "others" with 6% (Figure 3.15).



Figure 3.15: Percentage composition of Zooplankton recorded from study area

Diversity indices

Unlike phytoplankton, the zooplankton species diversity (H') varied from 3.116 to 5.035 with maximum in ST-3 and minimum in ST-5. The species richness (d) ranged between 3.152 and 4.424 with maximum in ST-3 and minimum in ST-5. The species evenness varied from 0.851 to 0.923 with the maximum in ST-1 and minimum in ST-5 (Table 3.27).

Station	H' (diversity)	d (richness)	J' (evenness)
ST-1	3.348	3.408	0.923
ST-2	4.255	3.399	0.854
ST-3	5.035	4.424	0.905
ST-4	4.052	3.770	0.872
ST-5	3.116	3.152	0.851
ST-6	4.089	3.357	0.904
ST-7	4.404	3.847	0.918

Table 3.27: Diversity indices, *a*-Shannon diversity (H'); b-Margalef richness (d) and c-Pielou's evenness (J') calculated for Zooplankton





3.17.8 Benthos

Macro-benthos

During the present investigation, four groups of benthic organisms namely polychaetes, crustaceans, bivalves and gastropods were recorded. Of these, polychaetes constituted the dominant group followed by crustaceans, gastropods and bivalves. Altogether 44 species of macro fauna were recorded. Of these, polychaetes topped the list with 25 species. Crustaceans were found to be the next dominant group in the order of abundance with 7 species. Bivalves and gastropods with 6 species each of the total benthic organisms collected. Among the polychaetes, *Armandia* sp., *Prionospio pinn*ata, *Eunice* sp., *Goniada emerita*, *Lumbrinereis* sp., *Notomastus aberrans*, *Nereis* sp., *Nephtys* sp., *Magelona cincta*, were found to be the most commonly occurring species in the samples collected in Mormugao coastal waters. Coming to crustaceans *Angeliera* sp., *Ampithoe romondi, Gammarus* sp. and in bivalves, veligers were found to be the common species in the collection.

The abundance and density of Macrobenthos at various sampling stations is given in Table 3.28.

Macrobenthos	ST-1	ST-2	ST-3	ST-4	ST-5	ST-6	ST-7
Polychaetes							
Armandia sp.	0	75	50	25	0	0	0
Armandia	25	0	25	0	0	0	25
longicaudata							
Capitella capitata	0	50	0	0	50	0	0
Cossura coasta	0	0	0	0	0	25	0
Cirratulus	50	0	25	25	25	25	50
concinnus							
<i>Eunice</i> sp.	100	25	0	25	0	0	100
Goniada emerita	0	50	0	50	25	50	0
Exogone clavator	0	0	100	75	0	0	0
Lumbrineris sp.	0	0	0	0	0	0	0

 Table 3.28: Abundance and density of Macro-benthos in sediments (in Nos/m²)





Macrobenthos	ST-1	ST-2	ST-3	ST-4	ST-5	ST-6	ST-7
Nephtys sp.	0	25	75	0	50	50	0
Nereis sp.	0	0	0	25	25	0	0
Notomastus	25	50	50	100	0	25	25
aberans							
Perinereis capensis	25	0	0	0	25	0	25
Platynereis sp.	75	100	0	50	25	50	75
Phylo capensis	100	0	25	0	25	25	100
Prionospio	0	0	0	100	0	0	0
capensis							
Prionospio cirrifera	0	0	0	0	0	25	0
Prionospio pinnata	75	0	75	0	0	0	75
<i>Sylli</i> s sp.	0	100	0	50	100	100	0
Glycera longipinnis	0	0	50	0	0	25	0
Glycera alba	0	0	125	150	0	0	0
Pygospio elegans	0	100	50	0	0	0	0
Sabellides sp.	125	75	100	50	50	0	125
Magelona cincta	0	100	0	75	0	0	0
Serpula sp.	0	50	0	0	25	0	0
Crustaceans							
Ampithoe rubricate	125	25	25	0	150	0	125
Ampithoe romondi	0	50	0	0	50	25	0
Angeliera sp.	25	0	0	50	0	0	25
Campylaspis sp.	50	25	50	25	50	0	50
Gammarus sp.	0	0	0	0	0	0	0
Gynodiastylis sp.	100	150	75	0	0	50	100
Paragnathia	0	125	0	0	50	0	0
formica							
Bivalves							
Anadara veligers	0	50	0	0	0	0	0
Anadora granosa	50	50	0	25	0	0	50
Cardium veligers	50	0	50	50	75	50	50
Donax veligers	0	0	100	100	50	50	0
Meretrix veligers	0	125	0	0	0	0	0
Meretrix casta	100	50	0	0	0	0	75
Gastropods							
Bullia veligers	50	0	100	75	0	0	50
Cerithidea	0	0	0	0	50	50	0
cingulate							
Littorina veligers	75	25	100	0	0	0	75





Macrobenthos	ST-1	ST-2	ST-3	ST-4	ST-5	ST-6	ST-7
Nassarius	0	50	25	50	50	25	0
variegatus							
Natica veligers	0	25	0	0	25	0	0
Turris veligers	50	0	50	50	0	50	50
Total	1275	1550	1325	1225	975	700	1250

Population density

The population density varied from 700 to 1550 Nos. m⁻² with maximum value at ST- 2 and minimum at ST-6 (Figure 3.16).



Figure 3.15: Population density of Macro-benthos

Percentage composition

When the results of percentage composition of benthic fauna were viewed, polychaetes topped the list with 59% to the total benthic organisms. Crustaceans, bivalves and gastropods contributed with 18%, 12% and 11% respectively to the benthic samples collected (Figure 3.17).







Figure 3.17: Percentage composition of Macro-benthos

Diversity Indices

The diversity values varied from 3.406 to 5.984 with maximum at ST-2 and minimum at ST-1. The Species richness varied from 2.913 to 4.051 with maximum at ST-6 and minimum at ST-1; with respect to Pielou's evenness, it varied from 0.8521 to 0.9624 with maximum at ST- 6; and minimum at ST- 1 (Table 3.29).

Table 3.29: Diversity indices, *a*-Shannon diversity (H'); b-Margalef richness (d) and c-Pielou's evenness (J') calculated for Macro-benthos

Station	Shannon diversity (H')	Margalef	Pielou's
		richness (d)	evenness (J')
ST-1	3.406	2.913	0.8521
ST-2	5.984	3.374	0.8539
ST-3	5.845	3.037	0.8606
ST-4	4.384	3.145	0.9561
ST-5	3.983	3.564	0.8561
ST-6	3.684	4.051	0.9624
ST-7	3.799	3.051	0.8534

Meio-benthos

In the present study, as many as 32 species belonging to four groups of meiobenthic organisms namely foraminiferans, nematodes, harpacticoids and ostracodes were recorded. Of these, foraminiferans topped the list with 12 species. Nematodes were found to be the next dominant group in the order of abundance





with 11 species. Harpacticoids and ostracodes came next with 6 and 3 species respectively.

Among the foraminiferans, *Ammonia beccari, Bolivina abbreviate,* and were commonly found in all the stations. With respect to nematodes, *Desmoscolex* sp., *Theristus sp., Astomonema* sp., *and Viscosia* sp., were found to be the common species in the samples collected in various stations. Coming to ostracodes, *Basslerites liebaui, Diasterope schmitti,* and harpacticoids, *Diarthrodes* sp., were found to be common species in the collection. The details are given in Table 3.30.

 Table 3.30: Abundance and density of Meio-benthos in sediments (in Nos/10 cm²)

Meiobenthos	ST-1	ST-2	ST-3	ST-4	ST-5	ST -6	ST -7
Nematodes							
Astomonema sp.	5	5	5	0	19	14	5
Daptonema conicum	4	0	6	0	4	9	6
Desmoscolex sp.	6	7	10	5	17	22	4
Draconema sp.	0	0	6	8	0	0	0
Halalaimus filum	4	6	6	0	22	22	5
<i>Microlaimus</i> sp.	6	3	6	9	6	15	6
Neochromodora sp.	6	7	0	6	0	4	5
Odontophora sp.	4	3	6	3	7	0	7
Stephanolaimus sp.	6	4	7	6	5	6	5
Theristus sp.	6	6	0	0	5	2	0
<i>Viscosia</i> sp.	8	3	6	0	0	3	9
Foraminiferans							
Ammonia beccarii	6	6	4	11	4	8	8
Amphisorus sp.	4	9	13	0	7	9	5
Astrorotalia inflata	3	5	0	11	3	0	11
Bolivia abbreviata	3	3	5	5	4	0	0
Eponides repandus	6	6	6	4	7	5	0
Globigerina sp.	6	0	6	5	4	7	9
Quinqueloculina sp.	0	5	0	5	7	5	8
Rosalina bertheloti	8	0	3	0	8	6	0
Spirillina limbata	6	4	6	12	8	5	0
Spiroloculina sp.	7	0	5	0	3	6	5
Textularia	7	5	6	4	5	6	6
agglutinans	1	5	U	4	5	0	U





Meiobenthos	ST-1	ST-2	ST-3	ST-4	ST-5	ST -6	ST -7
Cornoboides advena	6	0	5	15	4	3	5
Harpacticoids							
Apodopsyllus							
vermiculiformis	1	5	4	2	3	1	0
<i>Cervinia</i> sp.	3	5	8	5	2	0	2
Cylindropsyllus sp.	3	1	2	3	1	2	1
Diarthrodes sp.	5	1	4	4	2	3	8
Laophonte thoracica	4	8	6	4	4	3	4
Laptastocus sp.	1	6	6	0	6	8	6
Ostrocodes							
Basslerites liebaui	5	4	3	5	3	0	5
Diasterope schmitti	3	0	2	5	3	4	0
Tanella kingmaii	2	0	5	1	0	2	3
Total	144	117	157	138	173	180	138

Population density

The population density of meiofauna varied from 117 to 180 nos/10cm² with maximum at ST-6 and minimum at ST-2 (Figure 3.18).



Figure 3.18: Population density of Meio-benthos

Percentage composition

The results of percentage composition of meio-fauna revealed that foraminiferans constituted the maximum with 48% of the total meio-benthic organisms.





Nematodes, ostracodes and harpacticoids contributed with 38%, 9%, and 5% respectively to the total meio-benthic samples collected as shown in Figure 3.19.



Figure 3.19: Percentage composition of Meio-benthos

Diversity Indices

The diversity values varied from 3.213 to 6.782 with maximum at ST-3 and minimum at ST-5. Species richness varied from 4.772 to 5.678 with maximum at ST-5 and minimum at ST-2. Pielou's evenness varied from 0.849 to 0.974 with maximum at ST-2 and minimum at ST- 5 (Table 3.31).

Station	Shannon diversity (H')	Margalef richness(d)	Pielou's evenness (J')
ST-1	4.445	5.537	0.967
ST-2	6.422	4.772	0.974
ST-3	6.782	5.363	0.951
ST-4	4.312	4.896	0.956
ST-5	3.213	5.678	0.849
ST-6	3.542	5.546	0.945
ST-7	3.405	5.367	0.878

Table 3.31: Diversity indices a-Shannon diversity (H'); b-Margalef richness(d) and c-Pielou's evenness (J') calculated for Meio-benthos

3.17.9 Sea weed and Sea grass

The studies carried out by Pereria and Almeida -2014, indicates the presenece of sea weed species in various parts of Goa. However, only patchy distribution of





namely Gelidium pusillium, Gracilaria foliifera, Lithophyllum seaweeds orbiculatum, Hypnea spinella, Acanthophora muscoides, Acanthophora spicifera, Bostrychia tenella, Ralfsia verrucosa, Sphacelaria rigidula, Canistrocarpus crispatus, Dictyopteris australis, Padina antillarum, Padina australis, Padina Padina pavonica, Spatoglossum asperum, gymnospora, stochospermum polypodioides were reported in the study area during the premonsoon season. Similarly, the sea grass species namely Cymodocea serrulata was reported in the study area. During the present survey, no significant occurance of sea grass and sea weed species are observed in the study area.

3.17.10 Corals and associated faunal assemblages

The occurance of coral reef in the Grade island has been documented by researchers recently (Shesdev Patro et al., 2015). The nearest habitate of corals from the proposed site is Grand island located at about 7 km form the proposed site. Sreekanth et al., 2015 reported the presence of *Carijoa riisei* from the Grand island are *Carijoa riisei* (73⁰ 46' 46.605" E, 15⁰ 21' 0.636" N) at a depth of 10–12 m. The study also concluded that the occurrence of the species in Grande Island as a new locational record and could not assess the impact on the reef due to lack of baseline data on the reef health. The most abundant families that depend on the natural reefs are, Caesionidae (fusiliers), Pomacentridae (damsel fishes), Tetraodontidae (pufferfishes) and Chaetodontidae (butterfly fishes). Planktivores and carnivores dominated the natural reefs followed by omnivores and herbivores.

3.17.11 Turtle Nesting

Goa with a small coastal length of 120 km, records one of the earliest community based initiatives in sea turtle conservation, next to Kerala. Sporadic nesting of olive ridley and leatherback turtles has been recorded all along the coast of Goa but recent nesting records are only of olive ridleys. Of the 120 km coastline, about 8 km in Goa have been identified as major nesting sites and are being protected by the Forest Department of the State Government of Goa. These sites are Morjim in north Goa, and Galgibaga and Agonda in south Goa. Nesting takes place between October and March each year. All the turtle nesting grounds are beyond





10 km radius or outside the study area of the project. The location of turtle nesting grounds is given in the Table 3.32.

S. No.	Nesting Beach	Co-ord	inates
1.	Mandrem	15" 38' 57.25'N	73° 42' 55.0.4'E
2.	Ashvem	15" 38' 47.39'N	78° 43' 00.17'E
3.	Morjim	15" 36' 53.25'N	73" 44' 09.34'E
4.	Agonda	15" 02' 24.04 N	73" 59' 16.66'E
5.	Galgibaga	14" 57' 32.07 N	74" 02' 56.64 E

 Table 3.32: Location of Turtle Nesting Grounds in Goa

Source: WWF Report on Marine turtles along the Indian Coast, 2013.

Galibaga is the southern most location of nesting range with a poor density. It is a fairly undulating shoreline with sparse vegetation and witnesses the nesting of turtles in the breeding season. Besides the four major locations mentioned above, the other coastal stretches that also witness the sporadic nesting are Mobor, Kavellossim, Colva, Majorda, Varca and Betalbatim. However they do not fall in the 10 km radius of the study area. The details of the Turtle nesting grounds in Goa are depicted in Figure 3.20.The occurrence of other endangered species like Dugongs etc. was not found during the survey.



Figure 3.20: Turtle nesting grounds in Goa





3.17.12 Windowpane Oyster

The coastline of Goa is bestowed with a neumorous variety of flora fauna. The abundance of *Placuna placenta (Linne)* also called as windowpane oysters are found around the San Jacnito island and the same has been reported by many researchers. There is a healthy population in the Chicalim Bay. They are highly assymetrical bivavle. Characteristically large, flat, thin, pearly, sub-orbicular, transluscent shell with a mica-like appearance and are primarily a heterotrophic filter feeder (Campbell). Diet consists of plankton and free-floating detritus.

3.17.13 Mangrove Distribution

The nearest identified mangroves are observed in Siridao area of Zuari creek, at a distance of about 7 to 9 km ranging from sparse to dense vegetation from the proposed project site. In the study area there are patches of mangroves located along the sides of the River Zuari.

In Goa the mangroves Mangrove stands are best developed along deltaic coasts or in estuaries where soft mud comprised of fine silt and clay and rich in organic matter is available for growth of seedlings. Quartzitic and granitic alluvial are poor substrata, whereas volcanic soils are highly productive for mangroves (Macnae, 1968). The soil of Goa may be broadly classified into three main types:

- Laterites of high and low level type formed by natural metamorphosis and degeneration of underlying rocks along the ghats.
- (2) Red gravely soil derived from micaceous granite gneiss, covering the undulating plateau mixed with medium black soil adjoining riverbanks.
- (3) Alluvial soils including coastal alluvium along the coastal belt and in lowlying situations.

The details of the mangrove species found in the study area:

- Avicennia officinalis
- Avicennia alba
- Acanthus illicifolius
- Aegiceras corniculatum
- Excoecaria agallocha





- Rhizophora mucronata
- Rhizophora apiculata
- Bruguiera gymnorrhiza

3.18 TERESTRIAL ECOLOGY

3.18.1 FLORA

The State of Goa has 38.5 % of its land under forest cover, which is much higher than the national average. In absolute terms, 1,424.38 sq. km. of area is under forest, of which 1,224.38 sq. km. is government forest and 200 sq. km. is private forest. The physiography of the Goa district chiefly comprises undulating terrain of Western Ghats in a series of hills with several off-shoots and spours gradually merging in the west. The western ghat is the source of two prominent rivers in Goa viz. Mandovi and Zuari that flow off into the Arabian Sea near Panaji and Vasco-da-Gama. Forests are mostly confined to the eastern portion of the Western Ghats in the foothill slopes of Satari, Sanquem, and Canacona talukas. Scattered in patches are several private forests owned by the village communities, temples and private individuals. As per the classification of Champion and Seth 1968, following forest types can be observed in the South Goa district.

Evergreen and Semi- Evergreen Forests

Along the north-eastern and south-eastern portions bordering Karnataka state, few evergreen and semi- evergreen vegetation occur in the deep gorges and ravines of Sanguem, Satari and Canacona talukas. On the precipitous aspect the tree growth is mostly stunted having low timber value. The trees of common occurrence are Babbi (*Calophyllum wightianum*), Jambul (*Syzygium cumuni*), Ambo (*mangifera indica*), Onval (*Mimusops elengi*), Otamb (*Ariocarpus lakoocha*), Patpanas (*Artocarpus hirsute*), Nag Gulum (*Mesua ferrea*), Hopea wightiana, Bhirand (*Garcina indica*), Gulum (*Machilus Macarantha*), Chandodo (*Macaranga peltata*), Bhenoro (*Sterculia villosa*), Bibo (*Semecarpus anacardium*), Holigarna arnottiana and Mallotus sp. The undergrowth is comprised of *Colebrookea oppositifolia*, Wendlandia spp., Triumfetta rhomboidea, Hemigraphis spp., Callicarpa tanata, Saulria indica, Ixora brachiata, Woodfordia floriabunda, Lobelia





nicotianaefolia. The common bamboos occurring in these forests are Velu (*Bambusa arundinacea*) and Kanaki (*Dendrocalamus strictus*). Bhet (*Calamus tannuas*) is the important cane of evergreen belt.

Moist Deciduous Forest

This type of forest occurs along the foot hill slopes of hill tract from north to south and spurs leading towards west. This type of forests is distributed in about 385 square kilometers, providing the timber and fuel wood requirement of the district Natural teak is of sporadic occurrence in these forests, The prominent tree species in this zone are Maretha (*Terminalia crenulata*), Quinzol (*Terminalia paniculata*), Zambo (*Xylia xylocarpa*), Nano (*Lagerstroemia lanceolata*), Ghoting (*Terminalia belterica*), Sissoo (*Dalbergla latifolia*), Edu (*Adina Cardifolia*), Kalam (*Mitragyna parvifolia*), Karmal (*Dillenia pentagyna*), Assan (*Pterocarpus marsupium*) and Kusum (*Schleichera oleosa*).

In the under storey the common tree species found are Dhaman (*Grewia illiaefolia*), Shiras (*Albizzia lebbek*), Belati (*Albizzia procera*), Kanvanch (*Bridelia retusa*), Shivan (*Gmelina arborea*), Moi (*Lamnea coromandelica*), Bel (*Aegle marmelos*), Kadukavath (*Hydnocarpus laurifolia*), *Malotus phillippinensis*, Char (*Buchanania latifolia*), khair (*Acacia catechu*), Shanta Kudo (*Wrightia tinctoria*) and Mumeo (*Careya arborea*). The shrubby vegetation consists mostly of Galai (*Randia dumetorum*), Kevani (*Helicteres isora*), Karvi (*Strobilanthes callosus*), Jino (*Leea indica*), *Glycosmis pentaphylla*, *Ardisia solanacea*, *Ranbhendi* (*Urena lobatta*), Karvand (*Carissa carandas*), *Fleminhia congesta*, *Clerodendron infortunalum*, Nagur Cudo (*Holorrhena antihysenterica*) Karbel (*Murraya koenigli*) and *Tabernaemontana heynaena*. Also fern species of *Pteris*, *Selaginella* and *Ophiglossum* are seen on the moist forest floor. The common climbers of these forests are Ukshi (*Calycopteris floribunda*), Krishnasarva (*Ichnocarpus frutescens*) Ghotival (*Smilax spp.*) Shembi (*Caesalpinia sepiaria*), Vagati (*Wagatea spicata*) and *Caesalpinia nuga*. The ground flora represented by herbs and grasses.





Littoral and swamp forest

Littoral and Swampy forests can be further divided in three categories viz: Beach forest, Tidal or Mangrove forest and Fresh water swamp forest. The common plants of beach forests are *Casuarina equisetifolia, Callophyllum littoralis, Cocus nucifera, Manikara littoralis, Thespesia sp, Spinfex littoreus* and number of twiners and climbers. Tidal or mangrove forest is predominant in the area. A luxuriant growth of mangrove and associated species can be observed along the estuaries and back water of the coastal region. Common species of this forest comprised of *Rhizophora mucronata, Acanthus ilicifolius, Avicennia officinalis, Sonneratia caseolaris, Kandelia candel* and associate species. The important plant species found in swamp forest are *Cephalenthus, Holoptelia* sp, *Murray* sp. *Cana* sp and variety of grasses.

Vegetation Composition in the Study Area

The vegetation composition at the proposed project area mainly consists of trees, shrubs and herbs. The tree components other than Mangroves occur with a composition of Phiramgisaro (Casuarina equisetifolia) Naal (Cocos nucifera), Oondi (Calophyllum, inophyllum), Ambo (Mangifera indica), Moi (Lannea coromandelica), Kaju (Anacardium occidentale), Bhendi (Thespecia populinea), Kudo (Hollarhena antidysentric), Nano (Lagerstroemia lanceolata), Onwal (Mimusops elengi), Jamun (Syzgium cuminii) and Zamba (Xylia xylocarpa) etc. The other associates such as shrubs are *Calycopteris floribunda*, *Ixora coccinea*, Tabernamontana heyneana, Microcos paniculata, Derris trijoliata, Caesalpinia crista, Vitex negundo, Clerodendron inermi, intermixed with herbs include Achyranthes aspera, Malvastrum sp, Halophila beccarii. Sesuvium Leucas aspera, Phylanudiflora, Arthrocnemum indicum. portulacastrum, Melanthera biflora, sedges like Cyperus arenarius, Fimbristilis and grasses with Themeda triandra, Spinifex littorens, Digitariaadscendens etc. The list of floral species observed in the South Goa district is enlisted in Table 3.33.





Table 3.33: Plant species recorded in South Goa forest division

Botanical Name	Common/Local	Family	Habit	IUCN
	Name	D		Status
Dendrocalamus	Mango	Poaceae	Bamboo	NA
strictus		D : .		
Dioscorea sp	-	Dioscoriaceae	Climber	NA
Mukia maderaspatana	-	Cucurbitacea	Climber	NA
Passiflora foetida	Running pop	Passifloraceae	Climber	NA
Smilax zeylanica	Ghot vel or Kaval kamti.	Smilacaceae	Climber	NA
Acrostichum aureum	-	Pteridaceae	Fern	LC
Cynodon dactylon	Haryali	Poaceae	Grass	NA
Dactyloctenium	-	Poaceae	Grass	NA
aegyptium				
Digitaria adscendens	-	Poaceae	Grass	NA
Eragrostis uniloides	-	Poaceae	Grass	NA
Saccharum	-	Poaceae	Grass	LC
spontaneum				
Spinifex littoreus	Saramto	Poaceae	Grass	NA
Themeda triandra	Karad	Poaceae	Grass	NA
Achyranthes aspera	Aghado	Acanthaceae	Herb	NA
Ageratum conyzoides	-	Asteraceae	Herb	NA
Alternanthera sessilis	-	Amaranthaceae	Herb	LC
Arthrocnemum	-	Chenopodiaceae	Herb	NA
indicum				
Boerhavia diffusa L.	Punnarva	Nyctaginaceae	Herb	NA
Cyanotis axillaris	-	Commelinaceae	Herb	LC
Datura innoxia	Datura	Solanaceae	Herb	NA
Eclipta alba	Mako	Asteraceae	Herb	LC
Eichhornia crassipes	-	Pontederiaceae	Herb	NA
Elephantopus scaber	-	Asteraceae	Herb	NA
Halophila beccarii	-	Hydrocharitaceae	Herb	Vu
Hedyotis herbacea	-	Rubiaceae	Herb	NA
Hemidesmus indicus	Dudhshiri	Asclepidiaceae	Herb	NA
Hyptis suaveolens	-	Lamiaceae	Herb	NA
Ipomea pes- caprae	Maryadvel	Convolvulaceae	Herb	NA
Justiciasimplex	-	Malvaceae	Herb	NA
Launaea sarmentosa	-	Asteraceae	Herb	NA
Leucas aspera	Tumbo	Lamiaceae	Herb	NA
, Malvastrum sp	-	Malvaceae	Herb	NA
Melanthera biflora	-	Asteraceae	Herb	NA
Mimosa pudica	-	Mimosaceae	Herb	LC
Mollugo oppositifolia	-	Molluginaceae	Herb	NA
Nymphaea nouchali	KasturiSalak	Nymphaeaceae	Herb	





Botanical Name	Common/Local	Family	Habit	IUCN
	Name			Status
Nymphaea pubescens	KamalSalak	Nymphaeaceae	Herb	LC
Ocimum omericanum	Ramtulas	Lamiaceae	Herb	NA
Phyla nudiflora	-	Verbenaceae	Herb	NA
Portulaca quadrifida	Bhumygol	Portulacaceae	Herb	NA
Sesuvium	-	Aizoaceae	Herb	NA
portulacastrum				
Sida acuta	Bala, /Chikna	Malvaceae	Herb	NA
Sida cordata	-	Malvaceae	Herb	NA
Tridax procumbens	-	Asteraceae	Herb	NA
Triumfetta rhomboidea	Tupkati	Tiliaceae	Herb	NA
Musa paradisiaca	Keli	Musaceae	Large	NA
			Codao	
	-	Cyperaceae	Sedge	
	•		Seage	
Adathoda Vasica	Aduso	Acanthaceae	Shrub	NA
Ananas comosus	Ananas	Annonaceae	Shrub	NA
Caesalpinia sp.	-	Caesalpiniaceae	Shrub	NA
Calamus sp.	-	Arecaceae	Shrub	NA
Calotropis gigantea	Rui,Dhavirui	Asclepidiaceae	Shrub	NA
Calycopteris	Uski	Combretaceae	Shrub	NA
Cassia tora	Tavkhilo	Mimosaceae	Shrub	NA
Clerodendron inermi	Siritmari	Verbenaceae	Shrub	ΝΔ
Colubrina asiatca	-	Rhampaceae	Shrub	ΝΔ
Derris heterophylla	-	Fabaceae	Shrub	
	- Ditkoli	Publaceae	Shrub	
Lantana camara		Vorbonaceae	Shrub	
	- lino		Shrub	
Leea Inuica	JIIIU		Shrub	
	Acolo chivoro	Malyaaaaa	Shrub	
	Asale, chivara		Shrub	
Murreve keepigii	Vagali Korphil Karipatha		Shrub	
Dhooniy Jouroiroi	Karphil, Kanpalha	Aroooooo	Shrub	
	-	Arecaceae	Shrub	
Plumena sp.	-	Apocynaceae	Shrub	
Randia deumatorum	Gel	Rublaceae	Shrub	NA NA
rapernamontana	KUOO	Apocynaceae	Snrub	INA
		Fahaaaa	Chruch	
Theopolo lawre	- Dan Dharali		SHIUD	
Thespecia lampa	Ran Bhendi			
Thevetia peruviana	- Develoi	Apocynaceae	Shrub	
vitex aitissima	Bavaigi	verbenaceae	Shrub	NA
Vitex negundo	Limgud	Verbenaceae	Shrub	NA





Botanical Name	Common/Local	Family	Habit	IUCN
	Name			Status
Zizhuphus rugosa	Churna	Rhamnaceae	Shrub	NA
Zizuphus mauritiana	Boram	Rhamnaceae	Shrub	NA
Woodfordia	-	Lythraceae	Shrub	NA
floriabunda				
Bambusa arundinacea	Velu	Poaceae	Thorny	NA
Acacia catechu	Khair	Mimosaceae	Tree	NA
Adenanthera pavonia	Guni	Fabaceae	Tree	NA
Adina cordifolia	Haldu	Rubiaceae	Tree	NA
Albizzia lebbek	Siras	Mimosaceae	Tree	NA
Albizzia odoratissima	Kala Siras	Mimosaceae	Tree	NA
Alstonia scholarias	Saton	Apocynaceae	Tree	NA
Anacardium	Kaiu	Anacardiaceae	Tree	NA
occidentale				
Artocarpus	Phanas	Moraceae	Tree	NA
heterophyllus				
Bombax ceiba	Savar	Bombacaceae	Tree	NA
Borassus flabellifer	Toddy palm	Arecaceae	Tree	En
Calaphyllus	Oondi	Calophyllaceae	Tree	NA
inophyllum				
Callophylum	Undi	Callophyllaceae	Tree	NA
inophyllum				
Careya arborea	Kumbiyo	Lecethidaceae	Tree	NA
Carica papaya	Papaya	Caricaceae	Tree	DD
Caryota urens	Billemad	Arecaceae	Tree	LC
Cassia fistula	Bayo	Caesalpiniaceae	Tree	NA
Casuarina	Phiramgisaro	Casuarinaceae	Tree	NA
equisetifolia				
Ceasalpinia crista	-	Caesalpiniaceae	Tree	NA
Ceiba pentandra	Savar	Bombacaceae	Tree	NA
Cocos nucifera	Naal	Arecaceae	Tree	NA
Delonix regia	Gulmohar	Caesalpiniaceae	Tree	LC
Erythrina indica	Pongaro.	Fabaceae	Tree	LC
Ficus arnottiana	Asti payr	Moraceae	Tree	NA
Ficus asperrima	Kharvat	Moraceae	Tree	NA
Ficus bengalensis	Vad	Moracea	Tree	NA
Ficus glomerata	Rumbad	Moraceae	Tree	NA
Ficus racemosa	-	Moraceae	Tree	NA
Ficus religiosa	Pipal	Moracea	Tree	NA
Garcinia indica	Bhiran	Clusiaceae	Tree	Vu
Garunga pinnata	Kakad	Burseraceae	Tree	NA
Gmelina arborea	Shivan	Verbenaceae	Tree	NA





Botanical Name	Common/Local	Family	Habit	IUCN
	Name			Status
Grewia tillifolia	Dhaman	Tiliaceae	Tree	NA
Helicters isora	Kivan	Malvaceae	Tree	NA
Hibiscus tiliaceus	Belipata	Malvaceae	Tree	NA
Holigarnaarnottiana	Ranbibo	Anacardiaceae	Tree	NA
Hollarhena	Kudo	Apocynaceae	Tree	NA
antidysentric				
Holoptelia integrifolia	Vavalo	Ulmaceae	Tree	NA
Hopea wightiana	Pay	Dipterocarpaceae	Tree	NA
Lagerstroemia	Nano	Lythraceae	Tree	NA
lanceolata				
Lannea	Moi	Anacardiceae	Tree	NA
coromandelica	-			
Mallotus phillipinensis	Bems, Sendri.	Euphorbiacea	Tree	NA
Mangifera indica	Ambo	Anacardiaceae	Tree	DD
Manilkara hexandra	Kirni	Sapotaceae	Tree	NA
Mimusops elengi	Onwal	Sapotaceae	Tree	NA
Morinda citrifolia	-	Rubiaceae	Tree	NA
Polyalthia fragrans	Miryo, Mirio	Annonaceae	Tree	NA
Pongamia pinnata	Karanji	Fabaceae	Tree	LC
Pterocarpus	Asan	Fabaceae	Tree	Vu
marsupium				
Saraca indica	Asoka	Sapindaceae	Tree	NA
Schleichera oleosa	Kusum	Sapindaceae	Tree	NA
Semecarpus	Biboi	Anacardiaceae	Tree	NA
anacardium				
Spondia mangifera	Ambado	Anacrdiaceae	Tree	NA
Sterculia villosa	Aployo suplo	Sterculiaceae	Tree	NA
Syzgium	Bhedas	Myrtaceae	Tree	NA
caryophyllatum				
Syzgium cumini	Jamun	Myrtaceae	Tree	NA
Thespecia populinea	Bhendi	Malvaceae	Tree	NA
Trewia nudiflora	Bomovaro petari	Euphorbiacea	Tree	NA
Wrightia tinctoria	Kalakundo	Apocynaceae	Tree	LC
Xylia xylocarpa	Zamba	Mimosaceae	Tree	NA
Tectona grandis	Teak	Verbinaceae	Tree	NA
Terminalia crenulata	Maretha	Combretaceae	Tree	NA
Terminalia paniculata	Quinzol	Combretaceae	Tree	NA
Dalbergla latifolia	Sisso	Fabaceae	Tree	NA
Dillenia pentagyna	Karmal	Dilleniaceae	Tree	NA
Albezia procera	Belati	Mimosaceae	Tree	NA
Aegal marmelos	Bel	Rutaceae	Tree	NA
Wrightia tinctoria	Shanta kudo	Apocyanaceae	Tree	NA
Strobilanthes callosus	Karvi	Acanthaceae	Shrub	NA





Botanical Name	Common/Local Name	Family	Habit	IUCN Status
Urena lobatta	Ranbhendi	Malvaceae	Shrub	NA
Fleminhia congesta	-	Fabaceae	Shrub	NA
Holorrhena antihysenterica	Nagur Cudo	Apocyanacea	Shrub	NA
Wagatea spicata	Yagati	Caesalpiniaceae	Climber	NA

Source: Departement of Forests, Government of Goa.

Note: LC= Least Concern, VU= Vulenerable, En= Endangered, NA= Not Assessed, DD-Data deficient

3.18.2 FAUNA

Mammals

There are almost fifty species of mammals found in the State. Most of these are unfortunately hardly ever visible to the average visitor. Among the mammals found in the study area are common Jackal, Monkeys, Indian civet, wild dog, Indian hare, Gaur, Indian porcupine, Wild boar and the mongoose. Monkeys are found all across Goa. The most common species is the pink-bottomed macaque followed by the Hanuman langur. Goa has four species of bats, the fruit bat, the Dormers bat, the rufous horse-shoe bat, and the Malay fox vampire. Flying foxes are also present in large numbers. Most of these are found in the rural interior areas. The Indian giant squirrel, the smaller three-striped squirrel and the five-striped palm squirrel are also found in most areas. Commonly found mammals in the study area district and details of their conservation status as per IUCN List of threatened animals are given in Table 3.34.

S. No.	Zoological Name	English Name	IUCN STATUS
1.	Axis axis	Spotted deer	LC
2.	Bandicota indica	Bandicoot rat	LC
3.	Bos gaurus	Gaur or Indian bison	VU
4.	Canis aureus	Jackal	LC
5.	Cervus unicolor	Sambar	VU
6.	Cuon alpinus	Wild dog	EN
7.	Cynopterus brachyotis	Indian fulvous fruit bat	LC
8.	Delphinus tropicalis linn	Common Dolphin	DD

|--|





S. No.	Zoological Name	English Name	IUCN
			STATUS
9.	Prionailurus bengalensis	Leopard cat	LC
10.	Felis chaus	Jungle cat	LC
11.	Funambulus palmarum	Common palm squirrel	LC
12.	Herpestes edwardsii	Common grey mongoose	LC
13.	Hyaena hyaena	Striped hyaena	NT
14.	Hystrix indica	Porcupine	LC
15.	Lepus nigricollis	Indian Hare	LC
16.	Loris tardigradus	Red Slender loris	EN
17.	Lutra lutra	Eurasian Otter	NT
18.	Lutra perspicillata	Smooth coated Otter	Vu
19.	Macaca radiata	Bonnet macaque	LC
20.	Manis crassicaudata	Indian pangolin	EN
21.	Megaderma spasma	Indian false vampire bat	LC
22.	Melursus ursinus	Sloth bear	VU
23.	Muntiacus muntjak	Barking deer	LC
24.	Mus booduga	Indian field mouse	LC
25.	Otomopos wroughtoni	Wronghton's freetailed bat	DD
26.	Panthera pardus	Leopard	VU
27.	Panthera tigris	Tiger	EN
28.	Paradoxurus	Palm civet cat	LC
	hermaphroditus		
29.	Petaurista petaurista	Common flying squirrel	LC
30.	Phocoena phocoena	Porpoise	LC
31.	Pipistrellus dormeri	Dormers bat	LC
32.	Presbytis entellus	Common Langur	VU
33.	Pteropus giganteus	Flying Fox	LC
34.	Rattus rattus	House Rat	LC
35.	Ratufa macroura	Malabar Giant Squirrel	NT
36.	Rhinolophus luctus	Horse shoe bat	LC
37.	Suncus murinus (Linnaeus)	House shrew	LC
38.	Sus scrofa	Wild Boar	LC
39.	Tatera indica	Indian Gerbille	LC
40.	Tragulus meminna	Mouse deer	LC
41.	Tursiops aduncus	Indian bottlenose dolphin	DD
42.	Viverricula indica	Small Indian civet cat	LC





Birds

Goa has an abundant birdlife. There are some very colourful species found in the State and among these are the three common species of kingfisher: the storkbilled kingfisher is the largest and most distinctive, the breasted kingfisher and and the common kingfisher are the others. Other common and brightly coloured species include the grass-green, blue and yellow bee-eaters, the golden oriole, and the Indian roller, Hoopes, purple sunbirds, and several kinds of bulbuls, babblers and drongos. The exotic paradise flycatcher is fairly widespread in Goa and among the region's most exquisite birds.

The snowy white cattle egret, the large egret and the little egret and herons are most common in the paddy fields along with cows and buffaloes. The beautiful white bellied fish eagle, the brahminy kite and the pariah kite are birds of prey found around towns and fishing villages. House crows, jackdaws, king vultures and the white-backed vulture are also seen in most areas. In the state's forests are found the grey hornbill, the Indian pied hornbill and the magnificent great pied hornbill, several species of woodpecker including the lesser goldenback woodpecker and the Indian great black woodpecker, the red junglefowl, the grey or Sonnerat's jungle fowl. The commonly reported birds in goa and their conservation status as per IUCN List are given in the Table 3.35.

S.	Scientific name	Common name	IUCN
No.			status
1	Accipiter badius	Shikra	VU
2	Acridotheres fuscus	Jungle Myna	LC
3	Acrocephalus aedon	Thick billed Warbler	LC
4	Acrocephalus agricola	Paddyfield Warbler	LC
5	Aegithina tiphia	Common Iora	LC
6	Alcedo atthis	Common Kingfisher	LC
7	Amaurornis phoenicurus	White-breasted Waterhen	LC
8	Anas acuta	Northern Pintail	LC
9	Anas clypeata	Northern Shoveler	LC
10	Anas crecca	Common Teal	LC
11	Anas poecilorhyncha	Spot-billed	LC





S.	Scientific name	Common name	IUCN
No.			status
12	Anas querquedula	Garganey	LC
13	Anastomus oscitans	Asian Openbill	LC
14	Anhinga melanogaster	Oriental Darter	NT
15	Anthus richardi	Richards Pipit	LC
16	Apus pacificus	Large White Rumped Swift	LC
	Aquila pomarina	Lesser Spotted Eagle	LC
18	Ardea cinerea	Grey Heron	LC
19	Ardea purpurea	Purple Heron	LC
20	Ardeola grayii	Indian Pond-Heron	LC
21	Bubulcus ibis	Cattle Egret	LC
22	Cacomantis passerinus	Grey-bellied Cuckoo	LC
23	Calandrella brachydactyla	Greater Short-toed Lark	LC
24	Calidris temminckii	Temminck's Stint	LC
25	Celeus brachyyurus	Rufous woodpecker	LC
26	Centropus sinensis	Greater Coucal	LC
27	Ceryle rudis	Pied Kingfisher	LC
28	Chalcophaps indica	Emerald Dove	LC
29	Charadrius alexandrinus	Kentish plover	LC
30	Charadrius dubius	Little ringed plover	LC
31	Chloropsis aurifrons	Gold fronted chloropsis	LC
32	Circaetus gallicus	Short-toed Snake-Eagle	LC
33	Circus aeruginosus	Western Marsh Harrier	LC
34	Columba elphinstonii	Nilgiri Wood-Pigeon	VU
35	Columba livia	Rock Pigeon	LC
36	Copsychus malabaricus	White-rumped Shama	LC
37	Copsychus saularis	Magpie robin	LC
38	Coracina mealnoptera	Black headed cuckoo shrike	LC
39	Corvus macrorhynchos	Jungle crow	LC
40	Corvus splendens	House Crow	LC
41	Cuculus varius	Common Hawk-Cuckoo	LC
42	Cyornis tickelliae	Tickell's blue flycatcher	LC
43	Cypsirus Parvus	Palm Swift	LC
44	Dendrocitta vagabunda	Indian tree pie	LC
45	Dendrocopos mahrattensis	Yellow-crowned Woodpecker	LC
47	Dendrocygna javanica	Lesser Whistling teal	LC
48	Dicaeum agile	Thick billed Flowerpecker	LC
49	Dicaeum erythrorhynchos	Tickell's Flowerpecker	LC
50	Dicrurus aeneus	Bronzed Drongo	LC





S.	Scientific name	Common name	IUCN
No.			status
51	Dicrurus caerulescens	White bellied Drongo	LC
52	Dicrurus hottentottus	Hair crested Drongo	LC
53	Dicrurus macrocercus	Black Drongo	LC
54	Dicrurus paradiseus	Greater racket tailed drongo	LC
55	Dinopium benghalense	Lesser golden back	LC
		woodpecker	
56	Dryocopus javensis	White-bellied Woodpecker	LC
57	Ducula badia	Mountain Imperial-Pigeon	LC
58	Dumetia hyperythra	White throated Babbler	LC
59	Egretta gularis	Western Reef-Egret	LC
60	Elanus caeruleus	Black-winged Kite	LC
61	Eremopterix grisea	Ashy-crowned Sparrow-Lark	LC
62	Eumyias thalassina	Verditer flycatcher	LC
63	Fulica atra	Common Coot	LC
64	Gallicrex cinerea	Watercock	LC
65	Gallinula chloropus	Common Moorhen	LC
66	Galloperdix spadicea	Red Spurfowl	LC
67	Gallus sonneratii	Grey Junglefowl	LC
68	Glareola lactea	Small Pratincole	LC
69	Gorsachius melanolophus	Malayan Night Heron	LC
70	Halcyon pileata	Black-capped Kingfisher	LC
71	Halcyon smyrnensis	White-throated Kingfisher	LC
72	Haliaeetus leucogaster	White-bellied Fish-Eagle	LC
73	Haliastur indus	Brahminy Kite	LC
74	Hemicircus canente	Heart-spotted Woodpecker	LC
75	Hemiprocene longipennis	Crested tree swift	LC
76	Hemipus picatus	Pied flycathcher shrike	LC
77	Himantopus himantopus	Black-winged Stilt	LC
78	Hirundo concolor	Dusky Crag Martin	LC
79	Hirundo daurica	Red rumped Swallow	LC
80	Hirundo smithii	Wire tailed Swallow	LC
81	Hypothymis azurea	Black-naped Monarch	LC
82	lole indica	Yellow-browed Bulbul	LC
83	Irena puella	Asian Fairy-bluebird	LC
84	Lanius schach	Long tailed Shrike	LC
85	Leptoptilos javanicus	Lesser Adjutant	VU
86	Lonchura malacca	Black headed Munia	LC
87	Lonchura striata	White Rumped Munia	LC





S.	Scientific name	Common name	IUCN
No.			status
88	Megalaima haemacephala	Crimson breasted Barbet	LC
89	Megalaima viridis	White cheeked Barbet	LC
90	Merops leschenaulti	Chestnut headed bee-eater	LC
91	Merops orientalis	Little Green Bee-eater	LC
92	Merops philippinus	Blue-tailed Bee-eater	LC
93	Mesophoyx intermedia	Intermediate Egret	LC
94	Milvus migrans	Black Kite	LC
95	Motacilla citreola	Citrine Wagtail	LC
96	Motacilla madaraspatensis	Large Pied wagtail	LC
97	Muscicapa dauurica	Asian Brown Flycatcher	LC
98	Mycteria leucocephala	Painted Stork	NT
99	Myiophonus horsfieldii	Malabar Whistling-Thrush	LC
100	Nectarinia asiatica	Purple Sunbird	LC
101	Nectarinia lotenia	Loten's Sunbird	LC
102	Nectarinia zeylonica	Purple rumped Sunbird	LC
103	Nycticorax nycticorax	Black-crowned Night-Heron	LC
104	Nyctyornis athertoni	Blue bearded bee-eater	LC
105	Oriole oriolus	Golden oriole	LC
106	Oriolus xanthornus	Black headed oriole	LC
107	Orthotomus sutorius	Common Tailor bird	LC
108	Oxylophus jacobinus	Pied Cuckoo	LC
109	Pandion haliaetus	Osprey	LC
110	Passer domesticus	House Sparrow	LC
111	Pavo cristatus	Indian Peafowl	LC
112	Pelargopsis capensis	Stork-billed Kingfisher	LC
113	Pellorneum ruficeps	Spotted Babbler	LC
114	Perdicula asiatica	Jungle Bush-Quail	LC
115	Pericrocotus cinnamomeus	Small minivet	LC
116	Pericrocotus cinnamomeus	Small Minivet	LC
117	Pericrocotus flammeus	Scarlet Minivet	LC
118	Picumnus innominatus	Speckled Piculet	LC
119	Pitta brachyura	Indian Pitta	LC
120	Ploceus philippinus	Indian Baya	LC
121	Pomatorhinus horsfieldii	Indian Scimitar-Babbler	LC
122	Porphyrio porphyrio	Purple Swamphen	LC
123	Porzana fusca	Ruddy-breasted Crake	LC
124	Prinia hodgsonii	Grey-breasted Prinia	LC
125	Prinia inornata	Plain Prinia	LC





S.	Scientific name	Common name	IUCN
No.			status
126	Prinia socialis	Ashy Prinia	LC
127	Psittacula krameri	Rose ringed parakeet	LC
128	Psittacula kyanocephala	Blossom headed parakeet	LC
129	Pycnonotus cafer	Red vented Bulbul	LC
130	Pycnonotus jocosus	Red whiskered Bulbul	LC
131	Pycnonotus luteolus	White browed Bulbul	LC
132	Rhipidura albicollis	White throated fantail	LC
		flycatcher	
133	Saxicola caprata	Pied bush chat	LC
134	Saxicoloides fulicata	Indian Robin	LC
135	Sitta frontalis	Velvet-fronted Nuthatch	LC
136	Spilornis cheela	Crested Serpent-Eagle	LC
137	Spizaetus cirrhatus	Changeable Hawk-Eagle	LC
138	Sterna aurantia	River Tern	NT
139	Sterna bengalensis	Lesser Crested-Tern	LC
140	Sterna nilotica	Gull-billed Tern	LC
141	Streptopelia chinensis	Spotted Dove	LC
142	Sturnus pagodarum	Brahminy Myna	LC
143	Sturnus roseus	Rosy Starling	LC
144	Tachybaptus ruficollis	Little Grebe	LC
145	Terpsiphone paradisi	Paradise flycatcher	LC
146	Treron pompadora	Pompadour Green-Pigeon	LC
147	Tringa cinerea	Terek Sandpiper	LC
148	Tringa erythropus	Spotted Redshank	LC
149	Tringa glareola	Wood Sandpiper	LC
150	Tringa hypoleucos	Common Sandpiper	LC
151	Tringa nebularia	Common Greenshank	LC
152	Turdoides striatus	Jungle Babbler	LC
153	Turdus merula	Eurasian Blackbird	LC
154	Upupa epops	Ноорое	LC
155	Vanellus indicus	Red-wattled Lapwing	LC
156	Vanellus malabaricus	Yellow-wattled Lapwing	LC

Source: Departement of Forests, Government of Goa.





Reptiles

The State has a large reptilian/amphibian population. This includes the ubiquitous common house gecko, a variety of frogs and the common skink, monitor lizard, Garden Lizard. Twenty-three species of snakes are found in Goa. The nonpoisonous variety of snakes include the common blind snake, the Russell sand boa, the Indian python, the Indian wart snake, trinket snake, Indian rat snake, golden tree snake, common wolf snake, ,chequered keelback, striped keelback, Indian gamma and common green whip snake. Details of commonly observed reptilian fauna in the study area and their conservation status as per IUCN List are given in Table 3.36.

S.	Scientific name	Common name	IUCN
No.			STATUS
Snak	es		
1	Ahaetulla nasutus	Vine Snake	LC
2	Amphiesma stolatum	Buff striped keel back	NE
3	Boiga forsteni	Forsten's Cat Snake.	LC
4	Boiga trigonata	Common Indian Cat	LC
		Snake.	
5	Bungarus caeruleus	Common Indian Krait	VU
6	Calliophis nigrescens		LC
7	Cerberus rhynchops	Dogfaced water Snake	LC
8	Chrysopelea ornata	Golden back tree Snake	LC
9	Coelognathus helena	Trinket Snake	VU
10	Dendrelaphis tristis	Bronzeback tree Snake	NE
11	Echis carinatus	Saw scaled Viper	LC
12	Enhydrina schistosa	Hook-nosed Sea Snake	LC
13	Eryx johnii	Johns sand boa	LC
14.	Gongylophis conicus	Common Sand Boa	DD
15	Grypotyphlops acutus	Beaked worm snake	LC
16	Lycodon aulicus	Common Wolf snake	NE
17.	Macropisthodon plumbicolor	Green keelback.	LC
18.	Naja naja	Indian Spectacled Cobra.	LC
19	Oligodon arnensis	Common Kukri snake	LC
20	Oligodon taeniolatus	Variegated Kukri Snake	LC
21.	Ophiophagus hannah	King Cobra	VU





22.	Ptyas mucosa	Indian Rat Snake	LC
23.	Python molurus	Indian Rock Python	VU
24.	Ramphotyphlops braminus	Brahminy worm snake	LC
25	Trimeresurus malabaricus	Malabar Pit Viper	LC
26	Trimeresurus gramineus	Bamboo Pit Viper	LC
27	Uropeltis macrolepis	Bombay shield tail	LC
	macrolepis		
28.	Vipera russelii	Russels Viper	LC
29.	Xenochrophis piscator	Checkered keelback	LC
Lizar	ds, Skinks		
1	Calotes rouxii	Rouxii lizard	LC
2	Calotes versicolor	Indian garden lizard	LC
3	Chamaeleo zeylanicus	Indian chameleon	LC
4	Draco dussumieri	Flying lizard	LC
5	Mabuya macularia	Bronze skink	LC

Source: Departement of Forests, Government of Goa.

Amphibians

Amphibians are important components of many ecosystem and they play a vital role as predators in the food chain. They are good indicators of habitat quality due to their permeable skins, dual life mode and limited dispersal capabilities. Most of species inhabit arboreal, aquatic and terrestrial habitat. Most of amphibians are belongs to the family Ranidae and species like common Indian toad, Painted frog, green frog and *Rana* spp. are common in the area (Table 3.37).

 Table 3.37: List of Amphibian species reported in the study area

S No.	Scientific name	Common name	IUCN STATUS
Amphi	bians		
1.	Duttaphrynus	Indian toad	LC
	melanostictus (schnieder)		
2.	Hoplobatrachus tigerinus	Indian bull frog	LC
3.	Euphlyctis cyanophlyctis	Indian skipper frog	LC
4.	Sphaerotheca breviceps	Indian burrowing frog	LC
5.	Rhacophorus malabaricus	Malabar gliding frog	LC
6.	Rana malabarica	Fungoid frog	LC

Note: LC-Least concern, DD–Data Defecient, VU-vulnerable, EN-Endangered.





3.18.3 Eco-sensitive Zones

The Eco-sensitive Zones declared as Protected Areas in Goa by the Ministry of Environment and Forests and Climate Change are:

- (i) Cotigao Wildlife Sanctuary, South Goa
- (ii) Netravali Wildlife Sanctuary, South Gao
- (iii) Bhagwan Mahaveer Wildlife Sanctuary and National Park, North Goa
- (iv) Madei Wildlife Sanctuary, North Goa
- (v) Bondla Wildlife Sanctuary, North Goa
- (vi) Dr. Salim Ali Wildlife Sanctuary, North Goa

Of the above ecosensitve zones only Dr. Saliim Ali Wild life sanctuary falls within 15 kms radius of the study area. The Dr. Salim Ali Bird Sanctuary, Goa lies between latitudes 15° 31' 36.03" N and 15° 30' 35.35" N and longitudes 73° 52' 14.31" E and 73° 50' 44.12" E in the North Goa District of Goa State and extending over an area of 1.78 square kilometres. Location of the sanctuary is shown in Figure 3.21. It is a rich mangrove formation at the confluence of Mapusa river and Mandovi river. The sanctuary exclusively shelters varieties of amphibians, otters, crocodiles, varieties of fish, aquatic birds, shore birds and arboreal birds and reptiles, fruit bat (*Pteropus spp.*) commonly occur in the area, migratory birds, adjutant storks and raptorial birds like osprey visit the protected area annually.







Figure 3.21: Eco-sensitive Zone Map of Goa





3.19 FISHERIES

Goa has two kinds of fisheries, namely inland fisheries and marine fisheries.

Inland Fisheries

Inland Fisheries of Goa are one of the richest source spread over 250 kms in length. Inland fisheries are divided into two types, that is, Brackish and Fresh water fisheries. Brackish water fisheries include extensive estuaries or river mouth, a large number of lagoons, back waters and brackish water lakes, etc. Inland fishery resources are an important aspect of fishery resources and their marketing in the study area. Inland water of Goa produces a variety of fresh water species, brackish water fish and shrimps/prawns over the years.

Marine Fisheries

Marine fishery resources comprising of coastline of 104 kms. It is a broken coastline characterized by numerous bays and head lands. Groups of oceanic Islands with numerous creeks, mangroves and swamps. Goa has a large scope for fisheries production, particularly, through brackish water and marine production. Marine fishing is a seasonal industry for a period of nine months. The fishing season commences from the mid of August, when the fishing ban is lifted in the study area and lasts till the end of May. Marine fisheries are closed (practically closed) during monsoon, and fisherman utilize this period for mending their nets, maintenance of the fishing vessels and boats and also preparing new nets, etc. The list of fish species available in marine and inland Goa waters is given in Table 3.38.

Marine (Sea) Species	Inland (River/Creek)Species
Mackerels (Bangdo)	Prawns (Sungtam)
Oil Sardins (Tarle)	Lady fish (Muddoshi)
Other Sardins (Pedve)	Mullets (Shevto)
Prawns (Sungtam)	Gerres (Shetki)
Seer fish (Viswan)	Lutianus (Tamso)
Shark (Mori)	Cat fish (Sangot)
Skates (Fadke)	Anchovy (Motialli)
Rays (Vagolem)	Pearl spot (Kalunder)

Table 3.38: Fish species reported in Goan waters





Marine (Sea) Species	Inland (River/Creek)Species
KowalaCoval (Velli)	Betki (Channok)
Golden Anchovy (Kapsale)	Milk Fish (Gholsi)
Cat fish (Sangot)	Megalops (Keri)
Sciaenoids (Dodiaro)	Scatophagus (Mutre)
Butter fish (Saundale)	Ambasis (Burante)
Jew fish (Ghol)	Crabs (kurlio)
Indian Salmon (Rawao)	Black water Clams (kubye)
Silver belly (kampi)	False Clams (Tisrio)
Lobster (Shivod)	Oysters (Kalwam)
Soles (Lepo)	Mussel (Xinanee)
Silver Bars (karli)	Lepo
Pomfrets (Paplet)	Indian salmon
Lady fish (Muddoshi)	Balle Reddish
Mullets (Shevto)	Others (Pedve, Saundale)
Caranx (Tonki,Concoretc)	
Others Clupeids	
Bombay Duck (Bombil)	
Sepia (Manki)	
Perches (Gobro)	
Crabs (Kurlio)	
Ambasis (Burante)	
Ribbon fish (Balle)	
Thread fin (Dara Rane)	
Herrings	
Tunafish	
Horse Mackerals	
Leather Jacket (Diana)	
Indian Shad	

Source: Directorate of Fisheries, Government of Goa.

Finfish distribution

With respect to finfish distribution, the following species namely *Pampus argentus, Ilisha striatula, Pampus chinenis, Hyporhamphus dussumieri, Scomberoides Iysan, Lutjanus malabaricus, Harpadon nehereus, Cynoglossus linga, Rastrelliger kanagurta, Cynoglossus arel* and *Carangoides caeruleopinnatus* were predominantly recorded nearby in and around Karwad fish landing center, which is located near Mormugoa port waters.





Fish Landing

Proposed project is located in South Goa, which has one major, 3 medium and 4 minor fish landing Centers. Three fish landing centers of North Goa also falls with in the study area of the proposed project. Inland fish landing centers are present only in the Tiswadi Taluaka of the study area. The details of marine and inland fish landing centers in Goa are given in Tables 3.39 and 3.40 respectively.

S.No.	District	Fish Landing Centre	
1	North Goa	Siridao	
		Nauxi	
		Dauna Paula	
2	South Goa	Khari wada, Vasco	
		Baina	
		Bogmalo	

Table 3.39: Marine fish landing centre in the study area

Source: Directorate of Fisheries, Government of Goa.

Table 3.40:	List of Inland	fish landing cen	ters in the study area

Tiswadi Taluka		
1. St. Estevam	4. Chorao	7. Neura
2. Cumbharjua	5. Mandur	8. Agaciam
3. Diwar	6. Goa velha	9. Curca

Source: Directorate of Fisheries, Government of Goa.

Marine fish production during last 15 years have been anlysed. The marine fish production of Goa in the average consolidation of five years in last fifteen years showed a total sustainable steady growth of 81638 tonnes during the period of 2001-05 to 99427 tonnes in 2011-2015 thereby giving a hike of 21.79%. The details of five year average marine fish catch in Goa for 15 years are given in the Table 3.41. Trend of specie-wise production of marine fisheries during the period 2010 to 2015 in Goa is given in Table 3.42.





Species	Average	Average	Average	
	production	production	production	
	2001-2005	2006-2010	2011-2015	
Mackerals(Bangdo)	9279	17564	14833	
Sardines(Tarlo)	29149	28084	46094	
Cat Fish(Sangot)	1475	1914	651	
Shark Fish(Mori)	1432	1500	283	
Seer Fish(Wiswan)	3857	3044	2039	
Prawns(Sungtam)	5203	8986	8730	
Pomprets(Paplet)	694	402	702	
Cuttle Fish(Manki)	1340	1278	2100	
Tuna(Bokdo)	1035	1634	3041	
Ribbon Fish(BAlle)	3110	2134	628	
Reef Cod(Gobro)	788	316	1033	
KowalaKowal(velli)	482	416	589	
Golden Anchovy (Kapsale)	57	18	23	
Silver Belly(Kampi)	2885	2020	1743	
Soles(Lepo)	2087	1844	3745	
Silver Bar(Karli)	451	376	89	
Crabs(Kurlio)	876	1009	1210	
Sciaenoids(Dodiaro)	2546	2141	1654	
Butter Fish(Soundale)	491	926	707	
Others	14401	13200	9533	
Total	81,638	88,806	99,427	

Table 3.41: Five year marine fish catch at Goa for 15 years (Unit : MT)

Source: Goan fish trails, Volume-III-2016, Dept. of Fisheries, Government of Goa.

Species	Annual fish catch at Goa					
	2010	2011	2012	2013	2014	2015
Mackerals(Bangdo)	23831	22128	17860	12994	10308	10876
Sardines(Tarlo)	23732	26391	34329	31629	80849	57270
Cat Fish(Sangot)	1402	1545	364	383	598	367
Shark Fish(Mori)	3159	375	234	281	307	216
Seer Fish(Wiswan)	1229	1884	1616	2751	1621	2363
Prawns(Sungtam)	9970	8008	8968	8380	9283	9012
Pomprets(Paplet)	185	376	174	1342	643	977
Cuttle Fish(Manki)	1341	1012	1180	4422	2150	1737
Tuna(Bokdo)	2524	3801	2621	3520	1368	3896

Table 3.42: Fish catch at different Fish Landing Centers (Unit: in tonnes)





Ribbon Fish(BAlle)	839	49	644	1107	376	966
Reef Cod(Gobro)	1303	5	495	1409	1262	1993
KowalaKowal(velli)	279	438	562	1046	618	282
Golden Anchovy	2		50	29	2	33
(Kapsale)						
Silver Belly(Kampi)	1584	1012	1146	3328	1991	1240
Soles(Lepo)	1606	3995	3683	2579	3982	4487
Silver Bar(Karli)	219	62	98	54	121	110
Crabs(Kurlio)	763	1236	1160	830	1256	1568
Sciaenoids(Dodiaro)	1376	1448	1629	1425	1802	1966
Butter Fish	1116	978	656	594	676	630
(Soundale)						
Others	10002	11482	9159	9881	8894	8251
Total	87062	86185	86628	87984	128107	108240

Source: Goan fish trails, Volume-III-2016, Dept. of Fisheries, Government of Goa.

As per the fish landing data collected from Department of Fisheries, Government of Goa. Khariwada, Vasco is the largest fish landing centre in the study area. The details of fish catch recorded by the department of fisheries at different fish Landing Centers in the study area from 2013 to 2015 in South Goa are given in Table 3.43, and from 2013 to 2014 in North Goa are given in Table 3.44.

Table 3.43: Fish catch at different Fish Landing Centers in	South Goa
	(Unit: in tonnes)

S.	Species	K	hari wac	la	Baina			Bogmalo)	
Ν.		2013	2014	2015	2013	2014	2015	2013	2014	2015
1	Mackerals (Bangdo)	6465	2668	3711	150	339	186	17	97	16
2	Sardines (Tarlo)	4056	6022	7325	273	141	116	11	89	9
	Other sardines		0	1463		0	78	0	0	7
3	Catfish (Sangot)	143	195	67	0	0	28	0	0	0
4	Shark fish (Mori)	0	12	6	9	2	7	2	0	1
5	Seer fish (Wiswan)	81	98	114	14	14	23	3	5	2
6	Prawns (Sungtam)	1811	2312	1539	39	203	30	10	36	17





7	Pomfrets (Pap let)	102	18	120	2	5	76	0	0	0
8	Cuttle fish (Manki)	622	192	88	24	11	5	6	4	5
9	Tuna(Bokdo)	473	29	469	0	1	0	0	0	9
10	Ribbon fish (Balle)	119	18	80	0	2	0	0	0	0
11	Reef Cod (Gobro)	129	28	0	4	3	0	1	1	0
12	Kowalakowal (Velli)	177	45	13	14	5	0	2	21	0
13	Golden Anchovy (Kapsale)	0	0	26	2	0	0	0	0	0
14	SilverBelly (kampi)	1125	292	501	56	36	87	14	42	7
15	Soles(Lepo)	651	510	357	44	45	74	6	2	14
16	Silver Bar (karli)	0	7	41	0	_	4	0	_	0
17	Crabs (kurlio)	268	281	145	18	13	75	7	5	14
18	Sciaenoids (Dodiaro)	343	495	201	45	32	51	14	3	1
19	Butter fish (Soundale)	160	274	158	18	28	51	7	0	1
20	Lady fish	0	0	8	0	0	0	0	0	0
21	Mullet	0	0	9	0	0	7	0	0	2
22	Carnix	0	0	2	0	0	6	0	0	0
23	Perches	0	0	0	0	0	2	0	0	0
24	Lobster	0	0	0	0	0	0	0	0	1
25	Thresdfin	0	0	17	0	0	0	0	0	0
26	Others	1188	1032	716	80	107	102	47	203	40
	Total	7392	14528	19191	369	987	3023	2160	508	2161

Source: Department of Fisheries, Government of Goa, Goa.

Table 3.44: Fish Catch at different Fish Landing Centers of North Goa (Unit: in tonnes)

S.	Species	Siridao		Nauxi		Dauna Paula	
Ν.		2013	2014	2013	2014	2013	2014
1	Mackerals(Bangdo)	31	50	17	32	50	68
2	Sardines(Tarlo)	39	91	32	52	65	99
3	Catfish(Sangot)	5	6	0	8	2	2
4	Shark fish(Mori)	0	1	0	0	0	1





S.	Species	Sir	idao	Na	auxi	Dauna Paula	
Ν.		2013	2014	2013	2014	2013	2014
5	Seer fish(Wiswan)	0	1	0	0	0	0
6	Prawns(Sungtam)	21	42	27	50	67	89
7	Pomprets(Pap let)	0	1	0	0	0	2
8	Cuttle fish (Manki)	0	2	2	7	4	6
9	Tuna(Bokdo)	0	1	0	0	0	0
10	Ribbon fish (Balle)	0	0	0	0	0	0
11	Reef Cod (Gobro)	0	5	2	0	2	3
12	Kowalakowal(Velli)	15	56	22	21	32	41
13	Golden Anchovy	0	0	1	0	4	0
	(Kapsale)						
14	SilverBelly(kampi)	0	5	1	_	2	1
15	Soles(Lepo)	6	15	6	23	25	22
16	Silver Bar(karli)	0	2	4	3	11	2
17	Crabs (kurlio)	7	45	33	52	28	47
18	Sciaenoids(Dodiar	1	35	3	6	7	27
	0)						
19	Butter fish	0	0	0	4	1	0
	(Soundale)						
20	Others	47	68	38	63	76	78
	Total	2185	426	2201	321	2389	488

Source: Dapartment of Fisheries, Government of Goa

Fisherman Population

The project study area consists of 10 fishing vailages, of which 4 villages falls in Mramugao and 6 villages are in Tiswadi Taluka. As per the Marine Fisheries cencus 2010 (Goa) Published by Ministry of Agriculture & CMFRI, total of 405 fishermen families are registered in the study area. The study area has a total 2274 fishermen population. A Population of fisherman in the study area Taluka is given in Table 3.45.

S.No	Name of Village	Fishermen Families	Traditional Fishermen Families	Fisherfolk population
	Taluk:Marmagoa			
1	Vasco-Da-Gama	45	45	262
2	Baina	71	69	421

	Table 3.45:	Fishermen	population	in	the study	area
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S.No	Name of Village	Fishermen	Traditional	Fisherfolk
		Families	Fishermen Families	population
3	Bogmalo	23	15	109
4	Velsao	66	66	348
	Taluk: Tiswadi			
5	Caranzalem	20	20	100
6	Dona-Paula	20	20	98
7	Nauxi	19	19	86
8	Odxel	26	26	155
9	Siridona	90	90	548
10	Agassaim	25	25	147
	Total	405	395	2274

Source: Goan fish trails, Volume-III-2016, Dept. of Fisheries, Government of Goa.

3.20 ARCHEOLOGICALLY IMPORTANT SITES

The project area has several archeologically important monuments protected under the international conventions, national or local legislation. Several churches and forts of archaeological and historical importance are located in the study area are and some of them are protected and /or world heritage centers site. Status of the important forts and church located in the study area are summerised in following section:

Mormugoa Fort, Vasco

Mormugao Fort was build in 1624, was considered as one of the major costal forts in Goa. The fort is located to the north of Vasco Da Gama town and south of Murmogao Port. The Mormugao Fort covered a total region of six miles in circumference, contained towering bulwarks, three magazines, five prisons, a chapel and quarters for the guard. It had 53 guns and a garrison with 4 officers, and was an important fortress on the western coast. A coastal fort, sprawled over 6 miles, built by the Portuguese in 1624 solely to offer them supremacy against marine attacks, Mormugao Fort is today situated among some of Goa's most visited tourist attractions like Varca Beach.





Church of Our Lady of Rosary (1542-1549), Old Goa

This Church built in Manueline style on the holy hill, located approximately 9.5 kms form the present project site. There are two chapels and three altars with the main altar dedicated to Our Lady of Rosary.

REIS Magos Fort, Bardez

This fort was built on the banks of the Mandovi river, located about 12 kms from the project site. The Reis Magos Fort was converted to a sub-jail to lodge short term convicts. It was also used to lodge freedom fighters working for the liberation of Goa, when the movement intensified in 1950's . The Fort functioned as jail till 1993 and during this period a number of modifications were carried out.

In 2007, a tripartite agreement was signed between the Govt of Goa, INTACH and the Hamlyn Trust to restore and re-sue the fort as a Cultural Centre. The restoration was sponsored by the HHT. Fort was thrown open on 5th June 2012.

Our Lady of Exile Church, Desterro

A primitive chapel dedicated to St Thomas was built in 1672 in Desterro, Goa. This Chapel to St Thomas was then replaced with the present chapel dedicated to Our Lady of Exile at Desterro also called 'Nossa Senhora do Desterro, Goa' in Portuguese which was affiliated to the St Andrew's Parish in Vasco. In January 1997, the new parish was created of Our Lady of Exile Church, Desterro, Goa.

Aguada Fortress (Upper), Condolim

The fort Aguada built of laterite stone in 1512 comprises a lower fortification with bastions all around and an upper fort. The fort besides offering a safe berth to Portuguese ships was also their water storing point since the place had a perennial water supply. The word Aguada in Portuguese means a watering place. This fort is located around 9 km from the present project site.

Fortification Wall of Aguada Fortress (Lower), Condolim

Fortification wall of aguada fortress was built in 1612 by Portuguese and overlooking the Arabian Sea. It serves as a place for watering to Portuguese Armadas and a point for keeping close watch on intruders entering into the





Mandovi River. It has one bastion protruding towards the sea and four smaller bastions at different intervals. Fortification wall is around 9 KM from the present project site.

Our Lady of Health Church, Sancole

Our Lady of Health Church at Sancoale is located about 12 km from the project site. This church is also known as Nossa Senhora de Saude Church. Today only a part of the church's facade stands on the banks of the Zuari River. The erstwhile Portuguese Government had declared it a national monument on 19.3.1937. The Patron of Goa Blessed Joseph Vaz wrote his famed "Letter of Bondage" at this church in 1677.

Ruins of Shanta Durga Temple, Salcete

Ruins of Shanta Durga Temple, Salcete is located about 11km from project location. The original temple at Quelossim (Keloshi) in Salsete was destroyed by the Portuguese in 1564. The goddess was transferred to Kavalem and worship was continued there.

Ruins of Manguesh Temple, Cortalim, Salcete

The 18th century, Shri Mangesh Temple, lies on the north west of Ponda in Priol. Considered to be the most important temple in Goa, it belongs to the typical Goan Hindu temple style of architecture. This picturesque little temple is built on a hilltop amidst sprawling farmlands. The temple has shrines of Parvati (consort of Shiva – Destroyer of the Universe) and Ganesha (the elephant-god of Prosperity and Wisdom). Most of the Goan temples are noted for their chiseled architecture and their distinctive style.

British Cemetry at Dona Paula, Panaji

The British Cemetery is situated at a distance of 5 km from the study area. It was built around the year 1802 by the British, It is considered to be more than 180 years old and is the the only remnant of the British occupation of the territory of Goa during the Napoleonic period wars from 1799 to 1813 to prevent Goa from falling into the hands of the French The cemetery has 56 gravestones of sepulchral





relics and 47 well preserved tombs are found at the site, The tombs date from 1808 and to 1912.

Ruins of Kaivalya Math at Consua, Cortalim

There are two caves scooped in Laterite. It might have been used for meditation.

3.21 SENSITIVE INSTALLATIONS

3.21.1 Defense Installations

Defence installations situated within 5 Km from the proposed project location are listed below:

INS Hansa, is military airbase and operates from Dabolim Airport.

INS Mandovi is located along the banks of Mandovi river in Panaji. It was established as a Sailors Training Establishment in 1976. The National Defence College at INS mandovi aims to impart training in national and international security to select senior Civil and Defence Officers.

INS Gomantak caters to the logistics and manitanence support.

INHS Jeevanti is the naval hospital located in Vasco-da-gama

Goa Shipyard Limited designs and builds sophisticated ships for Navy and Coast Guard with the aim of achieving self-sufficiency in this vital technology.

It also builds commercial vessels like Offshore Supply Vessels, Oceanographic and Coastal Research Vessels, Fishing Vessels, Dredgers, Tugs, etc. Apart from shipbuilding it also carries out ship repairs and promotes use of indigenous equipment such as computers, radar, communication equipment, auxiliary machinery, electrical fittings and domestic equipment.

Signal Training Centre (HQ 2), comprises of a headquarters, a military training regiment and technical training regiments. This centre is the largest military establishment in the state of Goa and the only local services establishment available for aid to the civil power.

3.21.2 Densely Populated / Builtup Area / Educationoal Institutes

The headland sada and Vasco are situated beside the Murmugoa Port Trust and has a densely populated builtup area. The area also houses the MPT colonies and hospital run by the MPT. The Murmugao Municipal Corpporation comprises of the





areas of Vasco and Sada. Panajim and Sridao are the other densly populated areas with in 15 km from the proposed project. The total population with in the 15 km radius of the proposed project site as per Census of India 2011 is of the order of 2,67,477.

NIO is an important establishment located at about 5 km from the proposed project site located. NIO established over 40 years has grown into a large oceanographic laboratory of international repute focusing on the understanding of special oceanographic features of the Northern Indian Ocean.

The other organisations of importance within the study area are National Centre for Antarctica and Ocean Research (NCAOR), District Jail, Central warehouse, Indian Maritime Institue. There are schools, colleges and other educational institutions in the study area.

The cemeteries of importance within the 15km radius are Talegoa Church Cemetery, St. Andrews Church Cemetery, Murumugoa Cemetery, British Cemetery Sinquerim Cemetery, Vasco District cemetery. Apart from the above mentioned built up areas there a lot of places of worship and commercial centeres that includes the trourist homes, Hotels, Lodges and other State and private offices. The area is well connected by roads and railways.

3.21.3 Hospitals

The important hospitals located within 15 km area includes the Goa Medical College Cum Hospital, SMRC's V M Salgaocar Hospital, Mormugoa Port Trust Hospital, Chicalim Cottage Hospital.

Goa Medical College

Goa Medical College is the successor of the 'Escola Medico Cirungica de Goa' established by the Portuguese in the year 1842. In the year 1963, this Medical School was upgraded as Goa Medical College, attached to the Bombay University and later in the year 1983 affiliated to Goa University. This is one of the prestigious institution of the country, recognized by the Medical Council of India, admits 100 students for undergraduate M.B.B.S. Course, while 72 Post-Graduate are





admitted every year. The Goa Medical College Hospital were initially operating from Panaji and Ribandar, shifted to Bambolim in the year 1991, has presently 1000 beds, whereas 80 bedded TB and Chest Disease Hospital functions from St.Inez, Panaji. Similarly, a 20 bedded Rural Health and Training Centre is situated in Mandur. The entire complex at Goa Medical College, Bambolim is spread in an area of 11,34,798 Sq Mts.

SMRC's V M Salgaocar Hospital, 118 bedded multi-specialty hospital with a 50 bedded Cardiology Department including CCU, Non-Invasive and Invasive Setup.

Chicalim Cottage Hospital

The Cottage hospital is one of the six maor hospitals of Directorate of helath services, Governemnt of Goa. The Cottage Hospital, serves as referral Hospital.

Mormugoa Port Trust Hospital

Mormugao Port Trust has its own 100 bedded hospital, having fully equipped indoor and outdoor departments at Headland and first Aid Centres at Mormugao Harbour, MPT Workshop and at MOHP area. Medical facilities in the disciplines of General Medicine, General Surgery, Obstetrics & Gynecology, Pediatrics, Ophthalmology and Dentistry are available to the employees and their dependents. These are further supported by other Anesthesiology, Pathology, Radiology, Orthopedics. The hospital has also extended medical facilities of Ayurvedic and Homeopathic treatment to the employees and their families. Whenever necessary, arrangements for external specialist consultations/ referral are made in the interest of the patient. Apart from medical officers, the hospital is enriched with qualified and experienced nursing personnel and paramedical staff.

Chicalim Cottage Hospital

The Cottage hospital is one of the six maor hospitals of Directorate of helath services, Governemnt of Goa. The Cottage Hospital, serves as referral Hospital. The primary health care infrastructure has been developed as a three tier system such as Sub-Centres, Primary Health Centres and Community Health Centres. Sub-Centre is the most peripheral contact point between the Primary Health Care





System and the community and is manned generally by Multi-Purpose Health Workers (Male & Female) and a Peon/Attendant. Primary Health Centre is manned by a Medical Officer supported by para-medical and other staff. Some of the PHCs (minimum 12 in number) have attached hospitals ranging with 12 to 30 beds and are headed by a Health Officer. The details of Health Centers in the study area rae given in Table 3.46.

S. No.	Name of Taluka	Urban Health Centres	Primary Health Centres	Sub-centres
1	TISWADI	Urban Health Centre, Panaji	P. H. C, Corlim	 Batim Taleigao (Borbot) Taleigao (St. Paul) Goltim (Divar) Merces Ella Siridao Bambolim
2	MORMUGAO	Urban Health	P. H. C, Cansaulim	 Seraulim Betalbatim Benaulim-cana Benaulim Benaulim Arossim Majorda Velsao
		Center, Vasco	P. H. C, Cortalim	 Verna Naquelim Chicalim Consua Sindolum (Sancoale) Quelossim

Table 3.46: List of Health centers in the study area

The above table gives the details of the list of health centers that the public of the study area have access to. There are 2 Urban health centeres, 3 Primary health centers and 20 sub centers that are mainteained by the Goa State government.





3.21.4 Liquid Cargo Handling at MPT

Apart from bulk cargo and containers, Mormugao Port also handles various liquid cargo at other berths, which includes the petroleum products, edible oil, chemicals and liquid ammonia. However, the tankage area is away from the operational area of the terminal.

3.22 SOCIO-ECONOMIC STATUS

The aim of the socio-economic study is to assess the overall impact on various facets of socio-economic environment due to establishment of the project in the Study Area Villages. The present chapter outlines baseline socio-economic scenario of the study area villages. The study area (10 km radius around the proposed project area) is spread over in SubdistrictTiswadi and Murmagao of North and South Goa districts. The information presented in this chapter has been mainly extracted from Primary Census Abstract 2011. The following sections outline the socio-economic profile of the study area villages.

3.22.1 Demographic Profile

The study area comprises of 22 settlements. The total population in the study area settlements is of the order of 276038 persons residing in 65320 households as per Census of India 2011. The distribution of population and demographic profile of study area settlements is outlined in Table 3.47 and depicted in Figure 3.22.

S.No	Settlement Name	Total Households	Total Population	Total Male	Total Female	Population<6 years	Sex Ratio	Average
	District North Goa							
	Subdistrict Tiswadi (A)							
1	Batim	356	1489	739	750	132	1015	4
2	Curca	560	2518	1232	1286	256	1044	4
3	Siridao	578	2417	1179	1238	218	1050	4
4	Panaji (M Corp. + OG)	17807	70991	35988	35003	6180	973	4





S.No	Settlement Name					10		
		splor	tion	1ale	emale	tion<6	tio	e
		al useh	al oula	al N	al Fo	oula	c Rat	erag
		Tot Hoi	Tot Poj	Tot	Tot	Pol	Sex	Ave
5	Morambi-O-Grande	386	1523	768	755	139	983	4
	(Merces) (OG) WARD							
	NO0032 (Rural MDDS							
	CODE:626737)							
6	Renovadi (OG) WARD	125	500	259	241	42	931	4
	NO0033 (Rural MDDS							
	CODE:626738)							
7	Cujira (OG) WARD NO	296	1229	601	628	122	1045	4
	0035 (Rural MDDS							
	CODE:626740)							
8	Taleigao (OG) (Part)	6003	24201	12402	11799	2356	951	4
	WARD NO0036 (Rural							
	MDDS CODE:645598)					100		
9	Durgawadi (OG) (Part)	388	1610	830	780	180	940	4
	WARD NO0037 (Rural							
10	MDDS CODE:645599)	1000	7517	200	2010	700	1022	4
10		1803	/51/	3699	3818	/82	1032	4
11	Calapor (CT)	3514	14077	/118	6959	1443	978	4
12		1105	0885	4812	2073	525	431	6
15		24026	4322	71756	2193 67522	427	041	4
	Subdist Mormugao (B)	54050	139279	/1/50	07525	12002	941	4
14	Dabolim	1433	6027	3142	2885	699	918	Δ
15	Sao Jacinto Island	48	195	104	91	16	875	- - Д
16	Cuelim	430	1777	839	938	173	1118	4
17	Pale	473	1990	1010	980	202	970	4
18	Issorcim	189	841	434	407	61	938	4
19	Chicolna	669	2680	1350	1330	274	985	4
20	Mormugao (M Cl)	21524	94393	49633	44760	10025	902	4
21	Chicalim (CT)	1483	6933	3921	3012	618	768	5
22	Sancoale (CT)	5035	21923	11657	10266	2693	881	4
	Subtotal (B)	31284	136759	72090	64669	14761	897	4
	Total(A+B)	65320	276038	143846	132192	27563	919	4

Source: Primary Census Abstract, 2011.



Figure 3.22: Demographic profile of study area

The male and female population in study area settlements comprises about 52.11% and 47.89% respectively of the total population. The population comprising of children below the age of 6 years accounts for about 9.9% of the total population in the study area settlements. The sex ratio (no. of females per 1000 males) and average family size in the study area settlements is 919 and 4 persons per family respectively.

3.22.2 Caste Profile

The caste wise distribution of population in study area settlements on the basis of caste is summarized in Table 3.48 and depicted in Figure 3.23. The General Caste is the dominant caste in the study area accounting for about 92.50% of the total population followed by Schedule Tribes, which account 5.31% of the total population. Schedule Castes account for only 2.19% of the total population of study area settlements.

S. No	Settlement Name	Total Population	Schedule Caste	Schedule Tribe	General Caste
	District Goa				
	Subdistrict Tiswadi				
1	Batim	1489	12	21	1456
2	Curca	2518	11	497	2010
3	Siridao	2417	0	1265	1152
4	Panaji (M Corp. + OG)	70991	1707	4586	64698

Table 3.48: Caste profile of study area





S.		Total	Schedule	Schedule	General
No	Settlement Name	Population	Caste	Tribe	Caste
	Morambi-O-Grande (Merces)				
_	(OG) WARD NO0032 (Rural	4500	_		4540
5	MDDS CODE:626737)	1523	5	0	1518
	Renovadi (OG) WARD NO				
6		500	4	2	407
0		500	1	2	497
7	Cujira (OG) WARD NO0035	1000	1	1	1004
/	(Rufal MDDS CODE:626740)	1229	4	I	1224
0		24201	1007	2860	20225
0	CODE.040090)	24201	1097	2009	20235
	NO 0027 (Bural MDDS				
a	$CODE \cdot 645599$	1610	20	25	1556
10	Murda (CT)	7517	23	20	7122
10		14077	407	1011	12/20
10	Calapol (CT)	6995	427	920	12439 5074
12		0000	172	039	0074 4400
13		4322	20	110	4100
		139279	3000	11/40	123907
		0007	05	0.07	5055
14	Dabolim	6027	65	307	5655
15	Sao Jacinto Island	195	0	0	195
16	Cuelim	1777	2	841	934
17	Pale	1990	6	76	1908
18	Issorcim	841	4	5	832
19	Chicolna	2680	45	376	2259
20	Mormugao (M CI)	94393	2161	480	91752
21	Chicalim (CT)	6933	76	234	6623
22	Sancoale (CT)	21923	114	597	21212
	Subtotal(B)	136759	2473	2916	131370
	Subtotal(A+B)	276038	6039	14662	255337

Source: Primary Census Abstract, 2011.



Figure 3.23: Caste profile of study area

3.22.3 Literacy Levels

The details of literate and illiterate population amongst the total population of study area settlements are shown in Table 3.49. It is observed that about 81.62% of the total population in the study area settlements is literate, while about 18.38% are illiterate. The male and female literacy rate of the study area settlements is 84.53% and 78.45% respectively (Figure 3.24).

Table 3.49: Educational	profile of	study area	population
-------------------------	------------	------------	------------

S.	Village Names			te			ate	
N 0.		ion	ion	era		ion	tera	
•		al ulat	ulat rate	e Lit	nale rate	ulat erate	e III:	nale erate
		Tot: Pop	Pop Lite	Malo	Fer Lite	Pop Illite	Mal	Fer Illite
	District North Goa							
	Subdistrict Tiswadi (A)							
1	Siridao	2417	1786	929	857	631	250	381
2	Panaji (M Corp. + OG)	70991	60071	31090	2898	1092	4898	6022
					1	0		
3	Cujira (OG) WARD NO	1229	1033	516	517	196	85	111
	0035 (Rural MDDS							
	CODE:626740)							
4	Taleigao (OG) (Part)	24201	19755	10441	9314	4446	1961	2485
	WARD NO0036 (Rural							
	MDDS CODE:645598)							
5	Durgawadi (OG) (Part)	1610	1345	710	635	265	120	145
	WARD NO0037 (Rural							
	MDDS CODE:645599)							





S.	Village Names			e			te	
N O.		ion	ion	erat		ion	tera	
		l ulat	ulat ate	, Lit	ale ate	ulat rate	illi i	ale rate
		ota	opu	/lale	iter.	opu	lale	-em Ilite
6	Murda (CT)	7517	6117	2 3066	3051	1400	∠ 633	 767
7	Calapor (CT)	14077	11628	6043	5585	2449	1075	1374
8	Bambolim (CT)	6885	5971	4362	1609	914	450	464
9	Goa Velha (CT)	4322	3473	1779	1694	849	350	499
	Subtotal (A)	133249	111179	58936	52243	22070	9822	12248
	District South Goa							
	Subdistrict Mormugao							
1	Dabolim	6027	4739	2550	2189	1288	592	696
2	Issorcim	841	718	383	335	123	51	72
3	Chicolna	2680	2117	1127	990	563	223	340
4	Mormugao (M CI) WARD NO0001	3659	3433	2379	1054	226	104	122
5	Mormugao (M CI) WARD NO0002	2518	2136	1127	1009	382	166	216
6	Mormugao (M CI) WARD NO0003	3071	2547	1355	1192	524	211	313
7	Mormugao (M Cl) WARD NO0004	3852	3228	1828	1400	624	288	336
8	Mormugao (M Cl) WARD NO0005	4462	3488	1949	1539	974	407	567
9	Mormugao (M Cl) WARD NO0006	4059	3361	1715	1646	698	324	374
10	Mormugao (M Cl) WARD NO0007	3428	2348	1348	1000	1080	466	614
11	Mormugao (M Cl) WARD NO0008	4791	3384	1893	1491	1407	587	820
12	Mormugao (M Cl) WARD NO0009	5507	4468	2448	2020	1039	448	591
13	Mormugao (M Cl) WARD NO0010	4387	3688	1956	1732	699	284	415
14	Mormugao (M Cl) WARD NO0011	1954	1708	882	826	246	106	140
15	Mormugao (M Cl) WARD NO0012	3897	2841	1565	1276	1056	447	609
16	Mormugao (M Cl) WARD NO0013	4175	3453	1894	1559	722	303	419
17	Mormugao (M Cl) WARD NO0014	4103	3501	1839	1662	602	260	342
18	Mormugao (M Cl) WARD NO0015	5661	3901	2290	1611	1760	768	992
19	Mormugao (M Cl) WARD NO0016	5171	4191	2249	1942	980	462	518





S. N o.	Village Names	Total Population	Population Literate	Male Literate	Female Literate	Population Illiterate	Male Illiterate	Female Illiterate
20	Mormugao (M Cl) WARD NO0017	6061	4736	2558	2178	1325	592	733
21	Mormugao (M Cl) WARD NO0018	11104	9056	4755	4301	2048	999	1049
22	Mormugao (M Cl) WARD NO0019	4517	3669	1948	1721	848	364	484
23	Mormugao (M Cl) WARD NO0020	8016	6931	3570	3361	1085	499	586
24	Chicalim (CT)	6933	5886	3478	2408	1047	443	604
25	Sancoale (CT)	21923	16656	9429	7227	5267	2228	3039
	Subtotal (B)	132797	106184	58515	47669	26613	11622	14991
	Total (A+B)	266046	217363	117451	99912	48683	21444	27239

Source: Primary Census Abstract, 2011.



Figure 3.24: Literacy profile of study area population

3.22.4 Occupational profile

The details on occupational profile in the study area settlements are given in the Table 3.50. It is observed that 41.59% of the total population is engaged in some form of economically productive activity or vocational activity, and have been designated as Total Working population. On the other hand, Non-workers or persons who are dependent on the population, which is engaged in economically productive work accounts for about 58.41% of the total population. Among the





population that is working about 89.47% has been designated as Main workers while the remaining 10.53% has been designated as Marginal workers. In main working population Main worker Cultivators are 1.40%, Main Worker Agricultural Labour 0.49%, Main Workers Household Industry 1.29% and Main Workers Other 96.82%. The occupational profile is depicted in Figure 3.25.



Figure 3.25: Occupational profile of study area population





Table 3.50: Occupational profile o the study area population

S. No	Settlement Name		ulation		ators	culture		r			al		rkers	lation
		Total Population	Total Working Popu	Main Workers	Main Worker Cultiv	Main Workers Agric	Main Workers Households	Main Workers Othe	Marginal Workers	Marginal Workers Cultivator	Marginal Agricultur Labour	Marginal Workers Household	Marginal Other Wor	Non-Working Popu
Sub	district Tiswadi	4.400	400	0.47	10	0		070				-	50	4007
1	Batim	1489	422	347	42	3	26	276	75	6	6	5	58	1067
2	Curca	2518	925	877	58	9	6	804	48	3	6	1	38	1593
3	Siridao	2417	867	676	69	13	15	579	191	14	11	3	163	1550
4	Panaji (M Corp. + OG)	70991	30220	27709	206	77	299	27127	2511	57	43	125	2286	40771
5	Morambi-O-Grande (Merces) (OG) WARD NO 0032 (Rural MDDS CODE:626737)	1523	594	540	1	0	1	538	54	5	1	0	48	929
6	Renovadi (OG) WARD NO0033 (Rural MDDS CODE:626738)	500	186	168	0	2	2	164	18	1	0	0	17	314
7	Cujira (OG) WARD NO 0035 (Rural MDDS CODE:626740)	1229	481	409	5	2	7	395	72	2	2	3	65	748
8	Taleigao (OG) (Part) WARD NO0036 (Rural MDDS CODE:645598)	24201	10437	9582	67	36	111	9368	855	19	22	63	751	13764
9	Durgawadi (OG) (Part) WARD NO0037 (Rural MDDS CODE:645599)	1610	645	597	3	0	4	590	48	1	0	0	47	965





S. No	Settlement Name	Total Population	Total Working Population	Main Workers	Main Worker Cultivators	Main Workers Agriculture	Main Workers Households	Main Workers Other	Marginal Workers	Marginal Workers Cultivator	Marginal Agricultural Labour	Marginal Workers Household	Marginal Other Workers	Non-Working Population
10	Murda (CT)	7517	3015	2626	14	14	74	2524	389	8	3	21	357	4502
11	Calapor (CT)	14077	5743	5239	46	28	87	5078	504	10	9	24	461	8334
12	Bambolim (CT)	6885	4429	4252	33	4	8	4207	177	2	14	3	158	2456
13	Goa Velha (CT)	4322	1771	1506	29	21	137	1319	265	12	19	2	232	2551
	Subtotal (A)	139279	59735	54528	573	209	777	52969	5207	140	136	250	4681	79544
Sub	district Mormugao													
14	Dabolim	6027	2563	2434	174	19	34	2207	129	15	21	4	89	3464
15	Sao Jacinto Island	195	54	52	6	0	0	46	2	0	1	1	0	141
16	Cuelim	1777	673	613	71	103	14	425	60	7	13	1	39	1104
17	Pale	1990	701	585	46	14	11	514	116	3	64	1	48	1289
18	Issorcim	841	359	354	28	0	16	310	5	0	0	0	5	482
19	Chicolna	2680	1032	937	68	5	41	823	95	13	5	4	73	1648
20	Mormugao (M Cl)	94393	36929	32208	415	114	343	31336	4721	88	33	158	4442	57464
21	Chicalim (CT)	6933	3438	3201	20	5	35	3141	237	13	16	6	202	3495
22	Sancoale (CT)	21923	9310	7795	41	36	53	7665	1515	38	66	48	1363	12613
	Subtotal (B)	136759	55059	48179	869	296	547	46467	6880	177	219	223	6261	81700
	Total (A+B)	276038	114794	102707	1442	505	1324	99436	12087	317	355	473	10942	161244

Source: Primary Census Abstract, 2011.





3.22.5 Major Diseases reported in MPT Hospital

Information on the common diseases reported in the MPT hospital from 2010 to 2015 was collected. The most common diseases are Head Trauma (HT), followed by GF. The details of the cases registered for various diseses are given in Table 3.51.

3.23 TOURISM

Tourism is one of the dominant industries of Goa. North Goa beaches act as the major tourist destination and maximum hotels are located there. There are a lot of tourist desitnation in and around the study area includes various beaches, monuments of archeological importance etc. Some of the beaches includes Caranzelm beach, Donna Paula view point, Bambolim beach, Bogmalo beach, Baina beach, and salcete beach. The other destination in the study area is the Naval aviation meseum, Murmugoa Fort, Aguda Fort, the grande Island, Dr. Salim Ali bird sanctuary etc.





Table 3.51: Major Disease recorded in MPT Hospital (2010 to 2015)

Year	HT	IHD	CVA	Asthma	COPD	ALD	GF	Renal	PSY	Malaria	Dengue	Chikungunya	Enteric Fever	Others
2010 - 2011	303	23	10	23	76	32	144	12	-	16	26	42	17	465
2011 - 2012	327	12	2	19	70	37	100	5	1	20	1	6	4	407
2012 - 2013	225	37	21	25	46	52	149	11	21	11	1	21	8	607
2013 - 2014	215	28	11	8	52	24	111	3	2	15	-	15	-	386
2014 - 2015	212	18	6	10	62	29	77	3	2	4	-	4	-	301





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Chapter 4.0 IMPACT ASSESSMENT & MITIGATION MEASURES

4.1 INTRODUCTION

This chapter identifies environmental, social and health impacts and mitigation measures associated with the project implementation and operation of activity with the proposed modernization and consequential capacity enhancement at the terminal. For each aspect, the section identifies and describes both generic and specific potential impacts that might arise as a result of the project's implementation and operations.

The project does not involve with potential construction works. The major activities will include the enhancement of material handling systems, and storage of raw materials, if necessary.

Potential sources of environmental impact from operations may include shipping movements, discharge of wastewater and solid waste, accidental spillage, cargo unloading/loading and storage, noise pollution, air pollution due to material transfer and handling.

In view of the above, we analyze the likely environmental impacts in two phases of the project to suggest the mitigation measures;

- Implementation phase, and
- Operation phase

4.2 IMPACTS DURING IMPLEMENTATION PHASE

Various Impacts during the implementation phase of modernisation of the terminal were observed and adequate mitigation measures are suggested for the same.

4.2.1 Water Environment

Water shall not be abstracted from any surface or ground water body in the implementation phase of the project. No existing resources/water sources





(surface/groundwater), which are currently being used by the villagers for the purpose of obtaining drinking water and/or water for irrigation or other purposes.

Impacts on Water Quality

The total number of work force proposed to be deployed during the project implementation is very small and the proposed project is located within the Mormugao Port. The labourers will be coming from nearby areas and no labour camps are proposed at the project site. Thus, considering the location of the project, labour population involved in the project implementation activities shall use the existing sanitation facilities of Mormugao Port. There is an existing sewage handling facilities in operation at the Mormugao Port, which can handle the additional inputs due to the proposed modernization facilities in the port.

The only impacts envisaged on the surface and ground water quality of the area, during implementation phase is the accidental spillage of oil or fuel from machinery that may run off into near-by surface and groundwater water bodies and/or uncontrolled liquid effluents from the project implementation site.

Mitigation Measures

- Wastewater from the washing and other project implementation activities shall be treated accordingly and reused.
- Local people will be employed; hence, no labour camps will be required on the site.
- Workers shall use the existing toilets at the site.
- No additional waste water discharge or solid waste generation during the implementation phase is envisaged.

4.2.2 Biological Environment

Impact on Terrestrial Ecology

There is a built-up area in the headland Sada which has a dense population. The present project does not envisage any land acquisition or clearing of vegetation. The project is proposed within the existing facility only, thus, no immediate impact on terrestrial ecology and environment is envisaged. Dr. Saliim Ali Wild life





sanctuary is about 12.5 km from the project location. However, there is no anticipated impacts due to modernization of the terminal.

Mitigation Measures

- No terrestrial vegetation is envisaged to be cleared for the project implementation.
- Necessary material handling systems will be erected within the footprint of the project site.

Impact on Freshwater Biology

The erection of material handling systems will not have any impact on the freshwater bodies considering its location and operational philosophy. Hence no mitigation measures are required.

Impact on Marine Biology

The proposed project envisages modernization of material handling systems at the terminal. Proposed project does not involve dredging, reclamation and construction in the sea, as the entire facility will be within existing terminal area. There is no need of construction of new roads, and additional land acquisition for the proposed development is not envisaged. Dredging of channel for cape size vessels is not part of the proposed project. Hence, no significant impact is anticipated due to the proposed project on marine environment.

Mitigation Measures

- As a general rule, the developer will ensure that untreated effluents are not discharged into the marine environment.
- There will be no disposal of unused material into the sea. Thus the impact on ecology is temporary and reversible.

Impact on Mangroves ecosystem

The present project does not envisage any new construction hence there will not be any change in the land use pattern.





Mitigation Measures

The mangroves are present in the intertidal regions of the Rivers Mandovi and Zuari. This is almost 7 to 9 Kms from the proposed project location. The main stress for the mangroves is from deforestation and trawl nets and drag nets that have been a main reason for wiping off the newly germinating mangroves.

Though there is no impact due to the present project on the mangroves, as a part of the CSR activities it is suggested to take up afforestation with consultation of the forest department. It is suggested to work with mangrove conservation agencies in replenishing the mangroves along the deltaic regions of River Mandovi. Thereby, afforestation of the mangroves will also help in reducing the stress of declining biotic growth in the system due to various anthropogenic pressures.

Impact on corals ecosystem

The corals are primarily found in the area adjacent to the Grande Island. There is no development on the water front in the present project. Hence there will be no impact due to the mechanization/ modernization of the berths.

The Chicalim Bay is found to be a host of a wide variety of marine biota including the *Placuna placenta* or popularly called the windowpane oyster. However, it is not in the vicinity of the proposed project though it falls under the study area. Therefore, there will not be any impact on the Chicalim Bay or the biota present in the Bay due to this modernization project.

4.2.3 Land Environment

Impact on Land use/Landscape

The proposed project site is located within SWPL area and does not envisage the change in land use. The proposal does not involve with potential construction activities at the site, except construction of foundation for the installation of cargo handling equipments. Hence, no major impact is anticipated on land use during the project implementation phase.





Mitigation Measures

- All materials will be disposed as per the Goa State Pollution Control Board (GSPCB) norms.
- Land would be properly leveled, so that no isolated pools and puddles are created.

Impacts on Soil Quality

There is no major change is in the land use/landscape; hence no major impacts are anticipated on the soil quality. The waste generated will be reused for leveling and enrichment of land. Thus there will be no major impact on the soil quality during the project implementation phase.

Mitigation Measures

- Developer shall take adequate measures to prevent disposal of any waste generated which may contaminate the soil.
- Waste management plans as per the GPCB norms will be strictly followed to prevent spills and leakage into the soil.

4.2.4 Air Environment

Impacts on Ambient Air Quality

The major pollutant in the implementation phase is SPM being air-borne due to vehicular movement and operation of loading and unloading equipment. Vehicular movement and operation of DG Sets may generate pollutants such as NOx, CO and HC during project implementation. However, the requirement of construction material is very minimal in the proposed project. Hence, increase in gaseous and fugitive emissions would be very less and not expected to contribute significantly to the ambient air quality and will be within the prescribed limits for industrial regions.

Mitigation Measures

The following measures are suggested to control air pollution:

• Contractor will be responsible for maintaining properly functioning of equipments to minimize emissions.





- Equipment and vehicles will be turned off when not used for extended periods of time.
- Unnecessary idling of vehicles will be prohibited.
- Effective traffic management to be undertaken to avoid significant delays in and around the project area.
- Road damage caused by sub-project activities will be promptly attended to with proper road repair and maintenance work.
- Water sprinkling during the construction work.

Air Pollution control due to DG sets

The Central Pollution Control Board (CPCB) has issued emission limits for generators up to 800 KW. The same are outlined in Table 4.1, and are recommended to be followed during the project implementation phase.

Parameter	Emission limits (gm/kw hr)
NOx	9.2
HC	1.3
CO	2.5
PM	0.3
Smoke limit*	0.7

Table 4.1: Emission limits for DG sets prescribed by CPCB

Note: *Light absorption coefficient at full load (m⁻¹)

The above standard needs to be followed by the contractor operating the DG sets.

The other measures are recommended as given below:

- Location of DG sets and other emission generating equipment should be decided keeping in view the predominant wind direction so that emissions do not effect nearby residential areas.
- Stack height of DG sets to be kept in accordance with CPCB norms, which
 prescribes the minimum height of stack to be provided with each generator
 set to be calculated using the following formula:

H = h+0.2x √KVA





Where,

H = Total height of stack in metre

h = Height of the building in metres where the generator set is installed

KVA = Total generator capacity of the set in KVA

4.2.5 Noise Environment

Impacts on Noise Levels

The noise from equipments will be a temporary phenomenon. However, noise levels from equipments may result into significant impacts due to operation of several equipments at a time.

Noise levels from construction equipment are predicted at different distances and at terminal perimeter using random distribution of this equipment in the Jetty area. It is also assumed that only one-third of these equipment will be in operation and deployed at 200 m and beyond from the periphery of the terminal.

Ambient noise levels were found below the permissible limit both during day and night time. Present noise level has been determined for nearby areas. It is observed that the noise levels are well within the norms, but they observed to be slightly higher during peak hours. The temporary noise impacts in the immediate vicinity will be due to project implementation activity and vehicular movement.

Temporary impacts in the immediate vicinity along the sites due to noise generated from project implementation activities superimposed by existing vehicular noise are of utmost importance. The magnitude of impact will depend upon specific types of equipment to be used, the construction methods employed and scheduling of the work. Various mitigation measures and controls will be adopted for minimize noise levels.

The magnitude of impact will not be significant as the construction machinery employed will adhere to high quality, the vehicles such as trucks, dumpers, tempos etc. engaged will also be of good working condition (Euro II machines) so that impact due to noise is well within the permissible limits. The noise level likely to





generate during implementation activity will be in the range of 80 - 90 dB (A). These noise level generated from source will decrease with increase in the distance from the source because of the wave divergence. The decrease in noise level with the increase in distance follows the empirical formulae given below:

 $SPL2 = SPL1 - 20 Log_{10} (r2/r1)$

Where, SPL1 and SPL2 are the sound pressure levels at distance r1 and r2 respectively.

Considering the stationary construction equipment as point source strength of 90 dB (A) at a reference distance of 2 m, computed distances required to meet the permissible limits during the daytime for different land uses are mentioned in the Table 4.2.

Type of Land Use	Permissible Limits	Distance	
	(Day time)	Required (m)	
Residential	55 dB (A)	113 m	
Commercial	65 dB (A)	36 m	
Industrial	75 dB (A)	11 m	
Silence Zone	50 dB (A)	200 m	

Table 4.2: Permissible limits during daytime for different land uses

Mitigation Measures

The contractors will be required to maintain proper functioning of the equipment and comply with occupational safety and health standards. The equipments will be fitted with noise suppression devices and mufflers.

- Equipments shall be properly maintained and will be provided with mufflers.
- Staging of equipment and unnecessary idling of equipment within noise sensitive areas to be avoided whenever possible.
- Monitoring of noise levels will be conducted during the project implementation phase. In case noise levels are exceeding the predetermined acceptable noise levels contractor will stop the work and take necessary measures to minimise the noise levels.



The following Noise Standards for DG sets are recommended for the running of DG sets during the implementation:

- The maximum permissible sound pressure level for new diesel generator sets with rated capacity up to 1000 KVA shall be 75 dB(A) at 1 m from the enclosure surface.
- Noise from the DG set should be controlled by providing an acoustic enclosure or by treating the enclosure acoustically.
- Acoustic Enclosure should be made of CRCA sheets of appropriate thickness and structural/sheet metal base. The walls of the enclosure should be insulated with fire retardant foam so as to comply with 75 dBA at 1m sound level specified by CPCB.
- Acoustic enclosure/acoustic treatment of the room should be designed for minimum 25 dB(A) Insertion Loss or for meeting the ambient noise standards, whichever is on the higher side.
- DG set shall also be provided with proper exhaust muffler.
- Proper efforts to be made to bring down the noise levels due to the DG set, outside its premises, within the ambient noise requirements by proper sitting and control measures.
- A proper routine and preventive maintenance procedure for the DG set shall be followed in consultation with DG set manufacturer which would help in reduction in noise levels of DG sets.

It is known that continuous exposure to noise levels above 90 dB(A) affects the hearing of the workers/operators and hence has to be avoided. Other physiological and psychological effects have also been reported in literatures, but the effect on hearing acuity has been specially stressed. To prevent these effects, it has been recommended by international specialist organizations that the exposure period of affected persons be limited as specified in Table 4.3.





Maximum equivalent continuous Noise level dB(A)	Unprotected exposure period per day for 8 hrs/day and 5 days/week
90	8
95	4
100	2
105	1
110	1/2
115	1/4
120	No exposure permitted at or above this
	level

Table 4.3: Maximum Exposure Periods specified by OSHA

4.3 IMPACTS DURING OPERATION PHASE

4.3.1 Water Environment

Impact on Ground water/Surface water Quality

During operation phase ground water quality may be affected as result of the seepage of waste water generated from dust suppression measures, domestic sources, and oil spills. However, this capacity enhancement project is not envisaged to affect the ground/surface water quality of the region.

Water Requirement

The water requirement for the port facility shall be made from the existing water supply of Mormugao Port and the additional water requirement shall be met from the treated water of CETP operated by PWD. The project does not involve any ground/surface water withdrawal from local resources. The details of the existing and proposed water consumption due to capacity enhancement at the terminal are given in Table 4.4.

Table 4.4: Water requirement at the port facility

Particulars	Existing in M ³ /day	Proposed in M ³ /day
A. TOTAL WATER	310	500
CONSUMPTION		
1) Domestic	10	20
2) Greenbelt/ Dust Suppression	200	380





Particulars	Existing in M ³ /day	Proposed in M ³ /day	
3) Fire Fight	100	100	
B. EFFLUENT GENERATED	1.0	4.0	
a) Biodegradable	1.0	4.0	
2) Domestic	1.0	4.0	
b) Non-Biodegradable	Nil	Nil	
2) Domestic	Nil	Nil	
C. LOSSES	209	396	
1) Domestic	9.0	16	
2) Green Belt	50	80	
4) Dust Suppression	150	300	

Mitigation Measures

The Port operations will ensure that there will be no impact on surface or groundwater quality in the region.

- The sewage likely to be generated shall be treated with existing sanitation facilities at SWPL.
- Domestic sewage shall be transferred to the existing sewage handling facilities in operation at Mormugao Port after primary treatment.
- Ships/barges will not be allowed to release any oily bilge waste or ballast water in the sea and hence wastes from the ships will also not affect any surface or groundwater quality.
- Any effluents from the Port which have leachable characteristics will be segregated and recycled/disposed as per CPCB guidelines.

On an overall analysis it may thus be concluded that surface or groundwater bodies will not be impacted during the Port operations.

Impacts on Marine water quality

The major quantity of liquid waste that would be generated in the normal day-today operations at the terminal includes domestic effluents, berth washings, runoff



(during monsoon) etc. These wastes have a potential to pollute marine water, if disposed untreated. The potential sources of impacts on marine water quality during the Port operations are:

- Disposal of Jetty related wastes
- Disposal of ship generated wastes
- Escapement of cargo, and
- Effluent from coal stack yard

Mitigation Measures

- All effluents are routed through a treatment plant/settling pond, as appropriate, can largely mitigate impacts from the effluent from domestic and day to day operations.
- Jetty operations would also produce solid waste such as garbage, debris, and left over plastic items, containers, etc. which if not properly disposed might influence the near shore areas. Approved dumpsites and recycling measures will be taken to responsibly dispose off other wastes.
- Effluent form coal stock yard would contain suspended solids. It is proposed to be treated in a settling tank. The sludge so produced will be mainly coal dust, which can be dried on sludge drying beds. The dried sludge, which has fuel value, can then be distributed amongst the villagers. During monsoon months, the sludge will be stored separately, in a structure with adequate storage capacity. The collected water can be reused sprinkling on coal stack yard. It would reduce the water demand for sprinkling.

The International Convention for the Prevention of Pollution from Ships, 1973, as modified by the protocol of 1978 (MARPOL, 73/78), has issued guidelines for prevention of Marine Pollution. These are listed in subsequent paragraphs and should be strictly adhered to for prevention of marine pollution.

• Ships/barges are prohibited to discharge oil or oily water such as oily bilge water containing more than 15 ppm of oil within 19 km (12 miles) of land.



- Chemicals are evaluated for environmental hazard which may cause environmental hazards if discharged into the sea (categories A, B, C and D). Discharge into the sea of the most harmful chemicals (category A) is prohibited. Tank washings and other residues of less harmful substances (categories B, C and D) may only be discharged keeping in mind certain conditions e.g. total quantity of discharge, distance from the shore, depth of water prescribed depending on the hazards. There are no restrictions on substances such as water, wine, acetone etc.
- Harmful substances in the packaged form should not be disposed into the coastal sea.
- Sewage generated at the ship should not be disposed off into the sea, unless it is treated or it is disposed off at a certain distance from land.
- Garbage produced on ship must be kept on board and discharged either ashore or into the sea under certain conditions, such as distance from the land; discharge of all plastics is prohibited.

Leachate Generation

Proposed project envisages the storage of coal in closed stack yard. Runoff from coal piles due to sprinkling and storm water can be very acidic and high in suspended and dissolved solids and heavy metals and might contaminate the ground and surface waters.

However, there is no significant leachate generation is perceived from the water spraying on the coal pile. As coal is porous in nature, maximum or total water sprayed on it is absorbed. The water spraying is done periodically only to dowse the fire during stack piling. Thus the sprayed water gets fully absorbed in the stock pile which does not allow to runoff.

Mitigation Measures

The rain water surface runoff shall be collected in settling tank connected to plot garland drains having concrete lining. The clear water will be used for dust





suppression and the settled material shall be dumped back to the stockyard, so that leachate generation remains insignificant.

4.3.2 Biological Environment

Impact on Marine Biology

Potential sources of impacts on the marine biological environment essentially arise from pollution by shipping and Jetty operations. These include waste and wastewater discharges, accidents and spillage containing oil, heavy metals etc. Due to the proposed mechanization and capacity enhancement there will be a marginal increase in the vessel movement. However, the improved cargo handling equipments and dust suppression systems will minimize the fall off thereby reduce the stress on the marine environment.

Mitigation Measures

- The developer will ensure that untreated effluents are not discharged into the marine environment. The ships will also not be permitted to discharge wastes or untreated effluents in the sea.
- Project is expected to have no detrimental effect on fish and hence no impact on fisheries during the operations phase. However, any fishing within the Jetty limits will be prohibited for safety and security reasons.

Impact on Coral Ecosystem

The corals are primarily found in the area adjacent to the Grande Island. The corals are not native to the coast of Goa. The origin of the corals is from drifting along with the current and from the ballast waters of the ships. The favorable water climate has helped the corals to colonize this part of Goa. In spite of the port operations it has been found that the corals have been thriving, shows that the port activities do not exert pressure on the corals. However, researches have pointed out that the tourists' activity and unscientific diving and fishing has become a single source of threat to the corals.





Impacts on Marine Biota

There is a lot of sensitive ecosystem around the MPT, where the present project is proposed. However, there will not be any anticipated adverse impacts due to the modernization at the berths. Due to the enhanced capacity handling, there will be a marginal increase in the vessels that shall be berthed in the Berth 5A and 6A. However, there is no impact due to the additional vessels visiting the port due to the proposed project.

The Chicalim Bay is found to be a host of a wide variety of marine biota including the *Placuna placenta* or popularly called the windowpane oyster. However, it is not in the vicinity of the proposed project though it falls under the study area. Therefore, there will not be any impact on the Chicalim Bay or the biota present in the Bay due to this modernization project.

Impacts on Mangroves

The mangroves are found in the deltaic regions of the River Mondovi. Though they are in the study area they are away from the operations and since no new land cover change is expected, and there will not be any significant impact on the mangroves of the study area.

4.3.3 Land Environment

Impacts on Land Use/Landscape

No permanent change in the landuse and landscape is envisaged in the project. Hence, no likely impact is envisaged during the project operation phase. Though there are a number of heritage buildings and places of worship they will not be affected, as the area of operation will be restricted to the port premises only. The Department of Archeology already protects most of the historic monuments and hence no adverse impacts are expected.

Dr. Salim Ali Wild life sanctuary falls within the study area. As the project will be in the existing facilities that has been in operation for a long time, there is no expected adverse impacts due to the modernization and cargo capacity enhancement at the terminal.





Mitigation Measures

The modernization will lead to a fall in the emissions during cargo handling due to the use of modern handling equipments and advanced dust suppression systems. At present the cargo is stored in covered stockyards. Also a wind shield is provided along the stack yard. Hence no additional mitigation measures are required.

The increase in the capacity will lead to increase in the train rakes and this will have an impact on the air quality around the tracks. Regular monitoring and regulation of the speed of the trains in densely populated areas can considerably reduce the fine dust from re-suspension. However, to control fallouts from trains, it is suggested to transport the cargo in closed containers. Some methods of effective fugitive dust suppression are;

- Specific load profile guidelines.
- Applying a topper agent to loaded coal.
- Covering of the wagons with HDPE covers.

The increase in cargo transportation due to capacity enhancement shall be accommodated in the existing rail infrastructure and no expansion of tracks is proposed. Hence impact on the railways is not envisaged. There shall be no impact on the roadways as the evacuation of cargo will be mainly through trains. No road transport of cargo is part of the proposed project.

Impact on Soil Quality

The Port is located within the inter-tidal and the sub-tidal area and hence no major impacts are anticipated on the land environment during its operations. There will also not be any land disposal of liquid wastes generated from landside berth or shipping operations.

Mitigation Measures

• The developer shall take adequate preventive any land disposal of solid wastes generated from Jetty or ship operations which may adversely impact



soil quality surface runoff of oil, paints, fuel, and lubricant spillage due to land-side Jetty operations which many contaminate the soil.

- Waste Management Plan will be implemented, and care will be taken so that there are no accidental spills and leakages.
- Used lubricant oil will be re-used wherever possible for the maintenance of the machinery and will not be disposed on land or in the sea. Thus, there will be no potential contamination hazard to soils due to spillage of fuels and lubricant oils.

4.3.4 Air Environment

Impact on Ambient Air Quality

Vehicular movements at the Port during operation phase will not only contribute to the ambient air quality. Fugitive emissions from other sources (during dry cargo storage in open yards and transfer in conveyors, handling and transfer of raw materials such as ores), emissions from ships are not expected to contribute significantly to the ambient air quality in the port.

The following cargoes will be handled at the Terminal during its operational phase;

- Coal/Coking Coal
- Limestone
- Iron Ore
- Dolomite
- Bauxite
- Mineral Ores
- HR coils
- Steel Products

The handling details of various cargoes in the port are given in the following paragraphs:

Coal, Lime Stone, Minerals, and Steel Products

- Handling Equipment: Grab Ship Unloader
- Conveying Equipment: Closed Conveyors





- Reclaiming: Stacker/ Reclaimers
- Storage: Closed/Open storage Stack yards, Steel Sheds
- Provided with dust suppression, wind shields, green belt and water sprays
- Dispatch through Rakes

Mitigation Measures

- Cargoes e.g. Coal, Limestone, Iron Ore, and Mineral Ores will be handled in bulk form. For such cargoes, fugitive emissions are not generated.
- Entire operation would be handled in closed conveyor system. Thus, no air pollution is envisaged.
- Coal dust would to be cleaned regularly from coal stack pile areas using water sprays. The water can be channeled from various locations and brought to a common pond for treatment prior to disposal.

Air Pollution due to coal handling

Coal will be stored at coal storage yard in coal stock piles with an approximate maximum height of 7-8 m with side slope of 35°. During unloading and storage at coal stockyard, the following sources/activities could lead to air pollution:

- Dust caused by displacement of air
- Dust blown out by the wind
- Wind erosion from disposal sites

The above sources are described in the following paragraphs;

Dust caused by displacement of air

As the coal is loaded, it displaces air of quantum equal to its volume, which leads to entrainment of dust. As the air enters the environment at the location, where the coal is released at the stock yard, the air entrains the coal dust along with it and leads to entrainment of fugitive dust.





Dust generated by the Impact

The falling product has a certain velocity and the moment it hits the foregoing product that has already been loaded into the Rakes. This velocity represents a certain amount of kinetic energy that causes breakage of the product and therefore generates dust at the point of impact.

Dust blown out by the wind

As soon as the product leaves the spout, the wind can blow through the falling stream of product and will blow out the smaller and lighter particles.

Mitigation Measures

- All the mechanized handling systems and other associated equipments such as hoppers, belt conveyors, stacker cum reclaimers shall have integrated dust suppression systems.
- Imported Coal from Indonesia, Australia and Africa are generally high moisture content and handling such coal result in less emission.
- Coal and other dusty cargoes would be covered.
- Water sprinkling dust suppression systems will be provided at strategic transfer points.
- Windshield of 12 m height would be provided at the stock yard.
- Covered storage shed.

Impact prediction for Fugitive Coal Dust

Fugitive emission of uncaptured coal dust after rigorous implementation of dust suppression system has been estimated by application of mathematical modelling for area source. The contributing sources of fugitive dust from the terminal post DSS are uncovered portions of stock piles where stacking or reclamation is going on. This fugitive emission may be caused by strong winds acting upon the coal fraction while material handling operations on the stockpile is going on. No significant or detectable emissions are caused from the grab unloading, closed conveyance and wagon loading parts of the operations due to confined handling of the cargo.





An area source mathematical model has been run to estimate the concentration of fugitive dust in the air environment using AERMOD. AERMOD is a steady state dispersion model based on planetary boundary layer theory, developed jointly by US EPA and American Meteorological Society, and is US EPA model of preference for both simple and complex terrain since December, 2005. AERMOD is also prescribed by CPCB for modelling of ambient air quality in India. Source concentration has been calculated based on guideline given in Chapter 13 of Air Pollutant Emission Factors (AP-42), January, 1995.

Short term run of the model shows that the ambient air quality for PM10 is attained within/close to the boundary of the Terminal, as shown in Figure 4.1. Outputs of the model runs and interpretations thereof are given as an Appendix.









4.3.5 Noise Environment Potential Impact on Noise Levels

The material handling equipments and vehicular movement are the main sources of noise pollution during the operational phase. The proper mitigation measure can reduce the noise pollution.

Mitigation Measures

- All the equipments and vehicles shall adhere to high quality and good working conditions with noise generated within the permissible standards.
- The project developer will ensure that the berths are designed such that the sound pressure level in any situation (including emergencies such as blowing of safety/relief valves) shall not exceed 115 dB (A) and that the impulse noise level shall not exceed 135 dB (A).
- Appropriate standards regarding maximum allowed noise levels will be stipulated in the EPC contract.
- The noise levels will not exceed permissible limits 60 dB (A) at the perimeter of the terminal area.

4.4 SOCIO-ECONOMIC IMPACTS

The impacts on the socio-economic environment of the project area could arise due to the following:

- Impacts on structures, assets, standing crops, etc.
- Impacts on livelihood
- Impact on public infrastructure and civic amenities
- Impact on health and safety

Impacts on Structures, Assets, Standing Crops

The capacity enhancement facility ort shall be developed entirely on the existing facility in the port. Thus, the impacts due to loss of land, structures, assets or standing crops are not envisaged. The modernization and capacity enhancement at the terminal shall not lead to acquisition of private land or home steads entail displacement of people.





Impacts on Livelihood (fishing activities)

The project will have no detrimental effect on the coast, as the proposed capacity enhancement at the port is mostly on the landward site. Further no fishing activities exist in the Jetty limits. The project is also located away from any designated offshore fishing areas. Hence, the project is expected to have no detrimental effect on fish and hence commercial fisheries.

The project is likely to enhance the socio-economic conditions in the region through greater economic opportunities and multiplier effect in terms of creation of service and small industry opportunities to support the project.

Impacts on Public Infrastructure and Civic Amenities

The potential impacts of the project on local public infrastructure and civic amenities could arise due to pressure on resources (power, water, roads) due to the project implementation activities.

The electricity requirement for terminal activities will be self-generated and the developer shall not source electricity from the villages during the project implementation/ operation activities. No existing resources/water sources (surface/ groundwater) that are currently being used by the locals for the purpose of obtaining drinking water and/or water for irrigation or other purposes will be tapped into. Drinking water requirements during the operation phase will be met through tankers.

Impacts on Health & Safety

Given the minimal intrusion into the existing natural resources of the region (land, freshwater sources), adequate measures for dust suppression (the only credible source impacting the air environment), adequate distance from nearest habitation, and no adverse health impacts are expected, either during project implementation or operations of the project.

Due to modernization of equipments with high degree of mechanization and retrofitting state of the art dust suppression systems and barriers at all the strategic



locations beginning from unloading, conveying (closed loop conveyor), and stacking, until rake loading will result in net reduction in emissions. Hence, pollution due to coal handling and other bulk cargos will not have any significant impact on the health of the local habitants. Same time, transportation in covered rakes at present which will continue to do so in future also, will have no adverse impact on the health and safety of the local population.

4.5 MITIGATION MEASURES MATRIX

The likely Impact due to this modernization and consequential capacity enhancement proposal is assessed and mitigation measures on the land, water, air, noise, ecology and socio-economic environment are derived. The mitigation measures in the matrix format is given in Table 4.5.





Table 4.5: The Mitigation Measures in Matrix Form.

Phase	Sources	Mitigation Measures				
Land Environment						
Implementation Phase	 Change in land use/landscaping 	 No change in the landscape since no major construction activity is involved. Hence no likely impact on the cultural heritage landscapes, churches, temples, educational establishments, hospitals, etc. 				
Operation Phase	 Solid wastes generated at the site 	 Waste minimization and recovery methods. There is no possibility of mixing of wastes from different cargoes. Disposal of any generated hazardous and non-hazardous waste will be done through authorized agencies and norms. Municipal waste is segregated. Non-biodegradable waste is given to Municipality. No like impact on the cultural heritage landscapes, churches, temples, educational establishments, hospitals, etc. 				
Water Environment						
Implementation Phase	 Equipment modernization activities 	 No major construction activities are involved, hence no likely impact is envisaged. 				
Operation Phase	 Domestic waste water Release of ballast water from vessel 	 Sewage generated shall be treated with the available existing facilities of MMC. No release of ballast water is permitted near Port area. 				





Phase	Sources	Mitigation Measures
	 Spillage from dust suppression measures 	 Sprinkled water for DSS is absorbed in the coal stockpile. Surface runoff is collected in settling tank connected to garland drains for suitable treatment.
Air Environment		
Implementation Phase	Emissions from equipment and system modernisation	Regular maintenance of machineries and equipment's.
Operation Phase	 Fugitive dust emission from handling of cargoes Vehicular traffic DG sets 	 Coal has 9-11% moisture, resistant to dusting. Spraying of water over cargo and during handling. Year round covering of stock piles, covered storage shed. Windshields. Transportation of coal by closed pipe conveyor, closed conveyor galleries, single point closed silo loading. Closed hoppers with water fogging system. In transit, rakes covered with tarpaulin. Periodic maintenance of roads and regular sweeping by sweeping machines. Road water sprinkling. DG set – scheduled maintenance.
Noise Environment		





Phase	Sources	Mitigation Measures			
Implementation Phase	 Modernization activities 	 Protective equipments for workers. Scheduled maintenance of equipment/ vehicles to reduce noise levels and vibrations. 			
Operation Phase	 Cargo handling and other operational activities 	 Acoustic treatment of high noise equipment. Provision of protection devices (ear muffs/plugs) is provided to the workers operating in the vicinity of high noise generating machineries. DG set – scheduled maintenance 			
Ecology	Ecology				
Implementation Phase	Modernization activities	 No spillage in marine ecosystem. No likely Impact on the terrestrial ecology. No marine area expansion. Hence, no likely impact on the marine ecology, viz. Chicalim Bay, Grande Island, etc. No likely impact on the mangroves, corals, and Windowpane oyster. 			
Operation Phase	 Pollution from ship movement Jetty operations Waste water discharge 	 Pollution prevention as per the protocol MARPOL, 73/78. No release of ballast water is permitted in the Port area. All cargo handling equipment in the berth are spillage controlled. No waste water discharge is possible in the marine environment. No likely Impact on the terrestrial ecology. 			





Phase	Sources	Mitigation Measures
		 No likely impact on the marine ecology, viz. Chicalim Bay, Grande Island, etc. No likely impact on the mangroves, corals, and Windowpane oyster.
Socio-economic Envi	ronment	
Implementation Phase	Labour deployment due to modernization activities	 No outside labour is proposed to be deployed. Local labor shall be deployed. Hence, no likely impact during project implementation. No land acquisition.
Operation Phase	 Labour deployment Impact on Livelihood of fishing community Impact on public infrastructure and civic amenities Impact on health and safety 	 Local labour is proposed to be deployed. No fishing activity in the port area. Fishing activity is mostly in the offshore areas. Hence, no likely impact on the offshore fishing activity. No impact on the local power supply. No withdrawal of ground water and or use of surface water. No road transport is envisaged. Hence, no impact on the road infrastructure. Adequate dust suppression measures to control air emissions. Hence reduction in air pollution. No likely impact on the public infrastructure and civic amenities. No likely impact on the health and safety of local population.





Chapter 5.0 ENVIRONMENT MANAGEMENT PLAN

5.1 INTRODUCTION

Environmental Management Plan (EMP) is formulated as an essential part of the in EIA study to ensure that appropriate interventions are put in place to enhance the beneficial effects likely to accrue from the project and ameliorate the adverse effects from project activities, simultaneously to ensure compliance of statutory environmental parameters. The Environmental Management Plan (EMP) for the proposed project can be classified into the following categories:

- EMP during project implementation phase
- EMP during project operation phase

5.2 EMP DURING IMPLEMENTATION PHASE

Construction in the project will not involve any heavy civil works as the equipment will be installed on the existing foundations which have design capacity to bear loads of the new machinery. No construction on or near the berths will be necessary.

Equipment will be transported by road on truck trailers and will be spliced either by bolting together or welding. This proposed benign erection activity will not have any significant impact on the environment. The dismantled equipment will be cut into small pieces and scrapped to vendors on where-is basis.

The Terminal capacity enhancement is about modernisation of an existing operation completely on the Port backup/land side. No change on the berth/marine side is proposed. No berth or water side activates are proposed as part of the project.





5.2.1 Water Environment

The site fabrication activities in the implementation phase will not require any water and will not generate any effluent. Additional sewage from fabrication staff/workforce will be accommodated in the Terminal STP.

5.2.2 Land Environment

On completion of fabrication activities, the fabrication contractor will remove all fabrication wastages and debris, etc. as a part of the contract agreement.

Handling of paints and thinners will be carried out over wooden pallet supported boards. Site paintings will be carried out with spray guns ensuring minimum drift losses. All sand blasting will be carried out within fabric booths.

5.2.3 Air Environment

Control of Emissions and Noise

Minor air quality impacts may be caused by emissions from construction vehicles, equipment and DG sets brought by the fabrication contractor for welding purpose, and emissions from transportation traffic. The following measures will be followed recommended to control air pollution:

- Contractor will be responsible for maintaining properly functioning construction equipment to minimize exhaust.
- Construction equipment and vehicles will be turned off when not used for extended periods of time.
- Unnecessary idling of construction vehicles to be prohibited to control emissions and noise.
- Effective traffic management to be undertaken to avoid significant delays in and around the project area.
- Road damage caused by sub-project activities will be promptly attended to with proper road repair and maintenance work.
- Noisy fabrication activities will not be carried out beyond day light hours.



• All stationary engine driven equipment will be mandatorily acoustically enclosed or acoustically treated.

5.2.4 Marine Ecology

This capacity enhancement project involves modernization of the the mechanized material handling system on the landward site of the berths. No construction activity is involved in the seaward side of the existing berths. However, care shall be taken to ensure that no construction debris find way to the waters off the berths.

5.2.5 Solid Waste Management

Fabrication contractor's workers shall use the existing Terminal canteen facility. All the solid wastes arising from the fabrication activity will be collected, handled and disposed per established practices of the Terminal.

5.3 EMP DURING OPERATION PHASE

5.3.1 Air Environment

Break Bulk

During project operation phase, one of the major activities would be handling of bulk cargoes such as coal, coke, iron ore, lime stone, dolomite, bauxite, mineral ores, etc. These cargos are potential sources of dust and may contribute to fugitive dust emissions if not handled properly. The following management plan would reduce the impact of such emissions on the general environment.

The impacts due to dust emissions could be substantially managed by containment and reduction of emissions. The reduction in the emissions is achieved by continuous spraying of water so that the surface remains moist and the dust gets suppressed.

 Imported coal from Indonesia, Australia and Africa are generally having high moisture contents, often times exceeding 20%, Thus, handling of such coal at the port would result in lesser dust emission.



- Dust suppression systems will be provided at the hopper and at the point of discharge on the berth conveyor as well as the feeder underneath hopper at the ship unloader (Figure 5.1 and 5.2). Mist and fog sprayers will be used for this purpose.
- Dust suppression systems will be provided at all transfer points in the conveying and transfer systems to limit residual dust in the discharge area (Figure 5.2). Nozzles with capacity to atomise 2-6 RPM of water at 4-8 kg/cm² pressure has been envisaged for this purpose. With all the above-mentioned measures, no emission is anticipated from the main length of the conveyors.
- Stack yard will be provided with water spraying system (Figure 5.3). The sprinkler system would consist of pressurised high through sprinklers jets of capacity 4–5 RPM at pressure upto 12 kg kg/cm², which will operate at an inclination of 30–40 degree with respect to the horizontal. Each sprinkler will have a throw range of 25 m and will be installed at 30 m intervals all along the stockpiles.
- For wind generated dust generation, a windshield with a wire mesh fencing with fast growing creepers up to a height of 14 m around the coal/other bulk stack yard has been proposed (Figure 5.4).
- Even the In-motion wagon loading system would be complying with the zero emission standards as shown in Figure 5.5.
- In addition to all the above measures, greenbelt development for the dust suppressions.
- One highly efficient road sweeping machine is in place for sweeping the roads and paved area to mitigate any dust emissions through vehicular movements.

The Terminal is provided with AQUADYNE water fogging system, in the hoppers, which receives the unloaded material from the ship, at the Junction towers and in the conveying systems. Since this works on the fogging technology, the water droplets are of stipulated size and type to effectively control the finest fugitive





emissions. In the stack yard area, the stocks are under cover, and only are opened at the time of stacking and reclaiming, the sprinkling is carried under such conditions and therefore increased moisture contents limits the emissions completely.

Covered Storage Shed

Bulk cargo such as coal is proposed to be stored inside the covered shed. This covered structure with 125 m width and 275 m length will be self-contained with handling equipments like stacker/reclaimers. The firefighting and dust suppression system also shall be provided inside the covered storage so the fugitive emission is controlled. Covered storage shed proposed at the Terminal is shown in the Figure 5.6.

In addition, separate covered shed for storage of unitized steel product is planned at the terminal. This shed will store Cold Rolled (CR) coils to protect from the environmental effects.

Steel and Unitised cargo (Export cargo)

Steel and unitized cargo shall be handled in break bulk form, and is not likely to contribute to dust emissions. Steel products would be handled at the facility through Fork lifts and Gantry Cranes and stored in covered shed. Those cargos are then dispatched through rakes or roads with fully covered so that and no emission at this point is envisaged.







Figure 5.1: Water sprinkler system at ship unloader facility






Figure 5.2 A: The water spray/mist system in the berth hopper for dust suppression



Figure 5.2 B: The water spray arrangement on the berth conveyor with the dust hood







Figure 5.2 C: Water spray system at the transfer towers and conveyor systems







Figure 5.3: Layout showing sprinkler system at Stackyard







Figure 5.4: Windshield at Stackyard to control wind generated dust suspension







Figure 5.6: Covered Shed for coal cargo storage at the Terminal







Figure 5.5: The Silo Wagon Loading System

5.3.2 Water Environment

There are two sources of wastewater generation due to the proposed project development. One is the domestic wastewater and the second is the small quantity of water collected from the stack yard in the monsoon season. Both of these waste streams need to be treated appropriately.

Runoff water from coal and other bulk cargo stack yard

Water is sprayed over coal cargo in a controlled manner for dust suppression and to douse fire as necessary. The water sprinkled on the coal for dust suppression gets absorbed by the coal. As the coal heaps are continuously covered, rain water does not come in contact with coal heap. Very little leachate is produced





due to the water sprinkling/fogging and firefighting activity. The occasional leachate flows into the dump pond where the coal particle settles. The sludge resulted are cleaned periodically and disposed as per norms. Clean over flow from the garland drains after dust settlement can be collected and recycled for dust suppression and excess overflow will be discharged into outfall drain. Sludge so produced will be mainly coal dust, would be put back in the stack yard.

Domestic waste water

The waste water generation during the operation phase is mainly from the canteen and employee sanitary facility. The amount of effluent generation from these facilities shall be about 4 m³/day, and treated in the soak pit/setting tank before supplying to existing STP facility at Mormugao Port for further treatment and disposal. The Terminal presently uses 200-250 kld treated sewage from the STP of MPT. Additional quantity of water for dust suppression is proposed to be sourced from the presently operational 2300 kld CETP at Baina operated by PWD. The water balance diagram proposed to be used in the terminal during operation phase is given in Figure 5.7.



Figure 5.7: Water balance diagram during operation phase





Marine Water Pollution

No oil cargo is presently being handled at the Terminal. SWPL is not involved in the water side operation of the berths. Port conservancy including Oil Spill Contingency management is the responsibility of the landlord Port, the MPT.

It is strictly ensured that no cargo remnants find their way to the marine water at the edge of the berths. The Terminal has rotary broom suction vehicles as shown in the following picture which pick up cargoes remnants if any created due to occasional spill over from the cargo handling equipment.



5.3.3 Noise Control Measures

During operation phase, noise generation is envisaged from the cargo handling equipments, vehicle movements in the Terminal, etc. Following measures shall be adopted to maintain the noise levels within the prescribed limits;

- Preference shall be given to equipments that produce low noise.
- Adequate personal protective equipment (PPE) shall be provided to the persons working in high noise areas.
- Noise from the DG sets shall be controlled by providing an acoustic enclosure or by treating the enclosure acoustically.



5.3.4 Solid Waste Management

All the solid wastes arising in the premises is properly classified and disposed off as per the Goa SPCB norms. The non-hazardous solid waste generated from the activity is of the order of 0.5 tonnes/month. The composition of various solid waste materials generated is given in the Table 5.1.

Table 5.1:	Type of solid	waste generated	and its disposal
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S. No.	Solid Wastes	Quantity tons/month)	Disposal
1	Scrap Steel	26.25	Sale
2	Wooden Planks	13.5	Sale
3	Garbage	0.12	Given to MMC/MPT
			garbage disposal facility

The scrap steel and the wooden planks are sold to the vendors immediately without piling at the site.

Disposal of Wastes

Degradable component

The degradable portion of the solid waste is disposed suitably. The degradable portion is taken as about 38.9%.

Non-Degradable component

The non- degradable portion such as plastic bottles, cans, etc. is disposed off through an authorized vendor.

5.3.5 Terrestrial Ecology

As discussed earlier, no significant impact is envisaged on terrestrial ecology in the area due to the proposed project. However, there will be some fugitive emissions during the implementation and operation phases of the proposed project. But the impacts due to these emissions will be insignificant. However, further tree plantation program along the roads in and around the project area will be taken up. In addition, ornamental trees and shrubs will also be grown at the



proposed site to not only improve the bio-aesthetics but to contribute to a healthy state of terrestrial ecology in the area.

5.3.6 Greenbelt Development

Greenbelt has been developed around various project appurtenances of the proposed project, which will go a long way to achieve environmental protection and mitigation of pollution levels in the area.

Depending upon the topo-climatological conditions and regional ecological status, selection of the appropriate plant species has been made. The various criteria adopted for selecting the species for greenbelt development are:

- Plants should be fast growing
- Preferably perennial and evergreen
- Indigenous
- Resistant to SPM pollution
- Should maintain the ecological and hydrological balance of the region.

The general considerations involved while developing the greenbelt are:

- Trees growing up to 10 m or above in height with perennial foliage should be planted around the perimeter of the proposed project area and on both sites of the conveyor belt.
- Planting of trees should be undertaken in appropriate encircling rows around the project site.
- Trees should also be planted along the roadside.
- Since, the tree trunk area is normally devoid of foliage upto a height of 3 m, it may be useful to have shrubbery in front of the trees so as to give coverage to this portion.

Taking into consideration the above parameters, the greenbelt development plan has been evolved for the proposed alternatives to reduce the pollution levels to the maximum possible extent. Budget estimated for development of greenbelt in the project area is about Rs. 21 lacs.





5.4 ENVIRONMENT MANAGEMENT CELL (EMC)

Environmental Management Cell (EMC) is responsible for management in all environment related activities. The team is headed by a senior management executive. The organizational structure of EMC is shown in Figure 5.8.



Figure 5.8: Organization structure for Environment Management Cell (EMC)

The Head (Environment), a function looked after by the Terminal In-charge is responsible for environmental management activities in the proposed project. The EM Cell, *inter alia* supervises the monitoring of environmental pollution levels viz. source emission monitoring, ambient air quality, water and effluent quality, noise level either departmentally or by appointing external agencies wherever necessary. In case the monitored results of environmental monitoring are found to exceed the allowable limits, Environmental Management Cell implements remedial actions and get these suggestions implemented through the operation group.

The EMC also coordinates all the related activities such as collection of statistics of health of workers and population of the region, afforestation and greenbelt development.





Chapter 6.0 RISK ANALYSIS & DISASTER MANAGEMENT PLAN

6.1 INTRODUCTION

Risk assessment forms an integral part of EIA study. Risk assessment study deals with identifying and evaluating the magnitude of impending risks to which the neighboring population is exposed due to occurrence of accidents involved in the project construction and implementation. This influences in demonstrating the guidelines for preparation of disaster management plan, which will be executed to handle the situation, if any emergency occurs.

A major emergency in works is one, which has the potential to cause injury or loss of life. It may cause extensive damage to the property and serious disruption both inside and outside the works. Depending on its magnitude and escalation potential, it may require the assistance of outside emergency services to handle it effectively. Although the emergency may be caused by a number of different factors viz. unsafe conditions, human error, natural causes, acts of disruption/terrorism, etc.

Emergency/disaster is an undesirable occurrence of events of such magnitude and nature that adversely affect operations, cause loss of human lives and property as well as damage to the environment. Ports and related infrastructure are vulnerable to various kinds of natural and manmade disasters. Examples of natural disaster are flood, cyclone, tsunami, earthquake, lightning, etc., Manmade disasters include fires, explosion, leakage of toxic gases, terrorist activities, sabotage, etc. It is impossible to reasonably forecast the time and nature of disaster, which might strike a common user infrastructure. An effective disaster management plan helps to minimize the losses in terms of human lives, assets and environmental damage and resumes working condition as soon as possible.



Disaster Management Plan (DMP) forms an integral part of any risk assessment and management exercise; any realistic DMP can only be made after proper risk assessment study of the activities and the facilities provided in the installation. Correct assessment and evaluation of the potential hazards, advance meticulous planning for prevention and control, training of personnel, mock drills and liaison with outside services available can minimize losses to the facility's assets, rapidly contain the damage effects and effectively rehabilitate the damage areas.

6.2 APPROACH TO Disaster Management Plan (DMP)

Modern approach to disaster management involves the following two steps;

- Risk Identification
- Risk Evaluation

Risk identification entails:

- Identification of hazardous events in the installation, which can cause loss of capital equipment, loss of operation, threatens health and safety of employees, threaten public health and damage to the environment.
- Identification of risk is important processes & areas, to determine effective risk reduction measures.

Risk evaluation involves calculation of damage potential of the identified hazards with probable damage distances, termed as consequence analysis. Quantitative risk assessment further evaluates the actual risk due to a probable event occurring over a period of time by factoring in the probability of the event occurring, or frequencies of occurrence of the event.

The effect of a hazardous event in atmosphere, and consequent damage in case of accident may depend on:

- Wind speed
- Wind direction
- Atmospheric stability
- Port assets & population exposed in the direction of wind





Action plan depends largely on results of risk assessment data and may include one or more of the following:

- Plan for preventive as well as predictive maintenance.
- Augment facilities for safety, firefighting, medical (both equipment and manpower) as per requirements of risk analysis.
- Evolve emergency handling procedure both onsite and offsite.
- Practice mock drill for ascertaining preparedness for tackling hazards/ emergencies at any time of the day.

An important element of mitigation is emergency planning, i.e. recognizing that accidents are possible, assessing the consequences of such accidents and deciding on the emergency procedures, both onsite and offsite, that would need to be implemented in the event of an emergency. Emergency plans are likely to be separate for on-site as well as off-site matters, but they must be consistent with each other, i.e. they must be related to the same assessed emergency conditions. While an on-site plan will always be the responsibility of the works management, different legislation may place the responsibility for the off-site plan elsewhere.

6.3 OBJECTIVES

The overall objectives of the emergency plan are to:

- Localize the emergency and, if possible eliminate it.
- Minimize the effects of the accidents on people and property.

Elimination will require prompt action by operators and works emergency staff using, for example, fire-fighting equipment, etc.

Minimizing the effects may include rescue, first aid, evacuation, rehabilitation and giving information promptly to people living nearby.





6.4 IDENTIFICATION AND ASSESSMENT OF HAZARDS

Storms/floods, inventory fire, cyclones and tsunamis are potential disasters for the port. Their likelihood of occurrence and the resulting risk of damage have been incorporated into the design analysis of the Port. Disaster preparedness plans is summarized in Table 6.1.

Disaster	Description	Response Plan	Stages
Storms	Depending on the magnitude the storms can partially and temporarily splash over the deck of the jetty, thereby affecting its operation	 Deck level design based on storm surge history of the location Preparedness Plan Secure insurance coverage. 	Alert, Response Recovery
Earthquake	Proposed site is not in an earthquake prone zone (Zone III Low intensity zone, as per IS 1893 (Part 1): 2002)). Hence, probability of occurrence of earthquake of significant intensity are very rare	Building and Construction has adhered to/will adherer to relevant IS standards for structural design and construction.	Planning, Response, Damage Assessment and Recovery.
Fire	Local fire spots in the coal inventory can cue firefighting operations in the terminal.	 Fire Prevention and Preparedness Plan Install firefighting equipment Electrical work will be done by certified electrician. Provide Insurance coverage. 	Response, Planning Fire Drills, Damage Assessment.
Cyclone	High winds and coupled torrential rains may disrupt operations of the terminal	Cyclone preparedness plan	Alert, Response Recovery

Table 6.1: Summary of the Disaster Preparedness Plans





	temporarily			
Tsunami	High waves may disrupt	•	Tsunami	Alert,
	operations of the terminal		preparedness plan	Response
	temporarily			Recovery
Medical	Medical emergencies can	•	Medical	Response,
	occur at any moment and		Emergency Plan	Recovery
	therefore requires a quick	•	First aid	
	and coordinated effort to		equipment and	
	respond to the need		trained staff	

The proposed development will take into consideration all the potential disasters and plan accordingly to mitigate any negative effects of these disasters on the project infrastructure.

6.4.1 Coal Storage and Fire Risk

The terminal stokpiles significant quantity of coal at any point of time. Coal is not a hazardous commodity as per MSIHC Rules, 1989.

The coal in the stack catches fire only when the coal contains high percentage of Sulphur stored for longer period. The SWPL terminal mainly handles coke and thermal coal, so there is very less chance of catching fire. In any case, maximum dwell time of the coal at the terminal is not in excess of 10 days. So chance of fire further reduces.

Fires in coal stock pile ae unlikely, the same do not occure in the Terminal based on experience of several years. Generally, if any fire starts in the stckpile, it will start as localised hot-spots which are easy to spot and can be immediate doused using fire water moitors.

The coal stacks are covered with waterproof sheets and protected at the sites from collapse by crash barriers. Fire, if any, in the covered stockpile can not remain undeteced for more than 15 to 20 minutes.



The firefighting arrangements in the SWPL Terminal comprise TAC conforming/approved annular fire water hydrant system provided with fire and foam monitors, completely capable of containing any kind of fire within the battery limit of the Terminal. No offsite spread of fire is likely from the terminal.

A 5000 MT doble integrity cup-in-tank type ammonia storage tank of M/s Zuari Industries Ltd is located south of the Adani Mormugoa Port Terminal about 500 m from the coal stack yards of the SWPL Termial. The distance is too large for a coal stack fire to have any kind of risk on the on the ammonia tank. The POL bulk tanks of IOCL, HPCL and the three Phosphoric acid tanks of Zuari Industries Ltd. south of the fishing jetty are at a distance of about 1.85 km from the SWPL Terminal.

6.5 DISASTER CONTROL/RESPONSE PLAN

Disaster may arrive without any warning, unexpectedly in spite of all precautions and preventive measures taken. However, an efficient control/response plan can minimize the losses in terms of property, human lives and damage to the environment can be the minimum.

6.5.1 Emergency Plan for Natural Disasters

Due to its location (west coast), the terminal is not likely to be exposed to natural disasters of cyclones and tsunami. However, the operations will have preparedness for any unlikely event of natural origin.

Both the disasters give a short to very short notice, have potential to cause sudden and widespread damage to the Port infrastructure and the population beyond it, and make recover efforts difficult due to total collapse of administrative and welfare machinery.

It is essential for DMPs of a Terminal to have special provision for meeting with the challenges of cyclones and tsunamis. Since they do not give a long lead warning, pre-meditate and pre-rehearsed action between the first intimation and the onset of the event becomes crucial for effectiveness. Since both events





involve mass evacuation and widespread public notice, DMPs for cyclone and tsunami can ill-afford to be complicated.

(a) Emergency measures during a Cyclone

IMD usually gives a 24 to 36 hours early warning on the onset of cyclone right from the time a depression starts forming in the Bay of Bengal or Arabian Sea. Aided by weather satellite, path of a cyclone can be traced almost in real time. The path of the cyclone can be reliably predicted and early warning/alerts can be given 10 to 12 hours prior to the hit of the cyclone. Table 6.2 gives the actions to be taken before, during and after a cyclone by the Port authorities.

Sr.	Action	Responsibility
Actio	ons before the Cyclone	
1.	The Control Room (CR) will depute a Nodal Person to be on standby for receiving cyclone alert messages from MPT, DG Shipping, DG Lighthouse and Lightships, and Distt. Collector, as also from AIR and DD news telecasts and keep the CR In-charge abreast of the situation.	Marine Control Room (MCR) In- charge
2.	The Terminal In-charge will start taking Cyclone Action 12 hours before the forecast time of hit. He will issue cyclone warning in the terminal by asking the Nodal Person to play out warning on the Terminal paging channel, and individual call to all the HODs including Port security at the gate complex to be on high alert for further instructions.	Terminal In-charge Nodal Person in MCR.
3.	The Terminal In-charge will order implementation of Port shutdown and evacuation 8 hours before the time of hit. Following actions will be taken:	Terminal In-charge
	a. Cargo handling operation on the Port backup (bulk cargo area and on the berths) will be	Dry Cargo Department

Table 6.2: Actions to be taken in Cyclone Emergency





Sr.	Actio	n	Responsibility
	b.	stopped. All machinery will be folded back, retracted, fixed, moored and close-secured. All material handling on the berths will be stopped. Outriggers of the cranes will be lifted and secured, booms and hoists retracted and secured in position, and the cranes to be locked and tide down with tie down hooks provided on the berths.	Dry Cargo Department
	C.	All vessels berthed on the Terminal will be unmoored and set to sail to the anchorage area assisted by tugs.	MCR Traffic and VTMS In-charge, Tug masters
	d.	All loose material stored on the Terminal will be covered by tarpaulin and secured on the ground through grommets to the hooks provided on the edges of the hard stands.	Dry Cargo Department
	e.	The ventilators of the covered godowns will be opened to provide cross movement of cyclonic winds.	Transport and Materials Coordinator
	f.	Terminal In-charge will ask the HOD through the Nodal Person to relieve all the employees on duty except few who will be needed for final shutdown.	Transport and Materials Coordinator
	g.	A jeep with battery power loudspeakers will be pressed to announce Cyclone Warning in local language on the nearby area as instructed by the MPT.	Terminal In- charge, Nodal Person, HODs.
4.	The evacu hours	Terminal In-charge will order complete lation of the Terminal including the HODs 4 before the time of hit.	Terminal In- charge, Nodal Person
1		ning actions will be laken.	





Sr.	Action	Responsibility
	 Security patrol party will announce evacuation in all the buildings by megaphone announcements. 	Port security
	 ii. The MCR will be closed down systematically with all antennae lowered and secured, all equipment closed and powered off. All vessels at the anchorage will be asked to switch to VHS and UVHS channels as primary communication and maintain radio silence unless absolutely essential. MCR Communication will be put to roving mode. Communications will be handed over to the radio officer away from Vasco. 	Terminal In- charge, MCR In- charge
	 iii. Port closure and security arrangements will be briefly communicated to the District Crisis Group Centre by the Port In-charge through the hotline. 	Terminal In-charge
Actio	ons during the Cyclone	
1.	Terminal In-charge will be in contact with the MPT personnel and District Crisis Group Centre on need basis through his VHS radio set from his residence or City office.	Terminal In-charge
Actio	ons after the Cyclone	
1.	Terminal In-charge will order assembly of all HODs at his residence after winds velocities have come down below 50 km/hr.	Terminal In- charge, HODs
2.	Terminal In-charge will inspect damage in the Terminal personally along with HODs and verbally instruct corrective and remedial measures to be taken.	Terminal In- charge, HODs
	Following actions will be taken:	





Sr.	Action	Responsibility
	a. The MCR will be reopened and all communication and navigation equipment restarted, calibrated and synchronized.	MCR In-charge
	b. Vessel stationed at anchored will be supplied with necessary supplies and spares if required by Port supply and pilot boats. Any medical causality will be rescued and hospitalized if necessary.	Harbor master
	c. All debris and wasted material spilled due to wind and rain will be collected, checked for contamination, and disposed off in a well- designed pit in the Terminal premises.	Transport and Materials Coordinator
	d. Damage to structural work of the Terminal, namely the cranes and other tall material handling structures (conveyor galleries, watch towers, building glasses) will be inspected and necessary repairs and cleaning will be undertaken. Structures whose stability is under question will be cordoned off till they are inspected in detail and cleared for general use.	Engineering department
	e. Water supply will be tested for portability, and other sanitary services resumed after suitable inspection. Water accumulated due to heavy rains will be drained and area dried, sprayed with disinfectant, etc.	Communications and Medical Coordinator
	f. Status of Terminal will be communicated to the District Crisis Group Centre by the Port In- charge through the hotline	Terminal In- charge.
3	After the Terminal housekeeping has been brought to order, all machineries will be sequentially tested. Terminal operations will be resumed with berthing of cargo handling vessels	Terminal In- charge.
4	Terminal medical, logistics, communication and personnel facilities will be suitably extended to the Crisis Group Centre Team the leadership of the Dist. Collector for any further relief work as desired by the local and dist. administration.	Terminal In- charge.





(b) Emergency measures during a Tsunami

Early warning for a tsunami can be as short as one hour. Tsunami can be predicted by a network of seismic detection centers installed by the bordering nations after the December 2004 tsunami, as well as deep sea telemetered buoys placed by the MoES. Tsunami warning will be communicated to the Terminal MCR by the District Crisis Group Centre by telephone/emergency hotline.

Rapid action after the alert is critical to effective tsunami response. Unlike cyclone, tsunami is not accompanied by tell-tale disturbed weather and high winds, therefore Port must effectively communicate and elicit urgent action in this regard. Table 6.3 gives the actions to be taken in a Tsunami emergency.

Sr.	Action	Responsibility
a.	Actions before the Tsunami	
1.	The MCR will initiate high-intensity emergency tsunami warning through all communications channel including Terminal paging channel, and individual call to all the HODs, including Terminal security at the gate complex with clear instruction to shut down all operations possible within 20 minutes, and move as far as possible from the sea front using any means of transportation available, including running away.	MCR In-charge
2.	The MCR In-charge will carry out the following understanding authorization of the Terminal In- charge.	MCR In-charge
	Following actions will be taken:	
	a. All cargo handling operation on the Terminal and backup will be stopped immediately. All machinery will be folded back, retracted, fixed, moored and close-secured. Outriggers of the cranes will be lifted and secured, booms and hoists retracted and secured in position, and the cranes to be locked and tide down with tie	Dry Cargo Department

Table 6.3: Actions to be taken in Tsunami Emergency





Sr.	Actio	n	Responsibility
		down hooks provided on the berths.	
	b.	Mooring ropes of all vessels berthed on the Terminal will be slackened. Vessels will be asked to be on full power for any during- tsunami power assists. Tugs will be pressed to turn and send off any inbound vessel in the channel. All vessels in the anchorage will be communicated tsunami alert. All tugs and other MPT Port flotilla near the Terminal berth will be securely moored to the berths in the best wave shadow part of the berths.	MCR Traffic and VTMS In-charge, Harbour master, Tug masters
	C.	All HODs will ensure rapid and complete evacuation of the Port.	
	d.	MCR will be manned and operational with essential staff for communication and coordination.	Dry Cargo Department
	e.	Decision on electrical shut down will be taken by the MCR In-charge after consultation with the Port In-charge depending on the size of the Tsunami waves predicted and communicated.	HODs.
b.	Actio	ons after Tsunami	
1.	Termi of wa inspec releva remed	nal In-charge will resume office within minutes ves subsiding to below deck height. He will ct damage in the Terminal personally along with ant HODs and verbally instruct corrective and dial measures to be taken.	Terminal In-charge, HODs
	Follov	ving actions will be taken:	
	a.	Vessels at the berths will be immediately attended for evacuation of any medical emergency.	MCR In-charge, Harbour master, Tug masters, Communication and Medical Coordinator
	b.	All debris and wasted material floated over dye to wave hit will be collected, checked for contamination, and disposed off in a well- designed pit in the Terminal premises.	Dry Cargo Department





Sr.	Action	Responsibility
	c. Damage to civil and structural work of the Terminal, namely the berths, cranes, etc. will be inspected and necessary repairs and cleaning will be undertaken. Structures whose stability is under question will be cordoned off till they are inspected in detail and cleared for general use.	Engineering department
	d. Water supply will be tested for portability, and other sanitary services resumed after suitable inspection. Water accumulated due to wave hit will be drained and area dried, sprayed with disinfectant, etc.	Communications and Medical Coordinator
	e. Status of Terminal will be communicated to the District Crisis Group Centre by the Terminal In-charge through the hotline	Terminal In-charge
2.	After the Terminal housekeeping has been brought to order, all machineries will be sequentially tested. Port operations will be resumed after starting the unloading and stacking equipment.	Terminal In-charge.
3.	Port medical, logistics, communication and personnel facilities will be suitably extended to the Crisis Group Centre Team the leadership of the Distt. Collector for any further relief work as desired by the local and distt. administration.	Terminal In-charge.

6.5.2 Medical Emergency Plan

The proposed development plan is to implement a medical emergency plan. A medical emergency is an injury or illness from pre-existing conditions or from any operational cause that poses an immediate threat to a person's life or long term health. These emergencies may require assistance from another person, who should ideally be suitably qualified to do so, although some of these emergencies can be dealt with by the victim themselves. Dependent on the severity of the emergency, and the quality of any treatment given, it may require the





involvement of multiple levels of care, from a first-aider to an emergency physician through to specialist surgeons.

Purpose of the Plan

The primary objective of the medical response plan is to:

- Establish the coordinating mechanism necessary to respond to a health situation and to implement basic first aid treatment where applicable.
- Develop and implement a coordinating mechanism necessary to secure appropriate emergency transportation to a recognized health institution.

Basic First Aid

The basic first aid treatment in the event of a medical emergency should be made available. First Aid is the provision of limited care for an illness or injury, which is provided, usually by a certified person, to a sick or injured patient until definitive medical treatment can be accessed. It generally consists of series of simple, sometimes lifesaving, medical techniques, that an individual, either with or without formal medical training, can be trained to perform with minimal equipment. This equipment usually involves the medical supplies commonly found in a first aid kit.

Transportation of Patient

Assessing the condition of the person/s, the person/s must be transported to a recognized health institution for further treatment as quickly as possible to the nearest health institution at Vasco or Panaji where professional doctors and nurses are available for 24 hours.

6.6 TRAINING AND DEVELOPMENT

Risks and hazards abound in our society and therefore the proposed development is no exception. The Emergency Committee will develop a training and development program. This program will cover basic areas designed to minimize and prevent injury and illness where possible. This program will not be





required to divulge in general or in details about the many risks and hazards that exist or affect the project.

Training is the field concerned with workplace learning to improve performance. Such training can be generally categorized as *on-the-job* or *off-the-job*. On-thejob describes training that is given in a normal working situation, using the actual tools, equipment, documents or materials that they will use when fully trained. On-the-job training is usually most effective for vocational work. Off-the-job training takes place away from normal work situation which means that the employee is not regarded as productive worker when training is taking place. An advantage of off-the-job training is that it allows people to get away from work and totally concentrate on the training being given. This is most effective for training concepts and ideas.

(a) Storm Preparedness Plan

Storms caused by heavy rains/Cyclone can cause severe property damage and flooding, especially considering the project environment. Moreover, the restoration time is virtually unknown with these types of sustained damages. With this in mind, the EM Cell of the Terminal will carry out training in the form of drills to fine-tune and sort out the preparation process. These drills are important in accessing the integrity and functionality of the preparedness plan.

(b) Fire Prevention and Response Plan

Fire outbreaks are dangerous if not contained and extinguished in time. Time is of the essence when dealing with fires. The EM Cell will ensure that the several persons chosen from all departments are trained to fight a fire. These employees will be termed as essential employees. Firefighting trained employees will be termed as essential employees. A list of firefighters will be displayed on Terminal gate. It will be ensured that three Firefighting trained essential employees are rostered in every shift of Terminal operation





(c) Medical Emergency

Effective life-saving first aid requires hands-on training by experts, especially where it relates to potentially fatal illnesses and injuries, such as those that require Cardiopulmonary Resuscitation (CPR), as the procedures may be invasive, and carry a risk of further injury to the patient. First aid training will be provided to the selected employees from every department including security. These employees will be termed as essential employees. A list of first aiders will be displayed on Terminal gate. It will be ensured that one First Aid trained essential employee is rostered in every shift of Terminal operation.

6.7 COMPONENTS OF DISASTER MANAGEMENT PLAN (DMP)

An onsite emergency is one, which is having negligible effects outside the Terminal premises and can primarily be controlled by internal facilities and resources available. Some help may be required from external agencies or local authorities. Absence of any storage of hazardous commodities within the Terminal will ensure that hazard consequences will be well within the boundary, which can be easily mitigated by following the Onsite DMP. The existing Terminal has an onsite emergency plan which has been reviewed for the proposed capacity enhancement.

Offsite emergency affecting the neighboring areas and population outside the Terminal premises, requiring substantial contribution from local authorities and institutions like police, civil defense, state hospital and civil administration in addition to state fire services, etc. is not required for the type and magnitude of operation of the Terminal. The Terminal will take part in the overall emergency preparedness plan of the MPT for natural disaster of large magnitude such as tsunami and cyclone as instructed by MPT and the local civil administration.

6.7.1 Onsite Disaster Management Plan (DMP)

The section gives an outline of the DMP in implementation at the Terminal. Details that are part of the Onsite DMP are:

• Name and address of the person furnishing the information.





- Key personnel of the Organization and responsibilities assigned to them in case of an emergency.
- Outside Organization if involved in assisting during an onsite emergency:
 - Type of accidents
 - Responsibility assigned.
- Details of liaison arrangement between the Organizations.
- Information on the preliminary hazard analysis:
 - Type of accidents.
 - System elements or events that can lead to a major accident.
 - Hazards.
 - Safety relevant components.
- Details about the site:
 - Location of dangerous substances.
 - Seat of key personnel.
 - Emergency control room.
- Likely dangers to the Terminal
- Enumerate effects of
 - Stress and strain caused during normal operation.
- Details regarding
 - Warning, alarm, safety and security systems.
 - Alarm and hazard control plans in the line with disaster control and hazard control planning, ensuring the necessary technical and organizational precautions.
 - Reliable measuring instruments, control units and servicing of such equipments.
 - Precautions in designing of the foundations and load bearing parts of the building.
 - Continuous surveillance of operations.
 - Maintenance and repair work according to the generally recognized rules of good engineering practices.





- Details of communication facilities available during emergency and those required for an offsite emergency.
- Details of firefighting and other facilities available and those required for an offsite emergency.
- Details of first aid and hospital services available and its adequacy.

6.7.2 Key Personnel and Responsibilities in Event of Emergency

It is to be understood that the first few minutes after the start of an incident are most vital in prevention of escalation. Therefore, the personnel available at the site on round-the-clock will play an important role. Some of them will be the identified "Key Persons". Since the Terminal facilities are to be operated by highly skilled officers/operators with the help of "Terminal In-Charge/Dy. Terminal Manager", in the emergency he will also act as "Chief Controller" for incidence and he will nominate different "Emergency Coordinators" to control emergency situation.

The role of various coordinators is to assess the situation from time-to-time, take appropriate decisions in consultation with the "Chief Controller" and to provide timely resources to the "Key Persons" to fight the emergency. "Key Persons" as far as is possible are available during shift on a round the clock basis. An organogram of the officers at the liquid cargo operations during emergency is presented as Figure 6.1.









Key Personnel

The senior most officer present in the Terminal at the time of the incident will be the designated the "Chief Emergency Controller".

Duties and Responsibilities of Key Persons and Coordinators

a. Chief Emergency Controller

He will report at the "Emergency Control Centre" and will assume overall responsibility of the works and its personnel. His duties will be:

- To assess the magnitude of the situation and decide whether a major emergency exists or is likely to develop, requiring external assistance.
- To inform district emergency chief (i.e. District Collector).
- To exercise direct operational control over areas other than those affected.
- Assess the magnitude of the situation and decide if staff needs to be evacuated from the assembly points to identified safe places.
- To continuously review and direct shutting down of Port sections and operations in consultation with the other key personnel.
- To liaise with senior officials of Police, Fire Brigade, Medical and local administration, and pass on information on possible effects on the surrounding areas, outside the factory premises.
- To liaise with various coordinators to ensure casualties are receiving adequate attention and traffic control movement within the work is well regulated.
- To arrange for a log of the emergency to be maintained in the Emergency Control Centre.
- To release authorized information to press through the Media Coordinator.
- To control rehabilitation of the affected persons and the affected areas after the emergency.

b. Fire and Safety Coordinator

The main responsibilities of Fire and Safety Coordinator will be:





- To immediately take charge of all firefighting operations upon sounding of the alarm.
- To guide the firefighting team and provide logistics support for effectively combating the fire.
- To barricade the area at appropriate locations in order to prevent the movement of vehicular traffic.
- To operate the mutual aid scheme and call for additional external help in firefighting.
- To organize relieving groups for firefighting.
- To inform the Chief Controller and give "All Clear" signal when the fire emergency is over.

c. Engineering Coordinator

Responsibilities of Engineering Coordinator will be:

- To liaise with chief controller and various other Coordinators
- To stop/regulate all operations within the jetty
- To switch off main Instrument Control Panel
- To stop all engineering works and instruct contractors and their employees to leave the area
- To assess the water level in the fire water reservoir and supply engineering tools, fire-fighting materials and equipments to various Coordinators
- To start all pumps to replenish water and switch on the fire engine for hot standby.
- To liaise with transport coordinator to arrange for external water supply and fuel for generators/engines.
- To attend mechanical fault/failure of fire water pump and facilities.
- To assess situation in consultation with chief controller and if required, start/provide electric supply to certain areas/points.





d. Communication and Medical Coordinator

Duties and responsibilities of the Communication and Medical Coordinator will be:

- To liaise with Chief Controller and various other Coordinator.
- To take over entire communication system (external as well as internal).
- To arrange to distribute Walkie-Talkie/ VHF sets to various other coordinators.
- To inform police, fire brigade, civil authorities, hospitals & request for speedy help.
- To arrange for vehicles/ambulance for evacuation and causalities.
- To set and activate first aid center and arrange to mobilize medical team
- Arrange to procure required drugs and appliances.
- Arrange to transfer causalities to other hospitals/first aid center.
- To maintain a register for causalities (type of injury, number, hospitalization)
- To inform families of the causalities.

e. Finance Coordinator

The Asst. Manager (Finance) or his nominee:

- Release finances (cash/cheques etc.) as directed by the Chief Controller.
- Assist Material Coordinator in enactment of emergency procurement procedures and by deputing his staff.
- To liaise with Insurance Company personnel.

f. Transport and Materials Coordinator

Duties and responsibilities of Transport and Materials Coordinator will be:

- To liaise with Chief Controller and other Coordinators.
- To arrange issue of materials from warehouse round-the-clock during the emergency period.
- To arrange emergency procurements from local dealers or from neighboring industries.
- To arrange transportation of materials from warehouse to the site in consultation with other Coordinators.





- To arrange for police, help for control of traffic & public outside the affected area of the jetty premises.
- To arrange for entry for authorized personnel/vehicles only.
- To mobilize necessary vehicles as required by various Coordinators
- To arrange for regulating the traffic inside the Port area.
- To arrange to evacuate all unnecessary personnel from the Port and arrange for vehicles/ambulance for evacuation and casualties.
- To control and disperse crowd from the scene of fire.
- To mobilize all the firefighting spare equipment/ refills/hosepipes/trolleys etc. form the neighboring units, if required.
- To monitor stock of all firefighting equipments and replenish them as and when required.

6.7.3 Communication Facilities for Emergency

The following are the communication facilities are provided at the Terminal for emergency;

- One 3.0 km range Electric Siren to announce nature of emergency.
- For inter-location communications requisite number of P&T telephones will be provided including tie lines and hot lines for communication with district emergency services, authorities, hospitals, etc.
- The inter-terminal paging and public address system will have the following features:
 - All call with answer back
 - Group call with answer back
 - Interfacing with walkie-talkies
 - Field call stations
- Walkie-Talkies and mobile phones will be deployed for mobile-to-mobile and mobile-to-stationary communication.
- A broad communication diagram outlining interactions between various role players will be set up and rehearsed.





6.7.4 Details of First Aid and Hospital Services

Fully stocked first aid boxes shall be placed at strategic locations. A visiting medical practitioner from Vasco will be made available on call in case of emergency duty. The onsite medical center will be equipped with facilities for treatment of mechanical injuries, burn injuries and electric shock. An ambulance will be available in the port round-the-clock.

Personal Protective Equipment (PPE)

The following PPEs and other emergency handling equipment are stocked to be issued to the trained key personnel during an emergency.

- Fire proximity suit
- Fire entry suit
- Self-contained Breathing Apparatus with one spare cylinder (30 minutes)
- Water gel blanket
- Safety helmet
- Rubber hand gloves for use in electrical jobs
- Power tool

The quantities available will be sufficient to meet the needs of emergency handling personnel.

6.7.5 Rehearsal and Testing

'Fire Drills' are carried out periodically to test out the laid down system and facilities. The emergency handlers also "act out" their individual roles in accordance with the emergency procedures laid down to demonstrate that the entire emergency response system can perform efficiently and accurately. Mock drills for emergency are conducted twice a year.

6.7.6 Offsite Action in Event of Emergency

SWPL participates in the offsite DMP coordinated by the MPT and following external agencies, whose responsibilities are listed as follows:

- Police
- Fire Brigade of Directorate of Fire and Emergency Services, Goa





- Medical Services
- Technical Agencies
- Rehabilitation Agencies
- Electricity Board

Responsibilities of the Services

- 1. Police
- Control traffic & mob by cordoning off the area.
- Arrange for evacuation of people on advice from the Site Controller/District Collector.
- Broadcast/communicate through public address systems to the community on advice from the District/Sub Collector.
- Inform relatives about details of injured and casualties.

2. Fire Brigade

- Fighting fire & preventing its spread.
- Rescue & salvage operation.

3. Medical/Ambulance

- First Aid to the injured persons.
- Shifting critically injured patients to the hospitals at Vasco, Chicalim and Panaji
- Providing medical treatment.

4. Technical/Statutory Bodies

The body constitutes Factory Inspectorate, Pollution Control Board, and Technical Experts from large industries, such as Zuari Agro, etc.

- Provide all technical information to the emergency services, as required.
- Investigate the cause of the disaster.

5. Rehabilitation

• Arrange for evacuation of persons to nominated rescue center and arrange for their food, medical and hygienic requirements.





- Coordinating with the Insurance Companies for prompt disbursement of compensation to the affected persons.
- Maintain communication channels of nearby industries like telephone; telex etc. in perfect working condition.

6. Electricity Board

• To regulate/re-connect the power supply to the Terminal if specifically asked for by the Terminal.




Chapter 7.0 CORPORATE SOCIAL RESPONSIBILITY (CSR)

7.1 GENESIS

As a responsible corporate citizen, JSW as integrated its environment, HR and ethical business policies with appropriate community engagement and gender equity. In tune with this, JSW Foundation works closely with the village communities and creates synergies with other verticals of the JSW Group, to assimilate their intervention in a social development framework.

An independent Trust named JSW Foundation, administers the social development initiatives of the JSW Group companies. Every year, the Foundation in consultation with CSR teams at the Port, finalizes set of activities that get built into the business plan. The JSW Foundation lays emphasis on maintaining a continuum of social development thinking into the conduct of these activities.

The major activities of JSW Foundation are in the areas of;

- School & Education Sector
- Community Health
- Sports Activity
- Livelihood and Empowerment, especially for women
- Environment
- Infrastructure Development

7.2 CSR ACTIVITIES

JSW Group is facilitating the social activities in the following core areas with the help of Municipal Corporation, Education and Health Department of State Government, Local Community and Non-Governmental Organizations as part of the CSR activity. South West Port Ltd. (SWPL), Goa as such is engaged in delivering various CSR activities in project area in the following sectors.





7.2.1 School & Education Sector

JSW Group has been in the forefront of the education sector. The Foundation is facilitating necessary infrastructure and involved in various developmental activities for the students.

JSW Group as a part of its social responsibility has provided following facilities periodically in the local schools;

- > Provide school benches to Govt. Primary School, Sada
- Contributions (like water filter, projector, chairs, yoga mats, and digital camera) to differently abled children of New Dwan Ashadeep Special School, Headland Sada
- Infrastructure development in local schools



7.2.2 Community Health

Unlike Education, JSW Group is always in the forefront of the development of the health sector since its inspection. The JSW group is organizing health camps and blood donation camps in co-ordination as part of the social activity plan.

- Safe drinking water; provide water filter to strategic places at Headland Sada
- Organize blood donation camp in collaboration with Hospicio Hospital, Goa





- > Organize health camps
- > Water treatment plants (Filters) at Anganwadi centers



7.2.3 Sports Activity

JSW Group as a responsible corporate is always a step ahead in sports development for the students and local youths. The group is encouraging sports activities among local students by organizing various sports competitions in the schools. Some of the notable activities are:

- Provide playing equipments to New Dawn Ashadeep Special School, Headland Sada
- > Organizing partner of Goa Marathon
- Organize various sports activities to differently abled children of New Dwan Ashadeep Special School, headland Sada







7.2.4 Livelihood and Empowerment

JSW Group as a responsible corporate is attempting to strengthen the livelihood of the local fishing community by facilitating the necessary materials for the sustainable development of their fishing activities. Also, the Group shall empower the local woman community through various training programs/schemes with the help of local governance as a part of the CSR plan.

The following social activities are being carried out as part of the livelihood and empowerment of the local community;

- Provide stainless steel containers to Anganwadi centers at Headland Sada
- Financial assistance for a vocational center for women empowerment in Vasco



7.2.5 Environment

JSW Group as an environment responsible corporate is involved in the following activities and shall be strengthened further to protect the environment as part of the CSR activity plan.

- > Construction of waste management shed at IDC, Cacora
- > Provide waste bins to schools; under Swachh Bharat Abhiyaan
- Beautification (tree plantation) of highway median from Goa Airport to Varanapuri
- Renovation of parks and forest reserves









7.2.6 Infrastructure Development

JSW Group is in the forefront in providing the necessary infrastructure facility to the local villages. The following CSR activities are carried out as a part of the social responsibility plan.

- > Provide hand railing at critical sections at Sada and Bogda
- Refurbishment of toilets at Sada and Bogda: under Swachh Bharat Abhiyaan
- > Construction of community toilets in Bogda, and Sada

7.3 BUDGET

Budget for implementation of CSR activities in the project area villages for the next 5 years is given in the Table 7.1.





Name of the Category	2017-18	2018-19	2019-20	2020-21	2021-22	Grand Total
Improving Living Conditions	30	33	36	39	42	180
Promoting Social Development	50	53	56	59	62	280
Swachcha Bharat Abhiyan	20	23	26	29	32	130
Addressing Environmental Issues	25	28	31	34	37	155
Contingency	10	13	16	19	22	80
Grand Total	135	150	165	180	195	825

Table 7.1: CSR Budget for next 5 years (Rupees in Lacs)





Chapter 8.0 ENVIRONMENTAL MONITORING PROGRAM

8.1 INTRODUCTION

Continuous environmental monitoring is an essential component for ascertaining environmental performance of any developmental Project. It is an integral part of any environmental assessment process.

Environmental monitoring during implementation phase shall comprise:

- Ensuring presence of and adherence to appropriate permits, certificates, authorizations
- Compliance with the EMPs, work instructions, best construction practise and specific government regulations/directions if made available

Construction in the project will not involve any heavy civil works as the equipment will be installed on the existing foundations which have design capacity to bear loads of the new machinery. No construction on or near the berths will be necessary.

Equipment will be transported by road on truck trailers and will be spliced either by bolting together or welding. This proposed benign erection activity will not have any significant impact on the environment. The dismantled equipment will be cut into small pieces and scrapped to vendors on where-is basis.

8.2 AREAS OF CONCERN

From the continuous change in environmental baseline monitoring point of view, the important parameters are marine water quality, ambient air quality, noise, etc. Suggested monitoring parameters and programs are described in the subsequent sections.





8.3 IMPLEMENTATION PHASE

8.3.1 AMBIENT AIR QUALITY

Ambient air quality monitoring shall be monitored at three stations close to the construction sites. The monitoring will be conducted during the implementation phase. Relevant parameters to be monitored are PM₁₀, PM_{2.5}, SO₂ and NOx. An amount of Rs. 12 lakh has been budgeted for this purpose. Actual spending may differ from the budgeted amount. The ambient air quality monitoring shall be conducted by an agency approved by Goa State Pollution Control Board.

8.3.2 NOISE

Noise level monitoring during implementation phases will be carried out near the zones of activity. Noise monitoring will also be conducted by an agency approved by Goa State Pollution Control Board. Cost estimates for noise monitoring are inclusive in the Rs. 12 lakh as mentioned above.

8.4 OPERATION PHASE

8.4.1 Marine Water & Sediment Quality

The chemical characteristics of marine water, sediment quality and biological parameters will be monitored once in a year, preferably in the pre monsoon season during project operation phase. Both surface and bottom waters will be sampled and analyzed. The parameters to be monitored are as follows:

Marine Water

Physico-chemical parameters

- ≻ pH
- ≻ SS
- Salinity
- DO and BOD





- Phosphates
- Nitrites and Nitrates
- > Ammonium
- > PHc
- > Phenols

Biological parameters

- Light penetration
- > Chlorophyll and other phyto pigments
- Primary Productivity
- > Phytoplankton
- Zooplankton
- Coliforms

Marine Sediment

Physico-chemical parameters

- ≻ pH
- > Texture
- Total Kjeldahl Nitrogen
- Organic Carbon
- > Phosphorus
- > PHc

Biological Parameters

- Benthic Meio-fauna
- Benthic Macro-fauna

The marine water and sediment sampling and analysis will be conducted by a capable external agency. A provision of Rs. 2 lakh/year has been earmarked for this purpose.





8.4.2 AMBIENT AIR QUALITY

Ambient air quality monitoring is recommended to be monitored at three stations fixed after discussion with the Goa State Pollution Control Board. The monitoring can be conducted at a frequency as directed by the GSPCB. The parameters to be monitored are PM₁₀, PM_{2.5}, SO₂ and NO_x. An amount of Rs. 12 lakh/year has been earmarked for this purpose.

8.4.3 NOISE

Noise level monitoring during operation phases will be carried out at locations as suggested by the Goa State Pollution Control Board. Cost estimates for noise monitoring during operation phase is Rs. 1 lakh/year.

8.4.4 BIOLOGICAL ENVIRONMENT

Sites of greenbelt development will be monitored once every year, preferable premonsoon in the operation phase to study the growth of various species and to identify the needs if any, such; as for irrigation, fertilizer dosing, pesticides, etc. Greenbelt shall be raised and maintained by a professional horticulture agency.

8.5 SUMMARY OF ENVIRONMENTAL MONITORING PROGRAM

The summary of Environmental Monitoring Programme to be followed during implementation and operation phases is given in Tables 8.1 & 8.2

Table 8.1:Summary of Environmental Monitoring Programme for the ProjectImplementation Phase

S.	Aspects	Parameters to be	Frequency of	Location
No.		monitored	monitoring	
1	Ambient air quality	PM ₁₀ , PM _{2.5} , SO ₂ & NO _x , CO	During fabrication	Close to construction/f abrication sites or as





S. No.	Aspects		Parameters monitored	to be	Frequency monitoring	y of	Location
							GSPCB
2	Ambient Quality.	Noise	Equivalent Levels	noise	During fabrication	construction/ activities	Construction/f abrication sites or as suggested by GSPCB

Table 8.2:	Summary	of	Environmental	Monitoring	Programme	for	the
Project Operation Phase							

S. No.	Aspects	Parameters to be	Frequency of	Location
1	Marine water	monitored	monitoring	
	Physico-	pH, SS, Salinity, DO	Once, pre-	3 to 4 sites
	chemical	and BOD, Phosphates,	monsoon	
	parameters	Nitrites and Nitrates,		
		Ammonium, PHc,		
		Phenols		
	Biological	Light penetration,	Once, pre-	3 to 4
	parameters	Chlorophyll and other	monsoon	sites
		phyto pigments,		
		Primary Productivity,		
		Phytoplankton,		
		Zooplankton, Coliforms		
2	Sediments		-	
Ì	Physico-	pH, Texture, Total	Once, pre-	3 to 4 sites
	chemical	Kjeldahl Nitrogen,	monsoon	
	parameters	Organic Carbon,		
		Phosphorus, PHc	-	
	Biological	Benthic Meio-fauna,	Once, pre-	3 to 4 sites
	parameters	Benthic Macro-fauna	monsoon	
3	Ambient air	PM ₁₀ , PM _{2.5} , SO ₂ &NOx	As suggested/	Project
	quality		directed by	area or as
			GSPCB	suggested





S. No.	Aspects	Parameters to be monitored	Frequency of monitoring	Location
				by GSPCB
5.	Noise	Equivalent Noise Level	As suggested/ directed by GSPCB	Project area and sites within 1 km of the project area or as suggested by GSPCB

8.6 ENVIRONMENTAL MANAGEMENT CELL (EMC)

South West Port Limited, Goa has a functioning EM cell which takes care of day to day operations of the pollution control hardware, its maintenance and implementation of the environmental management systems, including adherence to statutory conditions laid out in the various permissions and liaison with the statutory agencies. Environmental parameters are being monitored at prescribed frequency by engaging the approved Consultants/Laboratory. Environmental Management Cell of SWPL will be responsible for implementation of various measures outlined in the Environmental Management Plan. The Environmental Management Cell shall also integrate the Environmental Monitoring Programme specified for the proposed project with the existing Monitoring Programme and coordinate its implementation. All necessary resources for the EMP implementation will be made available by SWPL.

8.7 BUDGET

The cost required for implementation of Environmental Monitoring Program (EMoP) during project implementation and operation phase is given in Chapter 9 Cost Estimates. The spending on the monitoring programme may be increased on discretion of the company as required.





Chapter 9.0 COST ESTIMATE FOR ENVIRONMENT MANAGEMENT

9.1 ENVIRONMENTAL MANAGEMENT PLAN (EMP)

The cost estimates for implementing Environmental Management Plan shall be Rs. 220.00 Lakh. The details are given in the Table 9.1.

Table 9.1: Summary of cost estimate for implementing EnvironmentalManagement Plan (EMP)

S. No.	Parameters	Cost (Rs. lakh),
		once
1	Dust suppression, and fire fighting system	84.00
2	Green belt development	21.00
3	Corporate social responsibility (CSR)	115.00
	Total	220.00

9.2 ENVIRONMENTAL MONITORING PROGRAMME (EMoP)

The cost estimate for implementation of environmental monitoring programme (EMoP) during project implementation and subsequent operation phase is estimated to be Rs. 12 Lac/annum. The detailed budget is given in the Table 9.2.

Table 9.2: Cost estimate for EMoP during project implementation phase

S. No.	Item	Cost (Rs. lakh),
		once
1	Ambient Air Quality	11.0
2	Noise	1.0
	Total	12.0

The marine water quality, sediment quality, noise, and air quality will be monitored during the project operation phase. Budget for monitoring is given in the Table 9.3.





S. No.	Item	Cost (Rs. lakh), yearly
1	Marine Water and Sediment Quality	3.5
2	Ambient Air Quality	12.0
3	Noise	1.00
	Total	16.50

Table 9.3: Cost estimate for EMoP during project operation phase

The cost figures given in the chapter are estimates. More resources will be allocated for monitoring if felt necessary and as directed by the GSPCB and other statutory authorities.





Chapter 10.0 DISCLOSURE OF CONSULTANTS

10.1 DISCLOSURE OF CONSULTANTS ENGAGED IN EIA STUDY

The EIA study has been conducted by WAPCOS Ltd., a Government of India Undertaking under Ministry of Water Resources. WAPCOS Ltd. is a QCI NABET accredited EIA Consultancy Organization, with Category A accreditation in Ports and Harbors. Certificate of QCI NABET Accreditation is given in Annexure VIII. WAPCOS Ltd. has a full-fledged Centre for Environment which has conducted the EIA study. The list of the experts involved in the EIA study is given in Table 10.1.

S. No.	Name	Expertise	Signature
1.	Dr. Aman Sharma	EIA Coordinator	Aman Shamp
2.	Mr. A. S. Leo	Air Pollution Expert	A-Stephen les
3.	Dr. S.K. Tyagi	Ecology and Bio- diversity Expert	Solo
4.	Mr. R.V. Ramana	Noise Expert	a viz
5.	Dr. K.K. Gaur	Social Expert	1×14 am.
6.	Mr. S.M. Dixit	Air Quality Expert	Ele Dirit
7.	Mrs. Moumita Mondal Ghosh	Landuse Expert	(nour our dad
8.	Mr. Swapan Kumar Bandopadhyay	Risk and DMP Expert	Darfee

Table 10.1: List of experts involved in EIA study





Chapter 11.0 PUBLIC HEARING

11.1 BACKGROUND

Public hearing (PH) for the proposed terminal capacity enhancement at berth 5A, 6A of Mormugao Port by South West Port Ltd. (SWPL), Goa has been conducted as per the revised EIA Notification dated 14.09.2006 (as amended). Notice for the PH was issued both in vernacular language Marathi (Tarun Bharat), Konkani (Bhangarbhuim) and in English (The Navhind Times, Herald, Indian Express) daily newspapers on dated 26.03.2017. The PH was conducted by Goa State Pollution Control Board (GSPCB) at Tilak Maidan, Vasco-Da-Gama, Goa on date 26.04.2017 at 10:30 AM onwards.

The panel members for the PH meeting are Collector & Dist. Magistrate, South Goa (Chairman), Addl. Dist. Collector II & Addl. Dist. Magistrate, South Goa, Environmental Engineer, GSPCB, Panaji, Goa and Scientist 'C', GSPCB, Panaji, Goa. The meeting is also attended by the representatives of project proponent (PP) and EIA consultants' M/s WAPCOS Limited, and ROOTS EHS advisory.

11.2 ISSUES RAISED BY PUBLIC DURING PH

The PP was asked to give a detailed presentation about the project and its environmental and socio-economic benefits to the public. The participants were then invited to give their objections and suggestions. After the detailed consultation based on the view of the public, the panel members prepared the proceedings. The proceedings and the clarifications of PP to the objections/ suggestions raised by public during PH and to their written submissions, becomes part of this report as an additional report. The major issues raised by public during the PH and its clarifications are given in Table 11.1.





Table 11.1: Major issues raised during Public Hearing (PH) and its reposnse by PP

S. No.	Objection/suggestions	SWPL Response
01	Commented on the ambient air quality data collection and the Indian standards used for comparison.	The project site which is northern face of the SADA headland is surrounded by sea (immediately in the north and in the south). The fugitive particulate matter originated from Terminal is largely controlled by pollution control measures implemented at the site. Further, these very low concentration emissions, if any, is not likely to travel over larger distances under normal atmospheric conditions. Accordingly, the AAQ monitoring stations have been located in the downward wind direction. The results are compared as per the CPCB guideline, standards.
02	Concern about increase in emissions from increased trucks and train transportation.	There is no road transportation of cargo at present and the same is not proposed in the modernization phase as well. The covering of train cargo cars is carried out immediately and automatically, after the loading operation using the in-motion wagon loading system with all round rope sealing thus not leaving any possibility of any escapement of cargo. This is a zero-exception and zero error activity, carried out with utmost stringency by the project proponent.
03	Concern about the double tracking of the south west railways and its impact on villagers.	The project proponent has not proposed any double tracking of railway. The facility is independent of the doubling of the tracks as the spare capacity of the present tracks would be sufficient to take care of the proposed enhancement.
04	Concerned about dredging activity and its impact on Khariwada, which will result in collapse of houses.	The project proponent has not proposed any dredging as part of the proposed modernization. The modernization and consequential increase in capacity is independent of the dredging activity.
05	Concerned about coal pollution in the houses in Khariwada and its health effects.	The coal stacks are provided with two level protection, with complete covering of the stacks with sprinkling of water, when either stacking or reclaiming operation is in progress. Secondly, the yard is surrounded with wind barriers of adequate size, to prevent any emissions from the stacks.





S. No.	Objection/suggestions	SWPL Response
06	Comment on Form I about suppressing the impact on nearby environment caused by surrounding activities.	The present proposal is for modernization and consequential increase in capacity. Due to better equipment and practices the pollution levels are likely to reduce. In addition, it is located in an operating port with regular monitoring for ambient condition. Hence there was no suppression of any facts. The impacts due to various activities are duly acknowledged in the EIA report.
07	Concern about use of 700 KLD of water for spraying on coal, where there is shortage of water in the Vasco city.	The quantity was optimized to 500 KLD as mentioned in the EIA report, The Port Terminal presently uses 200-250 KLD treated sewage from the STP of MPT. The additional quantity of water for dust suppression is proposed to be sourced from the presently operational 2300 KLD CETP at Baina operated by PWD.
08	Suggestion for covered shed for coal storage.	Engineering feasibility for the pre-engineered covered structure is underway. Covered shed for storage of coal shall be developed at the Terminal.
09	Environmental Impact on Bio-diversity Heritage site at Chicalim- Sancoale Bay has not been assessed in the draft EIA report.	The proposal is modernization of an existing operation. No new area or water front is involved. The environmental impact is assessed and included in the final EIA report.
10	Comment about no measures undertaken to control coal dust pollution.	Ambient air analysis carried out as part of the EIA as well as other routine monitoring carried out by project proponent and Goa State Pollution Control Board indicate the ambient air standards are within the stipulated margin in and around the Terminal. The fugitive particulate matter originated from Terminal is largely controlled by pollution control measures implemented at the site.
11	Contaminated coal water is discharged into the sea after being used for dust suppression. This polluted water is discharged into the sea and results in large black patches in the sea, killing the flora and fauna.	Water is sprayed over coal in a controlled manner and it is entrained/absorbed in the cargo. No effluent from the Port Terminal is discharged into the sea. The leachate if any is collected in a dump (settling) Pond, where the sediments settles. The settled solids then collected periodically and safely disposed.





S. No.	Objection/suggestions	SWPL Response	
12	No provision for disaster management plan, if disasters occur due to fire and cyclone, as other tanks also located nearby.	EIA report, Risk Analysis and Disaster Management Plan deals with natural and man-made calamities, and a preparedness and response plan for the same.	
13	EIA report uses 2011 census data, which is old and should not be relied upon, because we are now in the year 2017 for which fresh data should have been collected.	Census data of 2011 has been referred as secondary data for baseline study, which is as per EIA Guidance Manual and is an accepted practice. As no direct significant social impact is scoped for the EIA, primary data has not been collected.	
14	Conducting 3 different PH for the 3 projects, as all are interdependent and can't exist in isolation.	The proposed modernization and capacity enhancement project is not dependent on the capital dredging proposed by MPT, however it will benefit from the same as large size vessels could call on the SWPL Terminal. This can also be achieved by calling Panamax vessels at more frequent using the spare channel.	
15	Concern about destruction of marine biodiversity in the local area.	The project is operational since 2004 at the proposed site. The increase in capacity is only consequential to the modernization of the facility and no additional waterfront or land is to be utilized. Environmental Baseline Status, in various sections covers the details of the marine and terrestrial biodiversity study, and does indicate any threat to the biodiversity.	
16	Concern about 3 no. of air quality monitoring stations proposed during the project operation.	Three monitoring stations to be placed near to impact the area of operation are felt adequate to cover impacts of operation phase in ambient air quality. However, we will take MoEFCC/GSPCB's directions in this regard.	
17	Concern that no fishing activity in the vicinity of the project side. Report is silent on extent of fishing vessels and activity at the Khariwada Jetty.	No fishing is allowed in the Port area and near the channel due to security reasons as the Port is ISPS compliant. Fishing activity is duly discussed in the EIA report.	





S. No.	Objection/suggestions	SWPL Response	
18	Concern about turtle breeding in the Baina beach.	Isolated and random egg laying events are not classified as turtle breeding grounds and is not reported elsewhere.	
19	Corals near Grande Island will be destroyed due to dredging which is part of the project.	The fact that corals have been recently discovered at Grande Island has been duly mentioned in the EIA report. Dredging is not part of the proposal. The present proposal which is modernization at the berths are insignificant to have any impact which is nearly 7-8 km away by sea route.	
20	Marine biology sampling is done in two days	Marine sample collection was carried out from seven stations at different depths in two days' time. <i>In-situ</i> parameters were analyzed at the site and the other samples were preserved and taken for analysis which took several days to analyze in the laboratory.	
21	Baseline data on marine biodiversity is silent on endangered marine life.	Sensitive and endangered coastal life forms such as corals, turtles, dugongs, sea weeds, mangroves, etc. have been duly discussed in the respective sections in the EIA report,	
22	Concern about the CSR expenditure by the project proponent.	About 2 % of the total profit is spent on CSR. PP is committed to spent about 825 lacs on CSR activity in coming 5 years.	
23	Concern about leachate generation in the terminal from coal cargo runoff.	Water is sprayed over bulk cargo in a controlled manner and it is entrained/absorbed in the cargo, leachate, if any is collected in the settling tank and disposed off after treatment.	
24	Concern about employment opportunities given to the local Goans.	At present employment to the local goans at SWPL is about 60%. The proposal will open to employment opportunity to the locals.	
25	Concern about covering of coal stacks and its height.	Coal cargo is covered round the clock with tarpaulin, except at the time of stacking/reclaiming which is carried out under water sprinkling. Coal is stacked upto a permissible height.	
26	Concern about future generation who will suffer from carcinogenic diseases and impure air due the increases coal handing and transportation	SWPL terminal is provided with AQUA DYNE water fogging system, in the hoppers, which receives unloaded material from the ship, at the Junction towers and in the conveying systems. Due to Fogging technology, the water droplets are of stipulated size and type to effectively control the finest fugitive emissions. In the stackyard area the stocks are under	





S. No.	Objection/suggestions	SWPL Response
		cover, and only are opened at the time of stacking and reclaiming, the sprinkling is carried under such conditions and therefore increased moisture contents limits the emissions completely.
27	Public esteemed about CSR activities carried out by SWPL on women empowerment, education, environment protection through Swacch Bharat Abhiyan, etc.	Views are agreed and appreciated
28	Appreciated that in SWPL, to protect environment war footing steps are being taken. All workers' safety is considered.	Views are agreed and appreciated.
29	Demand for employment opportunity.	Views are agreed and appreciated
30	Appreciated that Terminal has helped small business making units like Hotels, GHs, etc, making economic condition of people increase.	Views are agreed and appreciated
31	Concern about expansion of port and additional air pollution of Ozone, SO ₂ , NO ₂ , will impact vegetation and monuments.	There is no primary or secondary source of tropospheric ozone from the project. There are no point sources of fuel combustion based pollutants, such as SO ₂ and NOx in the project (Except DG sets which are on standby duty and are operated occasionally)
32	Public suggested various mitigation measures including covered shed for bulk cargoes like coal.	All the bulk cargoes in the Terminal are tarpaulin covered at present. However, covered shed is also proposed to be developed for the coal cargo storage.





S. No.	Objection/suggestions	SWPL Response
33	Concern about dredging which will affect bentho-pelagic coupling. Damage houses, and landslides.	No dredging has been proposed as part of our modernization and consequential capacity enhancement project.
34	There are reports of presence of marine mammals like Dolphins in the neritic zone off Baina cost.	Sensitive and endangered coastal life forms such as corals, turtles, dugongs, sea weeds, mangroves, etc. have been duly discussed in the EIA report.
35	Concern about marine life and biodiversity of the Vasco Bay and Zuari River.	The proposal is about modernization of an existing operation completely on the Port backup/land side. No change in the berth/marine side is proposed. Impact is not likely due to the expansion proposal.
36	Concern about displacement of fisher folk community due to dredging, by road construction works, and doubling of Railway tracks.	No dredging is proposed as part of this project. So also, road transportation and road expansion is part of this proposal. No expansion of railway line by Indian Railways is necessary to accommodate additional cargo proposed to be handled as part of the capacity enhancement project, as the existing rail infrastructure is sufficient to handle additional cargo.
37	Concern about ballast water management guideline which is not in place at the port	Ballast water guidelines are communicated to the vessels by MPT and the same are enforced strictly as known to us.
38	Washing of barges in transit and dumping left over coal and ore in Mandovi and Zuari will increase river pollution causing unpredictable and irreversible effects on ecology and livelihood.	SWPL does not use barges for coal handling at present, and not envisaged in the future.





ANNEXURE I

S.	Pollutants	Time	Concentration in the Ambient Air	
No.		Weighted	Industrial,	Ecologically sensiti
		Average	Residential,	area (Notified by
			Rural and other	Central Government
			area	
1	Sulphur Dioxide(SO ₂)	Annual*	50	20
		24	80	80
		hours**		
2	Nitrogen Dioxide	Annual*	40	30
	(NO ₂)	24	80	80
		hours**		
3	Particulate Matter	Annual*	60	60
	(Size less than 10µm),	24	100	100
	<i>PM</i> ₁₀	hours**	100	100
4	Particulate Matter	Annual*	40	40
	(Size less than	24	40 60	40 60
	2.5µm), PM _{2.5}	hours**	00	00
5	Lead (Pb)	Annual*	0.5	0.5
		24	1.0	1.0
		hours**	1.0	1.0
6	Carbon Monoxide	8 hours**	2.0	2.0
	(CO)	1 hour**	4.0	4.0
7	Ozone (O3)	8 hours**	100	100
		1 hours**	180	180
8	Ammonia (NH ₃)	Annual*	100	100
		24	400	400
		hours**	100	100
9	Benzene (C_6H_6)	Annual*	5.0	5.0
10	Benzo(a) pyrene	Annual*	1.0 ng/m ³	$1.0 ng/m^3$
	(Bap)	,	7.0 119/111	7.0 Hg/III
11	Arsenic (As)	Annual*	6.0 ng/m ³	6.0 ng/m ³
12	Nickel (Ni)	Annual*	20 ng/m ³	20 ng/m ³

National Ambient Air Quality Standards (Unit: µg/m³)





Note:

* Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at a uniform interval.

** 24 hourly or 08 hourly or 01 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.





ANNEXURE- II

Ambient Noise Standards

Area Code	Category of Area	Limits in dB(A)Leq		
oout		Day time	Night time	
А.	Industrial Area	75	70	
B.	Commercial Area	65	55	
С.	Residential Area	55	45	
D.	Silence Zone	50	40	

Note: 1. Day time 6 A.M. and 9 P.M.

- 2. Night time is 9 P.M. and 6 A.M.
- 3. Silence zone is defined as areas upto 100 meters around such premises as hospitals, educational institutions and courts. The silence zones are to be declared by competent authority. Use of vehicular horns, loudspeakers and bursting of crackers shall be banned in these zones.
- 4. Environment (Protection) Third Amendment Rules, 2000 Gazette notification, Government of India, date 14.2.2000.

ANNEXURE III

GOVERNMENT OF INDIA Ministry of Environment and Forests (Regional Office, Southern Zone) Bangalore-34

MONITORING REPORT

1	Name of the project	Const. of two multipurpose cargo berths (5-A & 6- A) in Mormugao Port on BOOT basis by M/s. South West Port Ltd (formerly ABG Goa Port Ltd)
2	Clearance letter No.& date	PD-26018/2/2000-PDZ (CRZ) dt.24.1.2001
3	Location: District & State / UT	Mormugoa port, Goa
4	Address for correspondence:	Mr Anthony Fernandes, Unit In-Charge South West Port Limited. 1st Floor, Port Users Complex Mormugao Harbour, Goa-403 803 Phone: 0832- 2523000/002 Fax: 0832-2523006
5	Date of site visit for this report	01.06.2017
6	Date of previous visit(s) if any	23.01.2007 & 03.07.2008

7 Present status of the project

F. No. EP/12.1/49/GOA

The site visit was made to this port project along with Shri Anthony Fernandes, Unit In-Charge, Shri Patra and Jadhav, Manager (EHS) of South West Port Limited (SWPL) (formerly ABG Goa Port Ltd.).

Environmental Clearance: Environmental clearance for the development of berths Nos 5A & 6A were granted by the Ministry of Shipping (Port Wing) in the year 2001 (when it was with delegated power to grant EC). It was operational under Mormugao Port Trust subsequently taken over by South West Port Ltd (SWPL) on BOOT basis in 2004 and the commercial operations are started since February 2005.

Coal Handling: SWPL has developed fully mechanized cargo handling system along with state of the art dust suppression system, for handling the imported coking coal which included unloading of coal into hoppers, closed conveyors for coal transport, water sprinklers for dust suppression, cover for coal storage, auto loading in to the wagons etc. The house keeping is good. The compliance to different conditions of the environmental clearance is satisfactory.

Continuous Air Quality Monitoring: A continuous air quality monitoring station as per guidelines of Goa State Pollution Control Board has been installed and the data are sent to SPCB through MPT.

Environment Cell: PA informed that MPT has set a separate Environmental Cell with person qualified in the filed of Environment. An Environmental person from SWPL is also part of the Cell.

The detailed point wise compliance status is given in this report. The Compliance is Satisfactory.

epiptioned Fig 11/re 7 15/06/17

(E.Thirunavukkarasu) Scientist 'D'

PART-II - Compliance Status in brief

Status of compliance to the Environmental clearance issued by the Ministry of Shipping (Ports Wing) for the Construction of two multipurpose cargo berths (5-A & 6-A) in Mormugao Port on BOOT basis by M/s. ABG Goa Port Ltd, issued vide Ref: No. PD-26018/2/2000-PDZ (CRZ) dt.24.1.2001

<u>No</u>	SPECIFIC CONDITIONS	<u>COMPLIANCE</u>
1	All constructions as per approval	Complied
2	Adequate infrastructure to labourers	Complied
3	Dredging operations with out adverse impact	Complied
4	Disposal site not to interfere with natural drainage	Complied
5	Adequate fire fighting system in place	Complied
. 6	Staff to be trained in crisis management	Complied
7	Development of green belt	Complied
8	Liquid waste management	Complied
9	Adequate noise control measures	Complied
10	Quality of treated effluents to confirm standards	Complied
11	Environment cell to be set up	Complied
12	Necessary leakage detection system be provided	No Liquid handled
13	Standby DG sets for fire fighting system	Complied
14	Third party inspection during construction	Complied
15	Full support to RO scientists for inspection	Complied
16	Adequate funds for safeguards	Complied
17	Implement the environment management plan	Complied



Part -III - Detailed Compliance status of specific conditions

All constructions & drawings must have the approval of the competent authority.

Construction activities have been completed and operational. PA produced the approval of Port authorities and consent order of SPCB.

ii Adequate infrastructure facilities to the workers during construction.

PA informed that adequate infrastructure facilities were provided to the workers during the construction.

iii Dredging operations to be restricted to the minimum without affecting water quality & marine environment.

PA informed that only maintenance dredging in Port is being done by Mormugao Port Trust as and when required and the dredged materials is disposed at the identified dump site.

iv Disposal sites for excavated material to be done in such a way it do not interfere with natural drainage.

The dredge material was disposed a the designated dump site in consultation with NIO Goa.

v Adequate fire fighting system should be in place.

i

Fire fighting equipment including fire extinguishers have been installed at strategic locations and PA informed that they are getting support firefighting system from MPT fire Station and Goa Fire Brigade.

vi The staff posted in the sensitive zone to be properly trained in the implementation of Crisis management Plan prepared by the authorities.

The project authorities have informed that their staffs are periodically trained for safety precautions and crisis management. As per crisis management plans mock drills are conducted periodically. In the year 20016, mock drills were conducted on 16.02.2016 and 21.08.2016.

vii Development of green buffer with necessary species of plants.

PA has developed green belt within the available space and also informed that green belt developed in Dabolim airport road, Vasco road, and Vasco city.



viii Provision for collection, treatment and disposal of liquid waste from the ships.

PA informed that the collection, treatment and disposal of liquid waste from the ships is being done by Mormugao Port Trust. As per the information provided, the Mormugao Port Trust is having necessary facilities for the collection, treatment and disposal of liquid wastes from ships. These terminals handle only solid cargo. One settling tank is provided in the coal handling area to take care of the surface runoffs. PA has plan to provide covered shed for coal storage in near feature.

ix Adequate noise control measures to be in place

It was noted that personal noise control equipment like ear muffs are provided to the staff. PA informed that Mufflers, exhaust manifolds of Port equipment are regularly serviced. Noise level surveys are also conducted through competent agencies and readings revealed that the levels are within the limits.

x Quality of the treated effluents to confirm standards.

The project authorities are handling only coal and as such no effluents are generated.

xi An environmental cell to be set up with lab facilities for monitoring.

PA informed that MPT has set a separate Environmental Cell with person qualified in the filed of Environment. An Environmental person from SWPL is also part of the Cell.

PA has installed a continuous air monitoring station as per guidelines of Goa State Pollution Control Board and the data are sent to SPCB through MPT.

xii Necessary leakage detection devices with early warning system to be provided.

The project authorities have informed that this condition is not applicable as they are not handling any hazardous chemicals or fluids.

xiii Standby DG sets must be provided to ensure uninterrupted power supply to pump house and fire fighting systems.

Standby DG sets are in place

xiv Third party inspection during construction & operational phase with adequate insurance cover.

PA informed that Port assets are covered under General Insurance Port Package Policy



xv Full support to RO scientists for inspection.

Necessary assistance for monitoring was provided.

xvi Adequate fund provision for environmental safeguards

The project authorities allocated necessary funds to implement the environmental safeguards.

xvii Project authorities to follow mitigative measures as per the plans prepared and submitted

The project authorities have provided mitigative measures such as closed conveyors for coal transport, water sprinklers for dust suppression, cover for coal storage, auto loading in to the wagons etc.

(E.Thirunavukkarasu) Scientist 'D'

ching ering

F.No.10-5/2015-IA.III

Government of India Ministry of Environment, Forest & Climate Change (IA.III Section)

> Indira Paryavaran Bhawan, Jor Bagh Road, New Delhi - 110 003.

> > Dated: 19th June, 2015

To

The Vice President - Projects,

M/s South West Port Ltd., JSW Centre, Bandra Kurla Complex, Bandra (E), Mumbai – 400 051

Subject: Proposed Terminal Capacity Enhancement at Berth 5A-6A of Mormugao Port for Handling Coal And Coal Products, Iron Ore And Limestone including Unitised and Steel Products at Mormugao Port Trust, Mormugao, Goa by M/s South West Port Ltd. –Terms of Reference (ToR) - Reg.

Sir,

This has reference to your letter No. Nil dated 09.02.2015 forwarding along with application seeking for Terms of Reference for the aforesaid project.

2. The proposal was considered by the Expert Appraisal Committee (EAC) in its 148^{th} meeting held on $19^{\text{th}} - 21^{\text{st}}$ May, 2015 and the proponent has informed that:

- i. Proposal M/s. SWPL operates berth 5A and 6A at the Mormugoa Port Trust (MPT), Goa. It is proposed to enhance the Terminal capacity of Berth 5A and 6A of Mormugao Port for handling Coal, Coal Products, Iron Ore, Limestone including Unitised and Steel Products. Consequentially the total cargo to be handled is expected to go up to 12 to 13 MTPA of bulk (consisting of coal, iron ore, lime stone, dolomite, bauxite, mineral ores and other miscellaneous cargo), and about 2 MTPA of unitised cargo (consisting of steel bars, coils, flats and plates, and other steel products). The total cargo handling capacity hence is expected to increase to about 14 to 15 MTPA. The capacity enhancement shall be achieved by deploying highly mechanised and efficient handling systems like, Grab Ship Unloader (GSU) in place of Mobile Harbour Cranes, Stacker cum Reclaimer (ScR), Pipe conveyor, in-motion wagon loading system, Silos, Wagon Loader and Gantry cranes. Other components of the proposed project include open and covered storage area, steel sheds, wind shields, store buildings, canteen, DG sets, pavement and internal roads green belt, etc. The proposed modernisation will primarily involve:
 - a. Cargo Handling System: Two Grab Ship Un-loaders Two (4000 TPH) and one Mobile Harbour Crane one (800 TPH) as standby system for steel loading at 5A along with Ship's gear with a total capacity of 4,000 TPH.

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- b. Cargo Handling System- Bulk Break: Six Gantry cranes at Rail siding, and Jetty handling will involve Five forklifts
- c. Increase in Conveyor Belt Speed up to 4.6 m/s
- d. Increase in capacity of ScR i.e. Stacking up to 3000TPH and Reclaiming up to 2200 TPH.
- ii. **Location:** The facilities are located at Latitude 15°25' North and Longitude 73°47' East between the Major Ports of New Mangalore and Mumbai. It is inside a naturally protected harbour in the confluence Zone of Zuari River with the Arabian Sea. The site is connected by road and railway. The nearest railway station is Vasco which is about 4 km on the southern railways, and Madgaon is about 35 km on the Konkan railways. The nearest airport is Dabolim at about 8 km. The nearest town is Vasco da Gama (District Headquarters, South Goa Dist.) at about distance of 5 km.
- iii. **Justification:** These berths have mobile harbour cranes and conventional wagon loading system. The Ships calling at these berths are generally up to Panamax (80,000 90,000 DWT) in size and throughput of about 7.5 MTPA is being achieved presently. The implementation of proposed Project will lead to increase in Port efficiency, better utilization of existing resources and net reduction in pollution levels due to retrofitting of material handling system with latest dust entrainment systems and barriers.
- iv. No increase in backup area is proposed.
- v. No increase in present berth length/waterfront of 450 meter is proposed.
- vi. There shall be no dredging/reclamation for implementing the proposed project.
- vii. There will be no increase in rows of rail corridor and the project will not handle any hazardous cargo.
- viii. No new construction or intervention is proposed in the MPT as part of the proposed project.
 - ix. No potential fishing activity is carried out in the vicinity, due to traffic of cargo vessels, passenger vessels and Indian Navy flotilla.
 - x. The berths are erosion protected with under deck pitching, so no shoreline change corresponding to the waterfront of the project is likely.
 - xi. Water requirement is expected to be 350 KLD which would be met from Goa PWD and treated water from MPT – STP Plant.

3. The EAC enquired about the status of the Public Hearing. It was informed that Environmental Clearance for the project was granted in 2001. The Public Hearing was not conducted at that time. EAC was of the view that the Project Proponent (PP) should conduct Public Hearing either independently or by joining the MPT for public hearing proposed for the expansion of the Port. The EAC also suggested that PP should explore the possibility to have covered storage shed with geodesic or parabolic dome which are wind and live load efficient.

4. The EAC in its 148th meeting held on 19th – 21st May, 2015 recommended the project for the TOR with the following specific TOR with general conditions for preparation of the Environment Impact Assessment (EIA) Report and Environment Management Plan (EMP) in respect of the **Proposed Terminal Capacity Enhancement at Berth 5A-6A of Mormugao Port for Handling Coal And Coal Products, Iron Ore And Limestone**



including Unitised and Steel Products at Mormugao Port Trust, Mormugao, Goa by M/s South West Port Ltd.:

- (i) Submit the details of the consent validity and compliance of the conditions.
- (ii) Details of liquid waste and solid waste likely to be generated during construction and operation stages of the project and the arrangements for their management.
- (iii) Submit study on quantum of leachate generation and possibility its utilisation since it would be full of micro nutrients.
- (iv) Details of handling of each cargo, storage, transport along with spillage control, dust preventive measures. In case of coal, mineral cargo, details of storage and closed conveyance, dust suppression and prevention filters. Submit study on possibility of covered storage shed with geodesic or parabolic dome which are wind and live load efficient.
- (v) Submit a copy of layout superimposed on the HTL/LTL map demarcated by an authorized agency on 1:4000 scale along with the recommendation of the concerned State Coastal Zone Management Authority.
- (vi) Submit the status of shore line change at the project site.
- (vii) Details of the layout plan including details of channel, breakwaters, dredging and disposal.
- (viii) Submit the details of fishing activity and likely impacts on the fishing activity due to the project.
- (ix) Examine the details of water requirement, impact on competitive user, treatment details, use of treated waste water. Prepare a water balance chart.
- (x) The air quality monitoring should be carried out according to the notification issued on 16th November, 2009.
- (xi) Details of litigation pending against the project, if any, with direction /order passed by any Court of Law against the Project should be given.
- (xii) Examine road/rail connectivity to the project site and impact on the existing traffic network due to the proposed project/activities. A detailed traffic and transportation study should be made for existing and projected cargo traffic.

<u>General Guidelines</u>

(i) The EIA document shall be printed on both sides, as for as possible.

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ToR_South West Port

- (ii) All documents should be properly indexed, page numbered.
- (iii) Period/date of data collection should be clearly indicated.
- (iv) Authenticated English translation of all material provided in Regional languages.
- (v) The letter/application for EC should quote the MoEF&CC File No. and also attach a copy of the letter prescribing the TOR.
- (vi) The copy of the letter received from the Ministry on the TOR prescribed for the project should be attached as an annexure to the final EIA-EMP Report.
- (vii) The final EIA-EMP report submitted to the Ministry must incorporate the issues in TOR and that raised in Public Hearing. The index of the final EIA-EMP report, must indicate the specific chapter and page no. of the EIA-EMP Report where the specific TOR prescribed by Ministry and the issue raised in the P.H. have been incorporated. Questionnaire related to the project (posted on MoEF&CC website) with all sections duly filled in shall also be submitted at the time of applying for EC.
- (viii) Grant of TOR does not mean grant of EC.
- (ix) Grant of TOR/EC to the present project does not mean grant of approvals in other regulations such as the Forest (Conservation) Act 1980 or the Wildlife (Protection) Act, 1972.
- (x) Grant of EC is also subject to Circulars issued under the EIA Notification 2006, which are available on the MoEF&CC website: www.envfor.nic.in.
- (xi) The status of accreditation of the EIA consultant with NABET/QCI shall be specifically mentioned. The consultant shall certify that his accreditation is for the sector for which this EIA is prepared.
- (xii) On the front page of EIA/EMP reports, the name of the consultant/consultancy firm along with their complete details including their accreditation, if any shall be indicated. The consultant while submitting the EIA/EMP report shall give an undertaking to the effect that the prescribed TORs (TOR proposed by the project proponent and additional TOR given by the MoEF) have been complied with and the data submitted is factually correct (Refer MoEF office memorandum dated 4th August, 2009).
- (xiii) While submitting the EIA/EMP reports, the name of the experts associated with/involved in the preparation of these reports and the laboratories through which the samples have been got analysed should be stated in the report. It shall clearly be indicated whether these laboratories are approved under the Environment (Protection) Act, 1986 and the rules made there under (Please refer MoEF office memorandum dated 4th August, 2009). The project leader of the EIA study shall also be mentioned.

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(xiv) All the TOR points as presented before the Expert Appraisal Committee (EAC) shall be covered.

5. A detailed draft EIA/EMP report should be prepared in terms of the above additional ToRs and should be submitted to the State Pollution Control Board for conduct of Public Hearing. Public Hearing to be conducted for the project in accordance with the provisions of Environmental Impact Assessment Notification, 2006 and the issues raised by the public should be addressed in the Environmental Management Plan. The Public Hearing should be conducted based on the ToR letter issued by the Ministry and not on the basis of Minutes of the Meeting available on the web-site.

6. You are required to submit the detailed final EIA/EMP prepared as per ToRs including issues raised during Public Hearing to the Ministry for considering the proposal for environmental clearance within 3 years as per the MoEF&CC O.M. No.J-11013/41/2006-IA-II(I) (P) dated 08.10.2014.

7. The consultants involved in the preparation of EIA/EMP report after accreditation with Quality Council of India/National Accreditation Board of Education and Training (QCI/NABET) would need to include a certificate in this regard in the EIA/EMP reports prepared by them and data provided by other Organization(s)/Laboratories including their status of approvals etc. vide notification of the MoEF dated 19.07.2013.

8. The prescribed ToRs would be valid for a period of three years for submission of the EIA/EMP Reports.

(Dr. Ranjini Warrier)

(Dr. kanjini warrier) Director

Copy to:

The Member Secretary, Goa State Pollution Control Board, Dempo Towers, EDC Plaza, Patta, Panaji - 403 001, Goa.



GOA COASTAL ZONE MANAGEMENT AUTHORITY

C/o Department of Science, Technology & Environment, (Govt. of Goa) 1st Floor, Pandit Deendayal Upadhyay Bhavan, Pundalik Nagar,Porvorim-Goa. Email: dir-ste.goa@ nic.in, goacoastal zone @ gmail.com.

Ref. No. GCZMA/S/17-18/19/899

Dated: 18 /08/2017

ANNEXURE VI

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To, Ms. South West Port Ltd., 1st Floor, Port Users Complex, Mormugao Harbour, Mormugao,Goa.

Sub: NOC/Permission for proposed Terminal Capacity Enhancement at Berth 5A and 6A of Mormugao Port.
 Raf: Your application No. NUL deted 01/02/2017

Ref: Your application No. NIL dated 01/02/2017.

Sir,

With reference to your application on the above mentioned subject, it is hereby conveyed that the Goa Coastal Zone Management Authority (GCZMA) has examined your aforementioned proposal in the 153rd GCZMA Meeting held on 18/07/2017 in accordance to the provisions of the para 8 of the CRZ Notification 2011, as amended. As such the Authority after detailed discussion and due deliberation decided to approve the said proposal for proposed Terminal Capacity Enhancement at Berth 5A and 6A of Mormugao Port, subject to condition that operation and handling should be done in closed shed and further no enhancement in the capacity of the plant will be carried out unless prior Consent/Permission from the Goa State Pollution Control Board (GSPCB) is obtained.

This permission is further subject to compliance of the following conditions:

- 1. All the provisions of the CRZ Notification, 2011 as amended should be strictly complied with. In the event of a change in project profile or change in the implementation agency, a fresh reference shall be made to the GCZMA.
- 2. This NOC/Approval is issued without prejudice to any other permission as required under the law including that of ownership, court case etc. As such, prior to the commencement of the aforementioned 'Construction/development/facility' work, it will be incumbent upon the Applicant/Proponent to obtain permission for any other authority as required under the law including from the local authority, Town and Country Planning Department, Pollution Control Board, Revenue Authority etc.,
- 3. Traditional access/easement shall not be blocked.
- 4. The applicant/occupier should ensure that no waste is discharged into the nearest water body from the proposed construction activities.
- 5. This permission/NOC shall be valid for the period of 5 years from the date of issue.

6. This permission is liable to be revoked, if it is found, at any stage, that the application contained false information / wrong plans / calculations / documents / misleading or false information, etc. or account of violation of aforementioned conditions.

Merentar Yours faithfully, (Parag M. Nagarcenkar) Member Secretary (GCZMA)

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Encl: As above

Copy to:

- 1. P.A to Secretary (Environment) / Chairman (GCZMA), Secretariat, Porvorim.....for kind information.
- 2. The Chief Town Planner, Town & Country Planning Department, Patto, Panaji Goa..... for information and necessary action.
- 3. The Member Secretary, Goa State Pollution Control Board, Patto, Panaji-Goa for information and necessary action.
- 4. The Deputy Collector & S.D.O. (Mormugao), Vasco-da-Gama, Goa.... for information and necessary action.
- 5. The Chief Officer, Mormugao Municipal Council, Vasco-da-Gama Goa....for information and necessary action.





ANNEXURE – VII

Terms of Reference (ToR) compliances in the EIA study

S. No.	Additional ToR	Compliance in the EIA
		study report
01	Submit the details of the consent validity	Annexure III
	and compliance of the EC conditions.	
02	Details of liquid waste and solid waste	Para 4.3.1; Chapter-4
	likely to be generated during construction	Para 5.2.1; Chapter-5
	and operation stages of the project and the	Para 5.3.2: Chapter-5
	arrangements for their management.	
03	Submit study on quantum of leachate	Para 4.3.1: Chapter-4
	generation and possibility its utilization	Para 5.3.2: Chapter-5
	since it would be full of micro nutrients.	
04	Details of handling of each cargo, storage,	Para 2.7; Chapter-2
	transport along with spillage control, dust	Para 5.3.1: Chapter-5
	preventive measures.	
05	Submit a copy of layout superimposed on	Annexed
	the HTL/LTL map demarcated by an	Prepared through IRS,
	authorized agency.	Anna University, Chennai
06	Submit the status of shoreline change at	Para 3.14; Chapter-3
	the project site	
07	Details of layout plan including details of	The project does not
	channel, breakwaters, dredging, and	involve with dredging.
	disposal.	
08	Submit the details of fishing activity and	Para 3.19; Chapter-3
	likely impacts on the fishing activity due to	Para 4.3.2; Chapter-4
	the project.	Para 4.4; Chapter-4
09	Details of water requirement, impact on	Para 4.3.1; Chapter-4
	competitive users, treatment details, use of	Para 5.3.2: Chapter-5
	treated waste water. Prepare a water	





S. No.	Additional ToR	Compliance in the EIA
		study report
	balance chart.	
10	The air quality monitoring should be carried	Para 3.15: Chapter-3
	out according to the notification issued on	
	16 th November, 2009.	
11	Details of litigation pending against the	No
	project, if any.	
12	Examine road/rail connectivity to the	Para 1.4: Chapter-1
	project site and impact on the existing	
	traffic network due to the proposed project.	

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Quality Council of India

National Accreditation Board for Education & Training



WAPCOS Limited (A Government of India Undertaking)

Plot-76-C, Sector-18, Gurgaon – 122015, Haryana

are accredited under the QCI-NABET Accreditation Scheme for EIA Consultant Organizations (Version 3) for preparing EIA/EMP reports in the following sectors:

SI.No.	Contox Departmention	Sector (as per)		Cat.
	Sector Description		MoEFCC	
1	Mining of minerals (Open cast only)	1	1 (a) (i)	Α
2	River valley projects	3	1 (c)	A
3	Thermal power plants	4	1 (d)	Α
4	Ports, harbours, break waters and dredging	33	7 (e)	A

Note: Name of approved EIA Coordinators and Functional Area Experts are mentioned in SA AC minutes dated February 17, 2017 posted on QCI-NABET website.

The Accreditation shall remain in force subject to continued compliance to the terms and conditions mentioned in NABET's letter of accreditation bearing no. QCI/NABET/ENV/ACO/17/0300 dated 28 March 2017. The accreditation needs to be renewed before the expiry date by WAPCOS Limited, following due process of assessment.

CEO NABET

Certificate No. NABET/EIA/1518/ SA 022 Issue Date Mar. 28, 2017 Expiry Date 01.06.2018

For the updated List of Accredited Consultants please refer QCI-NABET website.

NABET is a member of International Accreditation Forum (IAF) and Pacific Accreditation Cooperation (PAC).

DEMARCATION OF HIGH TIDE LINE, LOW TIDE LINE AND COASTAL REGULATION ZONE FOR PROPOSED EXPANSION AT BERTH 5A AND 6A IN MORMUGAO PORT

FOR

SOUTH WEST PORT LTD., GOA





INSTITUTE OF REMOTE SENSING ANNA UNIVERSITY, CHENNAI-25

SEPTEMBER 2016

DEMARCATION OF HIGH TIDE LINE, LOW TIDE LINE AND COASTAL REGULATION ZONE FOR PROPOSED EXPANSION AT BERTH 5A AND 6A IN MORMUGAO PORT

ABSTRACT

On the request of M/S South West Port Ltd., Goa, a survey was carried out to demarcate the High Tide Line (HTL), Low Tide Line (LTL) for proposed expansion at Berth 5A and 6A in Mormugao Port, Goa. The satellite imagery of the study area were interpreted for geomorphic features in the vicinity of the survey site. The cadastral/village map was used as the Base Map. Based on topography and geomorphic features, HTL for the project site has been identified and traced in the field by Kinematic GPS survey. The HTL were superimposed on to georeferenced cadastral map to prepare a local level CRZ map at 1:4,000. The project boundary details provided by the client was superimposed on to CRZ map and enclosed.



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DEMARCATION OF HIGH TIDE LINE, LOW TIDE LINE AND COASTAL REGULATION ZONE FOR PROPOSED EXPANSION AT BERTH 5A AND 6A IN MORMUGAO PORT

1. INTRODUCTION

The coastal zone is the area of interaction between land and sea. The coastal Zone of Goa, has a very high concentration of population along with ecologically sensitive areas like mangroves. There is a spurt of developmental activities arising from huge residential colonies, new industries and tourism centres along the coast and in coastal zone. There is a need to protect the coastal environment while ensuring continuing production and development. This zone is extremely vulnerable and has to be managed judiciously striking a balance between ecological and developmental needs.

Government of India has issued a notification during February 1991 for regulating the developments along the coastal stretches of seas, bays, estuaries, creeks, rivers and backwaters which are influenced by tidal action. The land between 500 meters from the High Tide Line (HTL) and the Low Tide Line (LTL) is identified as Coastal Regulation Zone (CRZ). The coastal stretches within CRZ are classified into four categories, namely, Category I (CRZ-I), Category II (CRZ-II), Category III (CRZ-III) and Category IV (CRZ-IV). The notification has also laid down regulations to regulate the various activities in the coastal zone. The Ministry of Environment and Forests, Government of India, has approved a set of CRZ maps on 1:25,000 scale prepared from SPOT satellite imagery. On these maps, zones are demarcated as CRZ I, CRZ II and CRZ III, by the State CZMA.

Coastal Regulation Zone I includes the zone between High Tide Line and Low Tide Line. It also includes the areas that are ecologically sensitive

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and important, such as national parks/marine parks, sanctuaries, reserve forests, wildlife habitats, mangroves, corals/coral reefs, areas close to breeding and spawning grounds of fish and other marine life, areas of outstanding natural beauty/historically/heritage areas, areas rich in genetic diversity, areas likely to be inundated due to rise in sea level consequent upon global warming and such other areas as may be declared by the Central Government or the concerned authorities at the State/Union Territory level from time to time.

CRZ-II covers the areas that have already been developed up to or close to the shoreline. For this purpose, the "developed area" is referred to as that area within the municipal limits or in other legally designated urban areas which are already substantially built up and have been provided with drainage and approach roads and other infrastructural facilities, such as water supply and sewerage mains. CRZ-III covers the areas that are relatively undisturbed and those which do not belong to either Category-I or II. These include the coastal zone in the rural areas (developed and undeveloped) and also areas within municipal limits or in other legally designated urban areas which are not substantially built up. CRZ-IV refers to the coastal stretches in the Andaman and Nicobar, Lakshadweep and small islands other than those designated as CRZ-I, CRZ-II or CRZ-III.

The Ministry of Environment and Forest in the CRZ Notification, 2011 declared the following areas as CRZ and imposed with effect from the date of the notification the restrictions on the setting up and expansion of industries, operations or processes and the like in the CRZ. The areas that are defined as CRZ as per CRZ Notification, 2011 are

(i) The land area from High Tide Line (HTL) to 500mts on the landward side along the sea front.

(ii) CRZ shall apply to the land area between HTL to 100 meters or width of the creek whichever is less on the landward side along the tidal influenced water bodies that are connected to the sea and the distance upto which development along such tidal influenced water bodies is to be regulated shall be governed by the distance upto which the tidal effects are experienced which shall be determined based on salinity concentration of 5 parts per thousand (ppt) measured during the driest period of the year and distance upto which tidal effects are experienced shall be clearly identified and demarcated accordingly in the Coastal Zone Management Plans.

(iii) The land area falling between the hazard line and 500mts from HTL on the landward side, in case of seafront and between the hazard line and 100mts line in case of tidal influenced water body the word 'hazard line' denotes the line demarcated by Ministry of Environment and through the Survey of India taking into account tides, waves, sea level rise and shoreline changes.

(iv) Land area between HTL and Low Tide Line (LTL) which will be termed as the intertidal zone.

(v) The water and the bed area between the LTL to the territorial water limit (12 Nm) in case of sea and the water and the bed area between LTL at the bank to the LTL on the opposite side of the bank, of tidal influenced water bodies.

The Classification of the CRZ is also modified for the purpose of conserving and protecting the coastal areas and marine waters as CRZ - I, CRZ - II, CRZ - III and CRZ - IV. The CRZ - I include the areas that are ecologically sensitive and the geomorphological features which play a role in the maintaining the integrity of the coast like (a) Mangroves(b) Corals and coral reefs and associated biodiversity (c) Sand Dunes (d) Mudflats which are

biologically active (e) National parks, marine parks, sanctuaries, reserve forests, wildlife habitats and other protected areas (f) Salt Marshes (g) Turtle nesting grounds (h) Horse shoe crabs habitats (i) Sea grass beds (j) Nesting grounds of birds (k) Areas or structures of archaeological importance and heritage sites and the area between Low Tide Line and High Tide Line. The CRZ-II includes areas that have been developed upto or close to the shoreline. The CRZ-III includes areas that are relatively undisturbed and those do not belong to either CRZ-I or II, which include coastal zone in the rural areas (developed and undeveloped) and also areas within municipal limits or in other legally designated urban areas, which are not substantially built up. The CRZ-IV includes the water area from the Low Tide Line to twelve nautical miles on the seaward side and the water area of the tidal influenced water body from the mouth of the water body at the sea upto the influence of tide which is measured as five parts per thousand during the driest season of the year.

The Ministry of Environment and Forest has also provided guidelines for demarcation of High Tide Line in the CRZ Notification, 2011. As per the guidelines, Cadastral (village) maps in 1:3960 or the nearest scale shall be used as the base maps. HTL and LTL will be demarcated in the cadastral map based on detailed physical verification using coastal geomorphological signatures or features in accordance with the CZM Maps approved by the Central Government. 500metre and 200metre lines shall be demarcated with respect to the HTL.

In order to facilitate classification of Coastal Regulation Zones Government of India has approved few agencies/institutions across the Country vide Lr. No. J17011/8/92-1A III, dated 10.05.1999 of Ministry of Environment and Forests. Institute of Remote Sensing, Anna University being one of them, has been carrying out HTL and LTL mapping following the guidelines issued by Ministry of Environment &Forests, Government of India.

2. BACKGROUND OF THE STUDY

M/S South West Port Ltd., Goa, has requested Institute of Remote Sensing, Anna University to demarcate HTL,LTL and prepare CRZ map at 1:4,000 scale for the proposed expansion at Berth 5A and 6A in Mormugao Port, Goa. The study was carried out to demarcate the HTL and setback line for HTL in the vicinity of the project site.

3. STUDY AREA AND EXTENT

The aforesaid site is located, in waterfront of Mormugao Port.

4. NEED FOR THE STUDY

The objective of the present study is to examine the waterfront of Morugao Port and its related project activities in port, with reference to Coastal Regulation Zone Notification, 2011. Keeping in view of the requirements of notification, Institute of Remote Sensing, Anna University under took the project with following agreed scope of work:

- Demarcation of HTL,LTL near project site by conducting field survey using DGPS survey.
- Demarcation of ecologically sensitive entities such as Mangroves, Sand dunes, Turtle breeding grounds if any in the vicinity of project site etc.
- Superimposition of Project Boundary, HTL,LTL and ecologically sensitive areas if any on cadastral map at 1:4,000 scale.

5. DEMARCATION OF HTL ON THE LOCAL LEVEL MAP

5.1 Methodology adopted

The Village/Cadastral Map was used as the base map. The Geomorphology of the Coastal Zone has been studied from the temporal medium resolution satellite data. In order to prepare the local level map on 1:4,000 scale, the site has been inspected by IRS Scientists. Based on the geomorphic units, the high tide line has been identified in the field and traced by field survey. The tide level observations were collected from the Tide Tables . The highest high tide level and lowest low tide level for the past 19 years was determined from these tide tables.

As per the definition of high tide line, "The High Tide Line means the line on the land up to which the highest water line reaches during the spring tide". On the other hand LTL is defined as the seaward limit to which the waves recede during low tide.

In case of inland waters such as creeks and backwaters, the CRZ guidelines indicates that the development along rivers, creeks, creek lets and backwaters has to be regulated up to a distance where the tidal effects are experienced which has to be determined based on salinity concentration of 5 parts per thousand (ppt). Insitu observations of the salinity were used to delineate the HTL for creeklet, channels and backwaters.

6. GPS SURVEYING

The Trimble 5700 and 4000 SSE (Geodetic Surveyor Series) GPS receivers were used to conduct the surveying at the project site. The survey involves three components namely, 1. Establishing Base Station, 2. Control Survey for Village Maps and 3. Real Time Kinematic Survey for HTL Demarcation.

6.1 Establishing Base Station

The survey involves establishing one base station for Static Survey. The base stations were identified on stable locations with clear view of sky for uninterrupted access to GPS satellite signals. The control point with known elevation was used as initial reference station. The base station for the project site was established on firm ground and observed with static GPS survey from the known coordinates of the control point. The observations times were fixed based on the length of base lines to obtain highest possible accuracies.

6.2 Static Survey

The conduct of Static Survey using GPS requires two GPS receivers, one to be setup over the control point (with known co-ordinate) and another one over a reference station whose coordinates and distance from the control point are to be determined. Both these receivers must record data simultaneously. These known co-ordinates of the control point were fed and fixed for processing of the logged data to accurately determine the co-ordinates of the base stations.

6.3 Control Survey for Georeferencing Village Maps

The cadastral map pertaining to the project site was provided by the client. The hard copy cadastral map was scanned and georeferenced with the help of GPS coordinates of boundary points provided by the client and used for the preparation of local level HTL Maps.

6.4 Real Kinematic Survey for HTL Demarcation

Kinematic Surveying enables a very rapid survey of a number of base lines in areas where there is good satellite visibility. At least, two GPS receivers are required to perform a kinematic survey. One receiver is designated as the reference receiver and is set up over the Base Station. All baselines are measured relative to this station. The other receivers, called rovers, are moved in succession to trace and record the HTL on ground through ground profiling.

7. DEMARCATION OF HTL

Surrogate data such as Coastal Geomorphologic features identified from the satellite imagery, indicators available on the ground and Tidal data obtained from Survey of India were used to verify the HTL demarcated by Kinematic Survey.

8. OUTPUT

The observed baselines were processed using TGO software. The same were plotted at large scale using the ArcGIS 9.3 software and the same was superimposed in the georeferenced village/cadastral map. In the map of 1:4,000 scale, the HTL and setback lines from HTL, are marked as per CRZ Notification 2011 and Two Copies of Map are enclosed with this report.

9. CONCLUSION

The HTL demarcated by the IRS, Chennai, is shown in the Map and Two copies of the HTL/LTL Map with CRZ zonation at 1: 4000 Scale is enclosed

DIRECTOR, IRS

Director Institute of Remote Sensing Anna University, Citernai - 600 025.



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TABLE SHOWING HIL COURDINA

HTL POINTS	LATITUDE	LONGITUDE
1	15° 24' 36.648" N	73° 48' 3.600" E
2	15° 24' 40.990" N	73° 48' 0.062" E
3	15° 24' 46.872" N	73° 47' 52.368" E
4	15° 24' 55.080" N	73° 47' 40.668" E
5	15° 24' 51.804" N	73° 47' 33.324" E
6	15° 24' 51.768" N	73° 47' 25.512" E
7	15° 24' 57.659" N	73° 47' 27.547" E
8	15° 25' 7.572" N	73° 47' 30.876" E
9	15° 25' 0.069" N	73° 47' 27.394" E
10	15° 24' 51.876" N	73° 47' 24.612" E
11	15° 24' 47.340" N	73° 47' 19.320" E
12	15° 24' 49.591" N	73° 47' 12.755" E
13	15° 24' 26.300" N	73° 47' 8.363" E
14	15° 24' 21.420" N	73° 47' 12.660" E

PROGRE

22/19/1-DIRECTOR, IRS

Director Institute of Remote Sensing Anna University, Chennăi - 800 025.

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GOA STATE POLLUTION CONTROL BOARD गोंय राज्य प्रदुशण नियंत्रण मंडळ

(An ISO 9001-2008 Certified Board)

Phone Nos : 91-832-2438567, 2438528 2438563, 2438550

Tel / Fax No. 1 0832-2438528



Email id's :

Member Secretary, GSPCB - ms-gspcb.goa@nic.in Environment Engineer, GSPCB - es-gspcb.goa@nic.in Scientist, GSPCB - scientist-gspcb.goa@nic.in Asst. Env Engineer, GSPCB - aee-gspcb.goa@nic.in Asst. Law Officer, GSPCB - alo-gspcb.goa@nic.in

No. 5/ 6013 /13-PCB/ 14-66

Date: 2)/09/2013

Consent to Establish under Section 26 of the Water (Prevention & Control of Pollution) Act, 1974 & under Section 21 of the Air (Prevention & Control of Pollution) Act, [To be referred as Water Act and Air Act respectively]

Consent to Establish is hereby granted to:

M/s. SOUTH WEST PORT LIMITIED (Large Scale Enterprise) (Modernization of Wagon Loading System) (Red Category)

Chalta No. 1 of P.T. Sheet No. 7, Berth No. 5A & 6A, 1st Floor, Port Users Complex, Mormugao Harbour, Mormugao Goa

Located in the area declared under the provisions of the Water Act and Air Act subject to the provisions of the Act and the Rules and the Orders that may be made further and subject to the following terms and conditions:

- 1. The Consent to Establish is valid up to Commissioning of the facility as listed in serial no. 2 for a period of three years from the date of issue.
- 2. <u>This Consent to Establish is valid for the installation as mentioned below:</u>

Sr. No	Description	Quantity	
1.	Modernization and Installation of Rapid In Motion Wagon		
) 	Loading System at Berth No). 5A & 6A	

3. CONDITIONS REQUIRED TO BE COMPLIED UNDER THE WATER ACT:

- (i) The daily quantity of industrial effluent from the facility shall not exceed <u>NIL</u>
- (ii) The daily quantity of domestic effluent from the facility shall not exceed <u>NIL</u>

Dempo Towers, 1st Floor, EDC Patto Plaza, Panaji, Goa 403 001

4. <u>CONDITIONS REQUIRED TO BE COMPLIED UNDER THE AIR ACT</u>:

(i) The unit shall take adequate measures for control of noise levels from its own sources within the premises in respect of noise. The limits are as follows

Category of Area/ Zone	Limits in dB (A) Leq		
	Day time	Night time	
Industrial Area	75	70	
Commercial Area	65	55	
Residential Area	55	45	
Silence Zone	50	40	

Day time is reckoned between 6 a.m. to 10 p.m. and night time is reckoned between 10 p.m. to 6 a.m.

5. The unit shall make adequate arrangements and adopt mechanism for controlling the dust pollution.

6. <u>GENERAL CONDITIONS</u>:

- (i) The unit should obtain all permissions / approvals as required under the prevalent Rules / Acts in force.
- (ii) The unit shall apply for Consents to Operate of the Board as required under section 25(1)
 (b & c) of the Water (Prevention and Control of Pollution) Act, 1974 and under section 21
 of the Air (Prevention and Control of Pollution) Act, 1981 in the prescribed application
 form, 45 days before commissioning of the plant
- (iii) This Consent does not entitle the party to commence activities until and unless all the other Permissions as required under the relevant statutes are obtained by the party and this Consent to Operate is confined to matters arising out of the Air Act and Water Act only.

To, M/s. South West Port Limited (Chalta No. 1 of P.T. Sheet No. 7, Berth No. 5A & 6A), 1st Floor, Port Users Complex. Mormugao Harbour, Mormugao Goa

Copy to: - I Accounts Section 2 Concerned File 3 Guard File

Received Consent fee of: The capital Investment of the unit is Rs. 45 Crores			
Challan no.	Amount	Date	
6408	Rs. 30, 200/-	12/07/2013	

MEMBER SECRETARY GOA STATE POLLUTION CONTROL BOARD